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THE IMPACT OF AIDS ON LIFE AND HEALTH INSURANCE COMPANIES: A GUIDE FOR PRACTICING ACTUARIES

SOCIETY OF ACTUARIES AIDS TASK FORCE*

PREFACE

A. *The Task Force Report*

In April 1987, the Society of Actuaries established a Task Force on AIDS with the charge to examine the impact of AIDS on the solvency of life and health insurance companies. This report has been assembled by the Task Force as a comprehensive guide to practicing actuaries in evaluating the impact of AIDS on insurance companies. Following is a brief description of the various chapters of the report:

1. "The Impact of AIDS on Life and Health Insurance Companies" is a general overview of the Task Force report.

2. "A Practical Primer: AIDS and Life and Health Insurance" provides a comprehensive background on AIDS and the AIDS epidemic; this Primer was prepared by Tillinghast.

3. "AIDS, HIV Mortality and Life Insurance" is a report prepared by Michael J. Cowell and Walter H. Hoskins. This report combines techniques of actuarial science with modern epidemiology and biostatistics to develop a model for the spread of HIV infection and the associated financial impact on insurance companies.

4. "Modeling the Impact of AIDS-Related Life Insurance Claims" provides practical guidance to the actuary in developing a company model for the impact of AIDS.

5. "Projecting Extra AIDS Mortality for Individual Ordinary Life Insurance In Force" is a research report prepared by Milliman & Robertson, Inc. and has been included for its insights in modeling the impact of AIDS on individual companies as well as providing an alternative approach to developing models.

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6. "A Model of the Impact of AIDS on Group LTD" is an example of an elementary model for group disability products constructed along the lines of the Cowell-Hoskins approach.

7. "Modeling the Impact of HIV on Group, Medical, Disability and Life Insurance Plans" provides a comprehensive stochastic model for tracing the progression from HIV infection to AIDS and finally death. Health insurance costs are assigned at each stage, and the model has been constructed so that the cost impact of various types of treatment can be included. As a simulation model, information is provided on the distribution of costs as well as expected values.

8. "AIDS in Canada" reviews the spread of the AIDS epidemic in Canada and provides information on the impact of AIDS on Canadian insurance companies.

9. "Management Strategies and the Role of the Valuation Actuary" discusses points for consideration for management in responding to the AIDS-HIV epidemic and reviews the responsibility of the U.S. valuation actuary with respect to recognizing additional claims from AIDS and HIV.

10. "What Is a Company To Do?" concludes this report with practical guidance for insurance company management in responding to the AIDS epidemic.

B. *Individual Contributions*

The work of the Task Force, including this report, is the product of many individual contributions. A number of contributions are from individuals who are not specifically members of the Task Force, but who have joined together with us to develop as comprehensive a view of the impact of this dread disease as possible. To everyone who contributed, the Task Force would like to express its sincere thanks and appreciation.

Given the goal of a comprehensive report on AIDS, the various chapters of this report represent individual assignments rather than the work of the Task Force as a whole. Accordingly, it seems appropriate to describe the contributors to each chapter as well as express appreciation for the assistance given by other colleagues.

Chapter 1 was drafted primarily by the chairperson as an expanded summary of the Task Force report. Special appreciation is expressed to Daniel F. Case, who made numerous improvements to this section and who served as liaison with the American Council of Life Insurance and as secretary of

the Task Force, and to Carl Ricciardelli for bringing alternative models to our attention.

Chapter 2, "A Practical Primer," was prepared by Tillinghast, a division of Towers Perrin, and the Task Force very much appreciates being able to include this as part of the report. The Primer was prepared mainly by Tom Reese, who participated in a number of our meetings and made many other contributions. Other Tillinghast contributors to the Primer were Bob Beal, Jay Boekhoff and John Tiller. In addition to his many contributions as a Task Force member, we especially appreciate John Tiller bringing the Primer to our attention.

Chapter 3 is the already well-known Cowell-Hoskins paper "AIDS, HIV Mortality and Life Insurance." In addition to presenting this landmark paper, both Mike Cowell and Walt Hoskins contributed greatly to the work of the Task Force. The Task Force encouraged the release of this paper as soon as possible and, accordingly, expresses appreciation to the leadership of The Individual Life & Annuity Product Development Section, The Life Insurance Company Financial Reporting Section and The Reinsurance Section of the Society for publishing this paper as a Joint Special Report.

Chapter 4 on life insurance modeling guidance and considerations was prepared by a working group headed by Harry Woodman. The other members of the group were Task Force members Phil Barackman, David Christianson and Bill Koenig.

Chapter 5 is a research report prepared by Milliman & Robertson; we appreciate M&R allowing us to include it in our report. This report was written by Richard L. Bergstrom, Gary E. Dahlman, and Richard W. Mathes, who brought this report to our attention as well as making other contributions. Dan McCarthy also helped coordinate the inclusion of this in the Task Force report as well as participated on the Task Force.

Chapter 6 was authored by Bob Beal. The disability model used in this chapter was originally developed by Arthur L. Baldwin, who graciously provided it to the Task Force. Also, the Task Force would like to express appreciation to Paul Cooney for his participation and contributions to our work and to Dave Llewellyn, who served as liaison with the Health Insurance Association of America.

Chapter 7, including the concept and development of the Monte Carlo simulation model, is the work product of Mike Zurcher. The Appendix, "Dealing with the Impact of HIV on Group Insurance Plans," was prepared by Ron Colby and Mike Zurcher and is made available courtesy of Lincoln National Corporation.

"AIDS in Canada," Chapter 8, was prepared by Donald MacTavish, who also served as our liaison with the Canadian Institute of Actuaries.

"Management Strategies and the Role of the Valuation Actuary" was authored primarily by David Holland. Many Task Force members contributed comments, but special thanks go to Paul E. Sarnoff for his participation throughout the Task Force process but especially for his contributions regarding the role of the valuation actuary, to Donald D. Cody for his contributions regarding the role of the valuation actuary, and to Robin Michaelson for his invaluable input as liaison with the AIDS Working Party of the Institute of Actuaries in Great Britain.

The concluding chapter was prepared by Barbara Lautzenheiser, who also made many other contributions to the Task Force.

The Task Force would like to express its appreciation to the many actuaries who shared models, who gave advice and counsel, and who generally helped the development of our understanding of the process. At the risk of overlooking some who helped, we would like to specifically thank Donald R. Anderson, Mark D. Biglow, John K. Booth, William Carroll, John B. Dinius, Eli N. Donkar, Stephen Goss, James Hickman, Walter N. Miller, Harry H. Panjer, Peter W. Plumley, Jerome M. Stein, G. Todd Swim, and Jon K. Wilbur. We also would like to give special thanks to Dr. Ron Brookmeyer of Johns Hopkins University for his guidance and to Patricia L. Scahill and Chester T. Lewandowski, who served as liaison to the American Academy of Actuaries Committee on Risk Classification. Also, we appreciate the cooperation of the Joint ACLI/HIAA Ad Hoc AIDS Data Group, Joseph F. Crowe, chairman.

A critical component to the success of this Task Force has been the strong support and guidance of the leadership of the Society. Gary Corbett, President of the Society, and Allan Affleck, Vice President, have been instrumental in the formation and development of the Task Force. Also, Harold Ingraham, Immediate Past President, and Stephen Radcliffe, Vice President, have been of great support to the Task Force. Finally, Mark Doherty, Director of Research for the Society, has been of invaluable assistance throughout the work of the Task Force.

C. *Expressions of Opinion*

Expressions of opinion stated in this report are those of the authors of the individual chapters and are not the opinion or the position of the Society of Actuaries, its Sections or Committees. The Society assumes no responsibility for statements made or opinions expressed in this report.

CHAPTER 1

THE IMPACT OF AIDS ON LIFE AND HEALTH INSURANCE COMPANIES

1. OVERVIEW

"By the time America paid attention to the disease, it was too late to do anything about it. The virus was already pandemic in the nation having spread to every corner of the North American continent. The tide of death that would later sweep America could, perhaps, be slowed, but it could not be stopped.

"The AIDS epidemic, of course, did not arise full grown from the biological landscape; the problems had been festering throughout the decade. The death tolls of the late 1980s are not startling new developments but an unfolding of events predicted for many years."

– Randy Shilts, *And The Band Played On*

AIDS is devastating. Weekly reports by the Centers for Disease Control of AIDS cases and fatalities are like reports of dead and wounded in a war; in fact, it will not be long before the number of U.S. AIDS deaths surpasses the number of U.S. citizens killed in Vietnam. Yet AIDS is only the end stage of infection with Human Immunodeficiency Virus (HIV) that may have occurred years earlier.

The unfolding of the AIDS epidemic will have a significant impact on life and health insurance companies. Estimates of AIDS claims for business in force as of the end of 1986 measured through the year 2000 are of the order of magnitude of $50 billion just for ordinary life and group life coverages. Future ordinary life issues alone could add another $20 billion without considering the implications of group, health and disability coverages.

The impact to date is not being borne evenly by all companies. Based on reported claims for 1986, a large number of companies had AIDS claims of less than 0.5 percent of total ordinary claims, while a similarly large number had claims in excess of 1 percent of total ordinary claims. For some companies, AIDS accounted for more than 4 percent of ordinary claims. Because of the substantial variation by company, the Task Force report has focused on providing actuaries with tools that can be used in individual situations.

Actuaries in the U.S. are asked to render an opinion in conjunction with life insurance statutory statements that the reserves and other actuarial items make good and sufficient provision for unmatured obligations. The HIV-AIDS epidemic is becoming a measurable phenomenon and current signs

are that there is very little reason for optimism in the near future regarding AIDS mortality and morbidity. As the impact of AIDS becomes more measurable, actuaries should recognize this in valuing the liabilities of an insurance company.

2. A KILLER IN OUR MIDST

As of the end of 1987, approximately 50,000 cases of AIDS had been reported to the U.S. Centers for Disease Control; of these, nearly 28,000 have died already. The expectation of life once AIDS develops is only about 2 years.

The killer in our midst is HIV, which destroys the immune system and leads to AIDS. HIV has been described by Dr. Robert C. Gallo, one of its codiscoverers, as "the most complicated and catastrophic human virus in recorded history." At the 1987 annual meeting of the American Council of Life Insurance (ACLI), there was a presentation by Dr. James O. Mason, the Director of the Centers for Disease Control. Dr. Mason indicated that based on cohorts studied for 9 years following infection with HIV, 45 percent of the infected individuals had developed AIDS. Dr. Mason said,

> "if we observe these infected individuals long enough, a figure approaching 100 percent of those infected will develop symptoms of this disease that is invariably fatal. . . ."

Although much work is being done on the development of a vaccine for HIV infection, most people feel that the earliest a vaccine will be available is the middle of the next decade. A number of physicians and AIDS researchers feel that there will not be a vaccine in our lifetime.

The treatments that currently exist, such as the drug Zidovudine (AZT), tend to suppress the progression of the disease rather than reverse the infection. The treatment must be continued indefinitely, because once treatment ceases, the infection would again progress. Also, there are toxic side effects from treatment with AZT. From an insurance point of view, such treatments do not extend life sufficiently to reduce significantly the extra mortality cost, but on the other hand may increase the cost of health care by requiring longer and more expensive treatment.

The outlook for the development of a treatment that will reverse the infection is not very promising either. As a virus, HIV comprises a core of ribonucleic acid (RNA) and enzymes surrounded by a shell or envelope of proteins. The T-cell, which is an integral part of the human immune system, provides a specific receptor that is a perfect match for the HIV. After attaching itself to the T-cell, the virus passes through the cell's membrane,

stripping its shell and introducing the RNA and enzymes into the cell. There the RNA is converted into DNA, which takes over the cell, causing more HIV to be produced. Once infected at the level of the DNA molecule, there is no known way to kill the infection without destroying the cell; once infected, an individual may be considered infected for life.

HIV can be transmitted by sexual contact with an infected individual, by contact with blood (or blood products) such as might occur with IV drug abusers sharing contaminated needles and with transfusions, and before or at childbirth from an infected mother to her newborn. Right now the major weapon in the fight against AIDS is education.

Given the long latency period from infection with HIV until the development of AIDS, a large number of cases that will develop AIDS in the next few years are already infected. Although a tremendous amount of research is going on with respect to both vaccines and treatments, there is very little reason for optimism regarding a major shift in the course of the epidemic in the next few years.

Additional information on AIDS in general is given in "A Practical Primer: AIDS and Life and Health Insurance" prepared by Tillinghast, which is Chapter 2 of this report. The situation in Canada is fortunately not as advanced as it is in the U.S.; a description of the impact of AIDS in Canada is given as Chapter 8 of this report.

3. THE IMPACT OF AIDS ON LIFE AND HEALTH INSURANCE IN GENERAL

3.1 *AIDS-Related Claims in 1986*

During 1986, life and health insurance companies in the U.S. paid over $290 million in AIDS-related claims according to estimates published by the American Council of Life Insurance (ACLI) and the Health Insurance Association of American (HIAA). (See "AIDS-Related Claims Survey—Claims Paid in 1986," prepared by William Carroll, *Actuary*, ACLI, December 31, 1987.) This survey was based on responses by 275 companies representing 46 percent of the total industry claims. The estimated AIDS-related claims paid by the industry in 1986 by line of business were estimated as follows:

Ordinary Life	$93.3
Group Life	79.4
Individual A & H	34.7
Group A & H	84.8
Total	$292.2

The survey strongly cautions that

"For a number of reasons, the survey results may significantly understate the number and amount of AIDS-related life and health insurance claims paid in 1986 by the responding companies."

In adjusting the survey responses to the level of the total industry, adjustments were not made for this understatement, which results from problems in identifying AIDS-related claims. In their joint cover letter to the survey, the Presidents of the ACLI and HIAA said:

"Since the Centers for Disease Control forecast a dramatic increase in the number of AIDS cases during the next five years, we expect industry AIDS-related claims to increase many-fold during that period."

3.2 *The Cowell-Hoskins Model*

In measuring the impact of AIDS on the insurance industry, models of the progression from HIV infection through AIDS to ultimate death were reviewed by the Task Force. The primary model used by the Task Force was the model by Michael Cowell and Walter Hoskins, as set out in "AIDS, HIV Mortality and Life Insurance" (see Chapter 3 of this Task Force report). Using what appears to be the best data available, Cowell and Hoskins constructed a model describing the progression of the epidemic and its impact on life insurance companies in general.

Cowell and Hoskins project that for business currently in force, life claims will amount to $50 billion over the remainder of this century. Assuming HIV infection decreases to zero by 1997 and assuming no AIDS claims from issues after 1986, AIDS claims on individual business currently in force will rise to around 18 percent of total claims in 1997. If HIV testing is not permitted and sales increase at a 5 percent annual rate, an additional $20 billion of individual AIDS claims is projected cumulatively by year-end 2000. These projections do not include AIDS-related claims for disability and health insurance, which would also be substantial. (Techniques for modeling the impact of AIDS on disability and health products are discussed in subsequent chapters of this report.)

Expected mortality levels are significantly increased for someone infected with HIV. To match the expectation of life for someone who is HIV+, standard mortality (based on the 1980 CSO Basic Male Nonsmoker Table) would have to be increased over 5000 percent. Most companies do not issue business where the expected mortality exceeds 500 percent of standard. The underlying patterns of mortality for someone who is HIV+ are so different

from those of someone who is standard that it is questionable whether expressing such mortality as ratios of standard is meaningful. However, it is clear that the level of mortality for someone infected with HIV is extremely high compared to standard.

Another expression of the impact of the high level of mortality to be expected for someone who is HIV+ is to look at the present value of future claims. Cowell-Hoskins determined:

"Progression to AIDS and death under the slower SFCC/CDC assumptions produces death claims that, discounted at 6 percent interest, would require a net single premium of $515 per $1,000 issued to an HIV-infected individual."

3.3 *Developing Models for Alternative Scenarios*

Although Cowell and Hoskins used CDC data and projections, as well as industry data from the ACLI/HIAA, to fit their model, other scenarios could readily be developed. For example, alternative scenarios could be constructed using the Cowell-Hoskins techniques but varying items such as:

- the size of the at-risk group
- the factors for progression from at risk to infected (for example, level of progression, no progression after specified date, etc.)
- level of progression from infection to AIDS (for example, maximum percentage progressing, etc.)
- characteristics of risk group such as number of different sexual partners per annum (high, medium, low, monogamous) combined with various factors measuring progression from at risk to infected.

Health and disability lines also can be projected by using techniques in accordance with the methods used by Cowell and Hoskins. A sample disability model based on Cowell-Hoskins is set out in Chapter 6 of this report.

Projection techniques other than the Cowell-Hoskins are certainly appropriate for actuaries to use in measuring the impact of AIDS. An alternative approach for projecting the spread of the epidemic, designed to facilitate application to the circumstances of individual companies, is included as Chapter 5; this model was provided by Milliman & Robertson, Inc. A model to measure the impact of AIDS on group medical, disability and life plans is included as Chapter 7 of this report.

3.4 *Cautions Regarding Extrapolations*

Care should be taken in the interpretation of any models that involve significant extrapolation into the future—the further the distance from the

present time, the greater the likelihood of significant deviation. The Cowell-Hoskins model presents one scenario based on a number of assumptions.

There are problems with the data currently available on AIDS and HIV infection, and these problems will affect the reliability of any estimate. The results can be much worse than projected by Cowell-Hoskins for various reasons, such as a widespread infection by HIV in the heterosexual community. Even if the spread into the heterosexual population is much slower than the spread into high-risk groups to date, the ultimate impact may be more serious because of the much larger number of people in the heterosexual population. Problems with data and points for consideration regarding the Cowell-Hoskins model are covered in Section 8 of this chapter and Appendix 1, respectively.

More optimistic mathematical projections of the spread of the epidemic are also possible. For example, a three-parameter logistic curve can be fitted via the least-squares method to actual AIDS cases reported to the CDC. Although the actual fit for 1981 through 1987 is quite good, this model produces numbers that are much lower than the Cowell-Hoskins projections; these projections also are much lower than the CDC projections, which the Task Force feels must be given significant weight.

In summary, *although the Cowell-Hoskins model has been used extensively in this report, there should be a realization that the ultimate results may diverge considerably from this model and may diverge in either direction*. Time will ultimately tell the course of this epidemic, and in the meantime, provision should be made for revision of projections as experience emerges.

4. THE IMPACT OF AIDS ON LIFE AND HEALTH INSURANCE COMPANIES

Especially at the early stages of this epidemic, the burden of AIDS is not falling uniformly on all companies. Based on information from the ACLI/HIAA report "AIDS-Related Claims Survey—Claims Paid in 1986," AIDS claims on ordinary life business amounted to 0.9 percent of total claims overall in 1986. Yet when viewed on an individual company basis, the results were quite varied. Companies representing over 40 percent of the overall claims reported had AIDS claims of less than 0.5 percent of total claims in 1986. On the other hand, companies representing over 35 percent of the overall claims reported had AIDS claims at the level of 1 percent or more of total 1986 claims. Some companies reported AIDS claims in excess of 4 percent of their total 1986 individual life claims. Wide dispersion of results also was evident for other lines of business studied too. Given this wide variation by company, the Task Force concentrated on developing tools that

can be used by actuaries to project the impact of AIDS based on various individual situations.

There are a number of factors that can account for a significant variation in the effect of AIDS by individual company.

- One of the key factors initially will be the geographic mix of business written. There have been high concentrations of AIDS cases in certain cities and states. Companies that operate in limited geographic areas may have experienced excessively high claims or extremely favorable claims depending on how their geographic market corresponds to the geographic distribution of AIDS cases. This factor can be expected to diminish as AIDS becomes more widespread. Other key factors include the distributions by age and sex of insureds.
- The impact of AIDS will probably vary significantly by line of business. For instance, the process of risk selection should lead to different results for individual life, group life, and credit life. Different results can be expected from individual and group disability lines. Other lines also will be affected to varying degrees by AIDS.
- Even within a product line, the impact will be different by product and within product. For example, there will be a different impact between permanent and term based on the level of reserves accumulated. Even within a product such as universal life, there may be a wide variation at different underwriting levels (nonmedical, paramedical and medical).
- Assuming there has been antiselection in recent years, companies that have grown rapidly during this period are likely to have more AIDS claims than companies that have written a correspondingly lower percentage of their business recently.
- Marketing and underwriting philosophies also will affect the level of AIDS claims. Companies engaged in direct marketing programs may find that they have been subject to antiselection. Companies that were late in adjusting underwriting limits to reflect the need for testing for HIV also may have been selected against.

These variations by company increase the importance of a careful analysis of individual company AIDS experience by an actuary familiar with the detailed operations of the company. Guidance in modeling the impact of AIDS on an insurance company is given in Chapter 4 of this report.

5. STRATEGIES FOR MANAGEMENT IN RESPONDING TO THE AIDS EPIDEMIC

Through the end of 1986, the cumulative number of AIDS cases reported to the CDC was around 29,000, and for 1986, the ACLI estimates that total AIDS-related claims amounted to over $290 million. By the end of 1987, the cumulative number of AIDS cases had risen to nearly 50,000, and the total cost is not yet known. Currently the CDC estimates the number of people infected with HIV to be within the range of 420,000 to 1,649,000. Unfortunately, a large number of those currently infected with HIV can be

expected to progress to AIDS, and this is compounded by the possibility of further spread of infection. The net result is a problem where millions of dollars of benefits can be expected to grow into billions of dollars of benefits and where the effects will last over many years.

Although the *current* level of claims does not represent a threat to industry solvency, the burden of claims is not falling equally on all companies and the burden can be expected to increase as infection spreads and as more infected people develop AIDS. Because of the very long-term nature of this epidemic, there is time for insurance company management to plan how to control exposure and how to finance the claims that will emerge.

The problems of what management should do must be considered for both in-force business and new business. For in-force business, there are opportunities to prefund the claims via reserve strengthening, reduce dividends on participating business, increase premiums and other nonguaranteed elements where permitted, or decline to renew certain products where renewal is at the option of the company. For new business, management tools include risk selection and classification, repricing, product redesign, reinsurance, or even product discontinuance. Based on a survey by Coopers & Lybrand, many companies are already considering such actions. Various options for management are discussed more fully in Chapter 9 of this report.

6. AIDS AND THE RESPONSIBILITY OF THE U.S. VALUATION ACTUARY

The U.S. valuation actuary is asked to provide an opinion that the reserves and other actuarial items make good and sufficient provision for the unmatured obligations guaranteed by the policies of the company. If the actuary has doubts as to whether the statutory reserves make good and sufficient provision, then professional practice standards of the American Academy of Actuaries require further testing such as a gross premium valuation using assumptions based on actual and anticipated experience.

AIDS is becoming a leading cause of death especially at certain ages, and because of the number of people already infected, its significance can be expected to increase. Given the complex nature of HIV, there is very little reason for optimism that the course of the epidemic will be reversed in the near future by vaccine or cure.

In terms of materiality, the impact of AIDS appears to be such that it should be considered by the valuation actuary as part of the determination of whether the reserves make good and sufficient provisions for future unmatured obligations. Accordingly, the impact of AIDS should be considered

in establishing anticipated experience for purposes of a gross premium valuation. Various chapters of this report were designed to give practical guidance in measuring the impact of AIDS.

One of the advantages of the gross premium valuation method is that it provides for use of actual and anticipated experience of the company. Given situations such as AIDS where there is considerable variation by company, a company's own experience can be recognized in a gross premium valuation. Another advantage is that strategies adopted by management such as those with respect to dividends or nonguaranteed elements can be directly reflected.

In the event that there is concern about the level of security provided by current statutory valuation mortality tables, consideration should be given to the development of new valuation tables. New tables also could recognize improvements in mortality recognized at certain ages since the last tables were developed. Should it be felt that current statutory valuation tables are not adequate for in-force business, then reserve strengthening for in-force business also should be considered; this may be a by-product of the gross premium valuation, or some alternative approach could be adopted.

Key factors that must be kept in mind are that there are still very many unknowns about the ultimate course in this epidemic and that there is wide variation in results by company. Accordingly, considerations for dealing with the impact of AIDS should be pragmatic and provide for flexibility for adjustment as the true scope of the epidemic becomes known. The role of the valuation actuary with respect to recognizing the impact of AIDS is discussed in more detail in Chapter 9 of this report.

7. PROBLEMS WITH DATA ON HIV INFECTION AND AIDS

There are numerous problems with data relating to the scope of the AIDS epidemic. Some examples of problems or disparities in the information available are:

- Generally, the number of HIV-infected individuals in the U.S. has been assumed to be in the range of 1 million to 1.5 million. This is the number developed by the Public Health Service meeting at the Coolfont Conference Center in June 1986. This estimate has been recently reevaluated by the Public Health Service and the "Reevaluated Estimate of HIV Prevalence" for 1987 is now 945,000 to 1,400,000 infected (note that the Cowell-Hoskins estimate for 1987 was 920,000). However, using mathematical models, the number of persons infected with HIV at the end of 1987 ranges from

276,000 to 1,750,000 with their best estimate being from 420,000 to 1,649,000. In giving these estimates, the CDC observed:

"Procedures which produce such a wide range of results from the same data indicate that there are either insufficient data or insufficient models or both. Hence, there is need for improved data and model development to assist in monitoring HIV infection in this country."

- The above information on HIV prevalence is given in "Human Immunodeficiency Virus Infections in the United States: A Review of Current Knowledge and Plans for Expansion of HIV Surveillance Activities" prepared by the CDC, *et al*, for the Domestic Policy Council (November 30, 1987). An excerpt of this report is given as Appendix 3 of this chapter.
- Even actual cases reported by the CDC are subject to underreporting and delays in reporting. Dr. Mason of the CDC indicated in his address to the ACLI that reported AIDS cases are probably understated by 20% and reported AIDS deaths are understated by 10%. He also indicated that the Coolfont projections of AIDS cases are still within 5% of actual.
- As of September 1, 1987, the CDC revised the definition of AIDS; data are not yet available reflecting this new definition.
- Insurance company data also are subject to underreporting and misreporting. For many lines of business, companies may not have sufficient information or even attempt to record the cause of the claim, but only verify that it is a legitimate claim.

With problems such as those sketched above, extreme care should be taken in evaluating projections and data relating to AIDS. Further, care should be taken because projections can be prepared to fit almost any scenario (for example, match CDC data and then either increase rapidly, increase moderately, remain level, or decline).

One goal in mentioning this is to reemphasize the need for reliable data on AIDS and the prevalence of HIV infection. The CDC is implementing programs to develop more reliable information on the prevalence of HIV infection. The ACLI and HIAA have plans to collect information from insurance companies periodically. Such programs are of great importance as efforts are made to refine the measurements on the scope of the impact of HIV and AIDS. Insurance companies should make special efforts to track claims to determine the impact of AIDS; because of problems of misreporting of cause of claim, attention should be paid to all claims and not just AIDS-diagnosed claims.

Another goal is to emphasize that we are in the very early stages of modeling this epidemic. Although the results of the Cowell-Hoskins model appear to be the most reasonable projections currently available for our purposes, the ultimate course of the disease could be quite different. Should

there be a widespread movement of HIV infection into the general heterosexual community, the results could be much worse than currently projected. On the other hand, development of a successful vaccine or treatment would be most beneficial. Rather than conclude that these estimates have been prepared once and for all with micrometric precision, these estimates must be continually updated and refined.

Finally, the further one projects into the future, the more likely it is that there will be significant deviations from current estimates. In setting reserves, long-term estimates that are too conservative can be just as devastating as estimates that are too liberal. The initial course should be a moderate one with provision for correction as more data become available.

8. RECOMMENDATIONS

The grim face of the AIDS epidemic is becoming recognizable. As those infected with HIV progress to AIDS and as more people become infected, the specter of this epidemic will become more ominous. At present, we are still at the early stages of comprehending the impact of AIDS and HIV infection on life and health insurance companies; however, we feel certain the impact of AIDS and HIV infection will be felt for years to come.

As a Task Force, our charge was the short-term assignment of analyzing and reporting on the impact of AIDS and HIV on the solvency of life and health insurance companies. It is hoped that our report will be made available to the membership of the Society and that they will find it helpful in recognizing and responding to the impact of AIDS.

The Task Force recommends that the Society assign standing committees the responsibility for continuing to monitor the spread of the AIDS and HIV epidemic and the responsibility for further analyzing the impact of AIDS on the role of the valuation actuary. The committee monitoring the spread of the epidemic should monitor and report data regarding the prevalence of HIV and AIDS, both from a population standpoint and that of the insurance industry, and should be involved with developing models for the spread of the epidemic. The committee responsible for considering the role of the valuation actuary in light of AIDS should consider and communicate to the membership valuation approaches to the recognition of the impact of AIDS via modeling for gross premium valuation, the development of alternative techniques for the recognition of AIDS, and the consideration of the development of new valuation mortality tables that would also recognize AIDS.

Although the Task Force has endeavored to produce a report that would be a useful guide for practicing actuaries, there are a number of insurance-related areas that were not addressed by the Task Force. For example, the Task Force did not specifically address the impact of AIDS on products such as annuities, supplementary benefits and options, etc. or on financial issues such as GAAP reporting and federal income tax. There also are a number of areas of interest to actuaries that were beyond the scope of an investigation of the impact of AIDS on life and health insurance companies. For example, AIDS may have a significant impact on social insurance programs such as Social Security, Medicare and Medicaid in the U.S. and on comparable programs in Canada. AIDS also may have an impact on retirement and employee benefit programs, whether funded by insurance or not. The fact that such items were not addressed should be considered a function of time and resources rather than significance. It is recommended that subsequent Task Forces address additional insurance areas to the extent further research is needed, and particularly in modeling and monitoring the epidemic, it is recommended that the scope of the Task Force be expanded beyond insurance.

APPENDIX 1

POINTS FOR CONSIDERATION REGARDING THE COWELL-HOSKINS MODEL

A key challenge in measuring the impact of AIDS has been to develop a model to estimate the number of people infected with HIV and to measure the progression from infection through development of AIDS to ultimate death. The Cowell-Hoskins model used for financial projections shows 900,000 people infected cumulative in 1987, rising to 2.5 million by the year 2000. By 2000, the cumulative number of AIDS cases is projected to be 1.6 million, of which 1.3 million would have died.

The Cowell-Hoskins paper represents a tremendous advance in modeling the impact of AIDS on the life insurance industry. Nevertheless, certain factors should be kept in mind when considering their results:

a. The model is based on an assumed population at risk of AIDS of 3 million male homosexuals and bisexuals plus 750,000 IV drug abusers. These groups represent approximately 90 percent of the adult AIDS cases reported to date in the U.S. It should be noted that the assumed populations are based on broad estimates because exact data are unavailable.

b. Additional information is needed on the spread of AIDS in the heterosexual population. Reported cases of heterosexual transmission account for approximately 4 percent of the AIDS victims overall, but 30 percent of the female cases. Because the heterosexual population is so large, a spread at even a much reduced rate could still result in a large infected population.

c. The model for estimating the number of people infected has been fitted to CDC data of AIDS cases and deaths. Although this is thought to be the most reliable information available, there are problems with underreporting and with delays in reporting to the CDC. A 20 percent increase in cases has been cited as a possible adjustment for underreporting. With respect to reporting delays, the December 29, 1986 CDC report showed 29,003 cases had been reported through that date, but in the December 28, 1987 report, 34,984 cases are shown as having been incurred by the end of 1986.

d. As of September 1, 1987, the CDC revised the definition of AIDS to include dementia and emaciation. These cases were previously considered AIDS Related Complex (ARC) rather than AIDS and were not in the AIDS tabulations. The revised data from the CDC should be carefully studied when available.

e. Although the Cowell-Hoskins model is consistent with other models such as the one by Jeffrey Harris at M.I.T., there are other models that produce significantly different results. A report prepared by the RAND Corporation states that the CDC

> ". . .figure is now thought by many to be too low, particularly because it employs a very conservative estimate of HIV (Human Immunodeficiency Virus) incubation or latency, which determines how many seropositives convert to symptomatic AIDS over a period of time. Others think that underreporting of AIDS cases is even more egregious than the official corrections would suggest and that the extent of heterosexual transmission has been underestimated. Thus, although 220,000 cases might serve as a low-range estimate, case load numbers of 400,000 and 750,000 in 1986-1991 are more credible mid- and high-range estimates."

There appear to be little hard data supporting the RAND report; until more data become available, the CDC estimate must be considered more reliable.

f. The Cowell-Hoskins financial models were fitted to AIDS preliminary reports of experience collected by the ACLI/HIAA for 1986. Data subsequently received indicate 1986 actual experience was higher than previously thought. Further, there are serious concerns that the most recent estimate of 1986 AIDS-related claims may be understated because of problems in identifying and reporting AIDS claims.

g. The financial numbers are based on a model that assumes that the rate of infection will decline to zero by 1997. This reduces the ultimate risk group by approximately one-third. The model is further based on the assumption that the insured population that is HIV+ will ultimately grow to only 58 percent of the total risk group.

*h. The emergence of AIDS-related claims will be affected by the extent to which insurance companies are able to test applicants for HIV infection. Legislative and regulatory restrictions on risk classification could result in substantial increases in claims.

i. In addition to claims from AIDS itself, increased claims can be expected for insureds who have the HIV infection and who will incur claims for sickness and death from complications of this infection without necessarily having reached full clinical AIDS.

j. Further developments in treatment may affect the course of the disease. Although this may be somewhat advantageous from a life insurance point of view, such treatments may increase claims for health and disability insurance.

From the point of view of human compassion as well as concern over financial impact, it is hoped that events will be more favorable than the projection indicates. However, Cowell and Hoskins were striving for as fair a presentation as possible and these projections should be considered as a likely scenario.

APPENDIX 2

BIBLIOGRAPHY

A. ACTUARIAL AND INSURANCE-RELATED ARTICLES

1. "Risk Classification and AIDS," Committee on Risk Classification of the American Academy of Actuaries, May 1987.
2. "Preliminary Memorandum on AIDS," David Wilkie, R. Watson & Sons, July 1987.
3. "AIDS Dodelighed og Livsforsikring," Jakob Kolbye, July 1987.
4. "HIV Infection: Its Impact on Mortality and Underwriting," Jess L. Mast, *Reinsurance Reporter*, pp. 2–6.
5. "Thorns in Our Side: Some Problems in Underwriting for AIDS," Donald C. Chambers M.D., *Reinsurance Reporter*, pp. 6–11.
6. "AIDS: Survival Analysis of Persons Testing HIV+," Harry J. Panjer, Ph.D., Working Paper Series in Actuarial Science, August 24, 1987.
7. "AIDS and Life Insurance Company Solvency," American Academy of Actuaries Committee on Life Insurance, September 22, 1987.
8. "AIDS Bulletin No. 1," Report from Institute of Actuaries AIDS Working Party, September 1987.
9. "AIDS and Life Insurance," L. R. Mann, P. R. Muir, R. A. Collins, 1987 Convention of the Institute of Actuaries of Australia.
10. "AIDS Bulletin No. 2," Report from Institute of Actuaries AIDS Working Party, December 1987.

B. GENERAL ARTICLES

11. "Heterosexually Acquired HTLV-III/LAV Disease (AIDS-Related Complex and AIDS)," Robert R. Redfield, M.D., et al, *JAMA*, October 18, 1985, pp. 2094–2095.
12. *Confronting AIDS*, Institute of Medicine, National Academy of Sciences, National Academy Press, Washington D.C., 1986.

13. "The Economic Impact of the First 10,000 Cases of Acquired Immunodeficiency Syndrome in the United States," Ann M. Hardy, DPH, et al, *JAMA*, January 10, 1986, pp. 209–211.
14. "Association of Human T. Lymphotropic Virus Type III Antibodies with Sexual and Other Behaviors in a Cohort of Homosexual Men from Boston with and without Generalized Lymphadenopathy," Kenneth H. Mayer et al, *The American Journal of Medicine*, March 1986, pp. 357–363.
15. "A Quantitative Analysis of AIDS in California," George Deukmejian, Department of Health Services, March 1986.
16. "A Transmission Model for AIDS," E. G. Knox, *European Journal of Epidemiology*, September 1986, pp. 165–177.
17. "Minimum Size of the Acquired Immunodeficiency Syndrome (AIDS) Epidemic in the United States," Ron Brookmeyer, Mitchell H. Gail, *The Lancet*, December 6, 1986, pp. 1320–1322.
18. "Estimates of the Direct and Indirect Costs of Acquired Immunodeficiency Syndrome in the United States, 1985, 1986, and 1991," Anne A. Scitovsky, Dorothy P. Rice, *Public Health Reports*, January-February 1987, pp. 5–17.
19. "Risk Factors for Seroconversion to Human Immunodeficiency Virus among Male Homosexuals," *The Lancet*, February 14, 1987, pp. 345–348.
20. "The AIDS Virus," Robert C. Gallo, *Scientific American*, Volume 256, January 1987, pp. 46–56.
21. "Transmission Dynamics of HIV Infection," Robert M. May, Roy M. Anderson, *Nature*, March 12, 1987, pp. 137–142.
22. "Prevalence of Antibodies to Human Immunodeficiency Virus, Gonorrhea Rates, and Changed Sexual Behaviour in Homosexual Men in London," *The Lancet*, March 21, 1987, pp. 656–658.
23. "Plotting the Spread of AIDS," Roy Anderson, Robert May, *New Scientist*, March 26, 1987, pp. 50–59.
24. "The Sombre View of AIDS," Malcolm Rees, *Nature*, March 26, 1987, pp. 343–345.
25. "AIDS Surveillance in Europe: Report No. 13," World Health Organization Collaborating Centre on AIDS, March, 31, 1987.
26. "An Updated Quantitative Analysis of AIDS in California," George Deukmejian, Department of Health Services, April 1987.
27. "From Persistent Generalised Lymphadenopathy to AIDS: Who Will Progress?", C. A. Carne et al, *British Medical Journal*, April 4, 1987, pp. 868, 869.
28. "A Forgotten Factor in Pelvic Inflammatory Disease: Infection in the Male Partner," Martha Jacob et al, *British Medical Journal*, April 4, 1987, p. 869.
29. "Epidemiology of AIDS in Women in the United States," Mary E. Guinan, Ann Hardy, *JAMA*, April 17, 1987, pp. 2039–2042.
30. "The Costs of AIDS and Other HIV Infections: Review of the Estimates," Staff Paper, U.S. Congress, May 1987.

31. "The Costs of Treating AIDS under Medicaid," Anthony Pascal, A Rand Note, May 1987.
32. "Selection and Estimation of Growth Models with Application to Forecasting AIDS," Quang P. Duong, Bell Canada, Ian B. MacNeill, University of Western Ontario.
33. "The AIDS Epidemic: Looking into the 1990's," Jeffrey E. Harris, *Technology Review*, July 1987, pp. 59–65.
34. "Human Immunodeficiency Virus Infections among Civilian Applicants for United States Military Service, October 1985 to March 1986: Demographic Factors Associated with Seropositivity," Donald S. Burke et al, *The New England Journal of Medicine*, July 16, 1987, pp. 131–136.
35. "Financing the Struggle against AIDS," John K. Iglehart, *The New England Journal of Medicine*, July 16, 1987, pp. 180–184.
36. "Long Latency Precedes Overt Seroconversion in Sexually Transmitted Human-Immunodeficiency-Virus Infection," Annamari Ranki et al, *The Lancet*, September 12, 1987, pp. 589–592.
37. "Computer Models of AIDS Epidemiology," Peter J. Denning, *American Scientist*, July-August 1987, pp. 347, 348.
38. "Blood Transfusion and AIDS," Harvey G. Klein, M.D., Harvey J. Alter, M.D., American Medical Association Information on AIDS, July-August 1987, Volume 2, pp. 7–10.
39. "Serologic Tests for Human Immunodeficiency Virus (HIV)," Alfred J. Saah, M.D., "AIDS: Information for Practicing Physicians," *American Medical News*, July-August 1987, Volume 2, pp. 11–15.
40. "Epidemiology of Acquired Immunodeficiency Syndrome: A Brief Overview," John P. Phair, M.D., James P. Steinberg, M.D., "AIDS: Information for Practicing Physicians," *American Medical News*, July-August 1987, Volume 3, pp. 9,10.
41. "Clinical Trials of Drugs for the Treatment of AIDS," John R. LaMontagne, Ph.D., Maureen W. Myers, Ph.D., "AIDS: Information for Practicing Physicians," *American Medical News*, July-August 1987, Volume 3, pp. 5–8.
42. "Male-to-Female Transmission of Human Immunodeficiency Virus," Nancy Padian, Ph.D., et al, *JAMA*, August 14, 1987, pp. 788–790.
43. "Acquired Immunodeficiency Syndrome in Low-Incidence Areas," David W. Fleming, M.D., et al, *JAMA*, August 14, 1987, pp. 785–787.
44. "Revision of the CDC Surveillance Case Definition for Acquired Immunodeficiency Syndrome," *JAMA*, September 4, 1987, pp. 1143–1154.
45. "Acquired Immunodeficiency Syndrome (AIDS): An Update for the Clinician," Jonas A. Shulman, M.D., et al, *Emory University Journal of Medicine*, July/September 1987, pp. 157–190.
46. "Spontanverlauf der HIV-Infektion: Eine Bilanz 5 Jahre nach den ersten AIDS-Erkrankungen in Frankfurt/Main (Long Term Monitoring of HIV Infection: An Update 5 Years after the First AIDS Cases in Frankfurt on Main," Prof. Dr. E. B. Helm et al, *AIDS-Forschung (AIFO)*, October 1987, pp. 567–572.

47. "Human Immunodeficiency Virus Infections in the United States: A Review of Current Knowledge and Plans for Expansion of HIV Surveillance Activities," Department of Health and Human Services, Public Health Service, Centers for Disease Control, November 30, 1987.

C. PERIODICALS RELATING SPECIFICALLY TO AIDS

48. *AIDS Alert*, American Health Consultants, Inc., published monthly.
49. *AIDS Insurance Reports*, American Eagle Insurance Agency, Inc., published biweekly.
50. *AIDS Policy and Law*, Buraff Publications, published biweekly.
51. *AIDS Weekly Surveillance Reports*, Centers for Disease Control, published weekly.

APPENDIX 3

CDC ESTIMATES OF HIV PREVALENCE

The following is a copy of pages 15–24 of "Human Immunodeficiency Virus Infection in the United States—A Review of Current Knowledge and Plans for Expansion of HIV Surveillance Activities" prepared by the Department of Health and Human Services, Public Health Service, Centers for Disease Control, November 30, 1987.

VII. IMPLICATIONS FOR NATIONAL ESTIMATE OF HIV PREVALENCE

A. *The Public Health Service Estimate Approach Reconsidered*

In May 1986, during the Public Health Service (PHS) AIDS Planning Conference at Coolfont, West Virginia, a group of public health experts estimated the number of HIV infected persons in the United States to be 1 to 1.5 million. At the time, scientific speculation had focused on HIV levels several fold greater than this and no consensus had been attempted. The assembled group of nearly 100 individuals from within and outside Government who were experienced in the scientific and public health aspects of AIDS developed their working estimate based on the estimated size of populations at increased risk multiplied by the corresponding estimates of HIV prevalence from the limited data then available (Table 13). The group particularly expressed concern about the uncertainty of the size of groups at risk. The figure 1,000,000 to 1,500,000 was consistent with what was then known about the progression of HIV infection to AIDS (20% to 30% in 5 years) and the projected cumulative incidence of AIDS (270,000 diagnosed by the end of 1991). The Institute of Medicine, National Academy of Sciences subsequently reviewed the PHS working estimate and considered it reasonable for planning purposes (Institute of Medicine, 1986).

TABLE 13

PUBLIC HEALTH SERVICE ESTIMATE OF HIV PREVALENCE IN THE UNITED STATES BY POPULATION GROUP, 1986

TOTAL POPULATION INFECTED	ESTIMATED SIZE	APPROXIMATE SEROPREVALENCE	
Exclusively homosexual throughout life[1]	2,500,000	15%–20%	375,000–500,000
Other homosexual contact[1]	2,500,000–7,500,000	10%	250,000–750,000
Regular (at least weekly) intravenous drug abuse[2]	750,000	30%	225,000
Less frequent IV drug use[2]	750,000	10%	75,000
Persons with hemophilia[3]	14,000	70%	10,000
Other groups (transfusion recipients, other heterosexuals, infants)	?	?	?
Total			1,000,000–1,500,000

[1]Kinsey, et al: *Sexual Behavior in the Human Male*, Philadelphia, Saunders Publishing Co., 1948; and U.S. Census data, 1980.
[2]National Institute on Drug Abuse (personal communication), 1986.
[3]National Hemophilia Foundation (personal communication), 1986.

Since 1986, additional data have become available on seroprevalence in risk groups and in other populations, and estimates of the size of two of the risk groups have been modified. Based on the 1986 and 1987 seroprevalence observations, the average estimated prevalence can be adjusted from a range of 15–20% to the range of 20–25% for exclusively homosexual men; from 10% to 5% for bisexuals and men with infrequent past homosexual exposures; from 30% to 25% for heavy users of IV drugs; and the rate of 35% can be used for hemophilia B patients. NIDA currently estimates there are 900,000 heavy users of IV drugs, and 200,000 occasional or intermittent users (NIDA, personal communication). The current estimated number of hemophilia A patients is 12,400, and hemophilia B patients, 3,100 (Host Factors Division, CDC, and National Hemophilia Foundation, personal communication). For heterosexual adults 15–59 years of age without specific identifiable HIV risk factors, the population figure 142,000,000 was used based on the 1985 U.S. Census estimate of 148,000,000 less the totals for persons at higher risk in the table. The HIV prevalence in this population is difficult to estimate with the limited data available, but in blood donors and military applicants persons without identifiable risk have accounted for less

than about 15% of total infections when seropositives have been interviewed. Therefore, 15% of the age-, race-, and sex-adjusted rate for military applicants, or 0.021%, was selected as the HIV prevalence for this group. For the other groups (heterosexual partners of persons at high risk, heterosexuals born in Haiti and Central Africa, transfusion recipients, etc.) no population size or seroprevalence estimates are available. However, the data available from AIDS case surveillance suggest that this miscellaneous group may account for as many as 5% to 10% of total infections.

The estimate obtained by incorporating these revisions into the 1986 calculation (Table 14)—945,000 to 1,408,000—differs little from the earlier figure. The major limitation of both the original and the reevaluated estimate is the unknown size of the population of homosexual and bisexual men and the distribution within this population of the level of risk activity. In view of the limited impact of the new data and population size estimates, modifying the overall PHS working estimate for HIV infection in the United States does not appear warranted at this time based on this approach.

B. *Extrapolation from Observed Rates*

What if the prevalence or a multiple thereof from the only large currently observed groups, blood donors and military applicants, is used to estimate a national number of infected persons? The prevalence for first-time-tested donors, 0.043%, multiplied by the size of the population 13–59 years of age, 148,000,000, gives a national figure of 64,000. This is clearly an underestimate since persons at recognized high risk are largely excluded from the blood donor pool. (There also have been 45,000 AIDS cases reported as of early November 1987.) The military applicant adjusted prevalence of 0.14% multiplied by the size of the population 15–59 years of age gives an estimate of 207,000, also undoubtedly an underestimate because of the under-representation of persons at risk of HIV in the military applicant pool. Preliminary data from other populations including Massachusetts childbearing women and sentinel hospitals provide prevalence estimates 2 to 3 times as high as those in geographically corresponding military applicants. However, even a 3-fold multiple of the applicant prevalence-based extrapolation, 621,000, is well below the PHS estimate. More representative prevalence information will be needed to add precision to an estimate made by this approach.

C. *Mathematical Model Approach*

Several researchers, including Dr. Ron Brookmeyer of the Department of Biostatistics at the Johns Hopkins School of Public Health, Drs. Victor De Gruttola and Stephen Lagakos of the Department of Biostatistics at the Harvard School of Public Health, Dr. Jeffrey Harris of the National Bureau of

TABLE 14

REEVALUATED PUBLIC HEALTH SERVICE ESTIMATE OF HIV PREVALENCE IN THE UNITED STATES BY POPULATION GROUP, 1987

POPULATION	ESTIMATED SIZE	APPROXIMATE SEROPREVALENCE	TOTAL INFECTED
Exclusively homosexual throughout life[1]	2,500,000	20–25%	500,000–625,000
Other homosexual contact including highly infrequent[1]	2,500,000–7,500,000	5%	125,000–375,000
Regular (at least weekly) intravenous drug abuse[2]	900,000	25%	225,000
Occasional IV drug use[2]	200,000	5%	10,000
Persons with Hemophilia A[3]	12,400	70%	8,700
Persons with Hemophilia B[3]	3,100	35%	1,100
Heterosexuals without specific identified risks	142,000,000	0.021%[4]	30,000
Subtotal			900,000–1,270,000
Other groups (heterosexual partners of persons at high risk, heterosexuals born in Haiti and Central Africa, transfusion recipients, other)	additional 5–10% of total number of infections[4]		45,000–127,000
Total			945,000–1,400,000

[1]Kinsey, et al: *Sexual Behavior in the Human Male*, Philadelphia, Saunders Publishing Co., 1948; and U.S. Census data, 1980.
[2]National Institute on Drug Abuse (personal communication), 1987; excludes persons who have used drugs only once or twice.
[3]Host Factors Div., CDC, and National Hemophilia Foundation (personal communication), 1987.
[4]See Text (VIII. A.)

Economic Research in Cambridge, Massachusetts, as well as Mr. James Warner of the White House staff and AIDS coordinator for the Health Policy Group, have suggested that the number of persons infected with HIV can be estimated from data on reported AIDS cases in combination with data on the rate at which infected individuals progress on to AIDS. These approaches were considered in some detail at the October 15–17 workshop on mathematical modelling of AIDS and HIV infection sponsored by the Institute of Medicine, National Academy of Sciences. A variation of this technique is discussed below.

In all of the methods, the number of AIDS cases diagnosed each year can be calculated as the convolution of the number of persons infected in each preceding year and the number of those expected to be diagnosed with AIDS. For this particular approach, let $a(t)$ be the number of AIDS cases diagnosed in year t ($t = 1978, 1979, \ldots, 1987$), let $i(t)$ be the number newly infected in year t, and $d(x)$ be the proportion of infected persons expected to develop AIDS after x years ($x = 0,1,2. \ldots$) then:

$$a(t) = \sum_{z=1978}^{t} i(z) \cdot d(t-z) \qquad \text{(eq. 1)}$$

The number of cases of AIDS per year $a(t)$ is known from surveillance data and the disease progression rates $d(x)$ with accompanying 95% confidence bounds may be estimated from a prospective study of HIV-infected homosexual men in San Francisco. It is possible to estimate the number of persons infected, provided specific assumptions are made about the shape of $i(t)$. Three different sets of progression data were considered: one representing the best estimates from the cohort data, one representing the lower 95% confidence bounds (slowest rate of disease progression) and one representing the upper 95% confidence bounds (fastest rate of disease progression). Three different distributions for the infection curve were considered as follows:

logistic	$I(t) = 1/(1 + k \exp(-rt))$;
log-logistic	$I(t) = 1/(1 + (rt)^k)$; and
damped exponential	$I(t) = k \exp(rt^x)$.

AIDS cases reported to the CDC through November 2, 1987, were used in the analysis. The totals were adjusted for reporting delays to give the number of diagnosed AIDS cases each year through 1987. The parameters in the different infection curves and the total infections through 1987 were estimated from equation (1) using weighted non-linear least squares methods. The final estimates were adjusted for under-recognition and under-reporting of AIDS cases. Validation studies done in five major U.S. cities in 1985 suggested that 20% or more of AIDS cases were either not reported to health departments, or were not diagnosed by a method which would allow them to be counted under the AIDS surveillance definition used prior to September 1987. Variations over time in the completeness of reporting (such as a large number of early AIDS cases being missed) would also influence the projected number of cases, but were not considered in these analyses.

The resulting estimates for the cumulative number infected by the end of 1987 are shown in Table 15. The range of estimated values is large, from 276,000 to 1,750,000 persons infected, reflecting both uncertainty in the

progression rate for AIDS and the varied assumptions about the shape of the underlying infection curve. Using only the best estimate of the progression rate data from the San Francisco prospective study, the range of estimates is smaller, from 420,000 to 1,649,000.

TABLE 15

PERSONS INFECTED WITH HIV AT THE END OF 1987, UNITED STATES, ESTIMATED[1] FROM REPORTED AIDS CASES, BY RATE OF DISEASE PROGRESSION AND ASSUMED INFECTION CURVE

(with 95% confidence bounds in parentheses)

ASSUMED INFECTION CURVE[2]	Rate of Disease Progression[3]		
	SLOWEST PROGRESSION	MOST LIKELY PROGRESSION RATE	FASTEST PROGRESSION
Logistic	420,000* (403,000–438,000)	420,000* (312,000–528,000)	420,000* (268,000–572,000)
Log-logistic	1,363,000* (918,000–1,809,000)	853,000* (186,000–1,519,000)	276,000* (66,000–511,000)
Damped-Exponential	1,750,000 (576,000–2,936,000)	1,649,000* (566,000–2,732,000)	1,468,000* (556,000–2,380,500)

*chi-square goodness-of-fit $p > .50$

Notes:

[1]Each of the estimates for the number infected has been increased by 20% to account for unreported or unrecognized AIDS cases.

[2]See text (VIII.C.) for discussion of limitations of each curve.

[3]Data for disease progression are taken from a study of infected homosexual men in San Francisco. The lower 95% confidence estimate (slowest progression rate) for the cumulative number of men developing AIDS after each of 1–11 years was taken as 0%, 0%, 0%, 2%, 5%, 9%, 17%, 21%, 26%, 31%, 36%; the best estimate (most likely progression rate) was taken as 0%, 0%, 2%, 5%, 10%, 15%, 24%, 30%, 36%, 42%; and the upper estimate (fastest progression rate) was 0%, 0%, 4%, 8%, 15%, 21%, 31%, 39%, 46%, 52%, 58%. The rates for years 8–11 were not taken directly from the San Francisco data but were extrapolated from prior years.

These estimates must be evaluated in light of the assumptions made in the models about the shape of the curve and, hence, the spread of the infection. The logistic curve assumes that the spread of infection is limited to a closed group and that all persons in that group have an identical, constant risk for infection. The model does not take into account the addition of individuals who are newly at-risk, for example persons who only recently became sexually active or started using IV drugs. The logistic model also assumes that likelihood of transmission is the same for all those at-risk,

whether they are homosexuals, IV drug users, hemophiliacs, transfusion recipients, or heterosexual partners of infected persons and that this risk is constant over time. As a consequence of these highly implausible assumptions, the fitted model indicates that virtually all those who will ever become infected with HIV were already infected by 1984. Current data show that substantial numbers of new infections continue to occur in all population groups except hemophiliacs and transfusion recipients. For all of these reasons, the logistic model is inappropriate and will severely underestimate the total number of persons now infected.

Although the log-logistic model also assumes a closed group at-risk, it allows for a relative slowing in the rate at which the virus is spreading. Such a slowing would be expected for two reasons. First, persons are not homogeneous but have considerably varied risk. Risks will vary by type of exposure (homosexual, IV drug use, heterosexual, etc.) and by the frequency of exposure. Particularly in a closed or relatively closed group, those at highest risk would have become infected earliest in the epidemic while the virus might later spread more slowly among those with lower risk. Second, prevention and education efforts would slow the rate of infection. Countering this, however, is the argument that since the major groups at risk are not really "closed," the increasing prevalence of HIV infection could lead to increased spread simply because more infected persons are available to transmit the infection. The log-logistic model is much more appropriate than the logistic, but will likely still underestimate the eventual number of persons who will become infected with HIV.

The third model, the damped-exponential, also allows for a relative slowing in the rate at which the infection is spread, but does not assume that the population at-risk is closed. On the contrary, it assumes that the number of HIV infections is limitless. While such an assumption may be unreasonable over the long-term, it may accurately represent the short-term spread of HIV in populations where prevalence is low and/or the number of persons entering the risk groups exceeds or equals number becoming infected.

Both the log-logistic and the damped-exponential models fit the AIDS surveillance data well, and their curves have similar shapes in the early stages of the epidemic, but diverge rapidly beyond 1984 due to the different assumptions underlying them. Since very few persons infected with HIV progress to AIDS during the first 2–3 years, AIDS case data alone cannot determine which of these models is more appropriate and, hence, what is currently happening with regard to HIV infection. Rather the AIDS cases seen today reflect primarily trends in infection through and including 1984, before current prevention activities, including screening of blood donations,

testing and counseling efforts, and information and education activities began. For example, application of the damped-exponential model to surveillance data for transfusion-associated cases would lead to the erroneous conclusion that HIV has spread rapidly in the blood supply since 1984, while application of the log-logistic model to the same data in 1985 would have been falsely reassuring at that time before blood donations were screened for HIV.

It is unlikely that any one of these models accurately describes the transmission of HIV in the population. Many different models are consistent with currently available AIDS surveillance data, and these data alone are not sufficient to determine the extent of HIV infection. Procedures that produce such a wide range of results from the same data indicated that there are either insufficient data or insufficient models or both. Carefully obtained HIV incidence and prevalence data will be essential.

Implications. The estimation of a total number of persons infected remains complex and inexact. The approaches described for computing or recomputing a national HIV prevalence cannot be considered definitive. The results, however, are consistent with the previous PHS working estimate of 1 to 1.5 million. None of the approaches suggest that that estimate is currently too low or too high, and the available data and mathematical models do not at present warrant a change in the estimate. Since some HIV transmission clearly has occurred in the past 17 months, this implies that the 1.5 million upper limit of the original estimate may have been high at that time. There is no substitute for carefully obtained HIV incidence and prevalence data. Additional surveys and studies are needed to determine the extent to which HIV is spreading through the population.

IX. OBSERVATIONS AND COMMENT

This review of the extent and trends of infection with the human immunodeficiency virus in the United States is necessarily descriptive and qualitative. The marked variability in study design, sampling, and biases among the available serologic surveys and studies makes quantitative comparisons only approximate. Nevertheless, the picture emerges of extensive HIV infection in the recognized risk groups of homosexual and bisexual men, intravenous drug users, and hemophiliacs, and their heterosexual partners. Exclusively heterosexual persons who do not abuse drugs and who are not knowingly the partners of persons with or at risk of HIV infection are at present much less likely to be infected. However, no infection trend information is yet available to evaluate whether the risk is rising for this latter group.

With few exceptions, HIV prevalence in observed groups from the general population, which includes high-risk as well as low-risk persons, are a fraction of 1%. At this time, IV infection, like AIDS, occurs primarily in young to early middle-aged adults, although insufficient information is currently available on young children. In general, males are currently much more likely than females to be infected, blacks and Hispanics more likely than whites. Geographic differences in infection prevalence remain consistent with the distribution of AIDS cases. While new infections continue to occur, the rate of new infection in many groups of homosexual men appears to have declined, which may have major implications for the overall incidence of new infection, since this group has previously accounted for the largest number of AIDS cases. However, information is not currently sufficient to evaluate infection trends in IV drug users, heterosexually active persons, or in specific geographic areas.

Many gaps in our knowledge remain. More precise and more consistently collected data on this prevalence of HIV infection must be collected for currently recognized risk groups, heterosexually active persons, and accessible segments of the general population. Better and more extensive information is essential for targeting and evaluating control and prevention efforts at local and State level, for predicting future health care needs, and for understanding where the HIV and AIDS epidemic is headed. Better models which make use of the specific data will also aid in our understanding of the spread of this virus. Surveillance of the prevalence and incidence of HIV infection by continually monitoring sentinel populations and expanding focused seroprevalence surveys and studies, as well as developing models to help interpret the data remain a critical element of the Nation's response to this major public health crisis.

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REFERENCES

BAKER JL, KELEN GD, SILVERTSON KT, QUINN TC. Unsuspected human immunodeficiency virus in critically ill emergency patients. *JAMA*. 1987;257:2609–11.

BLANCHE S, ROUZIOUX C, VEBER F, ET AL. Prospective study on newborns of HIV seropositive women [Abstract]. In: *Abstracts from the III International Conference on AIDS. 1–5 June 1987, Washington D.C.*; 1987:TH7.4.

BURKE DS, BRUNDAGE JF, HERBOLD JR, ET AL. Human immunodeficiency virus (HIV) infection among civilian applicants for United States military service, October 1985 to March 1986. Demographic factors associated with seropositivity. *N Eng J Med*. 1987;317:131–6.

CDC. Antibody to human immunodeficiency virus in female prostitutes. *MMWR*. 1987;36:157–61.

CDC. Diagnosis and management of mycobacterial infection and disease in persons with Human T-Lymphotropic Virus Type III/Lymphadenopathy-Associated Virus infection. *MMWR*. 1986;35:448–52.

CHAMBERLAND ME, DONDERO TJ. Heterosexually acquired infection with human immunodeficiency virus (HIV) [Editorial]. *Ann Int Med*. 1987;107:763–6.

DODD RY, NATH N, BASTIAANS MJ, BARKER LF. Hepatitis-associated markers in the American Red Cross donor population: ten years' experience. In: Viral Hepatitis 1981 International Symposium. *eds*. Szmuness W, Alter HJ, Maynard JE. Philadelphia: Franklin Institute Press. 1982; chap. 13:145–55.

GOEDERT JJ, EYSTER ME, BIGGAR RJ. Heterosexual transmission of human immunodeficiency virus (HIV): association with severe T4-cell depletion in male hemophiliacs [Abstract]. In: *Abstracts from the III International Conference on AIDS. 1–5 June 1987. Washington D.C.*; 1987:W.2.6.

HARDY AM, STARCHER ET, MORGAN WM, ET AL. Review of death certificates to assess completeness of AIDS case reporting. *Pub Hlth Reps*. 1987;102:386–391.

INSTITUTE OF MEDICINE/NATIONAL ACADEMY OF SCIENCES. Confronting AIDS. Directions for Public Health, Health Care, and Research. Washington: National Academy Press. 1986; pp 69–70.

MARWICK C. HIV antibody prevalence data derived from study of Massachusetts infants. *JAMA*. 1987;258:171–2.

MOK JQ, GIAQUINTO C, DE ROSSI A, ET AL. Infants born to mothers seropositive for human immunodeficiency virus. Preliminary findings from a multicenter European study *Lancet*. 1987;1:1164–8.

NZILAMBI N, RYDER RW, BEHETS F, ET AL. Perinatal HIV transmission in two African hospitals [Abstract]. In: *Abstracts from the III International Conference on AIDS. 1–5 June 1987. Washington D.C.*; 1987:TH.7.6.

PETERMAN TA, STONEBURNER RL, ALLEN JR, JAFFE HW, CURRAN JW. Risk of HIV transmission from heterosexual adults with transfusion-associated infections. *JAMA*. In press.

POTTERAT JJ, PHILLIPS L, MUTH JB. Lying to military physicians about risk factors for HIV infections [Letter]. *JAMA*. 1987;257:1727.

SCOTT GB, MASTRUCCI MT, HUTTO SC, PARKS WP. Mothers of infants with HIV infection: outcome of subsequent pregnancies [Abstract]. In: *Abstracts from the III International Conference on AIDS. 1–5 June 1987. Washington, D.C.*; 1987:THP.91.

SEMPRINI EA, VUCETICH A, PARDI G, COSSU MM. HIV infection and AIDS in newborn babies of mothers positive for HIV antibody. *Brit Med J*. 1987;294:610.

SHOENBAUM EE, SELWYN PA, KLEIN RS, ET AL. Prevention of and risk factors associated with HTLV-III/LAV antibodies among IVDAs in methadone program in New York City [Abstract]. In: *Abstracts from the II International Conference on AIDS. 1986. Paris*. 1986:198.

STARCHER ET, BIEL JK, RIVERA CASTANO R, ET AL. The impact of presumptively diagnosed opportunistic infections and cancers on national reporting of AIDS [Abstract]. In: *Abstracts from the III International Conference on AIDS. 1–5 June 1987*. Washington, D.C. 1987:WP.88.

STONEBURNER RL, CHIASSON MA, SOLOMON K, ROSENTHAL S. Risk factors in military recruits positive for HIV antibody [Letter]. *N Eng J Med*. 1986;315:1355.

WEISS SH, GINZBURG HM, ALTMAN R, ET AL. Risk factors for HTLV-III/LAV infections and development of AIDS [Abstract]. In: *Abstracts from the II International Conference on AIDS. 1986. Paris*. 1986:204.

CHAPTER 2

A PRACTICAL PRIMER: AIDS AND LIFE AND HEALTH INSURANCE

This primer gives an overview that can be a basis for further study about the effect of AIDS on a particular life or health insurer. This primer provides preliminary background information only—this is by no means a thorough study of the AIDS epidemic.

Information was collected from materials gathered during Tillinghast's AIDS research. Since this summary is intended only to establish an initial understanding of AIDS, reference notations have been excluded. For an explanation of material presented here, contact Tom Reese at (714) 553-1277.

These notes are condensed from the original studies and papers. For a full understanding, it is recommended that the original material be read. This overview is not a substitute for the papers listed as major references in the final section.

This paper was written by Tom Reese (Tillinghast-Irvine), with contributions by Bob Beal (Hartford), Jay Boekhoff (Minneapolis), and John Tiller (Irvine).

DEFINITIONS

AIDS	Acquired Immune Deficiency Syndrome
HIV	Human Immunodeficiency Virus, the causative agent for AIDS; previously used names were: LAV, lymphadenopathy-associated virus HTLV-III, human T-cell lymphotropic virus type III ARV, AIDS-associated retrovirus
HIV+	HIV positive (seropositive), an indication of being infected with HIV, whether symptomatic or not
HIV−	HIV negative (seronegative), not infected
Seroconversion	The appearance of antibodies directed against HIV in the serum of an exposed person
LAS	Lymphadenopathy Syndrome, the prolonged presence of greatly enlarged lymph nodes together with moderate cellular immune deficiency

ARC	AIDS-Related Complex, LAS plus severe cellular immune deficiency, but without the presence of an opportunistic infection that would meet the CDC definition of AIDS
CDC	Public Health Service's Centers for Disease Control in Atlanta
ELISA Western Blot T-Cell Ratio	HIV antibody blood tests, described in the section on Underwriting

CDC Criteria

To facilitate accurate reporting, the CDC has established strict criteria for the diagnosis of AIDS ("CDC AIDS"):

I. Without Laboratory Evidence of HIV Infection
If HIV tests were not performed or were inconclusive, a case qualifies as "AIDS" if the patient both:
   A. Does not have a cause of immunodeficiency that disqualifies diseases as indicators of AIDS; a list of three types of causes is specified, and
   B. Is definitively diagnosed for an AIDS indicator disease; a list of 12 indicator disease categories is specified.

II. With Laboratory Evidence of HIV Infection
Regardless of the presence of other causes of immunodeficiency, a case qualifies as "AIDS" if the patient:
   A. Has a definitively diagnosed indicator disease from the list in I.B. or from another list of 12 specified disease categories, or
   B. Has a presumptively diagnosed indicator disease from a list of seven specified disease categories.

III. With Laboratory Evidence Against HIV Infection
A diagnosis of AIDS is ruled out unless both:
   A. All other causes of immunodeficiency (listed in I.A.) are ruled out, and
   B. The patient has had either
      1. Pneumocystis carinii pneumonia definitively diagnosed, or
      2. Both:
         a. A definitively diagnosed indicator disease from Section I.B., and
         b. A T-helper/inducer (CD4) lymphocyte count below a specified level.

Note: Before September 1987, the CDC definition of AIDS was basically the test described in rule section I above. Laboratory evidence of HIV infection was not part of the definition. The first weekly surveillance report that used the new definition was the 10/12/87 report. The definition change added 265 AIDS cases to that report that met the new definition but not the old.

There have been concerns that these criteria are too strict. The CDC definition is designed to be very specific in order to achieve accurate and uniform tracking of disease. The symptoms of ARC, however, can sometimes be as debilitating as those of AIDS. Many have died without reaching the confines of the CDC surveillance definition.

Cowell-Hoskins Paper

Citations of this paper refer to the paper distributed to members of three special interest sections of the Society of Actuaries in August 1987. This significant early study provides some valuable estimates about AIDS epidemic parameters. A summary of this paper, along with a complete reference, is contained in the section: "Cowell-Hoskins Paper Summary." The entire paper is reproduced as Chapter 3 of this Task Force report.

DESCRIPTION

Acquired Immune Deficiency Syndrome

"Acquired" because the disease arises by an infection.

"Immune deficiency" because the condition results in the failure of the body's immune system.

"Syndrome" because a number of rare but devastating diseases (opportunistic infections) can take advantage of the body's weakened defenses.

Discovery

AIDS was first described in 1981. The first sign of a new disease was the appearance of a rare cancer (Kaposi's sarcoma) among the "wrong" patients and an increase in pneumonia caused by a normally harmless protozoan (Pneumocystis carinii pneumonia, or PCP). It became evident that an infectious form of immune deficiency had appeared. The name "AIDS" was coined. The disease was apparently associated with lifestyle, since it was quickly spreading among homosexuals, intravenous drug users, recipients of frequent blood transfusions, and Haitians.

Although only identified in 1981, AIDS cases have been diagnosed as early as 1977. The diagnosis was declared retroactively after the identification of the disease. The earliest signs of the virus have been found in serum samples taken in a small region of Central Africa in the 1950s.

Spread

The HIV virus is present in most body fluids. The amount of viral particles present in tears, saliva, and urine are so small that it is apparently very difficult to contract the disease by exposure to those fluids. However, we don't know if exposure to extremely low concentrations means that infection will not occur or if the incubation period is just extremely long.

Transmission of the virus is through blood, semen, and vaginal fluids. Transmission is through sexual activity, not by casual contact. The chance of infection is highly correlated with other sexually transmitted diseases.

The HIV Virus

Only three years after the disease was described, its cause was conclusively shown to be the HIV virus. HIV is the third human retrovirus discovered.

The first human retrovirus was discovered in 1978. HTLV-I (Human T-lymphotropic Virus I) causes leukemia. The second human retrovirus was isolated in 1982.

A retrovirus has RNA as its genetic material. When the virus enters a host cell, a viral enzyme called reverse transcriptase uses the viral RNA as a type of template to assemble a corresponding molecule of DNA. The DNA travels to the cell nucleus and inserts itself among the host's chromosomes. Then, as the cell multiplies, these altered chromosomes are copied into the new cells produced.

The host cell for HIV is often a T4 lymphocyte, a white blood cell that has a central role in regulating the immune system. Once it is inside a T4 cell, the virus may remain latent until the lymphocyte is immunologically stimulated by a secondary infection. Then the virus reproduces itself at a very rapid rate, and the lymphocyte dies. The resulting depletion of T4 cells leaves the patient vulnerable to "opportunistic" infections by agents that would not harm a healthy person.

When a person is first infected, the immune system responds by making antibodies. That response is clearly not adequate, however, and the virus takes hold. In many cases, lymphocytes multiply abnormally in the lymph nodes. The nodes' structure collapses, and the number of lymphocytes in the blood decreases, leaving the patient open to opportunistic infections.

CDC STATISTICS

United States AIDS cases reported as of October 12, 1987:

Transmission Categories

	Males	Females	Total
Adults/adolescents:			
Homosexual/bisexual males	27,986 (71%)		27,986 (66%)
IV drug abusers	5,516 (14%)	1,460 (49%)	6,976 (16%)
Homosexual male and IV drugs	3,196 (8%)		3,196 (8%)
Hemophiliacs/coagulation disorders	407 (1%)	16 (1%)	423 (1%)
Blood transfusions	569 (1%)	317 (11%)	886 (2%)
Heterosexual contact	220 (1%)	710 (24%)	930 (2%)
Heterosexual, other countries*	544 (1%)	140 (5%)	684 (2%)
Undetermined	977 (3%)	312 (10%)	1,289 (3%)
Subtotal	39,415 (93%)	2,955 (7%)	42,370 (100%)
Children (under age 13)	318	277	595
Total	39,733	3,232	42,965

*"Persons without other identified risks who were born in countries in which heterosexual transmission is believed to play a major role although precise means of transmission have not yet been fully developed."

Age of Diagnosis

Age Group	Number of AIDS Cases	Percentage
0–5	518	1%
5–12	77	0
13–19	174	0
20–29	8,996	21
30–39	19,998	47
40–49	8,936	21
50+	4,266	10
Total	42,965	100%

State of Residence

Every state has recorded at least five AIDS cases.

States with More Than 1,000 Cases	Number	Percentage of U.S. AIDS Cases	Population* (million)	Cases per Thousand Population
New York	12,012	28.0%	17.77	0.7
California	9.747	22.7	26.98	0.4
Florida	2,946	6.9	11.68	0.3
Texas	2,894	6.7	16.68	0.2
New Jersey	2,552	5.9	7.62	0.3
Illinois	1,186	2.8	11.55	0.1
Pennsylvania	1,094	2.5	11.89	0.1

*Preliminary 1986 year-end figures from the Census Bureau.

Standard Metropolitan Statistical Area of Residence

SMSA's with More Than 1,000 Cases	Number	Percentage of U.S. AIDS Cases	Population* (million)	Cases per Thousand Population
New York	10,924	25.4%	9.12	1.2
San Francisco	4,096	9.5	3.25	1.3
Los Angeles	3,627	8.4	7.48	0.5
Houston	1,440	3.4	2.91	0.5
Washington, D.C.	1,278	3.0	3.06	0.4
Miami	1,183	2.8	1.63	0.7
Chicago	1,069	2.5	7.10	0.2

*Populations reported in the 1980 census.

Underreporting

The CDC has estimated that its statistics may be low by 20 percent, 10 percent for cases not reported and 10 percent for cases not diagnosed.

Even though California physicians are required by law to report AIDS cases to the California Department of Health Service, follow-up checking estimated undercounting at 17–25 percent in a study published April 1987.

Reporting Delays

The following table shows how the CDC AIDS case reporting figures change over time:

Year of Diagnosis	Reported End of Year					
	1983	1984	1985	1986	1987†	Ultimate*
Before 1979				11	11	11
1979	8	10	12	13	13	13
1980	45	46	47	51	52	52
1981	236	251	260	261	267	267
1982	932	976	992	999	1,013	1,013
1983	1,829	2,628	2,717	2,764	2,806	2,806
1984		3,780	5,341	5,531	5,641	5,705
1985			6,571	9,475	9,810	10,147
1986				9,897	13,954	15,210
1987					8,787	18,764

*Projected by Roland Mandat (Tillinghast-Denver) using techniques for estimating unpaid claim liabilities.
†Reported through the end of the third quarter, that is, before the change in the CDC's definition of AIDS.

EXPERIENCE OUTSIDE THE U.S.

Africa

The World Health Organization reported in June 1986 that there were estimated to be at least 50,000 AIDS cases in Central Africa, with 1 to 2 million people infected by HIV.

Among adults in Zaire, Uganda, and other African countries, the proportion of HIV-infected adults is 6 to 10 percent of the total population. African men and women are infected in roughly equal numbers, suggesting heterosexual transmission of the disease.

Australia

Through July 30, 1987, there have been 562 AIDS cases reported in Australia, of which 254 are still living. The distribution of cases by transmission category is: homosexual/bisexual male, 86 percent; blood transfusions, 7 percent; heterosexual transmission, 2 percent; and IV drug abusers, 0.5 percent.

By some estimates, about 30 percent of Australia's homosexual population is HIV+. It has been estimated that there are about 50,000 HIV carriers in Australia, approximately 0.3 percent of the total population.

Canada

Reported September 8, 1987 by the Laboratory Centre for Disease Control (LCDC):

Year of Diagnosis	New AIDS Cases in Canada
1979	1
1980	3
1981	6
1982	22
1983	53
1984	141
1985	314
1986	448
1987	245
Total	1,233

Of adult cases, 84 percent are homosexual/bisexual males, 0.4 percent are IV drug users, 5 percent were transmitted through blood transfusions, 2 percent are heterosexual partners of high-risk individuals, and 5 percent are persons from an endemic area.

U.K.

As reported in the October 5, 1987, report of the Department of Health and Social Security:

"There have been 1,067 AIDS cases reported in the U.K. through the end of September 1987. Further, microbiologists have reported 7,557 HIV+ cases to the Communicable Disease Surveillance Centre (CDSC) in England and the Communicable Disease (Scotland) unit. The cases are reported by category:"

	AIDS Cases		HIV+ Cases	
Category	Number	Percentage	Number	Percentage
Homosexual/bisexual male	901	84%	3,381	45%
IV drug abuser (IVDA)	15	1	1,184	16
Homosexual and IVDA	17	2	45	1
Hemophilia	60	6	1,061	14
Blood recipient	23	2	70	1
Heterosexual:		4		4
Contact of above groups	8		56	
Contact of other groups*	29		155	
No information			111	
Child of HIV+ mother	12	1	74	1
Other†	2	0	1,420	19
Total	1,067	100%	7,557	100%

*"Includes persons without other identified risk from countries where heterosexual transmission is believed to play an important role."
†Includes 1,255 "no information" HIV+ cases from England and 157 "other risks/not known" HIV+ cases from Scotland.

"(The HIV+) data must be interpreted with care as not all those people who have been infected with HIV presented for testing. It is currently estimated that about 40,000 people in the U.K. have been infected."

(Note: a January 10, 1987 article in the *Times* reported that leading specialists believe that between 40,000 and 100,000 people in Britain are now carriers.)

The HIV+ statistics come from stations set up in the U.K. to provide free HIV tests for whomever wants to be tested. Individuals' test results are strictly confidential and cannot be accessed by, for example, insurers or employers. Counseling is given before conducting the test, and post-test counseling is provided to HIV+ persons.

The progression of the AIDS epidemic in the U.K. is indicated by the growth in reported cases:

Year of Reporting	Cumulative AIDS Cases	Cumulative Deaths	Cumulative HIV+ Cases
1983	31	11	
1984	108	46	
1985	275	127	1,763
1986	610	280	3,877
1987*	1,067	605	7,557

*Through the end of September.

ESTIMATES OF THE INFECTION

1 to 1.5 Million—The Famous Figure

An estimate of the extent of the infection in the U.S. as of late 1986—Where did it come from?

Known as the "Coolfont estimates," they are part of the Public Health Service's official prediction. A group of about 10 scientists assembled in June 1986 at the Coolfont Conference Center in Berkeley Springs, W. Va.

The estimate:

Homosexual Men: estimated to be 4 percent of white men between ages 16 and 55 (1948 Kinsey data), assumed to be 18 percent infected.

Bisexual Men: estimated to be another 4 percent homosexual for three years or less plus another 10 percent bisexual (1948 Kinsey data), assumed to be 10 percent infected.

IV Drug Users: about 750,000 Americans use intravenous drugs at least weekly (National Institute on Drug Abuse data), assumed to be 30 percent infected. Another 750,000 use IV drugs less than weekly, assumed to be 10 percent infected.

Hemophiliacs: about 20,000, assumed to be 70 percent infected.

Other Groups: accounting for less than 10 percent of AIDS cases at the time, assumed to have a negligible rate of infection.

Summing these estimates produced a total of between 1 million and 1.5 million Americans infected with the AIDS virus in 1986.

The Coolfont projections assume that 20–30 percent of those infected in 1986 will develop AIDS by the end of 1991.

General Population Infection Rate

The U.S. population was 238.740 million in 1985. Assuming 1 to 1.5 million HIV infected results in a general population infection rate of about 0.5 percent. If those infections are generally among the 63.467 million males age 20 through 59 in 1985, the U.S. infection rate would be about 2 percent.

Lincoln National has published an estimate of prevalence of HIV+ cases under "probable scenario" assumptions. The mid-1987 HIV infection rate is estimated at 1.4 percent for males age 20–29, 3.4 percent for males age 30–39, and 2.3 percent for males age 40–49. These rates are based on 2 million persons infected in the U.S., eliminating certain classifications, such as IV drug users, not expected to be in the insurance market population.

At the Society of Actuaries annual meeting in Montreal on October 19, 1987, Howard Minuk (Chief Medical Officer of Mercantile & General Reinsurance in Toronto) gave these estimates of HIV+ prevalence among males age 20–59: 1.0 percent in Canada, 1.8 percent in the U.S., 4.0 percent in California, and 5.7 percent in Los Angeles.

U.S. Military Blood Tests

From October 1985 through March 1986, blood samples from 306,061 civilian applicants for military service from the U.S. were tested for HIV; 460 subjects were HIV+ (1.50 per thousand). Statistical breakdowns included:

Age: Prevalences increased directly and linearly with age from 18 years (0.25 per thousand) to 27 years (4.94). "These data suggest that teenagers and young adults have an appreciable risk of infection, and that the risk may be relatively constant and cumulative throughout this age group."

Sex: Sex-specific prevalences were 1.65 for males (263,572 tests) and 0.61 for females (42,489 tests).

Population Density: Low-density counties (less than 500 population per square mile) had a prevalence rate of 0.79 per thousand, while high-density counties had a rate of 5.70.

AIDS Endemicity: The prevalence rate among applicants from counties that were in metropolitan areas in which AIDS is considered endemic was 3.25. The rate for others was 1.25.

Insurance Test Results

The Home Office Reference Laboratory (HORL) in Shawnee Mission, Kans., reports these statistics for standard protocol HIV antibody tests performed in 1986 on specimens submitted to HORL by insurance companies:

Age	Percentage HIV+
1–19	0.25%
20–29	1.02
30–39	0.49
40–49	0.19
50–59	0.15
60+	0.04
All ages	0.30

The average HIV+ age was age 36.

Homosexuals

The homosexual population has been estimated to be over 50 percent HIV infected in San Francisco. It is thought that the homosexual infection rate is as low as 20 percent in other communities.

In a study of 799 homosexual/bisexual single men age 25–54 in San Francisco during the last half of 1984, seropositivity was 48 percent. The extent of the infection varied from 18 percent of those with no male sexual partners during the two years before entry to the study to 71 percent of those reporting 50 or more partners. Of the 65 men who gave a history of needle sharing within the past five years, 83 percent were HIV+.

The homosexual population, especially in areas of high concentration, has clearly changed practices to slow the spread of the disease. In San Francisco,

the increase in new infections has slowed to a rate of about 1 percent per year, down about 12–14 percent annually during the peak years of the spread from 1980 through 1982.

IV Drug Users

In New York state, which has the greatest concentration of heroin addicts in the U.S., 60 percent are believed to be infected with the HIV virus.

Hemophiliacs

These are an estimated 20,000 individuals with hemophilia in the U.S. About half of these require infusion of clotting factor concentrates once a week. Commercial clotting factor concentrates are prepared from pools of plasma from as many as 20,000 donors and have long been associated with transmittable infections such as hepatitis. About 50–75 percent of hemophilia patients are HIV+.

No evidence of exposure has been found prior to 1978. The majority of seroconversions occurred during 1981–1983. The chance of further infection is small now that clotting factor concentrates are routinely treated by heating.

HETEROSEXUALS

The Greatest Uncertainty

The "first wave" of the AIDS epidemic is occurring among the initial "at risk" groups—primarily homosexuals and IV drug users. The "second wave" of the AIDS epidemic, if there is one at all, will be among heterosexuals.

The size of this second wave will determine whether the AIDS epidemic will be only an enormous expense for the insurance industry or whether it will prove to be catastrophic for many companies. Even relatively low rates of infection will produce considerably more AIDS deaths than those that will result from the populations currently considered "at risk."

Projections like those of the CDC and the August 1987 Cowell-Hoskins paper are based on the assumption that the epidemic will remain within the first "at risk" groups. The basis for such an assumption would be the theory that heterosexual transmission will be limited primarily to the sexual partners of IV drug users and the female sexual partners of bisexual males.

If there is a second wave, why haven't we seen it yet? Three factors could explain why a second wave may be coming but years delayed from the first

wave. First, the risk of infection per exposure appears to be lower for heterosexual practices than for homosexual practices. Second, the progression from infection to disease may be slower for heterosexual transmission. Third, the circulation of exposure is slower in the heterosexual population than it was in the first wave "at risk" groups.

Further, it must be remembered that current AIDS case statistics are a result of infections from perhaps 10 years ago. The infections occurring now won't become AIDS cases for several years. The current 13-to-1 ratio of male to female AIDS cases may be quite different than current infection statistics. The military recruits HIV test results (see the "Estimates of the Infection" section) show a male to female HIV+ prevalence ratio of less than three to one.

Reported Cases

As of the October 12, 1987, CDC statistics:

	Males	Females	Total
Heterosexual contact	220	710	930
Heterosexual, other countries*	544	140	684
Total	764	850	1,614

*"Persons without other identified risks who were born in countries in which heterosexual transmission is believed to play a major role although precise means of transmission have not yet been fully developed."

Unreliability of Classifications

In a study by health department officials in Colorado, 20 military men were identified as infected by HIV. When they were interviewed by other enlisted personnel, 12 claimed heterosexual contact as their source of infection; but when they were reinterviewed by civilians, they described homosexual and bisexual practices.

Probability of Infection

A study published in August 1987 found 23 percent of 97 female partners of infected men were HIV+. All the women in the study had sexual contact within the last year with a man known to be seropositive for HIV or diagnosed as having AIDS or ARC. Women who used IV drugs or women with recent blood transfusions were eliminated from the analyses.

The number of sexual contacts was significantly associated with infection—seropositive women were 4.6 times more likely than seronegative women to have had more than 100 sexual exposures with their infected partner.

"The most likely interpretation of this funding is that each exposure is associated with a small probability of infection and that multiple contacts increase the probability of transmission."

In a 1987 survey of U.S. hemophilia treatment centers and physicians, 10 percent (77) of 772 spouses/sexual partners of HIV+ hemophiliac patients tested for HIV were seropositive.

Slower Progression Rate?

A section below discusses the rate of progression from HIV infection to AIDS. Studies available to date have been within the "first wave" risk groups. It is possible that the progression rate is slower for heterosexual transmission, just as the probability of infection per exposure seems to be less than for other risk groups.

Slower Circulation of Exposures

From a probability sampling of 1,034 single men age 25 to 54 in San Francisco:

No. of Sexual Partners in First Half of 1984	Homosexual Men	Bisexual Men		Heterosexual Men
		Male Partners	Female Partners	
0–1	29%	35%	83%	52%
2–9	44%	44%	15%	45%
10+	27%	21%	2%	3%

Over 20 percent of homosexual and bisexual men had more than ten partners in this half-year, compared with only 3 percent of heterosexual men.

Household Study

A study was undertaken to study the 45 spouses, 109 children, and 29 household contacts of 45 adult AIDS patients at the University of Miami School of Medicine. Enrollment in the study occurred at the time of AIDS diagnosis, with follow-up testing every 4 to 6 months for 1 to 3 years.

Of the 45 spouses, 13 were seropositive at the time of enrollment. The initial seropositive rate was 53 percent (9 of 17) for males and 14 percent (4 of 28) for females.

"The higher prevalence rate (for males) may be attributable to other factors, such as frequent other heterosexual contacts. Multiple other heterosexual partners were not noted among female spouses. When the seven male spouses with a history of other heterosexual partners were eliminated..., there was no significant difference... (20 percent for males, 14 percent for females)."

Of the 32 spouses who were seronegative at the time of enrollment, 13 seroconverted during the study.

"The length of sexual contact, number of contacts per week, and other types of sexual activity did not correlate with (HIV) antibody."

Experience varied greatly by category:

- Of the eight spouses no longer having sexual contact after enrollment, none became HIV+.
- Of the ten spouses who used barrier contraceptives after enrollment, one became HIV+.
- Of the other 14 spouses, 12 became HIV+.

Three of the eight HIV− male spouses converted to HIV+ during the study.

"In each instance, the female index patient acquired HIV infection from either blood transfusions or previous intravenous drug use. There was no identifiable risk factor for (HIV) infection in the three male spouses, nor did they have other sexual partners."

Ten of the 24 HIV− female spouses seroconverted during the study.

"We found that the seroconversion rate for male spouses (38%) was similar to that for female spouses (42%)."

Of the 109 children (age 3 months to 24 years), three had AIDS, ten had ARC, and two had LAS at the time of enrollment. All of these 15 children were less than four years old and had been born to HIV+ mothers.

"Two infants who were clinically and immunologically normal had (HIV) antibody when first tested at 3 and 6 months of age. Both became seronegative for (HIV) after 12 to 18 months of follow-up, suggesting passive transfer of maternal antibodies."

Two older children who were both sexually active young adults of Haitian ancestry who had spent about 13 years in Zaire before entering the U.S. were seropositive.

At entry to the study, 90 children were HIV−. None converted to HIV+.

Of the 29 adult household members, 20 were directly involved in the care of the AIDS patients in the household. All were HIV− at entry, and none converted to HIV+.

Link to Other Diseases

Heterosexual transmission is considered to be widespread in Africa, where there are often roughly equal numbers of males and females infected. Transmission may be higher in Africa than in developed countries because gonorrhea, genital ulcers, syphilis, and other sexually transmitted diseases are widespread. These often cause spores or ulcers in the genital epithelia and thereby make it easier for HIV to pass from one person to another.

Dr. Jay Levy, one of the two American discoverers of the AIDS virus, has been quoted as believing that the AIDS virus not only gives rise to opportunistic infections but is itself an opportunistic infection, flourishing in a body whose immune system has already been compromised by other agents, such as drugs, parasites, viruses, and malnutrition. That underlying immunodeficiency may be what the groups that have been associated with AIDS—namely, drug addicts, transfusion recipients, malnourished Africans and Haitians, and homosexuals—have in common. (Homosexuals are "immuno-compromised" as a group, exposed through multiple sexual contact to all sorts of fungal and bacterial infections routinely treated with antibiotics.)

PROGRESSION FROM INFECTION TO AIDS

Ultimate Level

No one knows what percentage of infected individuals will progress to full-blown AIDS. Early estimates were that only 20 percent would progress from HIV infection to AIDS. With the passage of time, it is now obvious that this early estimate was incorrect. Common estimates today are that 60 percent to 80 percent will progress to AIDS. Some have theorized that eventually 100 percent may progress to AIDS; some may simply have very long incubation periods of perhaps 20 years or more.

A research team in London claims to have identified genes that greatly affect the likelihood that a person infected by the AIDS virus will progress to AIDS. This work may be a basis for predicting that the ultimate progression percentage will be less than 100 percent.

Progression Studies

Data are very scarce, because it is usually not known when the virus was transmitted and when infection occurred. Some studies are available, however, to give some insight into the rates of progression from infection to AIDS:

- 83 cases of transfusion-associated AIDS diagnoses by 12/31/84 and reported to the CDC by 4/1/85 yield important data because the transmission date can be determined accurately.
- 543 subjects from groups at high risk of AIDS were studied at the University of Frankfurt from 1982 through 1985. This study is particularly valuable because it analyzed the progression through various discrete stages of the disease.
- 725 subjects in four separate HIV-infected populations in the U.S. and one in Denmark were studied for three years beginning in late 1982.
- Frozen blood samples dating back to 1978 for 719 San Francisco male homosexuals and bisexuals were available from a research project of Hepatitis B.

Initial studies have been among the highest risk groups. It may well be that different categories of transmission produce different patterns, rates of progression, and even ultimate levels of progression, to AIDS.

Progression Rates

The most significant data to date come from the Frankfurt study listed above. Two studies of these data have produced estimated progression rates from seroconversion to AIDS. The Cowell-Hoskins paper describes the Markov Chain model used in both studies. The second study was described by

Harry Panjer of the University of Waterloo in his paper dated August 24, 1987. The resulting progression rates are:

Years Since HIV Infection	Cowell-Hoskins		Panjer
	Annual	Cumulative	Cumulative
1	0.2%	0.2%	1.6%
2	2.5	2.7	8.1
3	9.9	12.4	18.8
4	12.9	23.7	31.3
5	12.7	33.4	43.7
6	12.3	41.6	55.0
7	12.5	48.8	64.6
8	12.9	55.5	72.6
9	13.2	61.4	78.9
10	13.5	66.6	83.9
11	13.8	71.2	87.8
12	14.1	75.3	90.8
13	14.3	78.8	93.1
14	14.5	81.9	94.8
15	14.7	84.6	96.1
16	14.9	86.8	97.1
17	15.1	88.8	97.8
18	15.2	90.6	98.4
19	15.4	92.0	98.8
20	15.5	93.2	99.1
21	15.7	94.3	99.4
22	15.8	95.2	99.5
23	15.9	96.0	99.6
24	16.0	96.6	99.7
25	16.1	97.2	99.8

The Panjer rates of progression are uniformly higher than the Cowell-Hoskins rates. This is generally because the Cowell-Hoskins study used the maximum length of the observation periods as an offset to the unknown time between progression and the current stage. The Panjer study was based on the average length of the observation periods.

MORTALITY

CDC Fatality Rates

United States AIDS deaths reported October 12, 1987:

Half-Year of Diagnosis	Number of Cases	Number of Known Deaths	Case-Fatality Rate
1981 (1)	86	78	91%
1981 (2)	181	164	91
1982 (1)	364	316	87
1982 (2)	641	560	87
1983 (1)	1,211	1,075	89
1983 (2)	1,580	1,354	86
1984 (1)	2,438	1,983	81
1984 (2)	3,179	2,551	80
1985 (1)	4,338	3,318	76
1985 (2)	5,437	3,825	70
1986 (1)	6,558	3,872	59
1986 (2)	7,456	3,133	42
1987 (1)	7,768	2,146	28
1987 (2)	1,652	259	16
Total	42,965	24,698	57%

Mortality Rates

From such statistics, mortality rates can be developed. An estimate was developed by Mike Cowell and Walter Hoskins as part of their August 1987 paper:

Years Since AIDS Diagnosis	Mortality Rate
1	45%
2	45
3	35
4+	25

ARC Mortality

AIDS certainly has an effect on mortality before the point of being classified as "CDC AIDS." There are documented deaths from ARC, and there have certainly been suicides by persons after finding out they are infected. Since these deaths don't fall under the CDC's surveillance definitions, no data are available.

DRUGS/VACCINES

Although just recently discovered, AIDS has been studied with such intensity that we know a great deal about the virus that causes it. The problems involved in HIV are so great, however, that there is little expectation of the discovery of a vaccine or a cure for AIDS at least within the next 5 years.

Plan of Attack

The virus can, hypothetically, be attacked at any of three points:

1. Kill the virus while it is still in the bloodstream,
2. Inhibit the action of the enzyme reverse transcriptase, preventing the RNA from producing its DNA copy and thus becoming part of the cell, and
3. Kill infected cells.

Human HIV antibodies do not kill the virus. The goal of a vaccine will be to cause the body to produce neutralizing antibodies that are different than those produced normally. This is not unusual; vaccines for polio and smallpox faced this obstacle.

It is unlikely that researchers will try to make a killed-virus vaccine such as is used against measles. If every last virus is not killed or weakened, such a virus might infect someone rather than protecting against the virus.

Another approach is to find a closely related, but nontoxic virus as a vaccine. Early smallpox vaccines used the cowpox viruses in this way. The goal will be to find a synthetic virus that is close enough to protect but far enough away not to cause disease.

Changing Target for Vaccines

HIV is like the flu virus—it keeps mutating into different forms. Just as an all-purpose flu vaccine does not exist, an AIDS vaccine may not be achievable.

Unlike many viruses that only have a few strains, HIV has many variants that form a continuum of related strains. An infected individual may actually harbor several strains of the virus. Although some neutralizing antibodies have been produced, all have been type-specific, neutralizing many but not all HIV variants.

AZT

Axidothymidine was formulated about 20 years ago as an anti-cancer drug. It was a failure in that role, but began being tested against AIDS in 1984.

A newer name for the drug is Retrovir (Zidovudine). The U.S. FDA authorized AZT for use in seropositive persons beginning September 15, 1987.

AZT follows the second plan of attack in the above list. The drug is a close chemical likeness of the virus' structure that forms DNA. When this likeness is supplied to an infected cell, reverse transcriptase incorporates it into a growing DNA chain. The likeness is enough different from the virus, however, that the altered DNA cannot integrate itself into the chromosomes or provide the basis for viral replication. Thus, the spread of the virus is stopped.

The cost of administering AZT is expected to be about $10,000 per year, and there appear to be serious side effects, requiring additional lab testing and blood transfusions. One serious side effect is the gradual destruction of the bone marrow.

A study of 160 AIDS and 122 ARC patients for 24 weeks revealed:

	AIDS		ARC	
	AZT	Placebo	AZT	Placebo
Probability of survival for 24 weeks	96%	76%	100%	81%
Probability of opportunistic infection in 24 weeks	36%	54%	9%	30%
Probability of death after 36 weeks (follow-up study)	6%	39%		

"The finding that AZT delayed progression to AIDS and resulted in sustained increase in level of CD4 cells in many patients with ARC suggests that AZT may be particularly beneficial to patients with less severe HIV infection."

It appears that AZT slows the progression of the disease but cannot reverse it. The impact on life insurance claims is apparently minor (simply pay the claim a little later). The impact on health and disability coverage should be major ($10,000 per year for the drug, plus a longer period of illness before death).

Ampligen

Described as "an experimental nontoxic drug," Ampligen "behaves like an artificial virus and causes the body to produce its own interferon." Announcing it in June 1987, the research team claimed the drug "showed ability both to strengthen the body's natural immune system and to suppress the

AIDS virus in patients with ARC and LAS." The U.S. FDA has approved a 6-month study of the drug.

Peptide T

The federal government has authorized tests on humans of a synthetic substance that appears to have a powerful inhibiting effect on the AIDS virus in laboratory experiments. Peptide T is a synthetic copy of a naturally occurring messenger chemical that permits communications between the brain and nerve cells. It appears to be able to block the virus from penetrating the cell membrane because it contains a pattern of amino acids similar to that of a piece of the AIDS virus. The hope is that Peptide T could prove effective as a vaccine against the AIDS virus.

Castanospermine

The National Cancer Institute has selected this "natural substance" drug for tests in animals. The drug is extracted from the seeds of an Australian chestnut tree. It appears to halt reproduction of the AIDS virus in the test tube.

MODELS

Micro vs. Macro

The first choice in designing a mathematical model to project AIDS claims is the level of detail to be modeled.

A "micro" model attempts to make projections from the finest level of detail, that is, the spread of the infection is modeled from assumptions about individual behavior. Example assumptions would be the frequency of different types of exposure, the frequency and number of different partners, and probability of infection per exposure by type of exposure.

The greatest difficulty with micro models at present is that the assumptions made are largely guesswork because there is so little known about individual exposure statistics. Further, there is no way to verify modeled results, because AIDS cases data generally are not available on a number and type-of-exposure basis.

Some AIDS micro models have been developed, however, and they are useful in understanding the spread of the virus. They also can be useful in helping to determine the reasonableness of assumptions for macro models.

Macro models begin by identifying a certain "at risk" population. They then assume a certain spread of the infection within that population. No specific assumptions are made about details such as the underlying number of exposures per individual and the probability of infection per exposure.

Key Assumptions

The major macro model assumptions are:

"At risk" Population: All AIDS cases are assumed to occur within this subgroup of the general population. An example group would be a percentage of males age 20–60. In determining what percentage of the general population in this category is "at risk," choices range from using a smaller percentage (the "most" at risk) with higher rates of infection to using a higher percentage with a lower infected proportion. Another consideration is whether the group should be subdivided into different at-risk populations with different assumptions. For example, males in their 20s will have a different level and pattern of infection spread than males in their 50s.

Infection Spread: The progress of the infection through the at-risk population, from the beginning of the spread through the end of the modeling period.

Progression from Infection to AIDS: The rates of conversion to AIDS (or perhaps ARC, if modeling medical or disability claims) after HIV infection. Different progression rates may be assumed for different at-risk populations, for example, heterosexual vs. homosexual groups.

AIDS Mortality: The rates of death from AIDS diagnosis.

Verification

While it can't be determined whether any model is "right," it is important to compare modeled AIDS cases and AIDS deaths with actual past experience to determine the reasonableness of results. It is important, in this process, to take account of the effects of reporting delays and underreporting.

Further "verification" of the reasonableness of modeled results can be made by comparing model projections to other commonly used projections such as the CDC projections. It must be remembered, however, that common acceptance of a particular projection doesn't make it valid—no one knows the course this epidemic will take in the future.

Insurance Models

Once a general epidemic model has been constructed, adjustments are made to fit the model to a specific insured population. Factors to consider

include geographic distribution, distribution system, market, product, and underwriting standards. Because of changing forces in antiselection and underwriting, different assumptions might be used for business issued in different eras. A large part of fitting the model to an insured population is verification based on experienced AIDS claims.

Further assumptions required for insurance modes include claim size and, for medical and disability coverages, claim frequency and duration.

Trend Projection

Even model results that seem to be "verified" by reproducing historical AIDS statistics must be viewed in consideration of future changes in the course of the epidemic. Factors to consider include changes in the behavior of at-risk individuals, the possible spread of the epidemic beyond the "first wave" at-risk population, and the effects of vaccines and treatments.

LIFE COVERAGE

Net Single Premium Comparison

The following net single premium values give a rough indication of the impact of AIDS mortality on life insurance claims:

	Net Single Premium per Thousand Using	
	5.5% Interest	7.0% Interest
Newly HIV+ cohort, considering AIDS death rates* only	$573	$502
Newly diagnosed AIDS cohort, considering AIDS death rates* only	876	849
Male age 35 alb, 1980 CSO mortality	163	111
Male age 35 alb, 500% of 1980 CSO mortality	346	274
Male age 35 alb, 1975–80 Basic Table select mortality	134	86
Male age 35 alb, 500% of 1975–80 Basic Table select mortality	277	208

*These calculations use assumptions to show relative magnitudes only. Deaths and progression to AIDS are assumed to occur at the end of the year. Assumptions are:

Years Since Infection/Diagnosis	Rate of Progression from Infection to AIDS	Rate of Death from AIDS Diagnosis
1	0.2%	45%
2	3	45
3	10	35
4+	15	25

Insurance Company Experience

A 1987 survey by Mel Young (Tillinghast-Darien) of 28 U.S. reinsurers produced these results:

	AIDS Claims As a Percent of Total			
	By Number		By Amount	
	1985	1986	1985	1986
Reinsurance Accepted	0.5%	0.9%	0.9%	1.7%
Direct Issues	0.1	0.2	0.6	1.1
Total	0.3	0.4	0.8	1.5

Death Claim Projections

Models such as the one described in the Cowell-Hoskins paper generally project AIDS death claims in the mid-1990s around 15% of projected individual life claims, assuming no appreciable amount of heterosexual transmission.

Results are highly dependent on the assumptions used in the projection. Results are vastly different by age group. Further, there will be tremendous variation by company. Each company needs to model its own situation to measure the impact of AIDS on its business. For further explanation, see the "Models" section.

HEALTH COVERAGE

Cost Estimates

Data on the costs of treating AIDS patients are hard to come by. The following are some examples of estimates that have been published:

- The CDC estimated lifetime hospital costs of $147,000 per AIDS patient in a report released January 1987. The estimate was based on a lifetime use of 168 hospital days, an average survival time of about 13 months, and an $878 average charge per hospital day (including inpatient professional charges). AIDS patients average 3.2 hospitalizations per patient per 12-month period. The length of each hospital stay was generally in the 15- to 25-day range.
- A State of California study released in April 1987 estimated average billed lifetime medical costs of $70,000 per AIDS patient. This was based on an average life expectancy of 18 months after the onset of AIDS. The averages ranged from only $61,000 in San Francisco to $88,000 in Los Angeles to $102,000 in San Diego. The average

hospital inpatient length of stay was 13.6 days, ranging from only 11.4 days in San Francisco to 15.8 days in Los Angeles to 17.9 days in San Diego.

- ARC medical costs were estimated at $752 per month in the above California study. No lifetime estimate was made because they had no estimate of ARC life expectancy.

Treatment Variations

AIDS care in San Francisco is apparently about the best available, and it is achieved at about the lowest cost. A substantial support network has been developed in the homosexual community there. Nonprofit organizations provide counseling and coordination of outpatient help and care.

Hoping that the low costs in San Francisco can be repeated, the U.S. Public Health Service announced in October 1986 a $15-million program to fund AIDS home care hospice, case-management, and counseling. The program is targeted at the four areas hardest hit by the epidemic—New York, Los Angeles, San Francisco, and Miami.

AIDS patients are typically hospitalized about three times before death. In San Francisco, the average length of hospital stay has been 21 days, compared to 17 days in Los Angeles and more than 25 days in New York (1986 data).

Those treatment variations strongly support the need for managed care among AIDS patients. Prompt identification of AIDS patients for large case management can provide the most cost-efficient and -effective treatment practices.

Changing Costs

AIDS medical costs have apparently decreased over time, because of better understanding of the disease (especially its terminal nature) and because of better organization of treatment options.

AIDS drugs, however, are likely to increase costs dramatically. This is due to the costs of the drugs, the prolonged life expectancy of patients that may be achieved, and the treatment of side effects of the drugs.

Underwriting Implications

For individual and small-group policies, the underwriting implication and required actions are similar to those necessary for life insurance. Because of the time that may exist between HIV infection or even initial AIDS symptoms and substantial medical expenses, normal preexisting exclusion

clauses may not be as effective in determining antiselection against health carriers.

This puts a greater burden upon medical underwriting selection in order to avoid an adverse distribution of risk. In response, companies are raising the minimum number of lives required for nonmedical issue, strengthening medical questionnaires, and requiring more attending physicians' statements. These standards may apply in large groups to COBRA extenders.

Other group underwriting standards, including excluded industries, minimum group sizes written, and prior number of carriers, should be reviewed.

DISABILITY COVERAGE

Disability AIDS Risk vs. Life AIDS Risk

A first impression is that disability insurance is relatively insulated from the AIDS risk because of the high mortality rate of AIDS patients. However, the expected number of monthly payments on a regular disability claim is not as long as one might expect:

	Average Monthly Payments for "To Age 65" Contract	
Age at Disability	30-Day Elimination Period	90-Day Elimination Period
50	11	29
40	14	36
50	15	38

With a life expectancy of about 2 years from the diagnosis of AIDS, the expected length of claim is not dissimilar between AIDS claimants and other claimants with a "To Age 65" benefit period. The primary disability insurance risk, as with life insurance, is the impact of AIDS on incidence of claims. In addition, drugs like AZT may lengthen the life expectancy of an AIDS patient, but not improve health sufficiently to allow return to work.

Group Disability Insurance

Group disability insurance has a significantly smaller AIDS risk than individual disability insurance.

- A group insurer may increase the rates of a case experiencing AIDS claims. On the other hand, the owner may choose to move the coverage to another insurer, leaving the first insurer with the AIDS claims.

- Group underwriting essentially eliminates the individual antiselection potential associated with individual insurance.
- It is easier for a group insurer to vary rates by state.
- Most group disability products integrate with Social Security, and most AIDS patients qualify for Social Security disability payments.

Individual Disability Insurance

The large majority of individual disability business involves noncancelable contracts (that is, rates and renewability guaranteed). Furthermore, noncancelable rates for most plans do not anticipate AIDS experience.

Guaranteed renewable contracts (that is, guaranteed renewability only) may increase rates, but such action can lead to high lapses of healthy insureds.

Additional risk exists from those HIV + insureds not having progressed to AIDS to go on disability either as a result of involuntary termination of employment or voluntary termination because of fear of passing the virus to other people through normal duties of occupation. This latter situation might occur with doctors or dentists.

In states that restrict or prohibit HIV blood testing, companies should consider eliminating shorter benefit periods and requiring Social Insurance Supplement riders.

Market Trends in Individual Disability

There is a trend to writing more individual disability insurance on small group cases with a minimum of three lives. This market can reduce the antiselection risk, but some of the more liberal underwriting requirements introduced to this market during the last several years should be reviewed with respect to the increased exposure to the AIDS risk. Premiums for this market are typically discounted by 10–25 percent. This practice should be reviewed in light of the overall adequacy of the guaranteed rates.

Some companies have aggressively sought the endorsement of their products by professional associations. This has been accomplished with premium discounts and some underwriting guarantees. There is more opportunity for antiselection in the association market.

Individual Underwriting

Companies are introducing blood testing—generally for amounts ranging from $2,500 to $4,000. One company uses a $3,000 testing limit in most states but $2,000 in states with higher concentrations of AIDS victims.

Claims Experience

Companies are seeing an average number of payments on closed AIDS claims ranging from 7 to 13 months. This average reflects a high proportion of early deaths and should increase with time.

Many companies have not observed a significant percentage of AIDS claims in the first two policy years. However, the potential antiselection from HIV+ applicants extends far beyond the first two policy years.

Claim Reserves

Tabular claim reserves should be based on a different continuance table for AIDS claims. For non-AIDS claims, the recovery pattern causes increases in claim reserves with duration of claim, which is inappropriate for AIDS claims. Even though some AIDS claimants have returned to work, it may not be appropriate to release the claim reserve because the claimants will most likely go back on claim.

If the Incurred But Not Reported formula were developed by using past experience, they may not anticipate an appropriate level of AIDS claims.

Policy Reserves

Policy reserves based upon the 1964 CDT may be conservative enough to absorb the AIDS risk on business written prior to 1983 or 1984. However, the antiselection from new business, particularly in states that restrict or prohibit blood testing and its impact on reserve adequacy should be examined separately. If companies adopt the Commissioners Individual Disability "Table A" valuation basis, policy reserves on new business will decrease significantly, leaving less cushion to absorb the AIDS claims.

COWELL-HOSKINS PAPER SUMMARY

Epidemiological Model

A "macro" model is used to model the spread of the infection through an assumed "at risk" population of 750,000 IV drug users and 3 million homosexuals. An underlying theory is taken from patterns of past epidemics.

At a rate of transmission, "*a*," from infected to noninfected persons the spread of the infection is modeled from 0 percent of the population (before 1975) to 100 percent of the population (assumed in the year 2000). An

alternative assumption stops the spread by 1997 at about two-thirds of the at-risk population being infected. The assumption in all scenarios is that 27 percent of the risk group is infected as of early 1987.

The rate of the spread of the infection is slowest at the beginning (when there are few infected persons to infect others) and at the end (when there are few noninfected persons to be infected). This produces the classical S-shaped curve that has been seen in historical epidemics.

Progression from Infection to AIDS

A Markov Chain model is used to study the progression of the disease through five stages, that is, At Risk But HIV−, HIV+ But Asymptomatic, LAS, ARC, and CDC AIDS. The results of the study are shown in the "Progression from Infection to AIDS" section of this chapter.

AIDS Mortality Rates

CDC statistics are analyzed to obtain the mortality rates shown earlier in the "Mortality" section of this chapter.

Verification of the Model

Applying the assumed new infections each year to the assumed progression rates and the assumed AIDS mortality rates produced modeled AIDS deaths in each year that are similar to the CDC's past reports and projections through 1991. Indeed, the assumed infections were obtained by experimentation until this approximate reproduction of CDC AIDS deaths was achieved.

Projection Results

Three scenarios are modeled:

Year	Cumulative Infections	*Cumulative* Cases	*Cumulative* Deaths
"Infection continues to 100% of at-risk group"			
1987	919,566	46,864	30,018
1991	2,312,760	255,092	177,796
2000	3,687,388	1,937,640	1,602,979
"Infection declines to zero by 1997"			
1991	1,945,951	252,266	176,336
2000	2,485,433	1,554,819	1,316,711
"Infection stops in 1987"			
1991	919,566	236,244	167,827
2000	919,566	748,409	678,493

Implications for Life Insurance

Under simplified assumptions, projections of U.S. AIDS-related life claims through the end of this century are:

- More than $30 billion from individual business in force 12/31/86 with approximately $14 billion in claims from those already infected and another $18 billion from those that will become infected,
- $20 billion from group business in force 12/31/86, and
- $20 billion from new individual business if no testing is done.

By the mid-1990s, total individual life AIDS claims could exceed $2 billion annually or about 15 percent of projected individual life insurance claims for all U.S. companies.

TESTING

AIDS Antibody Tests

A blood test for the antibody produced in response to the HIV was implemented in March 1985 for all blood donations. The standard test protocol is so accurate that the U.S. blood supply has been considered safe since that time. Later in 1985, insurers began testing for HIV on large-risk applications. Tests available include:

ELISA (Enzyme Immunosorbent Assay): The ELISA test is designed to be sensitive because its primary purpose was to prevent contaminated blood from being used for transfusion. This test is inexpensive and is used to screen out most negative samples. The charge to an insurer for a standard protocol (see below) test is generally less than $10.

Western Blot: This test is specific for the AIDS antibody. It is expensive (about $90 per test) and is usually used to identify actual positive samples after two ELISA screens.

T-Cell Ratios: These tests look for abnormally low T-cell counts or an abnormally low ratio of T-helper cells (T4) to T-suppresser cells (T8). The cost to an insurer for this test is about $35. The test is not specific to AIDS. About 4 percent of the general population would fail a T-cell test. Worse, the test appears to miss approximately 15 percent of HIV+ cases.

Test Protocol

A negative ELISA result is interpreted as seronegative.

To be considered seropositive, the standard test protocol requires two positive (repeatedly reactive) ELISA tests followed by a positive Western

Blot test. This is one of the most accurate tests used in insurance underwriting. The number of false positives is considered to be less than one out of 100,000.

In states that prohibit the use of antibody tests (California and, temporarily, Wisconsin), the less sensitive and less specific tests of T-cell ratios are used to measure the immune competence of the individual.

Seroconversion Delay

Because the tests measure antibodies to HIV rather than the virus itself, they cannot detect infection until enough antibodies have been produced. Typical times between infection by the virus and seroconversion are between six to eight weeks, although reported cases have been documented as taking up to eight months. It is possible that this time delay could be longer for heterosexual transmission.

Virus Tests

Inexpensive tests may be available soon that detect the virus itself rather than antibodies to the virus. This development would eliminate the problems associated with "false negative" results because of seroconversion delay. Virus tests to date, however, are useful only before a large number of antibodies have been formed; thus these tests may be only a supplement to, rather than a replacement for, the antibody tests.

UNDERWRITING

Testing Limits

The largest need for AIDS exists at the issue ages that have the highest nonmedical issue limits. Most companies responded by establishing AIDS blood testing procedures at low levels in 1987.

In a May 1987 survey conducted by Denise Fagerberg (Tillinghast-Irvine), 1986 and 1987 HIV blood test limits were obtained for 21 of the 26 top producing life insurance companies in the U.S. Among the survey results were:

- Two companies had no established blood testing limit.
- Seven implemented or changed limits in 1986.
- Three had already changed limits in 1987.
- Eight were in the process of lowering the current limits within the next two months.

Although the survey showed a definite trend toward decreasing blood testing limits, there was no change in nonmedical limits from 1986 to 1987. In a few cases, the blood testing limits were lower than nonmedical limits.

The blood testing limits ranged from around $100,000 to more than $500,000, with a median of about $250,000. These results were measured in May 1987; it is important to remember that these limits are in the process of change during 1987.

Given the high cost of insuring an infected individual, it appears that testing limits could be justified at levels that apply to most new business applications.

Guidelines

AIDS testing and underwriting is an extremely sensitive issue. The "State Regulations" section that follows discusses state regulation of AIDS tests, underwriting rates, and application questions. Some basic underwriting guidelines are:

- Sexual orientation is not to be used in underwriting.
- Tests should be used on a nondiscriminating basis. Rules should apply equally to males and females and to marrieds and singles.
- There must be a valid reason for ordering the test. A routine "age and amount" basis is acceptable.
- The applicant should be notified in writing and should sign a permission slip for HIV tests.
- Strict confidentially must be maintained. The agent should not be given the test results. For employer-sponsored insurance, the employer must not be notified of the reason for the declination.
- An effort should be made to have the applicant discuss the test results with his or her physician. The applicant should be notified in writing that coverage was declined for an important reason and that you wish to correspond with the applicant's physician but need permission to release that information.

Medical Information Bureau

The MIB announced in mid-1987 that it will no longer keep records that show an applicant for insurance has tested positive for AIDS virus antibodies. Instead, information will be maintained only for nonspecific blood-test codes. MIB says that its decision is designed to assure confidentiality in AIDS testing of insurance applications.

ANTISELECTION

Transamerica Life Companies Experience

As reported by Lloyd Von Sprecken, Vice President, Underwriting:

- Business issued prior to 1980, when no one knew of AIDS risk—average AIDS death claim amount is less than one-half the average amount for claims for all causes.
- Business issued 1980 through 1983, when awareness of the disease was amongst the groups at highest risk—average AIDS death claims soared to more than five times the average size claim.
- Business issued 1984 and after, when medical directors and underwriters became aware of the mortality problems AIDS would create—average AIDS claims dropped to about three times the average.

Insurance Company Surveys

Denise Fagerberg (Tillinghast-Irvine) conducted informal surveys of life insurance company AIDS claims:

- *1985 Ordinary Life Claims*: 106 companies reported 438 AIDS claims. The average size AIDS claim was $53,600; the average size of the total claims was $7,000.
- *1986 Ordinary Life Claims:* 158 companies reported 1,913 AIDS claims. The average size AIDS claim was $44,500; the average size of the total claims was $8,400. The AIDS claims represented 0.05 percent of claims by volume and 0.2 percent by number.

STATE REGULATIONS

Examples of state AIDS regulations are given below.

NAIC Model

The NAIC released a proposed bulletin regarding "Medical/Lifestyle Questions and Underwriting Guidelines" in March 1987. Major provisions are summarized below:

- Sexual orientation may not be used in the underwriting process, and application questions may not be directed at this issue.
- Questions relating to the actual presence of AIDS or ARC are generally permissible.
- No adverse underwriting decision shall be made because the applicant has demonstrated AIDS-related concerns by seeking counseling from health care professionals.
- The use of AIDS tests must be revealed to the applicant, and written consent must be obtained. Established test protocol must be followed.
- An insurer may impose territorial rates for rating an applicant for health or life insurance if the rates are based on sound actuarial principles or are related to actual or reasonably anticipated experience.

District of Columbia

An act passed by the City Council in mid-1986 prohibits insurers from using any AIDS test in underwriting or rate-making. The act also prohibits the use of personal characteristics for the purpose of seeking to predict the risk of developing AIDS or ARC. The act does not prohibit refusing to insure or rating an applicant who has actually been diagnosed as having AIDS, providing compliance with certain procedures.

California

The use of AIDS antibody blood tests is prohibited, thus restricting testing in California to T-cell ratio tests.

Regulations prohibit refusing coverage because the applicant is homosexual or bisexual. This prohibition includes the use of special underwriting standards in certain geographical areas or occupations.

Wisconsin

An earlier prohibition against the use of HIV antibody testing was withdrawn after the state epidemiologist found that the standard test protocol "is highly predicative of a true infection with the HIV virus." The standard test protocol is still prohibited for individually underwritten group contracts, however.

Maine

Insurers must obtain written consent for AIDS testing on a approved form. All persons tested must be offered post-test counseling that provides test results, social and emotional consequences, preventive practices, and referrals for medical care and support services.

New York and Massachusetts

These insurance departments are attempting to adopt regulations prohibiting AIDS testing, at least for health insurance. Temporary court restraining orders have blocked the regulations at present.

Applications

AIDS-related questions on insurance applications must be specific. States vary widely in the questions and wording they will accept. Some states will no longer approve questions they once permitted.

Health Insurance Mandates

Some states have discussed requiring coverage of AIDS-related services, such as requiring coverage of AZT whether or not the contract has a prescription drug benefit.

AIDS Exclusions

A couple of states have regulations that would prohibit the exclusion of coverage for the treatment of AIDS or its complications. The prohibition also applies to the placing of dollar limits on the benefits payable for such illnesses (other than overall policy maximums).

MAJOR REFERENCES

1. "A Crisis in Public Health," *The Atlantic*, October 1985, pp. 18–41.
2. "AIDS = An Industry in Dire Straits," by David K. Nelson, *Best's Review*, May 1987, pp. 20–26, 130–131.
3. "AIDS: A Legislative Update," by Brice Oakley of the Blue Cross and Blue Shield Association, August 19, 1987.
4. "AIDS: Experts Predict Epidemic Will Place Heavy Burden on Society," *Los Angeles Times*, December 8, 1986.
5. "AIDS, HIV Mortality and Life Insurance," by Michael J. Cowell and Walter H. Hoskins, published by the Society of Actuaries, August 1987.
6. "AIDS: Just the Facts...From Specialists at Johns Hopkins," *Johns Hopkins Magazine*, December 1986, pp. 15–27.
7. "AIDS: Survival Analysis of Persons Testing HIV+," by Harry H. Panjer of the Department of Statistics and Actuarial Science of the University of Waterloo, August 24, 1987.
8. "AIDS Weekly Surveillance Report," from the Centers for Disease Control, October 12, 1987.
9. "An Updated Quantitative Analysis of AIDS in California," by Kenneth W. Kizer, John Rodriquez, and Gary F. McHolland, April 1987.
10. "Blood Transfusion and AIDS," by Harvey G. Klein and Harvey J. Alter, *AMA-Information of AIDS for the Practicing Physician*, Volume Two, pp. 7–10.
11. "Estimates of the Direct and Indirect Costs of Acquired Immunodeficiency Syndrome in the United States, 1985, 1986, and 1991," by Anne A. Scitovsky and Dorothy P. Rice, *Public Health Reports*, January-February 1987, Vol. 102, No. 1, pp. 5–17.
12. "Evaluation of Heterosexual Partners, Children, and Household Contacts of Adults with AIDS," *Journal of the American Medical Association*, February 6, 1987, Vol. 257, No. 5, pp. 640–644.

13. "HIV Infection: Its Impact on Mortality and Underwriting," by Jess L. Mast, *Lincoln National Reinsurance Reporter*, Issue No. 113, July 1987.
14. "Human Immunodeficiency Virus Infections among Civilian Applicants for United States Military Service, October 1985 to March 1986," *The New England Journal of Medicine*, July 16, 1987, Vol. 317, No. 3, pp. 131–136.
15. "Male-to-Female Transmission of Human Immunodeficiency Virus," *Journal of the American Medical Association*, August 14, 1987, Vol. 258, No. 6, pp. 788–790.
16. "Quarterly Figures on AIDS," a press release of the Department of Health and Social Security (U.K.), October 5, 1987.
17. "Revision of the CDC Surveillance Case Definition for Acquired Immunodeficiency Syndrome," *Morbidity and Mortality Weekly Report,* Supplement, August 14, 1987, Vol. 36, No. 1S.
18. Dr. Bill Roberts of the Home Office Reference Laboratory, phone conversations and letter.
19. "Selected Sexual Practices of San Francisco Heterosexual Men and Risk of Infection by the Human Immunodeficiency Virus (letter to the Editor)," by Warren Winkelstein, Jr., Michael Sammuel, Nancy Padian, and James Wiley of the University of California Berkeley, *Journal of the American Medical Association*, March 20, 1987, Vol. 257, No. 11, pp. 1470–1471.
20. "Sexual Practices and Risk of Infection by the Human Immunodeficiency Virus: The San Francisco Men's Health Study," *Journal of the American Medical Association*, January 16, 1987, Vol. 257, No. 3, pp. 321–325.
21. "Summary Report on AIDS in California: Quantitative Analysis," Department of Health Services, January 9, 1986.
22. The AIDS Epidemic: Looking into the 1990s," by Jeffrey E. Harris, *Technology Review*, July 1987, pp. 58–64.
23. "The AIDS Virus," by Robert C. Gallo, *Scientific American*, Volume 256, January 1987, pp. 47–56.
24. "The Efficacy of Azidothymidine (AZT) in the Treatment of Patients with AIDS and AIDS-Related Complex," *The New England Journal of Medicine*, July 23, 1987, Vol. 317, No. 4, pp. 185–191.
25. "The Projections: Guesses Based on Guesses," by Don Colburn, *The Washington Post*, June 2, 1987, p. 14.
26. "Update: 'AIDS' in Canada," The Federal Centre for AIDS, September 8, 1987.

CHAPTER 3

AIDS, HIV MORTALITY AND LIFE INSURANCE

FOREWORD

Acquired Immune Deficiency Syndrome was first identified clinically in 1981. However, it was some time before the epidemic became a serious issue for the general public.

Until about 1984, most accounts in the popular press identified the disease with its principal group of victims, young homosexual males. In the minds of most of the general public, AIDS was not a concern for them personally. This same general attitude prevailed in the life and health insurance community.

Few insurers thought in terms of the numbers of their policyholders, existing or prospective, who might be infected. Not until the Centers for Disease Control and the Surgeon General issued warnings of the epidemic spread of the disease did life and health companies begin to recognize its serious potential consequences for their operations. Most companies kept no records of AIDS-related deaths, disabilities or medical claims until 1985. It was 1986 before industry-wide attention was given to the actions that insurers needed to take in order to manage the impact that this epidemic could have on the financial soundness of their companies.

As of mid-1987, most writers of individual insurance that obtain medical evidence in their normal underwriting procedures are, within the requirements of laws and regulations in the jurisdictions in which they operate, testing applicants at specified ages and amount levels for HIV, the Human Immunodeficiency Virus. Few major life and health insurers believe that they have not paid at least one AIDS-related claim. For many, the numbers of claims so identified are amounting to several dozen and are growing monthly. The largest insurers in North America have already paid life, disability and medical claims numbering in the thousands. Estimates of the financial impact of the disease to date are still fragmentary and are a subject of this joint special report.

Estimates of AIDS-related life insurance claims based on company survey figures indicate that in 1986 alone they amounted to $100 million on individual policies and almost another $100 million under group insurance, or about 1 percent of total life claims paid. Taking into account claims prior to 1986 and AIDS-related disability income and medical insurance claims, the industry has already paid out several hundred million dollars on claims resulting from complications of HIV infection.

Concerned that the impact of this epidemic could overwhelm the life and health insurance industry both financially and in terms of lack of reliable data on which to act, the Society of Actuaries in April 1987 formed a Task Force on AIDS. One member of that Task Force has been heavily involved since early 1986 with regulatory proposals in his home state that would restrict insurers' prerogatives to test for HIV infection in new applicants. He felt that his research and that of his co-author might be of value to the Society in advance of the Task Force's report.

The information presented in this joint special report is the work of the two authors. The views expressed are theirs and do not necessarily reflect those of the three Sections.

It is also hoped that much of this research will be valuable to the Society's Task Force on the subject, but the data and the opinions in this joint special report should not be construed as representing the views of the Task Force or of the Society of Actuaries as a whole.

The two authors subjected their research to the review of actuaries, epidemiologists and life insurance medical directors in Canada, the U.S., Britain and other countries in Western Europe. We greatly appreciate the extensive and thorough analyses by our reviewers. We incorporated numerous changes in this final version of our report to reflect their comments and suggestions.

Like most researchers of the subject, we have amassed a vast quantity of literature in a short period. In assembling our information and in our attempts to present it in a cohesive fashion, we have been acutely aware of the need of our members for data they can put to work quickly and of the demands of our profession that our work be reliable. We recognize that we are researching on the fringes of epidemiology, where neither of us claims expertise, but we sensed that we had, nevertheless, reached a number of observations that could help ". . . substitute facts for appearances and demonstrations for impressions." Accordingly, we concluded that, on balance, our responsibilities could best be met by presenting our research at this time as an interim report of our findings.

In both gathering and analyzing our data, we relied on traditional approaches that may be loosely defined as falling within the subject matter of what were previously Parts 3, 4 and 5 of the Society's examination syllabus. In many situations, however, we resorted to approaches that are not referenced in the Society's literature. Our professional responsibility to rely on "facts" was tested in numerous instances where we needed information that existed only as fragmentary reports from items in the written or spoken news media. This was particularly problematic in the section of our report on the

extent of the spread of HIV infection in the general population and in the insured population, and our estimates of its financial impact on insurance operations.

Our general approach was to validate as much of our information as possible with hard data from reliable sources. This was not always possible, and our projections must be interpreted in light of the paucity of data currently available.

Throughout this process, we were keenly aware that we would be presenting our findings long before all the "facts" became available. Indeed, we recognized that any report on this subject that waited for all the available facts would not be written in time for meaningful action to be taken. We incorporated some information in our report that did not become available until a few days before we went to press. This information was significant enough that we felt it should be included even though it could not all be fully validated.

Although the focus of this report is on life insurance, we believe that much of our research is also applicable to disability income and medical care coverages. Indeed, the part of our analysis that projects the progression of HIV infection through its various stages may be especially helpful to researchers attempting to project the financial impact of complications of HIV infection on disabilities and medical care costs.

Before proceeding into the body of our report, the reader might reflect on the efforts of an earlier researcher faced with the challenge of developing reliable information from fragmentary sources. In 1662, John Graunt constructed the first English life table from the crude records of births and deaths that he found in parish churches—the only data then available.

Reviewing that work at the tercentenary of its publication, a modern epidemiologist observed:

"Graunt did not wait for better statistics; he did what he could with what was available to him. And by so doing, he also produced a much stronger case for supplying better data."*

The authors will be satisfied if this joint special report is received in the spirit of the pragmatic ideals ascribed to John Graunt.

*Glass, David V., cited in Lilienfeld, Abraham M., *Foundations of Epidemiology*, New York, Oxford University Press, 1976, p. 23.

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The authors are indebted to Warren L. Kleinsasser, M.D. for bringing the Frankfurt Study to our attention and to his numerous ALIMDA colleagues for their helpful suggestions; to Daniel F. Case for his translation of the Frankfurt Study from the original German and his many draft reviews and suggestions including alternative models; to the Society of Actuaries and three sponsoring Sections for underwriting the cost of timely distribution; and to all the many other reviewers and contributors too numerous to mention.

We were especially encouraged by all those who told us that earlier drafts of this report had already helped them make further progress in unraveling the puzzle of AIDS and HIV infection. This puzzle can only be solved by many timely contributions, both in terms of independent original ideas and progressive cumulative refinements of existing ideas.

Finally, we wish to thank Carol J. Abraham, our untiring assistant, without whose help this report would not have been available on such a timely basis.

To all those who gave assistance and encouragement on this report, we express our appreciation.

I. AIDS AND LIFE INSURANCE

MICHAEL J. COWELL

1. ABSTRACT

Since its clinical identification in 1981, the presence of the Human Immunodeficiency Virus (HIV) [1] and its progression to Acquired Immune Deficiency Syndrome (AIDS) and resultant death have become a matter of worldwide concern. In addition to the 38,000 cases of AIDS reported in the U.S. through mid-July 1987, of which 22,000 have already resulted in death, the Centers for Disease Control (CDC) of the U.S. Public Health Service estimate that as many as 1.5 million Americans may be infected with HIV. AIDS cases in Canada have just passed the 1,000 mark, with half of the victims already dead. HIV infection appears to be at a considerably lower per-capita level in Canada than in the U.S.

The purposes of this report are to estimate the spread of HIV infection in the insured populations of the U.S. and Canada; to predict the mortality of those who test positive for HIV; to discuss the implications of immune deficiency disease for life insurance underwriting and pricing; and to project its long-term impact on insurance company solvency.

Estimates vary widely as to the percentages of HIV cases that will progress through stages of immune deficiency disease to AIDs-related complex (ARC) or fully developed AIDS. The longer a population of HIV-infected subjects is studied, the higher are the estimates of ultimate progression to AIDS. Increasingly, public health authorities are predicting that the vast majority of all HIV-infected subjects will progress to a serious immune impairment and eventually succumb to its complications.

Longevity prospects of HIV-infected populations studied to date are not encouraging. Mortality patterns of such populations bear no meaningful relationship to standard mortality in the general population nor to that of insured lives. From the time that fully developed AIDS is diagnosed, life expectancy is about 2.1 years. Mortality takes an extremely high toll, leaving fewer than one survivor in twenty after 8 years.

Life and health insurers in Canada and the U.S. are experiencing significant numbers of AIDS-related claims. Preliminary analysis of these claims suggests that the prevalence of HIV infection among the insured population is about half the rate in the general population, with infection among group insureds higher than among individual insureds. For those who are HIV-infected, the average amount of individual life insurance is substantially

larger than the industry average. The disparity for group life insurance is less pronounced.

Under the assumption that those covered by life insurance include no "hard core" intravenous (IV) drug abusers at risk of AIDS, we estimate that at year-end 1986 approximately $20 billion of individual and $15 billion of group life insurance in the U.S. are on the lives of HIV-infected subjects. We project that by the year 2000, individually insured claims could amount to more than $30 billion, with about $14 billion coming from insurance on those already infected and another $18 billion from new infections on existing insureds.

Because there is less information currently available on AIDS claims under group than under individual life insurance, our estimates for the group line are not as detailed; the limited information we have suggests the overall mortality patterns will not differ significantly.

At the levels projected, AIDS-related deaths from existing business in force could alone exceed 10 percent of the life insurance industry's total claims for individual and group coverages by the mid-1990s. The cost of not screening new applicants for individual life insurance for HIV infection could amount to many additional billions in claims by the end of the century.

2. NATURE OF THE EPIDEMIC — SPREAD OF INFECTION

2.1. Introduction

Acquired immune deficiency disease is an epidemic different from any that has affected humans in recorded medical history. All previously reported epidemics were relatively short in duration — weeks or, at most, months — from infection to manifestation.

Epidemics within living memory or recent history — influenza, cholera, bubonic plague — spread rapidly, with a large percentage of the population either immune or dead within a relatively short period. The Black Death is believed to have killed as much as one-quarter of Europe's population in the 14th century. In that sense it was a much greater disaster than what we are now facing, yet in some respects it fitted the classic epidemiological mold more closely than does AIDS. In more recent memory, the influenza epidemic of 1918–1919 claimed almost 550,000 victims in the U.S and an estimated 20 million worldwide, but ran its entire course in less than a year.

Acquired immune deficiency disease has, in contrast, an unusually long latency period.

It is estimated that after 5 years from HIV infection, approximately 15 percent will reach full clinical AIDS. Data from the CDC and from other studies suggest that higher percentages of an HIV-infected population will progress to AIDS in the second five years following infection.

Prevailing medical thinking now is that the vast majority of those infected with HIV will eventually incur a serious impairment to their immune system and die prematurely from its complications. The emphasis is on *prevailing* medical thinking, because knowledge about HIV infection is so new, and constantly undergoing change, that researchers are not of one mind on this or on many other aspects of the disease.

Analysis of the progression of HIV infection and its ultimate mortality toll produces estimates of survival that we believe are reliable for insurance purposes. In other words, we believe that the mortality pattern for a given cohort of newly infected subjects can be predicted with reasonable certainty. This information is helpful in evaluating the financial consequences of not screening out cohorts of subjects who are HIV-infected at the time they apply for insurance, but who could have been detected if such screening had been part of the underwriting process.

What we do not know with any degree of certainty is the impact on financial operations of the disease in existing insureds who are already HIV-infected, including those who were HIV-infected at the time they applied for amounts of insurance below the company's testing level, in existing insureds who may still become infected, and in new insureds who become infected after testing negative at time of issue.

The impact of existing insureds who are already HIV-infected depends primarily on the percentage who are HIV-infected and when they became infected. Estimates from the Surgeon General and the CDC are that between one and one-and-a-half million Americans would test HIV-positive [2]. This translates to an overall population average of 8 per 1,000 in the population age 20 and above. Within the age group 20–59, the most important range for insurance purposes, the rate may be as high as 18 per 1,000 men, but is probably less than 1 per 1,000 women. Above age 60, however, infection rates are so low that they may be ignored for practical purposes.

The estimated level of HIV infection in Canada is believed to be still quite low, perhaps as few as 50,000 to 75,000 as of early 1987. With over 90 percent of all AIDS cases in Canada confined to males, this translates to an infection rate of 10 or fewer per 1,000 men aged 20–59. Among Canadian women, the infection rate is still so low as to be barely measurable in the overall population.

2.2. HIV Infection — An Epidemiological Puzzle

Because the epidemiology of acquired immune deficiency disease is so different from that of any other on record, it requires particularly careful analysis.

With a new strain of influenza, for example, symptoms are quickly manifested, and its overall effects soon become measurable. In contrast, HIV infection by itself gives its victims no warning signs. The long latency period before symptoms of the disease become apparent means that large numbers of the population can become infected before the impact of their disabilities and deaths is known.

Identifying the numbers of the population infected by such a "silent" disease is the most difficult phase of this epidemiological puzzle. Yet it is critical that we obtain as accurate a measure as possible of the course of HIV infection in order to make credible estimates of its financial impact. The frustration of researchers of this epidemic is that the most important part of the puzzle is the most unyielding to attempts to unravel it.

We are navigating through a thick fog with only the crudest of instruments to plot our current position, let alone our course.

Our approach to this problem was to start with the best estimates of the Surgeon General and the CDC and to fit these data to a mathematical model based on a plausible rationale. We then validated the results of the modeling process against reported numbers of AIDS cases and deaths. We constructed our model as a series of fairly simple processes, each one of which may be separately refined as more information becomes available.

We recognize that the ultimate goal is to obtain credible numbers from which to project the financial impact of the epidemic on the insurance industry. However, at this stage of our analysis, we place more importance on validating the reasonableness of the processes of our model than on the absolute numbers that it generates.

Also, it cannot be emphasized too strongly that we are attempting to use mathematical models developed by researchers on the experience of "traditional" epidemics. We are encouraged by the closeness of fit of our models to actual numbers of AIDS cases and deaths reported to the CDC. However, like most other projections in this report, results based on fitting a totally different kind of epidemic to classical models must be interpreted cautiously.

2.3. Epidemiological Models — "Micro" and "Macro"

Epidemiologists use a variety of mathematical models to simulate the spread of an infectious disease throughout a population. The models of the "micro" variety are based on detailed assumptions about such factors as frequency of activities that expose people to infection, probabilities of transmission from an infected to an uninfected person, and average duration of infectiousness. A "micro" model of HIV transmission based on numbers of partners in various kinds of sexual activity is described by Knox [3].

Models at the other end of the spectrum make broad "macro" assumptions as to population aggregates, without attempting to simulate transmission on a person-by-person basis. Between these two extremes, some approaches model the spread of the disease within stratified subgroups of the population and among such groups.

The principal focus of this report is the impact of the disease not on individuals but on the insured population in the aggregate and, as a consequence, on the solvency of the insurance industry. Thus, we chose a model of the "macro" form. We did review the work of researchers whose models track the epidemic by stratifying the population into groups according to degree of risk. We expect that further analysis of the spread of infection will depend on such models that address the process of transmission of the disease within and among significant subpopulations and also from subject to subject.

The underlying theory of the form of epidemiological model we used [4] is that the incidence of new infection at any time (t) is proportional to the product of the prevalence (p_t) of the infection in the population and the portion ($1-p_t$) of the population uninfected, all reduced by the portion of the infected population that dies (q_t). The product of p_t and $1-p_t$ is assumed to be related to the incidence of new infection by an infection factor that may be expressed as a constant (α) over time or in a more generalized form (α_t) as a function of time also. In the infinitesimal calculus mode, the incidence of new infection may thus be expressed as:

$$\frac{dp_t}{dt} = \alpha_t \cdot p_t \cdot (1 - p_t) - q_t \qquad [1]$$

In its simpler form, where the infection factor is assumed to be a constant (α) over time and where the mortality term (q_t) is assumed to be sufficiently

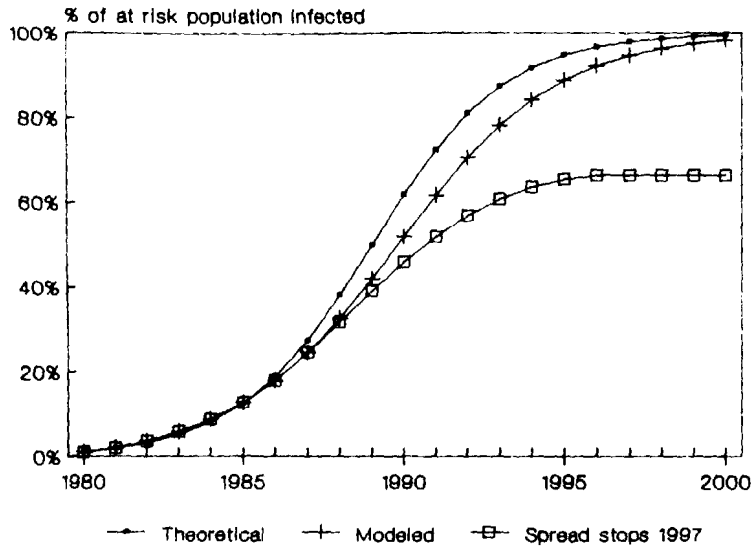
small to be treated separately, this formulation leads to the following expression for the prevalence of infection:

$$p_t = (1 + \alpha^{\alpha \cdot t})^{-1} \quad [2]$$

This formula produces the classical S-curve of the progress of an epidemic throughout a population, which is identified in Chart 1 as "theoretical" more for illustrative purposes than as necessarily representative of the likely future course of the disease. Estimates of the parameters for this equation, and its development in discrete form, more useful for period-by-period calculations where the infection factor (α_t) is assumed to vary over time, are contained in Appendix 1.

CHART 1

Epidemiological Model of HIV Spread



2.4. How Large Are the Groups "At Risk"?

The next step was to fit what we know about the actual spread of infection to a "macro" model based on a classical S-curve as described above.

CDC data indicate that in the U.S., 17 percent of reported AIDS cases among adults are in the IV-drug-abusing population and 73 percent are in the male homosexual and bisexual populations. Canada, in contrast, has a minuscule IV drug abuse problem. The Canadian Laboratory Centre for Disease Control (LCDC) reports that almost 83 percent of its AIDS victims are male homosexuals and bisexuals.

The National Academy of Sciences (NAS) estimates that the U.S. has a "hard core" IV-drug-abusing population numbering about 750,000. Male homosexuals in the U.S. are estimated to number 3 percent of the adult population, or about 2.5 million. NAS also estimates that another 2.5 million U.S. men are bisexual during some part of their lives [5].

To date, we have no comparable estimates of such populations in Canada; the geographic distribution of Canada's 1,000 or so AIDS cases suggests that they are concentrated almost entirely among the male homosexual communities of Montreal, Toronto and Vancouver.

We took the NAS figure of 750,000 IV drug abusers and assumed that the highest at-risk group in the male homosexual and bisexual community in the U.S. numbers at least 3 million. This would mean that if the disease had progressed uniformly throughout these two highest at-risk populations — and CDC information suggests that it has — then approximately 30 percent of each group would be HIV-infected as of early 1987.

Estimates of the extent of infection in Canada are still sketchy, but if Canada has a similar representation of homosexuals in its male population as the U.S., then the corresponding figure for that group would be 350,000, with between 15 percent and 20 percent infected.

Recent studies of IV-drug-abusing populations in New York City and of male homosexual communities in New York and San Francisco show a prevalence of HIV infection ranging from a low of less than 20 percent to a high of 70% or more. Especially among homosexuals, infection rates are believed to be lower in communities further away from the principal concentrations of these populations. Data from the San Francisco studies show that infection rates among male homosexuals rise rapidly with increases in the numbers of reported partners [6].

We also know from the SFCC/CDC Study discussed in Section 3.4 that HIV infection was already established in San Francisco's male homosexual community by 1978, at which time it is estimated to have been 4 percent.

AIDS cases and deaths in the U.S. may be closely replicated under the assumption that HIV entered both the male homosexual and the IV-drug-abusing populations in 1975 and that it progressed along the modeled S-curve shown in Chart 1 to the point that by early 1987 it had infected approximately 27 percent of each population. The resulting numbers are an HIV-infected population of about 1 million. When taken together with independent estimates of fewer than 100,000 HIV-infected women — believed to be mostly partners of IV-drug-abusing men or of male bisexuals — and with a small but as yet unestimated number of infected heterosexuals, these numbers aggregate reasonably well to overall estimates by CDC and the Surgeon General of the extent of the infection in the U.S. population.

These population aggregates were used solely for purpose of validating the assumptions in the model. In reducing these numbers to the individually insured population, we excluded IV drug abusers and females.

3. MORTALITY OF AN HIV-INFECTED POPULATION

3.1. Introduction

The principal focus of this analysis, and a significant part of this entire report, is to determine the progression from HIV infection to AIDS.

Several reports have been published on the incidence of AIDS in HIV-infected populations. Three studies were identified that provide the most reliable data with respect to the progression to AIDS in persons who tested positive for HIV but were otherwise asymptomatic or who had progressed to more serious stages of the disease. The first of these studies also provides reliable data on the conversion to HIV of persons at high risk. The other two studies corroborate the patterns of progression observed from the first.

3.2. The Frankfurt Study

The major source of data for this report is the study by the Center for Internal Medicine of the University of Frankfurt, West Germany. It observed subjects in groups at high risk of AIDS through various stages in the progression from apparent good health to death primarily caused by AIDS [7].

The Frankfurt Study is the first published analysis of progression from HIV-infected status in otherwise asymptomatic subjects, through the more serious stages of immune system impairment, all the way to fully developed AIDS and resulting death.

The study uses five classifications, or stages, to identify progression from healthy status to AIDS. This approach closely follows what has been identified as the "Walter Reed Staging Method" [8]:

- Healthy persons at risk for HIV infection, but testing negative
- Otherwise asymptomatic persons testing HIV positive (HIV+)
- Patients with HIV infection and lymphadenopathy syndrome (LAS), together with moderate cellular immune deficiency
- Patients with HIV infection and LAS, together with severe cellular immune deficiency (AIDS-Related Complex, or ARC, as defined by CDC)
- Patients with AIDS as currently defined by CDC.

The sixth and final stage is death.

The Frankfurt Study yields information more valuable than that provided by other studies in one major respect. Rather than studying just the single rate of progression from HIV infection to AIDS, it analyzed the progression of impairment to the immune system through these various stages to AIDS and ultimate death in terms of a number of discrete steps. In this respect, it presents a particularly valuable link previously missing from the literature.

The Frankfurt Study observed 543 subjects from groups at high risk of AIDS from 1982 through 1985; 377 of the subjects were HIV-infected on entry into the study. A total of 307 subjects were observed from 3 months to as long as 3 years; 259 of these were HIV-infected on entry into the study.

A detailed analysis of the Frankfurt Study is presented in the Actuarial Note, "*HIV Mortality*," which is part II of this chapter.

*3.3. National Cancer Institute (NCI) Study**

The second report presented the results of a prospective study of the 3-year incidence of AIDS in four separate HIV-infected populations in the U.S. and of one in Denmark [9].

The NCI Study was based on clinical observation of 725 persons at high risk of AIDS who had enrolled before October 1982 in cohort studies of male homosexuals in Manhattan, NY, Washington, D.C., and Copenhagen, Denmark, of IV drug abusers in Queens, NY, and of hemophiliacs in Hershey, PA.

A total of 276 of the subjects were either HIV-infected at enrollment or developed the antibody during the course of the study. The 3-year incidence

*This study was not cited as having NCI sponsorship; it is identified here as the NCI study for convenient reference since its four principal authors are associated with that institution.

of AIDS ranged from a high of 34.2 percent in the cohort of Manhattan homosexuals, to a low of 8.0 percent in the Copenhagen homosexuals. These results gave rise to estimates during 1986 that perhaps 25 percent, or at most 35 percent of HIV-infected subjects would progress to AIDS.

The results from the NCI Study tend to corroborate those in the Frankfurt Study. However, it should be noted that the observed conversions in the NCI Study, all the way from HIV infection to AIDS without reference to intermediate stages of the disease, suggested faster progressions than those used in the model from the Frankfurt Study.

3.4. San Francisco City Clinic/CDC Study

A study by the CDC in cooperation with the San Francisco City Clinic (SFCC) was begun in 1978 as a research project on Hepatitis B [10]. Once AIDS was identified, the CDC and the SFCC recognized that the stored, frozen blood samples collected since 1978 on 6,700 male homosexuals and bisexuals could yield information about HIV infections and AIDS. Stored blood samples of two groups of volunteers showed that 4 percent were HIV positive as early as 1978. In one group, 19 percent had progressed to AIDS by 1985; in the other, 29 percent had progressed to AIDS and another 42 percent to ARC. Analysis of the SFCC/CDC data shows 14–15 percent of HIV subjects developing AIDS within 5 years after infection, 22–25 percent after 6 years, and 32–36 percent after 7 years.

The more rapid progression to AIDS after 5 years from infection has led the SFCC study director to observe that there is an increased risk of AIDS in the second 5 years.

More recently, both the CDC and the Surgeon General have supported what is coming to be viewed as a prevailing medical view, namely, that the vast majority of HIV-infected subjects will eventually progress to a more serious stage of the disease and succumb to its complications.

3.5. AIDS Cases and Deaths

Weekly reports from the CDC are the principal source of data on aggregate AIDS cases and deaths. Through June 29, 1987, the CDC reported a total of 37,867 cases of AIDS in the U.S., of which 21,776 had resulted in death [11].

The Laboratory Centre for Disease Control in Ottawa reported 1,001 cases of AIDS in Canada as of May 4, 1987, of which 503 had resulted in death [12].

CDC data are in the form of AIDS case fatality rates (ratio of known AIDS deaths to reported AIDS cases) by half-year of AIDS diagnosis. We derived annual AIDS mortality rates by assuming that CDC AIDS case fatality rates fully represent the underlying cumulative AIDS mortality. These annual AIDS mortality rates are 45 percent in the first and second years since progression to AIDS, 35 percent in the third year, and 25 percent thereafter. These rates produce a life expectancy of about 2.1 years from progression to AIDS and an 8-year AIDS survival rate of 4.7 percent.

Chart 2 compares CDC AIDS case fatality rates to modeled cumulative AIDS mortality for 8½ years. As nearly as can be determined from CDC AIDS Weekly Surveillance Reports, the case fatality rates for durations 7 years through 8½ or more years are based on only 16, 9, 2, and 6 deaths, respectively.

Canadian data are not yet presented by time since progression to AIDS. Although the incidence of HIV infection appears to be much lower in Canada, there is no reason to believe that AIDS mortality rates in the infected population are any different from those in the U.S.

A detailed analysis of the CDC data is presented in "*HIV Mortality*," part II of this chapter.

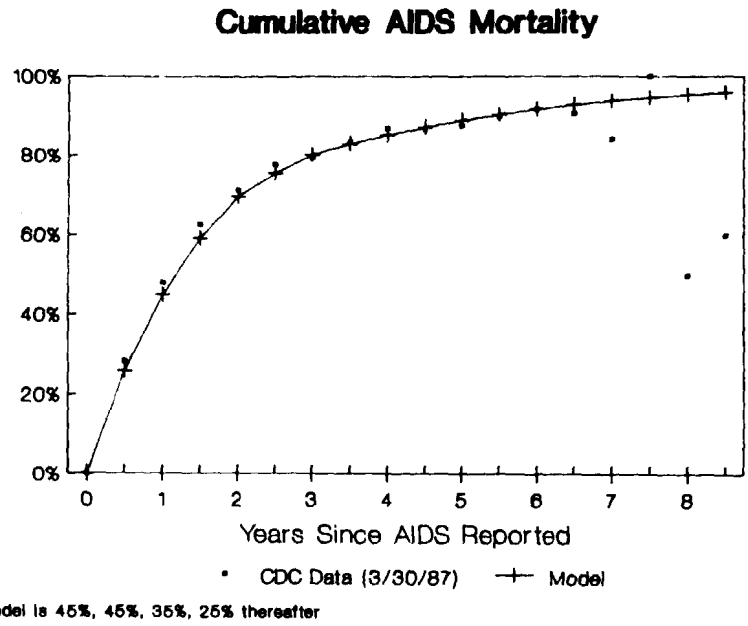
3.6. HIV Mortality Model Based on Frankfurt and CDC Data

It might have been desirable to study the mortality of HIV-infected persons directly from the Frankfurt HIV progression rates and AIDS mortality rates based on CDC data. However, because of the multiple stages of the disease and the high periodic probabilities of progression from HIV to AIDS and resulting death, traditional actuarial approaches based on single decrement table formulae to study the mortality of an impaired group were of limited value in this analysis. A different approach was needed.

A Markov Chain model was used to study HIV mortality based on Frankfurt and CDC data. This model simulates the progression of a group of newly infected subjects through the stages of HIV disease to AIDS and death. The process is not unlike that of creating a life, or multiple decrement, table from a limited period of observation, by joining together the experience of successive cohorts, even though no one cohort was observed to progress through the entire range of ages or decrements represented in the table.

In the Frankfurt Study, a sufficient number progressed from HIV infection or from a more serious stage of the disease to one or more successively

CHART 2



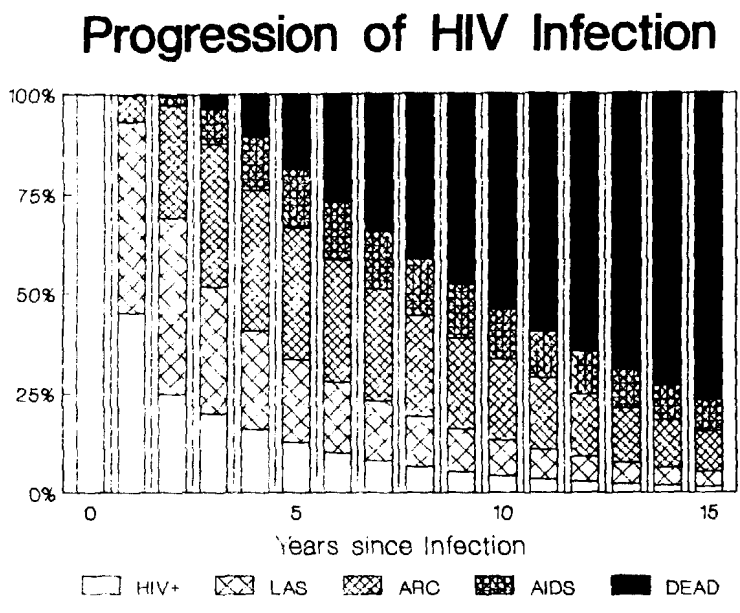
worse stages, or to death, to enable the results from one stage progression to the next to be linked together.

A detailed description of development and results of this model is presented in *"HIV Mortality,"* part II of this chapter.

The results of this modeling process are illustrated in Chart 3, which shows the percentage of an HIV cohort by stage and duration since infection. For an explanation of the legend, see the description of the "The Walter Reed Staging method" in Section 3.2 (The Frankfurt Study).

For illustrative purposes only, we calculated the level equivalent multiple of 1980 CSO Basic Male Nonsmoker Table rates that produces the same life expectancy as that of a 35-year-old cohort of newly infected males. To match the same life expectancy as produced by projecting Frankfurt and CDC data, mortality would have to be elevated to over 5,100 percent of 1980 CSO Basic rates. In other words, the level of HIV mortality at this age is over

CHART 3



10 times higher than the upper limit of what are considered by most insurers to be marginally acceptable substandard life insurance risks (500 percent).

As this analysis shows, the mortality patterns of an HIV-infected cohort are so different from those of insurable lives that comparisons to multiples of standard life mortality may result in misleading conclusions. This subject is addressed further in Sections 3.7 and 4.2.

Further discussion of comparisons to standard is presented in "*HIV Mortality*," part II of this chapter.

3.7. Summary of All Studies

Progression from HIV infection to AIDS as described in the various studies and models is summarized in Chart 4. The Frankfurt and SFCC/CDC models are compared to the New York City, D.C., and Danish data from the NCI Study. While these patterns are not identical, the results are quite

consistent in light of the different approaches used, the non-uniformity of identifying the time of infection, and the diversity of subjects studied.

Chart 4 also shows a fit of a Weibull function to the SFCC/CDC progression rates through the first seven years after infection. This progression pattern is based on an epidemiological model suggested, in slightly modified forms, by Brookmeyer and Gail [13], Elandt-Johnson and Johnson [14], Lui [15], and May and Anderson [16]. Referred to as a Weibull distribution, it assumes that the probability per unit time of progression to AIDS, for those HIV-infected subjects who ultimately reach that stage, increases with time (t) since infection. Under this assumption, the cumulative probability of progressing to AIDS by time t is expressed as:

$$F(t) = 1 - e^{-g \cdot t^2} \qquad [3]$$

In its more general form, the Weibull function is expressed as:

$$F(t) = 1 - e^{-g \cdot t^C} \qquad [4]$$

We found that the formula fitted SFCC/CDC progression rates quite closely for seven years with $c = 2$. The Weibull distribution in Chart 4 uses a value of $g = 0.009$.

The SFCC/CDC data measure progression from HIV infection to AIDS as a single-step progression without identifying intermediate stages of the disease. The application of a Weibull model to such rates results in a progression to AIDS that is initially slower than that from a model based on multiple step progressions from HIV infection to AIDS such as the Frankfurt Study.

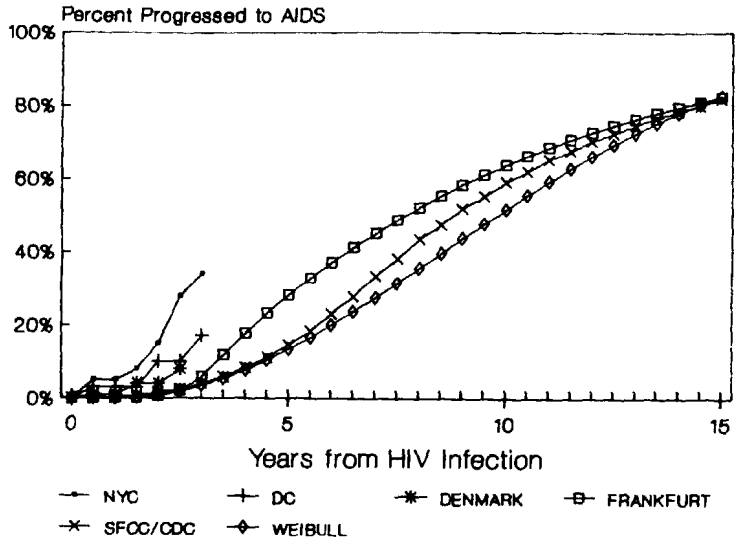
The SFCC/CDC model was produced by projecting SFCC/CDC progression rates such that 82 percent of an infected cohort progresses to AIDS within 15 years of infection, as in the Frankfurt model. Beyond that stage, so few of an initial cohort of HIV-infected subjects are alive that the financial impact is quite insensitive to the minor differences among the various projections.

Even in the early years after infection, the differences between the faster progressions under the Frankfurt model and the slower progressions under the SFCC/CDC model are far less significant than they may appear from inspection of Chart 4.

Under the Frankfurt model, 77 percent of HIV-infected subjects will have progressed to a more serious stage of the disease or all the way to AIDS and will have died within 15 years of infection. Males who become HIV-infected at age 35, for example, can anticipate a life expectancy of almost

CHART 4

Progression from HIV Infection to AIDS



11 years from time of infection compared to almost 43 years for healthy uninfected men the same age. Looked at another way, infection with HIV has the same effect on a 35-year-old as advancing by almost 40 years along the mortality scale.

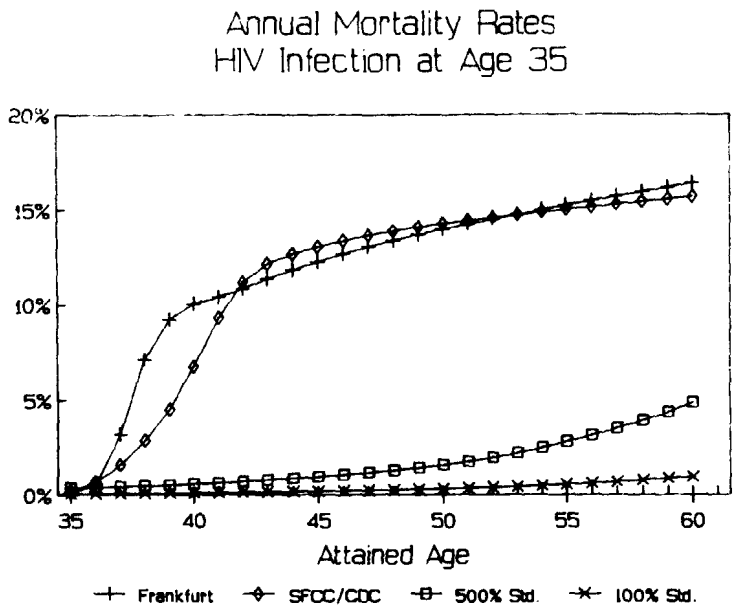
Under the SFCC/CDC model, 74 percent of HIV-infected subjects will have progressed to AIDS and died within 15 years of infection. Under these assumptions, males who become HIV-infected at age 35, for example, can anticipate a life expectancy of approximately 12 years from time of infection.

The progression rates from the Frankfurt and SFCC/CDC models may be thought of as the upper and lower bounds of a realistic set of progression rates developed from the most detailed and the longest duration of studies available. Notwithstanding the qualifications made earlier about modeling the progression of this epidemic, the available data clearly support prevailing

medical opinion that longevity prospects of HIV-infected subjects are not encouraging.

As Chart 5 illustrates, the mortality of such populations rises steeply following infection. Because of the unusually high number of early deaths, mortality of an HIV-infected population cannot be expressed in multiples of standard that are meaningful in a life insurance underwriting context.

CHART 5



Both models assume that the mortality patterns observed in the studied populations persist, that is, that no major breakthroughs in medical technology will occur to arrest or control the progression of the disease in HIV-infected subjects or to extend the life of those who progress to AIDS. Recent experimentation with AZT and other "retroviral" drugs has offered hope for some limited progress in delaying death once the disease has progressed

to full clinical AIDS. However, it will require documentation of significant success with such treatment before its impact can be translated into additional life expectancy.

Early estimates by CDC and others were that 10–20 percent of otherwise asymptomatic HIV-infected subjects would eventually progress to AIDS. Later, as the numbers of AIDS cases and related deaths grew, this estimate was revised upward closer to 50 percent. In a recent interview, the Surgeon General of the U.S. suggested that the ultimate progression rate might be closer to 100 percent. His view is consistent with the results suggested by projections based on the Frankfurt and SFCC/CDC data.

One final comment on these projections is that they reflect almost exclusively the progression of the disease and its ultimate death toll among the highest risk groups studied, namely, male homosexuals and IV drug abusers. There are some suggestions in the literature to the effect that the immune systems of these two groups were already seriously compromised before the introduction of the AIDS virus to Europe and North America. Increasingly, however, medical observers appear to be reaching the conclusion that the only factor of significance in the progress of the disease from HIV infection to AIDS is time.

Until much more is known about the spread of the disease in the healthy non-IV-drug-abusing heterosexual population, it remains somewhat conjectural whether this group will necessarily follow the same patterns of disease progression and mortality observed among the two highest-risk groups. In the absence of such data, we made no assumptions as to the extent of the spread of the disease beyond the existing groups considered to be at high risk of infection. To this extent, our estimates of AIDS deaths and claims costs are probably understated. However, a model developed by Harris [17] of HIV spread in the heterosexual population tends to confirm that it will be quite small relative to the high-risk groups for at least several years.

4. IMPLICATIONS FOR LIFE INSURANCE

4.1. Preliminary Observations

In a relatively free market environment, several conditions must exist for a risk to be insurable. Three of these conditions are fundamental to the actuarial soundness of an insurance plan. First, the risk must exist in sufficiently large numbers in the population to enable underwriters to establish a class in which each member has similar *a priori* likelihood of incurring a claim. Second, the likelihood of any one member incurring a claim must be

random and relatively small within an initial time period, so that premium levels can be kept to a small fraction of the amount insured. Third, members of the insured class should have no influence over the occurrence of a claim.

Life insurance meets the first two conditions and sufficiently meets the third for practical purposes. Underwriters apply selection criteria to attempt to keep death claims among new entrants to the risk pool within a fairly narrow band around "standard" or "expected" mortality. Even up to the higher ages at which life insurance is sold, standard mortality is still in the range of 2 to 3 percent a year. For example, even as high as age 60, the 1980 CSO Basic Male Nonsmoker mortality is less than 1 percent a year.*

4.2. Underwriting and Pricing

Most major direct writers of life insurance that use a selection process are able to justify including a high percentage of all applicants in their "standard" class. For a combination of economic, marketing and other practical reasons, this may mean including some risks that are underwritten at 125–150 percent of standard. Most writers, however, will treat as "substandard" risks that they expect will incur claims two or more times standard. Even at three or four multiples of standard, mortality associated with certain coronary diseases, for example, rates may still be low enough to meet the insuring criteria. Even at 500 percent of standard, for example, the 1980 CSO Basic Nonsmoker mortality is less than 1 percent a year at age 45.†

In the vicinity of 400–500 percent of standard mortality, typified by more severe coronary cases, few direct writers issue enough cases to achieve an adequate spread of risk. Coverage at these levels of mortality is typically made available through reinsurance arrangements with specialty companies. Above these levels, the probability of claim becomes so high that the premiums required would attract few buyers and the potential for antiselection would be severe. While insurance arrangements are sometimes made even beyond these extremely high multiples of standard, they often take on characteristics more usually associated with catastrophe risks and frequently involve serious limitations on benefit levels during the early years of such coverage.

As stated in Sections 3.6 and 3.7, the mortality patterns of populations that test positive for HIV bear no meaningful relationship to multiples of standard mortality in the general population or of insured life mortality.

*1980 CSO Basic Male Nonsmoker Table: $1000 \times q_{60} = 9.76$.
†1980 CSO Basic Male Nonsmoker Table: $1000 \times q_{45} = 1.96$.

On the basis of these criteria and the likelihood that an extremely high percentage of HIV-infected subjects will progress to AIDS, we conclude that such subjects are not insurable for individually underwritten coverage in the normal context that such coverage is understood. We recognize that any conclusion leaving underwriters no alternative but outright declination will appear harsh. We are hopeful that others will, in due course, find more options. Our solution is the only course of action we can honestly recommend as being responsible in light of the information we have analyzed.

Readers interested in a more thorough treatment of theory of insurability in general, and of HIV-infected subjects in particular, may wish to refer to the technical paper by Hammond and Shapiro [18].

The issue of HIV infection as it affects pricing is similar in some respects to dealing with any other impairment. A company sets its underwriting guidelines in an attempt to screen for the impairment above a certain amount limit. These limits are established so that the cost of underwriting is more than offset by the mortality "saved" by not issuing at standard rates.

Depending on the severity of the impairment, the insurer may offer the applicant insurance at rates that reflect the expected higher mortality of the specific impairment. If the expected mortality is so high that the company cannot afford to bear the risk, it may decline the case outright or seek specialty reinsurance facilities.

The process is not dissimilar in underwriting for HIV infection, although the outcome will almost certainly be to decline known HIV-infected applicants. On the basis of the more optimistic life expectancy projections of the SFCC/CDC model described in Section 3.4, the discounted present value of AIDS-related claims in a cohort of newly infected individuals at 6 percent is $515 per $1,000 of potential insurance. On the basis of the faster progression to AIDS modeled from the Frankfurt Study described in Section 3.6, this value is $545. We believe that this clearly fits the situation described earlier, namely, that the required premium would attract few buyers and the potential for antiselection would be severe.

Given this information and on the basis of estimates of HIV infection at different ages, companies can calculate the mortality saved by screening for HIV infection at various amount thresholds. The costs of screening can be evaluated against the benefit of saving claims with a present value of more than $500 per $1,000 of insurance that would presumably be declined.

By way of a simplified example, if the HIV infection rate among all males age 20–59 applying for life insurance is 1 percent, then testing *all* such applicants could be justified at a cost of less than $5 per $1,000. At a cost

of less than $50 for a three-test procedure of two ELISA tests followed by a Western Blot test, an insurer might justify HIV screening for amounts of insurance as low as $10,000. This three-test procedure has been reported to have only one false positive per 1,000 positive tests.

The decision as to testing level will, of course, depend on each insurer's specific situation, taking into account the additional underwriting complexity and delay involved in testing, the regulatory situation in each jurisdiction in which the company operates, and the marketing resistance to requiring tests for all but large amounts of insurance. Responsible underwriting management will include this kind of evaluation based on analysis of a company's known AIDS claims and its financial capacity to absorb claims below its screening threshold.

As with any testing procedure, a negative result does not always mean the individual is free of the disease. False negatives are, of course, much more difficult to identify than false positives. The latter can be detected from follow-up testing. The standard ELISA test has been reported to show negative results in a few cases per 1,000 individuals who subsequently are discovered to be HIV-infected. However, even for a company with well-developed testing procedures, it would be extremely difficult to estimate the impact of false negatives on mortality in a meaningful way that could be translated into pricing.

In addition to the cost of testing at the threshold the company establishes, some provision should be made for AIDS-related deaths among those who are HIV-infected when they apply, but who are applying for amounts of insurance below the company's testing threshold and are not discovered through other underwriting procedures. In the absence of specific knowledge about the makeup of a company's market, it is difficult to estimate this cost also. At the estimated population average infection rate exclusive of IV drug abusers, who are probably not purchasers of individual life insurance to any significant extent, we would again suggest an initial liability of $5 per $1,000 of insurance issued to males from 20 to 59. This estimate is based on $500 per $1,000 for each one newly insured assumed to be HIV-infected per 100 issues.

Finally, insurers should recognize that even with the most thorough testing procedures, some policyholders will become infected after issue. This is another potential source of AIDS-related claims that is difficult to quantify. While the potential spread of HIV infection among the non-IV-drug-abusing heterosexual population cannot be ignored, the most significant component

of such claims for the next several years will be the further spread of HIV infection within the groups currently at high risk.

4.3. Life Company Solvency

As indicated in Section 3.7, estimates of the spread of the epidemic into the heterosexual population will for some time be even more speculative than for those groups at high risk. In the estimates that follow, we assumed no significant spread of HIV infection into the non-IV-drug-abusing heterosexual population and no AIDS-related claims on females. As discussed previously, we acknowledge that both assumptions understate the eventual magnitude of AIDS deaths. However, at this stage of the epidemic we have no reliable data on which to make such estimates. The model developed by Harris [17] suggests that 120,000 non-IV-drug-abusing heterosexuals will be HIV-infected by 1990; while not negligible, even at this number, our assumptions as to financial impact would not be seriously affected. Rather than adding estimates based on conjecture to our partially validated projections, we elected to defer making estimates of the epidemic's spread beyond the existing groups at high risk.

This leaves the cost of the epidemic as it spreads further into the yet uninfected segments of the population considered to be at high risk. This cost has two major components: the financial impact of AIDS and related claims on in-force business, and the impact of taking on additional risks from new business. Both components depend for their analysis on the incidence of HIV infection in the insured and potentially insurable populations and on the prognosis for its further spread.

To estimate the first component, we assumed that new individual life business had been written on adult males since 1975 with the HIV infection levels developed in our model and that infection would begin to decline, peaking in 1997 as shown in Chart 1 at about 2 million, or just over 3 percent of all males age 20–59.

Information from the ACLI's Fact Book [19] and estimates for year-end 1986 put the amount of life insurance in force in the U.S. at $6.65 trillion. Of this total, $3.65 trillion was written individually, and the other $3 trillion was written on a group or credit basis.

From the ACLI's information on amounts of coverage by age and sex, we developed the following estimates of insurance coverage among U.S. males at the age groups most susceptible to HIV infection:

U.S. Males Attained Ages	Total Insurance In Force 1/1/87 (billions of dollars)		Estimated HIV-Infected 1/1/87 (billions of dollars)	
	Individual	Group	Individual	Group
20-29	$ 658	$ 209	$ 2.6	$ 0.9
30-39	675	504	9.9	6.3
40-49	505	436	6.6	4.7
50-59	277	301	1.5	1.1
20-59	$ 2,115	$ 1,450	$ 20.6	$ 13.0

Based on our estimates of the further growth of HIV infection and rates of progression to AIDS modeled from the SFCC/CDC data, we would expect individual life insurance in force in the U.S. as of year-end 1986 for these four 10-year male age groups to generate AIDS-related claims of over $30 billion through the end of the century. Approximately $14 billion of these claims will come from insurance on those already infected, and another $18 billion from new infections on existing insureds. In addition, we would expect approximately $20 billion of additional AIDS-related claims from group life insurance in force at year-end 1986. A projection of individual life claims under these assumptions is shown in Appendix 2. As more data become available on group life claims, we would expect to refine our estimates for this line.

Data on the extent of the epidemic in Canada are so sketchy at this time that our estimates of the financial impact on life operations in that country must be hedged.

Based on the lower incidence of AIDS cases and assumed HIV infection levels in Canada, it would appear that not much more than about $1 billion of the approximately $200 billion of individual, nor more than about $1.25 billion of the $200 billion or so group life coverage, as of year-end 1986 is on HIV-infected insureds. The apparently later entry of the infection into Canada suggests that the emergence of death claims may be somewhat slower than in the U.S. and that perhaps less than three-fourths of these HIV-infected amounts will show up as AIDS-related claims by the year 2000. The assumption of no significant spread of HIV infection beyond the male homosexual and bisexual community would, at this time, appear to represent less serious a problem of understatement of financial impact in Canada than in the U.S.

The second component of the financial impact is the additional risks the industry will assume by writing new business.

As discussed in Section 4.2, "Underwriting and Pricing," insurers will have to evaluate the risk not only of writing new business among the already HIV-infected population but also of insuring a population that will likely have even higher incidences of infection than today's levels. Although some limited testing may be undertaken for group insurance situations where individual evidence of insurability is routinely obtained, we assumed that new entrants into group plans would not normally be screened for HIV infection. Whatever impact AIDS deaths may have on group life claims will be reflected in rates for that business generally. However, if AIDS mortality were fully reflected in group life rates to such an extent that they were eventually to exceed individual life premium levels, it seems that a point could be reached at which employers might be unwilling to provide group life coverage.

For individual coverage, on the other hand, most insurers who obtain medical evidence are already screening new business applications, especially for high amounts of insurance. Although at the time of this report, each state allows some form of testing for individually underwritten life and disability income coverage, insurers' prerogatives to screen for HIV infection have already been challenged in some jurisdictions. In only one, however, the District of Columbia, has testing for HIV been entirely barred for insurance purposes. To date, there have been no such restrictions in Canada.

The ACLI estimates that approximately $1 trillion of new individual life insurance will be written in the U.S. in 1987. Of this total, over 60 percent will be written on males, and of that $600+ billion, approximately 85 percent will be written at the most critical ages for risk of AIDS, 20–59. We assumed $500 billion of new coverage distributed as follows:

U.S. Males Issue Ages	Estimated New Individual Life Insurance Written in 1987	
	Number of New Policies (millions)	Amount of New Insurance (billions of dollars)
20-29	2.400	$ 155
30-39	2.350	160
40-49	1.650	120
50-59	1.125	65
20-59	7.525	$ 500

With no testing, we estimate that approximately 55,000 of these 7.5 million policies would be issued on HIV-infected individuals, for a total insurance amount of more than $4 billion. The likelihood is that most, if not all,

of this amount would result in premature death claims from complications of HIV infection. Progression to AIDS and death under the slower SFCC/CDC assumptions produces death claims that, discounted at 6 percent interest, would require a net single premium of $515 per $1,000 issued to an HIV-infected individual. In other words, new individual life insurance written in the U.S. in 1987 could, if not screened for HIV infection, create an immediate additional liability for AIDS claims of over $2 billion.

With a 5 percent annual increase in new sales and the spread of new HIV infection declining to zero by 1997, then with no testing we could expect new business written from 1987 forward to generate $20 billion of AIDS claims by year-end 2000. With testing at successively lower dollar levels, an increasing proportion of this $20 billion would not have become insured.

We project that by the mid-1990s, annual claims from individual insurance in force at year-end 1986 and already HIV-infected will exceed $1 billion. Depending on the extent of the spread of infection among existing insureds, total AIDS claims could exceed $2 billion annually, or about 15 percent of projected individual life insurance claims for all U.S. companies. Even at this level, such extra claims would probably be within the ability of the industry to pay. Prudent financial management, in anticipation of additional claims at these levels, would probably call for reserves to be strengthened. At 10–15 percent of total claims, AIDS mortality would not likely lead to widespread insolvency.

However, without effective screening for HIV, the addition of several years of new business issued on infected applicants could double the level of projected AIDS claims by the mid- to late-1990s, at which point the industry would experience more serious problems, and some companies could face financial difficulties.

Preliminary analysis indicates that the cost of AIDS claims is not falling uniformly on all insurers. Companies that have grown faster in recent years during the very period that most HIV infections have occurred are bearing a disproportionate share of the added claims burden. Those marketing high-amount, low-premium-level products, especially at the most critical male ages 30–49 where infection levels are highest, will be harder hit than others. Companies with heavy concentrations of business in locations where the epidemic is more widespread will experience higher-than-average AIDS claims. Companies unfortunate enough to have combinations of two or more such sales patterns will obviously be the most seriously affected.

Further analysis will have to be performed on a company-by-company basis before conclusions can be drawn as to the magnitude of the problem

in terms of AIDS claims that might exceed a company's ability to pay. Such analysis also will have to take account of the surplus strain that many insurers will incur from other fixed-premium, noncancelable lines of business and from the lag in pricing group life and health coverages to reflect the increasing levels of AIDS claims being experienced in those lines.

5. CONCLUSIONS

HIV is the most serious epidemic that society has faced in modern times. It will have a profound impact on the insurance industry. It appears that the HIV epidemic will not be as serious in Canada as in the U.S., but it will cost the life insurance industry in the two countries tens of billions of dollars in premature death claims from its complications before it runs its course.

Massive education efforts to change practices that spread the disease could bring the epidemic under control by early in the 21st century. Major breakthroughs in medical technology could significantly improve this prospect.

Insurance industry executives must take strong leadership positions in educating the public about the implications of this disease for the availability and affordability of insurance. The leaders of our industry must communicate these messages clearly to policyholders, home office employees, agents, the news media, and legislative and regulatory officials.

The impact of HIV infection and AIDS will be serious, but if the industry addresses quickly and responsibly the underwriting and financial management challenges presented, even an epidemic of this magnitude need not be catastrophic.

REFERENCES

1. *Public Health Service Plan for the Prevention and Control of AIDS and the AIDS Virus,* Report of the Coolfont Planning Conference, U.S. Public Health Service, Washington, 1986, p. 1.
2. Ibid., p. 4.
3. Knox, E.G., *A Transmission Model for AIDS*, European Journal of Epidemiology, September 1986, Vol. 2, Number 3, pp. 165–177.
4. Koch, Michael G., M.D., *AIDS: Our Future,* Stockholm, Swedish Carnegie Institute, 1985, excerpted by AIDS Insurance Reports, Vol. 2, No. 10, May 1986.
5. *Confronting AIDS*, Institute of Medicine, National Academy of Sciences, Washington, 1986, pp. 58–60.
6. Winkelstein, W., et al., *Sexual Practices and Risk of Infection by the Human Immunodeficiency Virus, The San Francisco Men's Health Study*; Journal of the American Medical Association, January 1987, Vol. 257, No. 3, pp. 321–325.

7. Brodt, H.R., Helm, E.B., Werner, A., Joetten, A., Bergmann, L., Kluver, A., and Stille, W., *Spontanverlauf der LAV/HTLV-III-Infektion; Verlaufsbeobachtungen bei Personen aus AIDS-Risikogruppen*; Deutsche Medizinische Wochenschrift, Stuttgart, Vol. 111 (1986), pp. 1175–1180.
8. *The Walter Reed staging classification for HTLV-III/LAV Infection*, New England Journal of Medicine, 1986, Vol. 314, No. 2, pp. 131–132.
9. Goedert, James J.; Biggar, Robert J.; Weiss, Stanley H.; Eyster, M. Elaine; Melbye, Mads; Wilson, Susan; et al., *Three-year Incidence of AIDS in Five Cohorts of HTLV-III-Infected Risk Group Members*; Science, Vol. 231 (1986), pp. 992–995.
10. *Study: Risk of AIDS progression rises each year after infection*, AIDS Alert, April 1987.
11. *AIDS Weekly Surveillance Report*, United States AIDS Program, Center for Infectious Diseases, Centers for Disease Control, Public Health Service, Department of Health and Human Services, Atlanta, GA, June 30, 1987.
12. Laboratory Centre for Disease Control, *AIDS in Canada*, Ottawa, May 4, 1987.
13. Brookmeyer, Ron, and Gail, Mitchell H., *Minimum Size of the Acquired Immunodeficiency Syndrome (AIDS) Epidemic in the United States*; The Lancet, December 1986.
14. Elandt-Johnson, R.C., and Johnson, N.L., *Survival Models and Data Analysis*, New York, John Wiley, 1980, p. 184.
15. Lui, Kung-Jong, et al., *A model-based approach for estimating the mean incubation period of transfusion-associated acquired immunodeficiency syndrome*; Proceedings of the National Academy of Sciences, Vol. 83, pp. 3051–3055, May 1986.
16. May, Robert M, and Anderson, Roy M., *Transmission Dynamics of HIV Infection*, Nature, Vol. 326, p. 139, March, 1987.
17. Harris, Jeffrey, *The AIDS Epidemic; Looking into the 1990s*; Technology Review, July 1987, pp. 59–65.
18. Hammond, J.D., and Shapiro, A.F., *AIDS and the Limits of Insurability*; The Milbank Quarterly, 1986, Vol. 64, Suppl. 1, pp. 143–167.
19. *1986 Life Insurance Fact Book and 1986 Estimate of Key Life Insurance Statistics*; American Council of Life Insurance; Washington, DC, (1986).

APPENDIX 1

EPIDEMIOLOGICAL MODEL OF HIV INFECTION, AIDS CASES AND DEATHS, WITH CDC DATA

	Infection Continues to 100% of At-Risk Group					CDC		Infection Declines to 0 by 1997					Infection Stops in 1987				
Year	$a(t)$	New HIV Infections	Total HIV Infections	Modeled Cumulative AIDS Cases	Modeled Cumulative AIDS Deaths	AIDS Cases	AIDS Deaths	$a(t)$	New HIV Infections	Total HIV Infections	Modeled Cumulative AIDS Cases	Modeled Cumulative AIDS Deaths	$a(t)$	New HIV Infections	Total HIV Infections	Modeled Cumulative AIDS Cases	Modeled Cumulative AIDS Deaths
1975		113	113						113	113				113	113		
1976	1.50	392	504					1.50	392	504			1.50	392	504		
1977	1.32	1,382	1,887	3	1			1.32	1,382	1,887	3	1	1.32	1,382	1,887	3	1
1978	1.16	4,125	6,011	15	8			1.16	4,125	6,011	15	8	1.16	4,125	6,011	15	8
1979	1.00	10,284	16,295	59	30			1.00	10,284	16,295	59	30	1.00	10,284	16,295	59	30
1980	0.85	21,609	37,904	199	106			0.85	21,609	37,904	199	106	0.85	21,609	37,904	199	106
1981	0.71	38,395	76,300	588	321	337	146	0.71	38,395	76,300	588	321	0.71	38,395	76,300	588	321
1982	0.59	59,129	135,429	1,538	862	1,337	528	0.59	59,129	135,429	1,538	862	0.59	59,129	135,429	1,538	862
1983	0.50	82,744	218,173	3,607	2,078	4,119	1,753	0.50	82,744	218,173	3,607	2,078	0.50	82,744	218,173	3,607	2,078
1984	0.44	110,032	328,205	7,677	4,548	9,697	4,582	0.44	110,032	328,205	7,677	4,548	0.44	110,032	328,205	7,677	4,548
1985	0.42	149,488	477,693	15,020	9,145	15,948	8,161	0.42	149,488	477,693	15,020	9,145	0.42	149,488	477,693	15,020	9,145
1986	0.40	192,926	670,619	27,354	17,095	29,003	16,301	0.40	192,926	670,619	27,354	17,095	0.40	192,926	670,619	27,354	17,095
1987	0.40	248,947	919,566	46,864	30,018	55,000	30,000	0.40	248,947	919,566	46,864	30,018	0.40	248,947	919,566	46,864	30,018
1988	0.40	304,623	1,224,189	76,182	49,942	88,000	51,000	0.36	271,873	1,191,439	76,182	49,942	0.00	0	919,566	76,182	49,942
1989	0.40	349,432	1,573,621	118,354	79,294	133,000	81,000	0.32	273,764	1,465,203	118,255	79,250	0.00	0	919,566	117,440	78,883
1990	0.40	372,330	1,945,951	176,780	120,877	191,000	122,000	0.28	256,127	1,721,330	176,062	120,529	0.00	0	919,566	171,162	118,123
1991	0.40	366,809	2,312,760	255,092	177,796	265,000	176,000	0.24	224,621	1,945,951	252,266	176,335	0.00	0	919,566	236,244	167,827
1992	0.40	334,492	2,647,252	356,776	253,259			0.20	185,909	2,131,859	348,753	248,868	0.00	0	919,566	310,175	226,984
1993	0.40	284,197	2,931,449	484,541	350,187			0.16	145,283	2,277,142	466,060	339,547	0.00	0	919,566	388,943	293,329
1994	0.40	227,313	3,158,762	639,622	470,692			0.12	105,836	2,382,978	602,741	448,504	0.00	0	919,566	465,748	362,695
1995	0.40	173,190	3,331,952	821,073	615,501			0.08	68,714	2,451,692	755,065	574,192	0.00	0	919,566	533,821	429,922
1996	0.40	127,130	3,459,082	1,025,399	783,492			0.04	33,740	2,485,433	917,678	713,476	0.00	0	919,566	591,682	491,746
1997	0.40	90,791	3,549,873	1,246,771	971,550			0.00	0	2,485,433	1,084,550	862,114	0.00	0	919,566	640,865	547,286
1998	0.40	63,575	3,613,449	1,477,774	1,174,839			0.00	0	2,485,433	1,249,705	1,015,318	0.00	0	919,566	682,670	596,654
1999	0.40	43,906	3,657,355	1,710,496	1,387,404			0.00	0	2,485,433	1,407,848	1,168,294	0.00	0	919,566	718,205	640,235
2000	0.40	30,033	3,687,388	1,937,640	1,602,979			0.00	0	2,485,433	1,554,819	1,316,711	0.00	0	919,566	748,409	678,493

As described in Section 2.3, the continuous form of the underlying epidemiological model, where the mortality term (q_t) is assumed to be sufficiently small to be treated separately, is:

$$\frac{dp_t}{dt} = \alpha_t \cdot p_t \cdot (1 - p_t) \quad [1]$$

The solution of this equation is:

$$p_t = (1 + e^{-\alpha \cdot t})^{-1} \quad [2]$$

The discrete form is developed as follows:

$$\Delta p_t = p_{t+1} - p_t \quad [3]$$

$$= (1 + e^{-\alpha \cdot (t+1)})^{-1} - (1 + e^{-\alpha \cdot t})^{-1} \quad [4]$$

$$= \frac{(e^{-\alpha \cdot t}) \cdot (1 - e^{-\alpha})}{(1 + e^{-\alpha \cdot (t+1)}) \cdot (1 + e^{-\alpha \cdot t})} \quad [5]$$

$$= (1 - e^{-\alpha}) \cdot (1 - p_t) \cdot p_{t+1} \quad [6]$$

$$= \frac{(1 - e^{-\alpha}) \cdot p_t \cdot (1 - p_t)}{1 - (1 - e^{-\alpha}) \cdot (1 - p_t)} \quad [7]$$

The projections in this Appendix were developed from the discrete form with the value α varying over time. The values of α_t ("*a*[*t*]" in the projections) were chosen empirically to produce AIDS cases and deaths that most closely matched CDC reported numbers through 1986 and projections to 1991.

The theoretical expression of the S-curve in Chart 1 is based on a constant value of $\alpha = 0.485$, and the use of 1989 as t_m, the inflection year of the curve, in the formula:

$$p_t = (1 + e^{-\alpha(t - t_m)})^{-1} \quad [8]$$

Note that:

$$p_{t_m} = 0.5 \quad [9]$$

APPENDIX 2

ESTIMATE OF U.S. INDIVIDUAL LIFE AIDS CLAIMS 1976–2000
HIV INFECTION DECLINES TO 0 BY 1997

Year	HIV Infection			CDC Deaths to 1991 Model to 2000		Insured Deaths Annual	Insured as % of U.S. Deaths	Insurance Deaths Cumulative	U.S. Individual Insured Deaths Annually (mil.)	AIDS Claims to Total Ind. Claims	AIDS Claims			Cumulative AIDS Claims	
	Total HIV Infection	Insured HIV Infection	Insured HIV to Total Infection	Cumulative	Annual						Average Claim	Annual Claims (000)	Cumulative (000)	Infection Stops 1987 (000)	Claims from Infections after 1987 (000)
1976	504	64	12.6%			0		0	$4,635	0.0%		$0	$0	$0	
1977	1,887	312	16.5%			0		0	$4,879	0.0%	$15,909	$1	$1	$1	
1978	6,011	1,137	18.9%			1		1	$5,312	0.0%	$16,421	$12	$13	$13	
1979	16,295	3,442	21.1%			4		4	$5,548	0.0%	$17,177	$62	$75	$75	
1980	37,904	8,908	23.5%			14		18	$6,094	0.0%	$18,168	$248	$323	$323	
1981	76,300	20,065	26.3%	146	146	43	30%	61	$6,640	0.0%	$19,367	$839	$1,162	$1,162	
1982	135,429	39,907	29.5%	528	382	120	31%	181	$6,993	0.0%	$20,798	$2,494	$3,655	$3,655	
1983	218,173	72,548	33.3%	1,753	1,225	295	24%	476	$7,306	0.1%	$22,472	$6,619	$10,275	$10,275	
1984	328,205	123,402	37.6%	4,582	2,829	653	23%	1,129	$7,959	0.2%	$24,414	$15,950	$26,225	$26,225	
1985	477,693	203,757	42.7%	8,161	3,579	1,330	37%	2,459	$8,789	0.4%	$26,625	$35,403	$61,628	$61,628	
1986	670,619	323,658	48.3%	16,301	8,140	2,524	31%	4,983	$9,600	0.8%	$29,118	$73,499	$135,127	$135,127	
1987	919,566	478,375	52.0%	30,000	13,699	4,527	33%	9,510	$10,368	1.4%	$31,903	$144,431	$279,558	$279,558	
1988	1,191,439	647,339	54.3%	51,000	21,000	7,713	37%	17,223	$11,197	2.4%	$34,782	$268,257	$547,815	$547,815	
1989	1,465,203	817,479	55.8%	81,000	30,000	12,468	42%	29,691	$12,093	3.9%	$37,461	$467,060	$1,014,875	$1,004,025	$10,850
1990	1,721,330	976,658	56.7%	122,000	41,000	19,088	47%	48,779	$13,061	5.8%	$39,766	$759,076	$1,773,951	$1,702,810	$71,140
1991	1,945,951	1,116,256	57.4%	176,000	54,000	27,687	51%	76,466	$14,106	8.2%	$41,667	$1,153,652	$2,927,603	$2,676,080	$251,523
1992	2,131,859	1,231,795	57.8%	249,000	73,000	38,108	52%	114,574	$15,234	10.8%	$43,202	$1,646,325	$4,573,928	$3,927,022	$646,906
1993	2,277,142	1,322,086	58.1%	340,000	91,000	49,795	55%	164,369	$16,453	13.4%	$44,385	$2,210,158	$6,784,086	$5,417,846	$1,366,240
1994	2,382,978	1,387,862	58.2%	449,000	109,000	61,757	57%	226,127	$17,769	15.7%	$45,224	$2,792,907	$9,576,993	$7,040,435	$2,536,558
1995	2,451,692	1,430,566	58.4%	574,000	125,000	72,792	58%	298,919	$19,190	17.4%	$45,786	$3,332,839	$12,909,833	$8,645,117	$4,264,716
1996	2,485,433	1,451,535	58.4%	713,000	139,000	81,851	59%	380,770	$20,726	18.2%	$46,161	$3,778,322	$16,688,155	$10,133,655	$6,554,500
1997	2,485,433	1,451,535	58.4%	862,000	149,000	88,229	59%	468,999	$22,384	18.3%	$46,417	$4,095,322	$20,783,477	$11,476,947	$9,306,531
1998	2,485,433	1,451,535	58.4%	1,015,000	153,000	91,583	60%	560,582	$24,174	17.7%	$46,595	$4,267,300	$25,050,778	$12,674,777	$12,376,001
1999	2,485,433	1,451,535	85.4%	1,168,000	153,000	91,906	60%	652,488	$26,108	16.4%	$46,721	$4,293,973	$29,344,751	$13,734,957	$15,609,794
2000	2,485,433	1,451,535	58.4%	1,317,000	149,000	89,488	60%	741,976	$28,197	14.9%	$46,811	$4,189,059	$33,533,810	$14,667,629	$18,866,181

Estimate of U.S. Individual Life AIDS Claims 1976–2000
HIV Infection Stops in 1987

Year	HIV Infection			CDC Deaths to 1991 Model to 2000		Insured Deaths Annual	Insured as % of U.S. Deaths	Insurance Deaths Cumulative	U.S. Individual Insured Deaths Annually (mil.)	AIDS Claims to Total Ind. Claims	AIDS Claims		
	Total HIV Infection	Insured HIV Infection	Insured HIV to Total Infection	Cumulative	Annual						Average Claim	Annual Claims (000)	Cumulative (000)
1976	504	64	12.6%			0		0	$4,635	0.0%		$0	$0
1977	1,887	312	16.5%			0		0	$4,879	0.0%	$15,909	$1	$1
1978	6,011	1,137	18.9%			1		1	$5,312	0.0%	$16,421	$12	$13
1979	16,295	3,442	21.1%			4		4	$5,548	0.0%	$17,177	$62	$75
1980	37,904	8,908	23.5%			14		18	$6,094	0.0%	$18,168	$248	$323
1981	76,300	20,065	26.3%	146	146	43	30%	61	$6,640	0.0%	$19,367	$839	$1,162
1982	135,429	39,907	29.5%	528	382	120	31%	181	$6,993	0.0%	$20,798	$2,494	$3,655
1983	218,173	72,548	33.3%	1,753	1,225	295	24%	476	$7,306	0.1%	$22,472	$6,619	$10,275
1984	328,205	123,402	37.6%	4,582	2,829	653	23%	1,129	$7,959	0.2%	$24,414	$15,950	$26,225
1985	477,693	203,757	42.7%	8,161	3,579	1,330	37%	2,459	$8,789	0.4%	$26,625	$35,403	$61,628
1986	670,619	323,658	48.3%	16,301	8,140	2,524	31%	4,983	$9,600	0.8%	$29,118	$73,499	$135,127
1987	919,566	478,375	52.0%	30,000	13,699	4,527	33%	9,510	$10,368	1.4%	$31,903	$144,431	$279,558
1988	919,566	478,375	52.0%	50,000	20,000	7,713	39%	17,223	$11,197	2.4%	$34,782	$268,257	$547,815
1989	919,566	478,375	52.0%	79,000	29,000	12,240	42%	29,462	$12,093	3.8%	$37,273	$456,210	$1,004,025
1990	919,566	478,375	52.0%	118,000	39,000	17,821	46%	47,283	$13,061	5.4%	$39,212	$698,785	$1,702,810
1991	919,566	478,375	52.0%	168,000	50,000	23,895	48%	71,178	$14,106	6.9%	$40,731	$973,270	$2,676,080
1992	919,566	478,375	52.0%	227,000	59,000	29,795	50%	100,973	$15,234	8.2%	$41,985	$1,250,942	$3,927,022
1993	919,566	478,375	52.0%	293,000	66,000	34,672	53%	135,645	$16,453	9.1%	$42,998	$1,490,824	$5,417,846
1994	919,566	478,375	52.0%	363,000	70,000	37,153	53%	172,798	$17,769	9.1%	$43,674	$1,622,589	$7,040,435
1995	919,566	478,375	52.0%	430,000	67,000	36,459	54%	209,257	$19,190	8.4%	$44,013	$1,604,682	$8,645,117
1996	919,566	478,375	52.0%	492,000	62,000	33,711	54%	242,968	$20,726	7.2%	$44,156	$1,488,538	$10,133,655
1997	919,566	478,375	52.0%	547,000	55,000	30,371	55%	273,338	$22,384	6.0%	$44,230	$1,343,292	$11,476,947
1998	919,566	478,375	52.0%	597,000	50,000	27,050	54%	300,389	$24,174	5.0%	$44,282	$1,197,831	$12,674,777
1999	919,566	478,375	52.0%	640,000	43,000	23,919	56%	324,307	$26,108	4.1%	$44,324	$1,060,180	$13,734,957
2000	919,566	478,375	52.0%	678,000	38,000	21,026	55%	345,333	$28,197	3.3%	$44,358	$932,672	$14,667,629

II. HIV MORTALITY

WALTER H. HOSKINS

1. ABSTRACT

In studying Acquired Immune Deficiency Syndrome (AIDS) and its causative agent Human Immunodeficiency Virus (HIV) to assess their impact on life insurance underwriting, pricing, and solvency, the authors were faced with a scarcity of data about the progression from HIV to AIDS. While the mortality of AIDS patients is well documented, the long latency period of HIV has not allowed long-term studies of HIV-infected patients.

Estimates vary widely as to the percentages of HIV-infected patients that will progress to fully developed AIDS. The longer a population of HIV-infected subjects is studied, the higher are the estimates of ultimate progression to AIDS. Early estimates by CDC and others were that 10–20 percent of otherwise asymptomatic HIV-infected subjects would eventually progress to AIDS. Later, as the numbers of AIDS cases and related deaths grew, this estimate was revised upward closer to 50 percent. In a recent interview, the Surgeon General of the U.S. suggested that the ultimate progression rate might be closer to 100 percent.

The purpose of this Actuarial Note is to estimate the mortality of a population that has just become infected with HIV. Data for studying progression from HIV infection to AIDS (Frankfurt) and AIDS mortality (CDC) were analyzed, and a model was built to use the data.

This note is a detailed discussion of the sources of data used in the model; the reasons for modeling; the assumptions, formulas, and methods used in the development of the model; the derivation of the modeled progression rates; and the results of the model.

2. SOURCES OF DATA

2.1. HIV Progression Rates — The Frankfurt Study

The major source of data for this note is a study by the Center for Internal Medicine of the University of Frankfurt, West Germany [1]. It observed subjects in groups at high risk of AIDS through various stages in the progression from apparent good health to death primarily caused by AIDS.

It appears to have been an extremely well-run prospective study, completely documented on a subject-by-subject basis. It is the first published study of its kind that analyzes the progression from an HIV-infected status

in otherwise asymptomatic patients, through more serious stages of immune system impairment, all the way to fully developed AIDS and resulting death.

The design of the Frankfurt Study yielded information of more value than that from other studies available in one major respect. Rather than studying the single rate of progression from HIV infection to AIDS, it analyzed the progression of the disease as a process involving a number of discrete steps.

The Frankfurt Study observed 543 subjects from groups at high risk of AIDS from 1982 through 1985; 377 of the subjects were HIV infected on initial examination. A total of 307 subjects were observed for 3 months or longer; 259 of these were HIV infected on initial examination.

The study uses five classifications, or stages, to identify progression from healthy status to AIDS. This approach closely follows what has been identified as the "Walter Reed Staging Method" [2]:

1a	Healthy persons at risk for HIV infection, but testing negative for HIV infection.	(At-Risk)
1b	Patients testing positive for HIV infection but otherwise asymptomatic.	(HIV+)
2a	Patients with HIV infection and lymphadenopathy syndrome (LAS), together with moderate cellular immune deficiency.	(LAS)
2b	Patients with HIV infection and LAS, together with severe cellular immune deficiency (AIDS-Related Complex, or ARC, as defined by CDC).	(ARC)
3	Patients with AIDS as currently defined by CDC.	(AIDS)

The sixth and final stage was death.

The most significant data for the purposes of our analysis are summarized in Table 1. This table is essentially a restatement of Table 5 of the Frankfurt Study. It shows the results of a longitudinal study of all patients who were observed for at least three months.

Patients were grouped by:

1. the length of time they were observed in the study (Range of Observation Periods), and
2. their status at the start of their observation period (Stage 1a through Stage 3).

Each observation period/stage cell comprises a different, independent group of patients. For example, 120 patients were classified as stage 2a at the start of their observation period. Of these, 19 were observed for anywhere between 24 and 36 months. Of these patients, 14 progressed at least to stage

TABLE 1

FRANKFURT STUDY "TABLE 5" DATA

Range of Observation Periods	Stage 1a (At-Risk)	Stage 1b (HIV+)	Stage 2a (LAS)	Stage 2b (ARC)	Stage 3 (AIDS)	All Stages
(A) Number of Patients Observed by Stage and Observation Period						
3–6 months	10	9	21	8	6	54
6–12 months	14	18	51	29	9	121
12–24 months	21	20	29	20	7	97
24–36 months	3	5	9	7	1*	35
All Periods	48	52	120	64	23	307
(B) Number of Patients Whose Health Worsened by at Least One Stage or Who Died during the Observation Period						
3–6 months	1	1	3	0	4	9
6–12 months	6	10	20	3	6	45
12–24 months	9	15	14	10	5	53
24–36 months	2	4	14	4	0*	24
All Periods	18	30	51	17	15	131
(C) Percentage of Patients Observed Whose Health Worsened by at Least One Stage or Who Died During the Observation Period						
3–6 months	10%	11%	14%	0%	67%	17%
6–12 months	43	56	39	10	67	37
12–24 months	43	75	48	50	71	55
24–36 months	67	80	74	57	0*	69
All Periods	38%	58%	42%	27%	65%	43%

*One patient with AIDS was still alive 28 months after diagnosis of Kaposi's sarcoma; all others with AIDS had died before the end of 24 months.

2b while under observation. Progression to stage 2b could have occurred any time during the patient's observation period (between 0 and 36 months).

Table 1A shows the number of patients observed. Table 1B shows the number of patients whose health worsened while under observation. Table 1C shows cumulative HIV progression rates (cumulative HIV infection rates in the case of stage 1a, cumulative AIDS mortality in the case of stage 3) for the patients under study. These cumulative progression rates are *not* periodic progression rates.

Of the 20 observation period/stage cells, 19 had three or more patients under observation. The raw cumulative progression rates to the next stage of the disease increased with length of observation period for all of these 19 cells except for two cells, where they remained level. This is remarkable consistency considering that each cell was independent of all the others.

2.2. AIDS Mortality Rates – CDC Data

AIDS Weekly Surveillance Reports [3] from the U.S. Public Health Service's Centers for Disease Control (CDC) are the best available source of data on AIDS mortality. While the Frankfurt Study provided data on AIDS mortality, CDC data were used in our model because of the CDC data's high reliability resulting from the large numbers of patients studied. Through March 30, 1987, the CDC reported a total of 33,482 cases of AIDS in the U.S., of which 19,394 had resulted in death.

Table 2 is an excerpt from the March 30, 1987 CDC AIDS Weekly Surveillance Report. The deaths shown are those cases, reported by half-year of the date of AIDS diagnosis, that are known to have resulted in death. For example, of the 6,420 AIDS cases diagnosed between July 1, 1986 and December 31, 1986 *and* reported to CDC through March 30, 1987, a total of 1,817 AIDS deaths have been reported to CDC through March 30, 1987. It is probable that some AIDS deaths may go unreported even though their cases were reported.

TABLE 2

EXCERPT FROM SECTION G
AIDS WEEKLY SURVEILLANCE REPORT
UNITED STATES AIDS PROGRAM
CENTER FOR INFECTIOUS DISEASES
CENTERS FOR DISEASE CONTROL
MARCH 30, 1987
UNITED STATES CASES REPORTED TO CDC

Date of AIDS Diagnosis (by Half-Years)	Cases Reported to CDC through 3/30/87	Known Deaths Reported to CDC through 3/30/87	Case Fatality Rate through 3/30/87
1987 Jan. – March	1,460	229	16%
1986 July – Dec.	6,420	1,817	28
1986 Jan. – June	6,260	3,013	48
1985 July – Dec.	5,335	3,343	63
1985 Jan. - June	4,314	3,081	71
1984 July – Dec.	3,166	2,464	78
1984 Jan. – June	2,410	1,916	80
1983 July – Dec.	1,578	1,316	83
1983 Jan. – June	1,203	1,045	87
1982 July – Dec.	637	553	87
1982 Jan. - June	363	318	88
1981 July – Dec.	178	160	90
1981 Jan. – June	84	77	92
1980 and Earlier	74	62	84
Total	33,482	19,394	58

3. HIV MORTALITY MODEL BASED ON FRANKFURT AND CDC DATA

Analysis of Frankfurt HIV progression rates and CDC AIDS mortality rates yields valuable data needed for the development of HIV mortality rates. It would be desirable to be able to calculate HIV mortality rates directly from these data. However, traditional actuarial methods of analyzing mortality and other contingencies using single decrement formulae were of limited value in this situation. This is because of the multiple stages of the HIV disease and the high periodic probabilities of progression from one stage to the next. Multistage progression systems are not directly nor easily calculable. A different approach was needed.

A Markov Chain model was developed to study HIV mortality based on Frankfurt and CDC data. This model simulates the progression of a group of newly HIV-infected patients through the stages of the HIV disease to AIDS and death.

The process is not unlike that of creating a life, or multiple decrement, table from a limited period of observation, by joining together the experience of successive cohorts, even though no one cohort was observed to progress through the entire range of ages or decrements represented in the table. In the Frankfurt Study, a sufficient number progressed from one stage of the HIV disease to the next to enable the results from one stage progression to the next to be linked together.

The format of the data presented in the Frankfurt Study, showing progression from one stage of the disease to the next, is particularly useful for this method of modeling in that increasing the detail of the model decreases the impact that a specific graduation, projection, or other statistical technique has on the overall results of the model.

It is important to note that the assumptions of the model are determined by the format of the available data (in the case of the Frankfurt Study, rates of progression based on duration since progression to current stage). Different assumptions would almost certainly be used to build a model based on data available in a different format.

4. ASSUMPTIONS OF MODEL

4.1. Assumption 1 — Classification

At a particular time, everyone can be classified by stage and duration in stage (duration since progression to that stage). Note that duration for the stage "dead" is not applicable.

4.2. Assumption 2 — Progression or Nonprogression

In a particular time period, everyone either

1. progresses to the next stage, or
2. remains in current stage.

In other words, it is assumed that the disease is progressive and irreversible and that:

1. no one goes back a stage (The Frankfurt Study notes seven out of 307 [2.3 percent] going back one or more stages but suggests that this could be attributed to a misjudgment of initial condition as opposed to an actual improvement)
2. no one skips a stage (although rapid, almost instantaneous, successive progressions are allowed).

4.3. Assumption 3 — Probability of Progression

The probability of progression is:

1. dependent only on:
   a. stage, and
   b. duration in stage (duration since progression to that stage)
2. independent of:
   a. age, sex, and other usual underwriting factors,
   b. duration since HIV infection (This is different from duration since progression to current stage, factor 1.b. above. For example, the probability of progressing from ARC to AIDS depends on duration since progression to ARC, and not the time it took to progress from HIV infection to ARC.), and
   c. calendar year. (The model assumes persistence of current conditions and environment, i.e., no changes in attitudes especially with regard to sexual activity, no changes in available medical treatment, and no changes in the reportability of the HIV disease.)

By way of contrast to these assumptions, the number of HIV infections can be estimated by multiplying the "at-risk" population by the probability of HIV infection. The probability of HIV infection is almost certainly more dependent than successive progressions on:

a. age, sex, and other usual underwriting factors, because of the characteristics of observed "High-Risk" groups, and

b. calendar year because of changes in attitude especially with regard to sexual activity, changes in available medical treatments, and changes in the reportability of the HIV disease.

4.4. Assumption 4 — Uniform Force of Progression

A uniform force of progression is acceptable for time periods shorter than observation periods.

5. MODEL FORMULAS AND METHODS

5.1. Levels

Levels in this model are counts of patients by stage, duration in stage, and time since the start of the model. Levels are known as "states" in Markov Chain models and "nodes" in Operations Research models.

The count of patients in stage S, at duration D in stage, at time T since the start of the model, for a model using N time periods per year is:

$$L^{(N)}_{S,D,T} \qquad [1]$$

where N is the number of time periods per year,
S is the stage,*
D is the duration in stage (in years), and
T is the time since the start of the model (in years).

Note that T is used only for recording the results of the model at a time since the start of the model and does not affect the probability of progression.

5.2. Flows

Since progression or nonprogression are the only two possible events, there are only two flows in the model:

1. Progression (from one stage to the next), and
2. Nonprogression.

Flows are known as "decisions" in Markov Chain and Operations Research models.

*0 = "1b" = "HIV+", 1 = "2a" = "LAS", 2 = "2b" = "ARC", 3 = "3" = "AIDS", and 4 = "Dead."

The probability of patients from stage S at duration D in stage, progressing to stage $S+1$ at duration 0 in stage, for a single time period, for a model using N time periods per year is:

$$Q_{S,D}^{(N)} \quad [2]$$

where N is the number of time periods per year,
S is the stage, and
D is the duration in stage (in years).

The probability of patients from stage S at duration D stage, remaining in stage S at duration $D+1$ in stage, for a single time period, for a model using N time periods per year is:

$$1 - Q_{S,D}^{(N)} \quad [3]$$

Where annual progression rates are defined, progression rates for an Nth of period are derived as follows:

$$Q_{S,D}^{(N)} = 1 - (1 - Q_{S,D}^{(1)})^{1/N} \quad [4]$$

and

$$Q_{S,D+N/N}^{(N)} Q_{S,D}^{(N))}, \text{ for } H = 0 \text{ to } N - 1 \quad [5]$$

Where semiannual progression rates are defined, progression rates for an Nth of period are derived as follows:

$$Q_{S,D}^{(N)} = 1 - (1 - Q_{S,D}^{(2)})^{2/N} \quad [6]$$

and

$$Q_{S,D+N/N}^{(N)} = Q_{S,D}^{(N)}, \text{ for } H = 0 \text{ to } \left(\frac{N}{2}\right) - 1 \quad [7]$$

5.3. Progression

The number of patients in a stage for duration of zero is equal to the number of patients in the previous stage at any duration who did progress during the previous time period.

$$L_{S,O,T}^{(N)} = \sum_{D=0}^{x} \left(L_{S-1,D,T-1/N}^{(N)} \times Q_{S-1,D}^{(N)} \right) \quad [8]$$

5.4. Nonprogression

The number of patients in a stage for a duration greater than zero is equal to the number of patients in that stage in the previous duration who did *not* progress during the previous time period.

$$L^{(N)}_{S,D,T} = L^{(N)}_{S,D-1/N,T-1/N} \times \left(1 - Q^{(N)}_{S,D-1/N}\right), \text{ for } D > 0 \qquad [9]$$

5.5. Time Periods — The Continuous Model

A significant issue in developing the model was the number of time periods per year to be used. Recall that "N" is the number of time periods per year. Since the first year of observation in the Frankfurt Study was in six-month intervals, the model should have at least two time periods per year ($N \geq 2$). Also, the number of time periods per year should be even.

However, the use of a six-month time period ($N = 2$) would result in artificial restraint of a minimum time to progress four stages (from HIV infection to death) of two years. This would produce unacceptable distortions. Therefore a shorter time period (a larger N) had to be used. A continuous model ($N = \infty$, or an infinite number of infinitely short time periods per year) would eliminate the artificial minimum time to progress four stages.

Since a count was kept of all patients by stage and duration in that stage, doubling the number of time periods per year would double the number of cells modeled. In addition, the number of time periods in the duration of the model would also double. Therefore doubling the number of time periods per year would quadruple the time necessary to run the model. A continuous model therefore implies an infinitely long time to run a model.

However, it was discovered by experimentation that the counts of patients produced by a model based on a certain number (N) of time periods per year was nearly linearly related to the length ($1/N$) of the time period used. This near linearity was confirmed by testing up to $N = 36$, a model of which took a prohibitively long time to run. The reason for this near linearity is unknown.

Using this discovery, we approximated a continuous model ($N = \infty$) from a one-month model ($N = 12$) and a two-month model ($N = 6$) by the following formula:

$$L^{(\infty)}_{S,D,T} = 2 \times L^{(12)}_{S,D,T} - L^{(6)}_{S,D,T} \qquad [10]$$

The derivation of this formula is in the Appendix.

5.6. Initial Values

The model starts with a single cohort group of 100,000 newly HIV infected patients. (Stage = 0 = "1b" = "HIV+", duration = 0, and time = 0.)

$$L^{(N)}_{0,0,0} = 100{,}000 \quad [11]$$

$$\text{else } L^{(N)}_{S,T,D} = 0 \quad [12]$$

5.7. Reported Results

The model reported the number of patients by stage for successive six-month intervals. Duration within stage was not reported. Reporting results for intervals shorter than six months would not be helpful because the model assumptions are based on six-month data and the model produces rough linearity between six-month intervals.

6. MODELED PERIODIC PROGRESSION RATES

6.1. Date of HIV Infection

One issue in this and subsequent analysis is the difficulty in determining the precise time at which HIV infection occurs. HIV infection is defined as the initial progression from HIV negative status to HIV positive status. Even under clinically controlled conditions, it is difficult to precisely pinpoint such time.

Unless subjects at high risk of HIV infection, but actually HIV negative, are examined frequently enough to have a negative test closely followed by a positive test, the precise date of HIV infection cannot be determined. Because of the unknown time between HIV infection and initial observation of the infection, it is likely that progression appears to take place faster in studies than it does in reality. As the disease progresses, however, and more subjects come under medical observation, the measurements of progression to later stages are likely to be more precise.

6.2. HIV Progression Rates for the First Three Years

In building periodic HIV progression rates, it was assumed that each of the four ranges of observation periods fully represented the underlying cumulative HIV progression through the upper limit of the range. Specifically

that the 3–6 month range represented the underlying cumulative HIV progression through the 6th month, the 6–12 month range represented the underlying cumulative HIV progression through the 12th month, and so on. Assumed periodic rates were derived from these assumed cumulative rates. Table 3 shows the development of the assumed periodic HIV progression rates. Section 6.6 discusses the choice of the upper limit of the range of length of the observation period as opposed to the average length.

TABLE 3

DEVELOPMENT OF ASSUMED PERIODIC HIV PROGRESSION RATES

Cumulative Period (months)	Assumed Cumulative Progression Rates	Period (months)	Not Yet Progressed at Start of Period	Progressed during Period	Assumed Periodic Progression Rates
(A) Progression from Stage 1b to Stage 2a					
0–6	11%	0–6	100%	11%	11%
0–12	56	6–12	89	44	50
0–24	75	12–24	44	19	44
0–36	80	24–36	25	5	20
(B) Progression from Stage 2a to Stage 2b					
0–6	14	0–6	100	14	14
0–12	39	6–12	86	25	29
0–24	48	12–24	61	9	15
0–36	74	24–36	52	25	49
(C) Progression from Stage 2b to Stage 3					
0–6	0	0–6	100	0	0
0–12	10	6–12	100	10	10
0–24	50	12–24	90	40	44
0–36	57	24–36	50	7	14

The raw assumed periodic progression rates were then graduated where necessary, with the objective of preserving as closely as possible the raw assumed cumulative progression rates. The amount of graduation was minimal because the high consistency of the raw progression rates implied little need for graduation. The impact of the minimal graduation was negligible and was tested by running the model with the raw progression rates.

The graduated periodic HIV progression rates for Stages 1b, 2a, and 2b for the first three years since progression to that stage are included in Table 4.

TABLE 4

PERIODIC PROGRESSION RATES USED IN THE MODEL

Period	Stage 1a (At-Risk)	Stage 1b (HIV+)	Stage 2a (LAS)	Stage 2b (ARC)	Stage 3 (AIDS)
First Six Months	N/A	10%	15%	[5%]	[26%]
Second Six Months	N/A	50	30	[5]	[26]
First Year	N/A	[55]	[40]	10	45
Second Year	N/A	45	35	45	45
Third Year	N/A	20	35	15	35
Fourth and Subsequent Years	N/A	20	20	20	25

Notes: Stage 1a progression rates (HIV Infection Rates) are not used in the Model.
Stage 1b, 2a, and 2b progression rates are derived from Frankfurt Study data. These rates are graduated for the first three years and projected for the fourth and subsequent years.
Stage 3 progression rates (AIDS Mortality Rates) are derived from CDC data. These rates are graduated for the first six years and projected for the seventh and subsequent years.
[ ] indicate effective rates calculated from either First and Second Six Month rates, or from First Year rates.

6.3. HIV Progression Rates for the Fourth Year and On

HIV progression rates for Stages 1b, 2a, and 2b for the fourth and subsequent years since progression to those stages were projected to be 20 percent. This is approximately the average of the third-year HIV progression rates for those stages. Results of models using this rate closely approximate the result of models using a continuation of the third-year rates. We consider this to be the most reasonable assumption.

The impact of projection is lessened because of the small number of survivors in a stage when the projected progression rates start being used. Since only 20 percent to 42 percent of the patients did not progress to the next stage of the disease before the start of the fourth year, the ultimate progression rates do not have as much impact on the model as do the rates for the first three years.

The projected periodic HIV progression rates for Stages 1b, 2a, and 2b for the fourth and subsequent years since progression to that stage are included in Table 4.

6.4. AIDS Mortality Rates

Table 5 shows the development of modeled AIDS mortality rates. These rates were developed from CDC data by assuming that CDC Case Fatality Rates for each half-year of AIDS diagnosis fully represented the underlying

cumulative AIDS mortality from the midpoint of the half-year through the date of the report.

TABLE 5

MODELED AIDS MORTALITY RATES DERIVED FROM SECTION G
AIDS WEEKLY SURVEILLANCE REPORT
UNITED STATES AIDS PROGRAM
CENTER FOR INFECTIOUS DISEASES
CENTER FOR DISEASE CONTROL
MARCH 30, 1987

Date of AIDS Diagnosis (by Half-Years)	Assumed Average Years Since AIDS Diagnosis	Actual Cumulative AIDS Mortality	Modeled Annual AIDS Mortality Rate	Modeled Cumulative AIDS Mortality
1986 July – Dec.	0.5	28%	45%	26%
1986 Jan. – June	1	48	45	45
1985 July – Dec.	1.5	63	45	59
1985 Jan. – June	2	71	45	70
1984 July – Dec.	2.5	78	35	76
1984 Jan. – June	3	80	35	80
1983 July – Dec.	3.5	83	25	83
1983 Jan. – June	4	87	25	85
1982 July – Dec.	4.5	87	25	87
1982 Jan. – June	5	88	25	89
1981 July – Dec.	5.5	90	25	90
1981 Jan. – June	6	92	25	92

Modeled AIDS mortality rates are 45 percent annually in the first and second years since the progression to AIDS, 35 percent in the third year, and 25 percent thereafter. This produces a life expectancy of about 2.1 years from progression to AIDS and a 6-year AIDS survival rate of 8 percent.

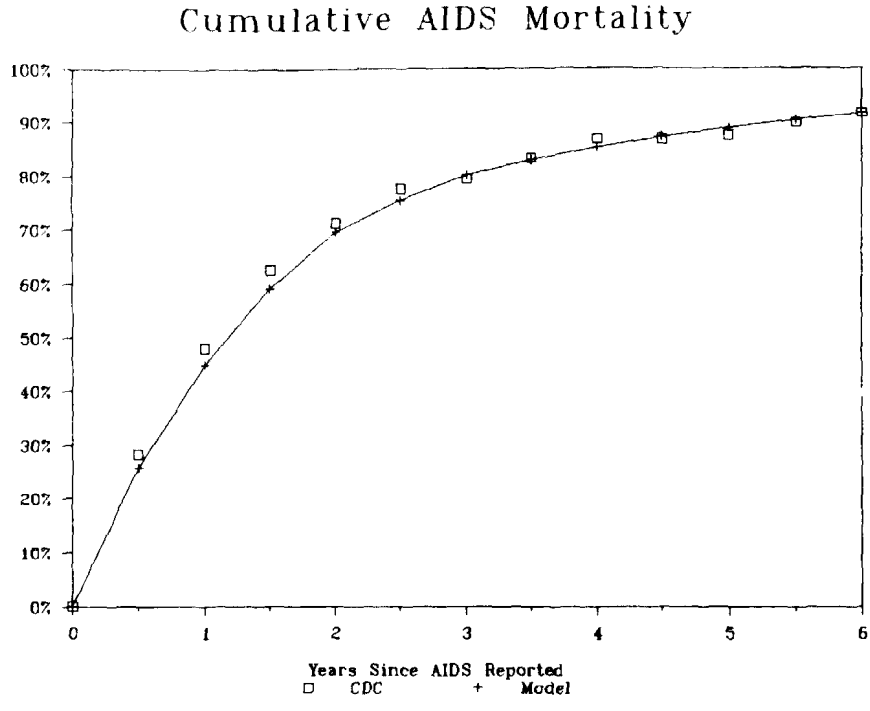
Chart 1 compares modeled cumulative AIDS mortality to actual CDC Case Fatality Rates for the first six years since diagnosis of AIDS.

6.5. Summary of Modeled Periodic Progression Rates

Stage 1a progression rates (HIV Infection Rates) were not used in the model.

Stage 1b, 2a, and 2b progression rates were derived from graduated Frankfurt data for the first three years since progression to that stage and projected for the fourth and subsequent years.

CHART 1



Notes:

□ **CDC Data are CDC AIDS Case Fatality Rates as of March 30, 1987.**

\+ **Model Data are Cumulative AIDS Mortality based on Annual AIDS Mortality Rates of 45%, 45%, 35%, and 25% thereafter.**

Stage 3 progression rates (AIDS Mortality Rates) were derived from graduated CDC data for the first six years since progression of AIDS and projected for the seventh and subsequent years.

Table 4 shows the progression rates used in the model. The rates are periodic progression rates (i.e., second-year progression rates show the percent of patients who have been in the stage for one year who will progress to the next stage in the second year).

Table 6 shows modeled cumulative progression rates resulting from the periodic progression rates in Table 4 for comparison to the raw cumulative progression rates in Tables 1–3 and 5. Not only are the modeled progression close to the assumed raw progression rates, but the results of models based on either set of rates are similar.

TABLE 6

MODELED CUMULATIVE PROGRESSION

Duration (months)	Duration (years)	Stage 1a (At-Risk)	Stage 1b (HIV+)	Stage 2a (LAS)	Stage 2b (ARC)	Stage 3 (AIDS)
6	0.5	N/A	10%	15%	5%	26%
12	1	N/A	55	41	10	45
24	2	N/A	75	61	51	70
36	3	N/A	80	75	58	80
48	4	N/A	84	80	66	85
60	5	N/A	87	84	73	89
72	6	N/A	90	87	78	92

Note: These cumulative progression rates were derived from the periodic progression rates in Table 4 for comparison with cumulative progression rates in Tables 1–3 and 5.

The expected number of years to progress from one stage of the disease to the next, based on Table 4 periodic progression rates, is:

2.25 years from Stage 1b (HIV+) to 2a (LAS),
2.74 years from Stage 2a (LAS) to 2b (ARC),
3.97 years from Stage 2b (ARC) to 3 (AIDS), and
2.10 years from Stage 3 (AIDS) to death.

This results in an expected number of years from HIV infection to death (HIV life expectancy) of 11.06 years.

6.6. "Low Assumptions" Versus "High Assumptions"

Where possible, "low assumptions" (i.e., lower progression rates) were used to offset any assumptions that might be construed as "high assumptions" (i.e., higher progression rates).

Periodic progression rates based on the duration since the start of the observation period would be considered "high assumptions" because this assumes the patients progressed to their stage at the start of their observation period, whereas they had probably been in the stage for some unknown time before the start of their observation period.

Periodic progression rates based on the maximum length of observation period (as opposed to the average length) would be considered "low assumptions" because this overstates the assumed duration of observed progressions.

It is likely that using the maximum length of observation periods offsets somewhat the unknown time between progression to current stage and the start of the observation period. This is why we used the maximum length of observation period, and not the average length, in deriving assumed progression rates.

Table 7 compares the maximum and average lengths of observation periods. This table shows that the use of the average length of observation period would result in progressions in approximately 80 percent (75–83 percent) of the time of progressions based on the maximum length.

TABLE 7

COMPARISON OF MAXIMUM AND AVERAGE LENGTHS OF OBSERVATION PERIODS

Range of Length of Observation Periods (months)	Maximum Length of Observation Periods (months)	Average Length of Observation Periods (months)	Ratio of Average Length to Maximum Length
3–6	6	4.5	75%
6–12	12	9	75
12–24	24	18	75
24–36	36	30	83

7. MODEL RESULTS AND COMPARISONS

The results of the model based on Frankfurt HIV progression rates and CDC AIDS mortality rates are shown in Tables 8 and 9 and in Chart 2. These results are compared to other mortality scenarios in Tables 10 and 11 and in Charts 3 and 4.

7.1. Frankfurt/CDC Model Results

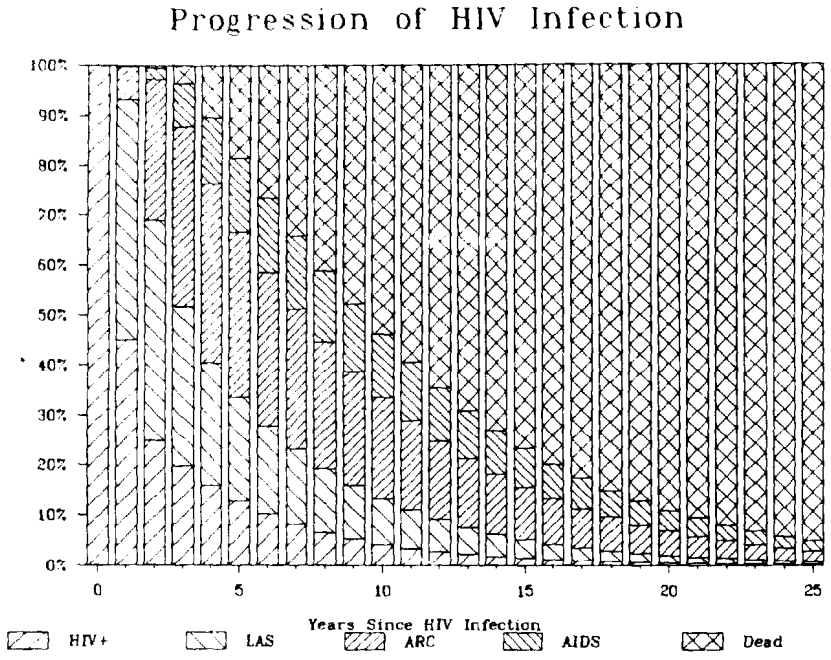
The major results of the model, specifically the progression of the HIV disease in terms of the percent of a newly HIV infected cohort by stage of the disease and duration since HIV infection, are shown in Table 8 and illustrated in Chart 2. Half-year results not shown in Table 8 can be calculated by interpolation.

TABLE 8

RESULTS OF MODEL
BASED ON FRANKFURT STUDY HIV PROGRESSION RATES
AND CDC AIDS MORTALITY RATES

Years Since HIV Infection	Progression from HIV Infection to Death (Percent Distribution by Stage)				
	Stage 1b (HIV+)	Stage 2a (LAS)	Stage 2b (ARC)	Stage 3 (AIDS)	Dead
0	100.0%	0.0	0.0	0.0	0.0
0.5	90.0	9.2%	0.8%	0.0	0.0
1	45.0	48.2	6.6	0.2%	0.0
1.5	33.4	47.5	18.3	0.7	0.1%
2	24.8	44.2	28.3	2.2	0.5
2.5	22.1	37.3	33.9	5.1	1.5
3	19.8	31.8	36.0	8.8	3.6
3.5	17.7	27.5	36.5	11.6	6.7
4	15.8	24.6	35.9	13.3	10.4
4.5	14.2	22.5	34.6	14.3	14.4
5	12.7	20.7	33.2	14.8	18.6
6	10.1	17.7	30.6	14.9	26.7
7	8.1	15.0	28.0	14.6	34.2
8	6.5	12.7	25.3	14.2	41.3
9	5.2	10.8	22.7	13.5	47.9
10	4.2	9.1	20.2	12.6	54.0
11	3.3	7.6	17.9	11.7	59.5
12	2.7	6.4	15.7	10.7	64.6
13	2.1	5.3	13.7	9.7	69.1
14	1.7	4.5	12.0	8.7	73.2
15	1.4	3.7	10.4	7.8	76.8
16	1.1	3.1	9.0	6.9	79.9
17	0.9	2.6	7.7	6.1	82.7
18	0.7	2.1	6.6	5.4	85.2
19	0.6	1.8	5.7	4.7	87.3
20	0.4	1.5	4.9	4.1	89.1
21	0.4	1.2	4.1	3.6	90.7
22	0.3	1.0	3.5	3.1	92.1
23	0.2	0.8	3.0	2.7	93.3
24	0.2	0.7	2.5	2.3	94.3
25	0.1	0.6	2.1	2.0	95.2

CHART 2



"Walter Reed Staging Method":

HIV+	1b	Patients testing positive for HIV infection but otherwise asymptomatic.
LAS	2a	Patients with HIV infection and lymphadenopathy syndrome (LAS), together with moderate cellular immune deficiency.
ARC	2b	Patients with HIV infection and LAS, together with severe cellular immune deficiency (AIDS-Related Complex, or ARC, as defined by CDC).
AIDS	3	Patients with AIDS as currently defined by CDC.

Table 9 shows annual rates of progression to AIDS, cumulative progression to AIDS, annual HIV mortality rates, and cumulative HIV mortality. Annual rates of progression to AIDS are defined as those progressing to AIDS during the year divided by those not yet progressed to AIDS as of the start of the year.

TABLE 9

RESULTS OF MODEL
BASED ON FRANKFURT STUDY HIV PROGRESSION RATES
AND CDC AIDS MORTALITY RATES

	(A) Progression from HIV Infection to AIDS		(B) HIV Mortality (HIV Infection to Death)	
Years Since HIV Infection	Annual Rate*	Cumulative Progression	Annual Rate†	Cumulative Mortality
0	0.2%	0.0	0.0	0.0
1	2.5	0.2%	0.5%	0.0
2	9.9	2.7	3.1	0.5%
3	12.9	12.4	7.0	3.6
4	12.7	23.7	9.2	10.4
5	12.3	33.4	10.0	18.6
6	12.5	41.6	10.3	26.7
7	12.9	48.9	10.7	34.2
8	13.2	55.5	11.2	41.3
9	13.5	61.4	11.7	47.9
10	13.8	66.6	12.1	54.0
11	14.1	71.2	12.5	59.5
12	14.3	75.3	12.8	64.6
13	14.5	78.8	13.1	69.1
14	14.7	81.9	13.4	73.2
15	14.9	84.6	13.7	76.8
16	15.1	86.9	13.9	79.9
17	15.2	88.8	14.1	82.7
18	15.4	90.5	14.3	85.2
19	15.5	92.0	14.5	87.3
20	15.7	93.2	14.7	89.1
21	15.8	94.3	14.9	90.7
22	15.9	95.2	15.0	92.1
23	16.0	96.0	15.2	93.3
24	16.1	96.6	15.3	94.3
25	16.2	97.2	15.4	95.2

*Of those HIV infected but not yet progressed to AIDS.
†Of those HIV infected but not yet dead.

7.2. Comparisons to Other Mortality Scenarios

Table 10 adds standard mortality to modeled HIV mortality and compares the results to standard mortality, marginally insurable substandard mortality,

and two alternative HIV mortality scenarios. The standard mortality in this model is 1980 CSO Basic Male Nonsmoker. Marginally insurable substandard mortality is defined for this analysis as five times standard (500% of standard).

TABLE 10

EXPECTED MORTALITY UNDER VARIOUS SCENARIOS

Attained Age	Years	"FM-High"	"FM-Mid"	"FM-Low"	"500%"	"100%"
		(A) Annual Mortality Rates				
35	0	0.2%	0.1%	0.1%	0.4%	0.1%
36	1	2.0	0.6	0.3	0.4	0.1
37	2	6.9	3.2	1.6	0.4	0.1
38	3	10.9	7.1	3.6	0.5	0.1
39	4	12.4	9.3	4.7	0.5	0.1
40	5	13.0	10.1	5.1	0.6	0.1
45	10	16.2	12.3	6.2	1.0	0.2
50	15	18.1	14.0	7.2	1.6	0.3
55	20	19.4	15.3	7.9	2.8	0.6
60	25	20.5	16.4	8.7	4.9	1.0
		(B) Cumulative Morality				
36	1	0.2%	0.1%	0.1%	0.4%	0.1%
37	2	2.2	0.7	0.4	0.8	0.2
38	3	8.9	3.8	2.1	1.2	0.2
39	4	18.9	10.7	5.6	1.7	0.3
40	5	28.9	19.0	10.0	2.2	0.4
45	10	67.3	54.6	32.3	5.8	1.2
50	15	87.1	77.4	52.0	11.3	2.4
55	20	95.4	89.7	67.4	19.9	4.3
60	25	98.5	95.6	78.8	33.2	7.7

Scenario Descriptions: "FM-High"—HIV Mortality 20% faster than Model HIV Mortality plus 100% Standard Mortality.
"FM-Mid"—Model HIV Mortality plus 100% Standard Mortality.
"FM-Low"—One-Half of Model HIV Mortality plus 100% Standard Mortality.
"500%"—"Marginally Insurable Substandard Mortality" (500% Standard Mortality).
"100%"—"Standard Mortality" (1980 CSO Basic Male Nonsmoker Age 35).

The two alternative HIV mortality scenarios are introduced solely to provide a range of estimates around the best estimate. The original and two alternative HIV mortality scenarios are defined as follows.

FM-Mid is the original best-estimate model results discussed up to this point. FM-Mid is short for *F*rankfurt/CDC *M*odel *Mid*range results.

FM-High approximates using the *average* observation period in determining the raw cumulative progression rates as opposed to using the *maximum* observation period. FM-High cumulative HIV mortality rates at *Y* years were set to FM-Mid cumulative HIV mortality rates at *Y*/0.80 years. In other words, FM-High takes only 80 percent of the time that FM-Mid takes to progress to a given cumulative HIV mortality. See Section 6.6 for the derivation of the 0.80 factor.

FM-Low arbitrarily uses one-half of the HIV mortality rates used in FM-Mid.

Annual mortality rates for each scenario is shown in Table 10A and illustrated in Chart 3. Cumulative mortality for each scenario are shown in Table 10B and illustrated in Chart 4.

Table 11A shows the complete expectation of life at HIV infection at age 35. HIV mortality rates under the three "FM" scenarios for the 26th and subsequent years were held at the 25th year rates for purposes of calculating the complete expectation of life.

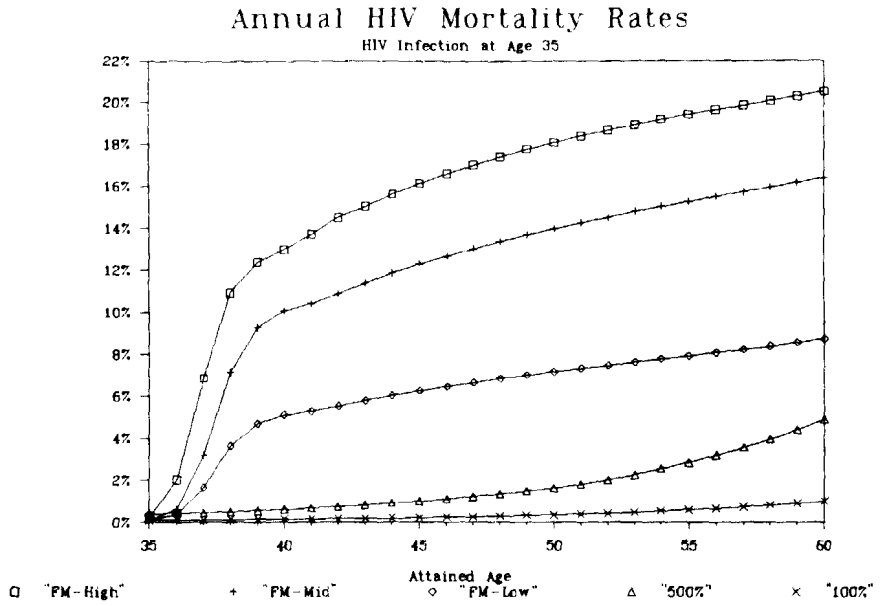
For illustrative purposes only, the equivalent level multiples of 1980 CSO Basic Male Nonsmoker Table rates were calculated that would produce the same life expectancy of a 35-year-old cohort of males newly HIV infected. Table 11B shows the multiple of standard mortality that yields the same complete expectation of life as in Table 11A.

To match the same life expectancy as produced by projecting Frankfurt and CDC data, mortality would have to be elevated to over 51 times standard. In other words, this level of mortality is over 10 times higher than the upper limit of marginally acceptable substandard life insurance risks (5 times standard).

Table 11C shows the expected "half-life" of a group of patients HIV infected at age 35. "Half-life" is defined as the time in years at which cumulative mortality is expected to be 50 percent (i.e., half the patients are dead). Table 11D shows the multiple of standard mortality that yields the same expected "half-life" as in Table 11C.

Further analysis shows significant differences between the *patterns* of cumulative HIV mortality and cumulative mortality based on extreme multiples of standard mortality. As Chart 3 shows, HIV mortality rises steeply following infection. This produces an usually high number of early deaths even when compared to high multiples of standard. Such significant differences make comparisons of HIV mortality to multiples of standard mortality potentially misleading. This is demonstrated by the different "Equivalent Multiples of Standard Mortality" shown in Tables 11B and 11D.

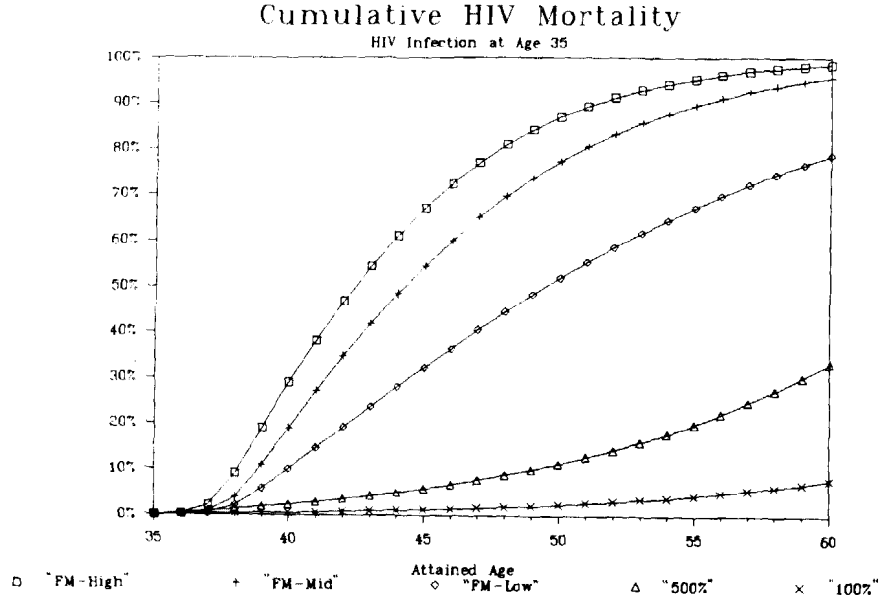
CHART 3



Scenario Descriptions:

□	"FM-High"	HIV Mortality 20% faster than Model HIV Mortality plus 100% Standard Mortality.
+	"FM-Mid"	Model HIV Mortality plus 100% Standard Mortality.
◇	"FM-Low"	One Half of Model HIV Mortality plus 100% Standard Mortality.
△	"500%"	"Marginally Insurable Substandard Mortality" (500% Standard Mortality).
×	"100%"	"Standard Mortality" (1980 CSO Basic Male Non Smoker Age 35).

CHART 4



Scenario Descriptions:

□	"FM-High"	HIV Mortality 20% faster than Model HIV Mortality plus 100% Standard Mortality.
+	"FM-Mid"	Model HIV Mortality plus 100% Standard Mortality.
◇	"FM-Low"	One Half of Model HIV Mortality plus 100% Standard Mortality.
△	"500%"	"Marginally Insurable Substandard Mortality" (500% Standard Mortality).
×	"100%"	"Standard Mortality" (1980 CSO Basic Male Non Smoker Age 35).

TABLE 11

EXPECTATIONS OF LIFE UNDER VARIOUS SCENARIOS

"FM-High"	"FM-Mid"	"FM-Low"	"500%"	"100%"
(a) Complete Expectation of Life in Years at Age 35				
8.75	10.89	16.93	28.24	42.62
(B) Multiple of Standard Mortality for Same Complete Expectation of Life at Age 35				
74.6	51.3	20.8	5.0	1.0
(C) Expected "Half-Life" in Years at Age 35 (Years until 50% Cumulative Mortality)				
7.43	9.25	14.46	29.63	44.10
(D) Multiple of Standard Mortality for Same Expected "Half-Life" at Age 35 (Years until 50% Cumulative Mortality)				
87.0	63.6	30.2	5.0	1.0

Scenario Descriptions: "FM-High"—HIV Mortality 20% faster than Model HIV Mortality plus 100% Standard Mortality.
"FM-Mid"—Model HIV Mortality plus 100% Standard Mortality.
"FM-Low"—One-Half of Model HIV Mortality plus 100% Standard Mortality.
"500%"—"Marginally Insurable Substandard Mortality" (500% Standard Mortality).
"100%"—"Standard Mortality" (1980 CSO Basic Male Nonsmoker Age 35).

8. CONCLUSION

The model based on Frankfurt HIV progression rates and CDC AIDS mortality rates shows cumulative HIV mortality rates of approximately 19 percent for 5 years, 55 percent for 10 years, 77 percent for 15 years, 90 percent for 20 years, and 96 percent for 25 years. The results are consistent with the view of the U.S. Surgeon General that the progression from HIV infection to AIDS might ultimately reach close to 100 percent.

The magnitude of the results was corroborated by other studies discussed in *AIDS and Life Insurance,* part I of this chapter, and were useful in generating models of HIV infection and progression to AIDS and death.

Please read Section 3.7 of *AIDS and Life Insurance* for a discussion of the persistence of current HIV mortality and the appropriateness of deriving HIV progression rates from studies of high-risk groups and then applying them to other dissimilar groups.

Finally, a few closing observations on the usefulness of modeling:

- A mathematical model is a representation of an actual real-world system. Knowledge of the system is incorporated in the model and then the model can be used to predict the system. A model can confirm or refute an "intuitive feel" for the overall system.

A model has the ability to test the effect of changes in assumptions, including extrapolations.

- A model is especially useful in that a challenge to the overall results of a model must be supported by challenges to specific factors and/or assumptions. In other words, someone disagreeing with the results of a model must be able to dispute a specific assumption, relationship, or methodology.
- Forrester [4] has an excellent and highly recommended presentation on the construction and validation of mathematical models.

9. REFERENCES

1. BRODT, H.R., HELM, E.G., WERNER, A., JOETTEN, A., BERGMANN, L., KLUVER, A., AND STILLE, W., *Spontanverlauf der LAV/HTLV-III-Infektion; Verlaufsbeobachtungen bei Personen aus AIDS-Risikogruppen;* Deutsche Medizinische Wochenschrift, Stuttgart, Vol. 111 (1986), pp. 1175–1180.
2. *The Walter Reed staging classification for HTLV-III/LAV Infection*, New England Journal of Medicine, 1986, Vol. 314, No. 2, pp. 131–132.
3. *AIDS Weekly Surveillance Report*, United States AIDS Program, Center for Infectious Diseases, Centers for Disease Control, Public Health Service, Department of Health and Human Services, Atlanta, GA, March 30, 1987, p. 5.
4. FORRESTER, JAY W., *Industrial Dynamics*, Cambridge, MA, The M.I.T. Press, 1961, chapters 4 and 13.

10. APPENDIX

DERIVATION OF APPROXIMATION OF CONTINUOUS MARKOV CHAIN MODEL

Linearity between the counts ($L^{(N)}$) resulting from a model with N time periods per year and the length ($1/N$) of time period used gives:

$$\frac{\Delta(L^{(N)})}{\Delta(1/N)} = \text{a constant} \qquad [1]$$

and

$$\left(\frac{L^{(A)} - L^{(B)}}{1/A - 1/B}\right) = \left(\frac{L^{(B)} - L^{(C)}}{1/B - 1/C}\right) \qquad [2]$$

Solving for $L^{(A)}$ gives:

$$L^{(A)} = L^{(B)} + \left(\frac{1/A - 1/B}{1/B - 1/C}\right) \times (L^{(B)} - L^{(C)}) \qquad [3]$$

If $B = 2C$, then:

$$L^{(A)} = L^{(2C)} + \left(\frac{1/A - 1/2C}{1/2C - 1/C}\right) \times (L^{(2C)} - L^{(C)}) \quad [4]$$

$$= L^{(2C)} + (1 - 2C/A) \times (L^{(2C)} - L^{(C)}) \quad [5]$$

$$= 2 \times L^{(2C)} - L^{(C)} - (2C/A) \times (L^{(2C)} - L^{(C)}) \quad [6]$$

If we define $L^{(\infty)} = \lim_{A \to \infty} L^{(A)}$, then:

$$L^{(\infty)} = \lim_{A \to \infty} [2 \times L^{(2C)} - L^{(C)} - (2C/A) \times (L^{(2C)} - L^{(C)})] \quad [7]$$

$$= 2 \times L^{(2C)} - L^{(C)} - \lim_{A \to \infty} [2C/A] \times (L^{(2C)} - L^{(C)}) \quad [8]$$

$$= 2 \times L^{(2C)} - L^{(C)} - 0 \times (L^{(2C)} - L^{(C)}) \quad [9]$$

$$= 2 \times L^{(2C)} - L^{(C)} \quad [10]$$

If $C = 6$ (and $B = 2C = 2 \times 6 = 12$), then:

$$L^{(\infty)} = 2 \times L^{(12)} - L^{(6)} \quad [11]$$

Note: The model was designed to be capable of using any even number of time periods per year.

ADDENDUM #1

The following comments and tables should be of benefit to those working to reproduce Appendices 1 and 2 of part I of this chapter.

In developing the Appendices of part I, Mike Cowell used HIV progression rates from the SFCC/CDC Model instead of from the Frankfurt Model as might be expected. SFCC/CDC Model HIV progression rates are lower than Frankfurt Model HIV progression rates.

The SFCC/CDC Model

The SFCC/CDC Model is described in part I, Section 3.7. It is based on HIV progression rates from the San Francisco City Clinic/CDC Study (part I, Section 3.4), and AIDS mortality rates from CDC AIDS Cases and Deaths data (part I, Section 3.5).

The results of the SFCC/CDC Model are shown in the following tables. These tables are analogous to Tables 8 through 11 of part II, which show the results of the Frankfurt Model.

The results of the SFCC/CDC Model and the Frankfurt Model are illustrated in Charts 4 and 5 of part I.

The Frankfurt Model

The Frankfurt Model is described in part I, Section 3.6 and in part II.

TABLE 8

SFCC/CDC MODEL
RESULTS OF MODEL BASED ON
SAN FRANCISCO CITY CLINIC/CDC HIV PROGRESSION RATES
AND CDC AIDS MORTALITY RATES

Years Since HIV Infection	Stage 1b (HIV+))	Stage 2a (LAS)	Stage 2b (ARC)	Stage 3 (AIDSJ)	Dead
0	100.0	*	*	0.0	0.0
1	99.7	*	*	0.2	0.1
2	98.5	*	*	0.8	0.7
3	95.9	*	*	1.9	2.2
4	91.6	*	*	3.4	5.0
5	85.4	*	*	5.4	9.2
6	76.8	*	*	8.0	15.2
7	66.4	*	*	10.6	23.0
8	56.4	*	*	12.0	31.6
9	48.0	*	*	12.3	39.8
10	40.8	*	*	11.9	47.3
11	34.7	*	*	11.3	54.1
12	29.5	*	*	10.4	60.1
13	25.0	*	*	9.5	65.5
14	21.3	*	*	8.5	70.2
15	18.1	*	*	7.6	74.3
16	15.4	*	*	6.7	77.9
17	13.1	*	*	5.9	81.0
18	11.1	*	*	5.2	83.7
19	9.4	*	*	4.5	86.0
20	8.0	*	*	3.9	88.0
21	6.8	*	*	3.4	89.8
22	5.8	*	*	2.9	91.3
23	4.9	*	*	2.5	92.5
24	4.2	*	*	2.2	93.6
25	3.6	*	*	1.9	94.6

*Included in Stage 1b (HIV+).

TABLE 9

SFCC/CDC MODEL
RESULTS OF MODEL BASED ON
SAN FRANCISCO CITY CLINIC/CDC HIV PROGRESSION RATES
AND CDC AIDS MORTALITY RATES

Years Since HIV Infection	(A) Progression from HIV Infection to AIDS		(B) HIV Mortality (HIV Infection to Death)	
	Annual Rate	Cumulative Progression	Annual Rate	Cumulative Mortality
0	0.3%	0.0	0.1%	0.0
1	1.2	0.3%	0.6	0.1%
2	2.6	1.5	1.5	0.7
3	4.5	4.1	2.8	2.2
4	6.8	8.4	4.4	5.0
5	10.1	14.6	6.6	9.2
6	13.5	23.2	9.2	15.2
7	15.0	33.6	11.1	23.0
8	15.0	43.6	12.0	31.6
9	15.0	52.0	12.5	39.8
10	15.0	59.2	12.9	47.3
11	15.0	65.3	13.2	54.1
12	15.0	70.5	13.4	60.1
13	15.0	75.0	13.6	65.5
14	15.0	78.7	13.8	70.2
15	15.0	81.9	14.0	74.3
16	15.0	84.6	14.1	77.9
17	15.0	86.9	14.2	81.0
18	15.0	88.9	14.3	83.7
19	15.0	90.6	14.4	86.0
20	15.0	92.0	14.5	88.0
21	15.0	93.2	14.5	89.8
22	15.0	94.2	14.6	91.3
23	15.0	95.1	14.6	92.5
24	15.0	95.8	14.7	93.6
25	15.0	96.4	14.7	94.6

TABLE 10

SFCC/CDC MODEL
EXPECTED MORTALITY UNDER VARIOUS SCENARIOS

Attained Age	Years	SFCC/CDC Model
(A) Annual Mortality Rates		
35	0	0.1
36	1	0.6
37	2	1.5
38	3	2.8
39	4	4.4
40	5	6.6
45	10	12.9
50	15	14.0
55	20	14.5
60	25	14.7
(B) Cumulative Mortality		
36	1	0.1
37	2	0.7
38	3	2.2
39	4	5.0
40	5	9.2
45	10	47.3
50	15	74.3
55	20	88.0
60	25	94.6

TABLE 11

SFCC/CDC MODEL
EXPECTED MORTALITY UNDER VARIOUS SCENARIOS

	SFCC/CDC Model
(A) Complete Expectation of Life in Years at Age 35	11.85
(B) Multiple of Standard Mortality for Same Complete Expectation of Life at Age 35	43.9
(C) Expected "Half-Life" in Years at Age 35 (Years until 50% Cumulative Mortality)	11.30
(D) Multiple of Standard Mortality for Same Expected "Half-Life" at Age 35 (Years until 50% Cumulative Mortality)	54.0

CHAPTER 4

MODELING THE IMPACT OF AIDS-RELATED LIFE INSURANCE CLAIMS

SOCIETY OF ACTUARIES
AIDS TASK FORCE SUBCOMMITTEE*

INTRODUCTION

The purpose of this paper is to provide the information, considerations and framework needed to formulate a model for estimating the effect of future AIDS-related life insurance claims. This paper is not meant to be an exhaustive treatment of the subject. It presents background information setting forth the main considerations in constructing a model and provides pertinent information about the nature and incidence of AIDS deaths, especially with respect to life insurance risks.

Alternative approaches for constructing a company model are then presented with some ways to explore implications on company mortality. Finally, sample models have been included. These are provided for demonstration only and are not meant to serve as actual projections of any company's experience. Each company must assess its own unique situation. The three models illustrate the range of detail that may be considered, from the simpler approach of example 1 to the more refined of example 3.

There are a variety of methods that can be used to construct an AIDS model. This paper will be successful if it provides some background and framework so that the reader can construct a model to fit his or her own unique needs. There is still much to be learned, and the actuary is encouraged to pursue alternative approaches.

I. GENERAL CRITERIA TO BE CONSIDERED IN MODEL CONSTRUCTION

A. Resources and Time Available

Resources available may dictate the type of model to be used. Data availability is another consideration. It makes little sense to use a very sophisticated model if detailed data on claims and in-force contracts are not available or are not credible. Creating models with PCs and speadsheet programs will

*Philip J. Barackman, David J. Christianson, William C. Koenig, and Harry A. Woodman; assisted by Steven D. Lash, Jeffrey S. Marks, and John K. Wilbur.

likely give good initial results as well as flexibility to make future modifications. Of course, mainframe applications might also be quite successful. If modeling is done manually, the model needs to be much simpler. One must consider what personnel are available to gather data, create models, run and update them. Finally, the time frame within which the results must be developed may have an impact.

B. Level of Detail

The level of detail needed depends in large part on the audience for which a report is being prepared, such as management, the board of directors, shareholders, or regulators, and the purpose for which the model is being run. More complex models should increase predictability as well as provide answers to a broader variety of questions and hypotheses regarding the potential impact of AIDS. On the other hand, complex models may be harder to understand than simpler models. They may also obscure the effect of weak assumptions in the model. It may be advantageous to run a simple model to check the results of a more complex model.

C. Frequency of Model Revisions

Any model must be occasionally revised to reflect evolving knowledge. If frequent revisions are expected, one must consider the flexibility of the model to accept improved or additional data and assumptions. In order to gain facility with assumptions of various types and degrees of refinement, it may be instructive to work with simple models prior to constructing a comprehensive one.

D. Intended Use of Model Results

The purpose for running the model should dictate the type of model constructed. There are a variety of reasons to run an AIDS model. The purpose may be to examine one or more of the following:

1. Viability of certain products or markets
2. Underwriting and blood-testing limits
3. Retention limits
4. Pricing changes
5. Policyholder dividend changes
6. Stockholder dividends
7. Company solvency and profitability
8. Setting aside extra reserves

9. Setting aside or earmarking surplus
10. Setting realistic GAAP benefit reserves
11. Tax effects of additional mortality
12. Effect on net worth of company.

In most cases, the actuary will be trying to estimate future claims from AIDS. However, projecting old and new business separately may be desirable to permit use of the data to set underwriting and blood-testing limits. If the issue is stockholder dividends, the model must produce current as well as future earnings or at least be able to tie into other models that will produce earnings. Reserves may be looked at in total in examining solvency issues for the company, but it may be necessary to look at them at selected ages for GAAP benefit reserves.

E. Willingness to Undertake Original Research

The actuary must decide whether to perform original research into the likely spread of AIDS or to accept someone else's projections. Advantages of the former include the possibility of a new model contributing to everyone's understanding of AIDS. The actuary doing the work will certainly gain a fuller understanding of the disease. Disadvantages include the difficult and specialized nature of the disciplines involved, which are likely to be unfamiliar to the actuary. Further, results will be questioned to the extent they differ from prevailing "expert" opinion.

The advantages of using previously published estimates of the disease's spread include:

1. Instant credibility, if CDC estimates are used;
2. Ease of interpretation, in that estimates can fairly easily be described as more or less severe than the CDC estimates, or be related to a specific environmental assumption; and,
3. Ease in effort, in that little or no original work is required.

II. CONSTRUCTING A POPULATION FRAMEWORK

A. Micro and Macro Projections

Macro projections are estimates of total AIDS deaths without subdivision into risk groups. Micro projections subdivide AIDS risk groups by extent of sexual activity or other exposure characteristics with different assumptions as to probabilities of infection for each group. Depending on the resources available and the purpose of the model, either a greater or lesser reliance on

micro assumptions may be appropriate. At this point in time, the degree of certainty in any projection is so limited that any significant degree of refinement generally seems unwarranted. Further information is needed before micro projections will achieve any degree of reliability. However, work on micro projections should be encouraged in order to develop and refine methodology as data become available and also to determine what data will be useful and hence to focus efforts on obtaining such data. One micro consideration, the spread of the disease through the heterosexual population, becomes more and more important as the length of the projection period increases.

The actuary will choose whether to use a model incorporating macro population assumptions or a more sophisticated projection using micro assumptions. Should the actuary choose to segment a population AIDS projection into currently recognized at-risk groups, the effort will be most useful to:

1. Recognize that different at-risk groups have had different insurance needs and buying characteristics;
2. Separate the more certain parts of the analysis (the disease's spread through the male homosexual population) from the more speculative (the disease's spread into the heterosexual population); and
3. Recognize differences in transmission rates for the infection among different at-risk groups, to the extent these differences are shown to exist.

B. Characteristics of At-Risk Groups

1. *Homosexual AIDS Susceptibles.* The Cowell-Hoskins model makes reasonable assumptions as to the numbers of males infected because of homosexual activity. Their assumption is that only 60 percent of an estimated 2.5 million homosexuals and 2.5 million bisexuals are "AIDS susceptible," i.e., engage in high-risk activity that exposes them to infection.

2. *Heterosexual AIDS Susceptibles.* The Cowell-Hoskins model does not account for any significant extent of AIDS infection in the heterosexual population. Some experts feel that infection through heterosexual activity will become extensive. Others feel that it will not be a problem. Though a spread through heterosexual contact is not a principal problem currently (CDC data indicate that U.S. born heterosexuals account for only 2 percent of AIDS deaths), it should not be ignored. Factors to consider are:

a. AIDS Susceptibles. Those likely to be at significant risk are those who have promiscuous sexual activity or who have an infected partner (e.g., a partner who is an IV drug user or who received contaminated blood). The percent of heterosexuals who are AIDS susceptible is unknown.

b. Infection Incidence. Because transmission of the AIDS virus appears to be less likely through vaginal sex than anal sex, the prevalence of infection among AIDS-susceptible heterosexuals may be at a lower rate than among homosexuals.
c. Progression from Infection to AIDS. Some experts speculate that repeated exposure quickens the progression from infection to AIDS. Should this be shown to be the case, progression may be slower among heterosexuals than among homosexuals because of a lower frequency of exposure to infected persons after initial infection.

The combination of the above three factors may account for the present low number of heterosexuals who have AIDS.

3. *IV Drug Users*. As suggested in the Cowell-Hoskins paper, they are not likely to be a significant factor in estimating life insurance AIDS claims. They do represent, however, a significant proportion of current AIDS victims. It is possible that the spread of infection and/or progression from infection to AIDS may be faster among IV drug users than among homosexuals.

4. *Contaminated-Blood Victims*. These persons are a factor in estimating life insurance AIDS claims although, according to CDC figures, they represent only 4 percent of AIDS deaths. The spread of infection is currently well contained because of testing of blood donors. However, the progression from infection to AIDS may be slower than average, suggesting that the number of such persons getting AIDS may not decrease rapidly.

C. Course of the Disease

The ultimate spread of the disease through the population is as yet unknown. However, there is no shortage of estimates, and they vary widely. Factors that contribute to wide differences in estimates include assumptions as to:

a. The number of lives presently HIV+;
b. The progression rate from initial infection to full-blown AIDS;
c. The future rate of infection among high-risk groups given modified behavior;
d. The extent to which the disease crosses into the heterosexual population, and how easily it is transmitted once there; and,
e. The likelihood of discovering an effective vaccine.

A projection of AIDS claims will be relatively meaningless unless placed in the context of a particular set of assumptions as to the course of the disease through the total population. Once this environmental assumption is made, the impact of AIDS on a particular company operating in this environment can be projected with due recognition to the company's particular characteristics.

D. Elements of an AIDS Projection

The elements of an AIDS population projection will include:

1. The total HIV-infected lives in each year of the projection;
2. The number of AIDS cases in each year;
3. The number of AIDS deaths in each year; and,
4. An estimate of the population death rate due to AIDS.

In addition, a projection may include the number of lives at *each* AIDS classification by the "Walter Reed Staging Method." This will be more useful for lines other than life insurance. As more information becomes available, it will be useful to estimate the number of lives by age groupings.

E. Credibility of Projections

A satisfactory population AIDS projection will be one that either reproduces credible data or differs only in ways that can be explained and justified. The projection must be internally consistent with respect to:

1. Total lives infected each year;
2. The probability of HIV+ lives progressing to AIDS in any year;
3. AIDS mortality rates; and
4. Total AIDS deaths each year.

With the current state of knowledge, all long-term projections are extremely speculative.

III. INFORMATION NEEDED AT THE COMPANY LEVEL

A. Lapse Rates

At this time, the actuary will have little concrete basis for setting lapse assumptions of HIV+ and high-risk insureds. It is prudent to be conservative and to test the effect of variations in this assumption.

1. Lower lapse rates can be expected of persons who have a higher expectation of becoming a claimant or who believe that they would be prohibited from reestablishing coverage should their current coverage be lost. In modeling the future impact of AIDS on life insurance, ignoring this fact can lead to a serious understatement.
2. AIDS victims are unlikely to allow life insurance coverage to lapse, although some may be forced into lapsing by financial difficulty and/or the placement of a higher priority on maintaining health coverage.
3. Asymptomatic HIV+ insureds will no doubt exhibit much better persistency than average if they have knowledge of their HIV status or if they perceive themselves as

being at high risk. Increased testing and education will likely increase the portion of HIV + insureds exhibiting better persistency.

B. Nature of In-Force Business

To project the impact of AIDS for a particular company, the actuary will need to analyze the impact on both the in-force business and new business. For the in-force business, cells must be defined that are significantly relevant for the purpose at hand, but not more refined than is warranted by the tenuous nature of some of the required assumptions. However, it may pay to construct a somewhat more refined model than is warranted by current assumptions with the hope that in the future, assumptions can become more refined.

In representing the in-force business by cells, the following factors are especially relevant:

a. *Sex of Insureds*. Over the near term, AIDS will predominantly be a male disease. Females represent only about 7 percent of cases reported to date with about half of those being IV drug abusers, who are probably not in the insured population. Projections over longer terms should reflect an increase in HIV infection in females according to the results of epidemiological modeling of HIV spread beyond the current high-risk groups.

b. *Age of Insureds*. Since AIDS does not follow the typical mortality age pattern, it is important to consider age in analyzing its impact on life insurance business. By age at diagnosis, about 90 percent of AIDS cases fall into the 20 to 49 age range and 10 percent into the age 50 + range. Of the 90 percent, about half fall into the 30s and one quarter each fall into the 20s and 40s. It is not clear how this distribution will change over the long term.

C. Antiselection Scenario

Any estimate of future claims from "new sales" must recognize the likelihood that at-risk lives will select against companies in their own best interests. HIV testing, and underwriter awareness of the medical problems that are often associated with the early stages of immune deficiency disease, are the defenses available to combat antiselection. Below the testing limit, the actuary should expect both larger-size issues (bounded, of course, by the testing limit) and more issues to HIV + lives. Above the limit, known HIV + 's are excluded, but at-risk HIV − 's will buy more often and in larger amounts than they would have before. Testing limits should be assumed to be public knowledge.

D. Current Underwriting Standards

Underwriting needs to perform two critical functions with respect to AIDS:

a. The screening of AIDS victims. These are clearly uninsurable.
b. The screening of HIV+ applicants who do not yet have AIDS. These are also uninsurable. The Cowell-Hoskins Report (see Chapter 3) is required reading on this point.

Several factors need to be considered relating to underwriting.

a. Full use of the company's rights during the contestable period will be necessary for those AIDS or ARC deaths where it appears the insured misrepresented his medical condition.
b. Only testing for HIV or HIV antibodies can screen asymptomatic HIV+ applicants. In states where testing is not allowed or only the T-cell test allowed, assumptions will be required regarding how many HIV+ applicants are being accepted for insurance, recognizing the greater likelihood of antiselection. The T-cell test is a test of the immune system. It is not an AIDS-specific test. It will produce negative results for some individuals who would have given a positive HIV test. The actuary must recognize the limited effectiveness of the T-cell test.
c. Even HIV testing is not 100 percent effective for newly infected individuals nor for those with a ravaged immune system. An assumption reflecting lack of total effectiveness needs to be developed. (Of course, HIV testing does not prevent claims from those who become infected after testing negative.)
d. Many companies continue to write life insurance without required testing below a threshold amount of insurance. This presents an opportunity for HIV+ applicants to obtain coverage. Testing limits may not be low enough to discourage antiselection. The market is not ignorant of testing limits. The presence of HIV+ insureds in new business at subtesting threshold amounts should not be ignored in AIDS impact modeling.

E. Geographic Distribution

AIDS cases reported to date are not distributed geographically in proportion to the U.S. population nor probably to any company's insured population. It is also clear that the distribution is changing over time (see recent CDC AIDS Weekly Surveillance Reports showing cases by SMSA and date of diagnosis). It is reasonable to assume that the geographic distribution of current HIV+'s bears some semblance to the current reported AIDS case distribution (but, unfortunately, more like what the reported case distribution will look like several years from now).

Companies with concentrations of in-force in the high AIDS-per-capita states and cities will need to make appropriate adjustments to total population HIV+ estimates.

Companies with low concentrations in these areas should be cautious in fully adjusting total population HIV+ estimates based on the geographic distribution of cases reported to date. The latter actually reflect the HIV+ distribution several years ago.

F. Markets Served/Marketing Objectives

It will be important to consider how the current markets served and future marketing objectives are different than those which have generated the existing in-force business.

Representation of current and future new business by cells for the purpose of AIDS impact modeling will need to reflect any changes in relevant characteristics implied by changes in markets or marketing. Such characteristics would include sex, age, socioeconomic group, and geographic distributions, as well as target market selection of at-risk groupings and any underwriting changes.

The results of this analysis may be critical input to reshaping a company's marketing strategies and objectives in light of AIDS. Although the initial response to AIDS has been primarily one of underwriting, changes in marketing may also be required to provide safe passage through the AIDS era.

G. Company AIDS Experience/AIDS Claim Profile

AIDS impact modeling should be viewed not as a one-shot task, but as an iterative process in which actual company experience plays a key function. In order to validate an AIDS impact model and to provide a firmer and more refined basis for future assumptions, it is imperative that each company monitor and analyze its own AIDS experience. Results will vary significantly by company. Each model must be customized to reflect particular company characteristics. (Unfortunately, the fact that a model replicates past experience is no guarantee as to its predictive value. This is a necessary, not sufficient, requirement.)

It may become of increasing importance to determine what portion of AIDS claims are coming from insureds who tested negative at issue. As HIV spreads, assumptions regarding post-issue infection will need to be refined.

A basic problem is the identification of AIDS-related claims. Adjustments should be made for underreporting of AIDS claims, both in U.S. data and company statistics. Many claimants and attending physicians do not disclose the true cause of the claim. A working definition of a "suspected AIDS

claim'' needs to be developed to help offset the veiled or misstated cause problem. Following are some AIDS-related diseases that may be helpful in developing such a definition:

a. Kaposi's sarcoma
b. Pneumocystis carinii pneumonia
c. Toxoplasmosis
d. Cryptosporidiosis
e. Cytomegalovirus infection
f. Primary lymphoma of the brain
g. Candida esophagitis
h. Atypical mycobacterial infection
i. Cryptococcal infection
j. Chronic mucocutaneous herpes simplex infection
k. Chronic interstitial pneumonitis (pediatric).

The AIDS claim profile for a specific company is an invaluable source of information regarding the characteristics of HIV + insureds (as of several years ago) and the degree of antiselection by amount, etc. Studying individual claims will provide pointers for sharpening underwriting procedures and skills.

IV. ADJUSTING POPULATION ASSUMPTIONS TO REFLECT COMPANY CHARACTERISTICS

A. Company Characteristics

Once an environmental scenario has been constructed, the actuary must review the particular characteristics of a company to estimate the extent of its exposure to the assumed AIDS deaths. If the population AIDS projection were segmented by at-risk grouping, then each segment can be considered individually. The ultimate impact of the disease on any company is as yet unknown. Estimates can vary widely, based not only on differences in population AIDS projections, but also on differences in estimates as to:

1. The rate at which at-risk lives select against companies through larger purchases, more frequent purchases, or through purchases at amounts designed to avoid automatic testing;
2. The effectiveness of testing, especially the T-cell test;
3. The remedial effect of heightened underwriter awareness of AIDS symptoms;
4. The protective value of publicity about testing;
5. The unproven effectiveness of AIDS exclusion riders when used; and
6. The degree to which the company differs from the general population with respect to

the percentage of its insureds in high-risk groups (as indicated by geographical/age/sex distributions).

B. At-Risk Groupings

Although it is impossible to classify individual policies by sexual preference and activity or drug use, it will be quite important to make such a classification in defining representative cells based on population estimates and judgment. (Different groups may well have different insurance-buying habits.) AIDS claims over the near term will come mainly from the current high-risk groups (homosexuals, bisexuals, and IV drug abusers). Over the longer term, promiscuous heterosexuals may contribute more to claims. Some degree of cell definition by at-risk group allows the results of epidemiological modeling to be easily included in the impact model. This will be particularly important as the question regarding heterosexual spread becomes better quantified and projected.

1. *Homosexual and Bisexual AIDS Susceptibles*. The proportion of this group may be significantly lower among insureds than in the general population because such persons do not have a high level of personal need for insurance and, in some cases, lifestyle may not be consistent with an interest in insurance. The proportion among those insured (before antiselection became a factor) may only be 25–50 percent of that in the general population.

2. *Heterosexual AIDS Susceptibles*. The proportion of this group among insureds may also be lower than that in the general population. However, it is likely that the proportion will be higher than for homosexuals, perhaps 50–75 percent. There is some speculation that women in this group are more susceptible to AIDS infection than men. This may further reduce the proportion of AIDS susceptibles among insureds if the company insures a lower proportion of women than in the general population.

3. *IV Drug Users*. They are not a significant factor in an insurance population. Not only is the lifestyle inconsistent with an interest in insurance, but insurers routinely underwrite for drug abuse.

4. *Contaminated-Blood Victims*. The proportion of this group in the company population is likely to be somewhat lower than in the general population. Hemophiliacs are less likely to obtain insurance because of uninsurability or high extra premiums. Others that have received blood may also have insurability problems related to underlying disease.

V. UNDERWRITING ERA

The actuary will probably want to differentiate in his/her analysis between "in-force" business and "new sales." There are probably three distinct blocks of business for most companies:

A. The first era would include business written before the early 1980s, predating any underwriting response to AIDS, but also predating a level of knowledge regarding AIDS necessary for significant antiselection. This business presumably would reflect little antiselection, but would still be subject to post-issue HIV infection. The level of AIDS claims in this group would likely represent the underlying proportion of company exposure to AIDS out of the general population.

B. The second era would include business written between the early 1980s and the implementation of the company's underwriting response to AIDS. This business could reflect a significant degree of antiselection and contain more HIV + insureds at issue purchasing large policies.

C. The third era would reflect business written after implementation of the company's underwriting response to AIDS. The second and third eras may have an imprecise boundary, since underwriting for AIDS has and continues to evolve.

VI. CONSTRUCTING THE COMPANY MODEL

A. General Criteria

In setting up an AIDS model the general criteria to consider are:

1. The medium to be used, PCs or mainframes, spreadsheet or specifically written programs.
2. The level of detail of the model.
3. The flexibility to change data and assumptions.
4. The purpose of creating a model, will the desired results be produced?

B. Population Assumptions

A general AIDS population projection must be incorporated.

1. Select whether it will be based on original research or published data.
2. The data will be incorporated in either a macro or micro model.
3. No matter which is selected (macro or micro), estimates of the future course of the disease must be considered. In a macro projection, overall factors should be applied to estimate future changes. In a micro model each subgroup projection is tailored to the estimate.
4. The AIDS projection will include the following elements:
   a. The total HIV-infected lives in each year of the projection;
   b. The number of AIDS cases in each year;

c. The number of AIDS deaths in each year; and,
d. An estimate of the population death rate due to AIDS.

C. Profile of In-Force Contracts

Given that HIV+ lives are assumed to be a percentage of the population (by sex, age, and geographical cells, if available), a company can review its "in-force" to see what percentage of the population it insures and thus estimate the number of HIV+'s in its insured population. However, this simple estimate must be tempered by recognizing particular company characteristics:

1. Some IV drug users and victims of contaminated blood transfusions, to whatever extent they sought insurance, may have been screened out by pre-AIDS underwriting;
2. Unmarried and childless homosexual or bisexual males have had less traditional need for life insurance;
3. HIV+'s are heavily concentrated in a relatively few geographic areas. The actuary should consider whether the company's in-force has a higher or lower than expected concentration in those areas and to what extent the geographical distribution of AIDS claims is expected to change over time.

D. Comparison with Recent Death Claims

Once an estimate of the company's percentage of HIV+ lives among its in-force is made, it can be validated by a comparison with actual recent AIDS claims. Care must be taken to identify all company AIDS deaths, since underreporting could lead to a major understatement of the company's exposure among HIV+ lives. Even after careful checking, some estimate of further underreporting should probably be included.

E. In-Force Exposure

Future claims arising from in-force business can then be estimated. Either:

1. An average policy size is determined, perhaps increasing over time to recognize additions. This average size is applied to the number of company AIDS deaths expected from the in-force block, given:
   a. The population pattern of AIDS deaths;
   b. The company's share of the population;
   c. The company's estimated share of the HIV+ population.
2. Or, the estimated population death rates due to AIDS can be applied directly to the amount of business assumed to be in-force on AIDS susceptibles, if the actuary has segmented the population AIDS projection by at-risk group.

In either case, the implicit assumption is that current HIV− lives in the company's population will become infected and die of AIDS at the same rate as the general population, but in the same reduced proportion as indicated by the analysis in Section VI.B. If population estimates are segmented by risk group, the future claims from the in-force can be split as well, highlighting differences in company exposure and the estimated future course of the disease among the groups.

F. Persistency

One further refinement is suggested. It is to be expected that at-risk lives will exhibit excellent persistency. This may be reflected in a number of ways:

1. If the population AIDS projection has been segmented by at-risk groups, the company's block of business within each group may be assumed to experience a significantly reduced lapse rate;
2. A less satisfactory solution focuses on HIV+ lives rather than at-risk groups. The HIV+'s in the insured population are assumed to experience a significantly reduced (zero?) lapse rate; or,
3. At least, the actuary should estimate the effect on the company's mix of HIV+/HIV− lives of a reduced HIV+ lapse rate and increase the assumption of the company's share of HIV+'s, over time, as a proxy for a more direct approach.

G. Antiselection and Remedial Action

Antiselection and remedial action can be recognized in two ways:

1. The business can be split into tested and nontested blocks. This permits specific recognition of the different characteristics of the blocks, both estimates of antiselection as to lives and amounts, the heavier mix of HIV+ lives expected in the nontested group, and the effectiveness of HIV testing; or
2. An overall "protective factor" may be estimated and applied to the company's percentage of participation in the epidemic. The factor would be made up of separate elements for fear of testing (publicity), underwriter awareness, and the proportion of business tested.

Under either approach the value of changing testing limits can be estimated.

H. Weakness of the T-Cell Test

The actuary must recognize the limited effectiveness of the T-cell test. Business written in jurisdictions where only the T-cell test is permitted may be recognized by:

1. Setting up a separate block for that business, with appropriate assumptions as to the percentage of HIV+ lives accepted; or
2. Adjusting the "protective factor."

I. New Sales

Future claims arising from new sales can then be estimated by:

1. If new sales are segmented by testing status:
   a. Average policy sizes are determined for each block;
   b. These are increased to reflect antiselection; and
   c. The results are applied to the anticipated deaths in each block given the assumed percentage of HIV+ new entrants in each (near zero for HIV-tested, company average for untested);
2. If new sales are not segmented by testing status:
   a. An average size policy is determined;
   b. It is adjusted to reflect antiselection and the remedial protective factor; and
   c. The results are applied to the anticipated deaths.
3. If the actuary has segmented his/her population projection by at-risk group, the estimated population death rates due to AIDS can be applied directly to the amount of business assumed to be in-force on AIDS susceptibles.

In any case, the implicit assumption is that HIV− lives among the company's new entrants will become infected and die of AIDS at the same rate as the general population, but in increased proportion due to antiselection and in decreased proportion due to protective factors.

If population estimates were split by at-risk group, the claims from new sales can be split as well, highlighting differences in company exposure among the groups and emphasizing the major impact of a spread into the heterosexual population.

VII. MORTALITY PROJECTIONS

The projected company AIDS deaths can be matched against a projection of total company in-force, year by year, to estimate AIDS extra mortality rates. Alternatively, they can be matched against a pre-AIDS projection of claims to estimate the increase expected due to AIDS. Also, they can be used to determine annual costs of AIDS claims and additional reserves needed to cover AIDS claims.

The distribution of AIDS claims by sex and age is most important. A 15 percent increase in overall mortality might indicate a 100 percent increase

for males age 25–45. Distribution of claims by age can be recognized either by:

1. Including age-sex cells in all modeling; or
2. Distributing total estimated AIDS deaths, by age and sex, in proportion to the current population distribution.

VIII. SCENARIOS

Because so much is still unknown, the actuary should experiment with assumptions and become familiar with the impact on his/her company if events are more or less favorable than his "best guess" would indicate.

DESCRIPTION OF METHODOLOGY FOR A SIMPLIFIED AIDS PROJECTION

HYPOTHETICAL LIFE MODEL EXAMPLE 1

This model is put together to illustrate a method of modeling and is not meant to reflect the actual situation of any company. Each company should develop its own set of assumptions based on its own situation.

This company is a medium-sized company with $10 billion of participating business in force on 500,000 policyholders (with a $20,000 average size). The company is an older company operating in the family and middle-income markets. Sales have occurred at all ages, but particularly among young to middle-aged adults and their children. Persistency has been good. About 50 percent of the current policyholders are males aged 20–49, about 0.5 percent of the U.S. population at those ages.

General Criteria

It is decided to use a PC model, developed on a spreadsheet program. Since the actuarial staff is small and so many of the assumptions are subject to wide variability, a simple model is used. This model will allow changes to population data as well as adjustments to the data on a broad basis. The model is being constructed to consider company solvency and profitability, setting aside extra reserves, pricing changes and policyholder dividend changes.

Population Assumptions

This model relies on having available one or more credible scenarios of how AIDS is expected to spread through the general U.S. population and focuses on attempting to relate these to the company.

Taking as a given the general population AIDS scenario as found in the Cowell-Hoskins paper is easier than developing one. It saves time and the need to explain differences with ones already developed by the "experts."

Currently, there is a great deal of uncertainty in making any long-term projection of the number of AIDS infections and deaths in the U.S. This is due to the uncertainty over not only how many people are currently infected but also the future rate of spread among the various subpopulations (or at-risk groups). The rate of spread depends to a large degree on how much people are willing to modify their high-risk sexual behavior, something that these actuaries do not feel well-qualified to predict.

A macro model is built, starting with the number of general population AIDS deaths and estimating the company's expected share of these deaths.

Profile of In-Force Contracts

First, the number of policyholders in the predefined high-risk group of all males aged 20–49 is compared with the number of such persons in the general population. If the company's policyholders in this group were representative of the general population, then a direct proportion of AIDS deaths would be used. However, there are various reasons why this proportion is reduced. One that can be measured is the difference in geographical distribution among the at-risk population. Since a smaller proportion of the company's business is found in New York and California than in the general population distribution, the proportion of AIDS deaths is reduced. Differences are also assumed for presumed differences between the company's policyholders and the general population high-risk group in terms of drug use, sexual orientation and promiscuity. That is, the direct percentage needs adjusting for differences that largely can only be guessed at but that would explain any difference between the company's current AIDS experience from what would be expected by applying its "share" of the high-risk U.S. population to the number of AIDS deaths currently in the U.S.

There are three scenarios modeled. Each starts in 1987 with company AIDS deaths expected to be adjusted to only 40 percent of the 0.5 percent share of U.S. population AIDS deaths. However, this 40 percent adjustment factor is assumed to increase each year in scenarios 2 and 3 due to antiselection and a changing geographical distribution of AIDS deaths.

Comparison with Recent Death Claims

After a reasonable adjustment factor is arrived at, estimated deaths are compared with actual AIDS deaths among policyholders, adjusted for assumed underreporting of 10 percent. The adjustment factor appears to reasonably correlate estimated and actual deaths.

In-Force Exposure and Persistency

An average size policy of $25,000 was discovered by analysis of in-force contracts of the at-risk group, adjusted by correlation to actual AIDS claims. A 4 percent annual increase in size is assumed, due to dividend additions and assumed better persistency.

Antiselection, Remedial Action and New Business

The greater a company is selected against, the larger will be its share of U.S. AIDS deaths in the future. A weakness of this simplified model is that antiselection is not explicitly included because new business is not separately projected from in-force business. Rather, some assumptions are needed to factor in antiselection, specifically how a company's "share" of AIDS deaths and its average size AIDS claim will increase due to its issuing insurance to infected persons. These assumptions may be developed better by projecting new business separately from in-force, but in this particular model some simplifying rates of increase were used, increasing average size claims by an additional 2 percent and 4 percent per year in scenarios 2 and 3, respectively.

The company has AIDS blood-testing limits at $100,000 and plans to lower them as the industry reduces its limits. Due to its market and geographical location and examining recent claims, little antiselection is assumed.

T-cell Test

Since little business is written in California, no specific adjustment is made.

Shortcomings

The model is not a well-refined one. As more data become available or as different issues need to be researched, a new, more complex model will

TABLE 1

A HYPOTHETICAL AIDS PROJECTION*
(IMPACT ON DEATH CLAIMS, SURPLUS)

	Scenario 1 Infection Stops in 1987			Scenario 2 Infection Stops by 1997			Scenario 3 Infection Rate Continues			(D)	
Calendar Year	(A) Expected U.S.A.	(B) Deaths Co.	(C) Death Claim Cost	(A) Expected U.S.A.	(B) Deaths Co.	(C) Death Claim Cost	(A) Expected U.S.A.	(B) Deaths Co.	(C) Death Claim Cost	Projected Mortality w/o AIDS	Projected Surplus w/o AIDS
1987	12,923	26	$ 650	12,923	26	$ 650	12,923	26	$ 650	$ 25,000	$150,000
1988	19,924	40	1,040	19,924	41	1,086	19,924	41	1,107	28,000	168,000
1989	28,941	58	1,568	29,308	61	1,713	29,352	63	1,837	31,400	188,200
1990	39,240	78	2,194	41,279	88	2,620	41,583	94	2,960	35,100	210,800
1991	49,704	93	2,895	55,807	121	3,819	56,919	133	4,524	39,300	236,100
1992	59,157	118	3,589	72,532	160	5,353	75,463	184	6,759	44,100	264,400
1993	66,345	133	4,207	90,679	204	7,234	96,928	245	9,720	49,300	296,100
1994	69,366	139	4,573	108,957	250	9,398	120,505	317	13,582	55,300	331,600
1995	67,227	134	4,585	125,688	295	11,755	144,809	396	18,324	61,900	371,400
1996	61,824	124	4,412	139,284	333	14,065	167,991	478	23,888	69,300	416,000
1997	55,540	111	4,108	148,638	362	16,207	188,058	557	30,063	77,600	465,900
1998	49,368	99	3,810	153,704	382	18,129	203,289	626	36,490	87,000	521,800
1999	43,581	87	3,482	152,976	388	19,518	212,565	681	42,872	97,400	584,400
2000	38,258	77	3,205	148,417	384	20,476	215,575	718	48,818	109,100	654,500
P.V. of Claims (8%)			$25,371			$65,645			$113,975		
Scenario assumptions:											
(1) Adjustment factor of 40% is increased annually due to antiselection at:			0%			2%			4%		
(2) Average size claim increasing from a 1987 value of $25M at an annual rate of:			4%			6%			8%		

*For a hypothetical company with 500,000 contracts for $10 billion in-force, 50% of which are in the high-risk group (male attained ages 20–49). When compared to the about 50 million males aged 20–49 in the U.S.A. population, this 250,000 is 0.5% of the U.S.A. high-risk group.

(A) Expected AIDS deaths (U.S.A.) = based on the three scenarios found in Appendix 1 of Michael Cowell's paper "AIDS and Life Insurance."

(B) Expected AIDS deaths (company) = expected AIDS deaths (U.S.A.) + 0.5% + adjustment factor (40%), increased for antiselection (see scenario assumption (1) as noted above).

(C) Death claim cost (company) = expected AIDS deaths (company) + average size AIDS claim ($25M), adjusted for normal increase and antiselection (see scenario assumption (2) as noted above).

(D) Projected mortality and surplus (without AIDS) are assumed to have increased at 12% per year, based on a separate projection of company financials.

likely be built. Since original research was not done, there is less understanding of the future course of AIDS and its effect on the company. As mentioned above, antiselection is not explicitly modeled.

HYPOTHETICAL LIFE MODEL EXAMPLE 2

A. General Criteria

The purpose of this example model is to project AIDS claims for a hypothetical company for 1988 through 2000. This model has a moderate level of detail with flexible assumptions. For example, the model could be changed to illustrate the impact of changing testing limits. Please note that all the factors are illustrative only and not guidelines. Each company should develop its own set of assumptions based on its own situation.

B. Population Assumptions

This example uses the Cowell general AIDS population projection that assumes that the HIV infection declines to 0 by 1997 (see Appendix 2). Here we will assume that all the HIV infecteds will be males 18–54. Table 2 gives the appropriate projections.

TABLE 2

AIDS PROJECTION FOR U.S. POPULATION
FROM COWELL PAPER (INCLUDING 9/17/87 ADDENDUM #1) AND SOA DISKETTE
ASSUMES HIV INFECTION DECLINES TO 0 IN 1997

Year	Total HIV Infection	Cumulative AIDS Cases	Annual AIDS Deaths	U.S. Population Males 18–54	General Population AIDS Mortality Rate
1988	1,191,439	76,181	19,925	63.2	0.00032
1989	1,465,203	118,255	29,309	63.8	0.00046
1990	1,721,330	176,062	41,280	64.4	0.00064
1991	1,945,951	252,266	55,807	65.1	0.00086
1992	2,131,859	348,753	72,534	65.7	0.00110
1993	2,277,142	466,060	90,679	66.4	0.00137
1994	2,382,978	602,740	108,958	67.0	0.00163
1995	2,451,692	755,065	125,690	67.7	0.00186
1996	2,485,433	917,677	139,286	68.4	0.00204
1997	2,485,433	1,084,549	148,640	69.1	0.00215
1998	2,485,433	1,249,704	153,206	69.8	0.00220
1999	2,485,433	1,407,847	152,978	70.5	0.00217
2000	2,485,433	1,554,819	148,418	71.2	0.00209

Actual numbers taken from SOA diskette and may differ slightly from paper. U.S. population data derived from census data; assumes population grows at 1% annually.

C. Profile of In-Force Contracts

In this example, we are assuming that the at-risk group is males 18–54. Therefore, the company's exposure will be measured by the number of males 18–54 insured. In this example, we will assume that this company's insured population will experience 40 percent of the general population AIDS mortality rate. This recognizes factors such as geographical distribution of business, lack of insurability of IV drug abusers, etc. This is a very important assumption and requires actuarial judgment in recognizing each company's unique characteristics.

D. Comparison with Recent Death Claims

In developing a model for an actual company, the next step would be to compare the model to the company's recent AIDS death claims. This step will be bypassed in this example of a hypothetical company.

E. In-Force Exposure

The projection model starts on 1/1/88. The business will be divided into three underwriting eras as described in Section V. For this example, era 1 will be all business sold prior to 1/1/84. This will represent business sold before measurable antiselection and testing. Era 2 will be business sold from 1/1/84 to 12/31/87. This will represent business sold with some antiselection but before testing. There are 100,000 male 18–54 lives in force as of 1/1/88 for era 1 and 30,000 for era 2. Era 3 is all sales (males 18–54) after 1/1/88 that are subject to current antiselection and testing. Era 2 business in this age group has a $50,000 average size on 1/1/88. Era 3 has a $60,000 average size. Both are assumed to grow by $2,500 annually (to represent additions).

F. Persistency

To simplify this example, one annual factor is used to incorporate lapses and deaths. The era 1 block will decrease by a constant 4 percent annually, era 2 at 5 percent, and era 3 by 7 percent. It would be relatively easy to vary this assumption by duration.

To account for the fact that those who are already HIV-infected or who believe they are strongly at risk to become HIV-infected will exhibit excellent persistency, the company's share of general population infected (40 percent) is increased each year. For example, the company is assumed to

experience 40 percent in year 1, 42 percent in year 2, 50 percent in year 6, and 57 percent in year 13.

G. Antiselection and Remedial Action

Each era has its own antiselection factor. No measurable antiselection is assumed for era 1; therefore its factor is 1.00. Era 2 is assumed to have moderate antiselection (factor = 1.25). Era 3 is divided into tested and untested blocks. The tested block has an antiselection factor of 1.25 (those who are not yet infected but believe they are strongly at risk will buy more insurance). The untested block has an antiselection factor of 2.00.

H. Weakness of T-cell Test

This example assumes HIV testing nationwide and ignores the T-cell test. Therefore, the projections are understated depending on the amount of business in T-cell states.

I. New Sales

Sales are assumed to be 10,000 males 18–54 in 1988, growing 5 percent annually. It is assumed that 25 percent of the policies each year will be over $100,000 and therefore HIV-tested. The average size of the untested issue is $50,000 regardless of issue year. These policies will accumulate $2,500 of additions each year after issue. The average size of a tested issue in 1988 is $200,000. The average issue size will grow by $10,000 each year. These policies will accumulate $10,000 of additions each year after issue.

The projection method for the untested block of new sales is very similar to era 1 and era 2. All use the general population AIDS mortality rate (technically, the mortality rate for the untested block should be lower than the general population AIDS mortality rate to recognize that while asymptomatic HIV-infecteds will be accepted, the AIDS question should screen those with actual AIDS). The tested block of business will experience a much lower mortality rate, which will vary by year of issue. Table 3 will help explain this.

Table 3 is derived from the Cowell paper and the SOA diskette. It shows the number dying from AIDS annually by year of infection. This is important in calculating the mortality rate for the tested blocks. We assume that testing will identify all of those who are currently infected. So the tested block of 1988 issues only experiences the deaths from those who become infected from issue (1988 on). For example, there are 55,807 projected AIDS deaths

in 1991, but only 6,103 (4,075 + 1,687 + 346) of those are from people infected from 1988 on. The mortality rate for era 1, era 2, and the untested block is 0.00086 (55,807/65.1 million). The mortality rate for the tested block of 1988 issues is 0.00009 (6,103/65.1 million). For 1989 tested issues it is 0.00003 (2,028/65.1 million).

J. Future Enhancements

Several assumptions could be developed further in future versions of the model. The lapse assumption could vary by duration, and a separate non-AIDS mortality rate could be used. A more direct way of accounting for the good persistency of the HIV-infected could be developed. The weakness of the T-cell test could be recognized.

The two assumptions with the most impact on the projections are the percentage of the general population AIDS mortality rate that the company experiences (e.g., 40 percent) and the antiselection factors. These two should be constantly reviewed and refined to reflect the current thinking.

TABLE 3

AIDS Projection for U.S. Population
from Cowell Paper (Including 9/17/87 Addendum # 1) and SOA Diskette
Assumes HIV Infection Declines to 0 in 1997

Year of Infection	Number Dying Year by Year after Infection in Year Indicated																								
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1976	0	1	3	8	14	21	30	39	43	41	38	34	30	27	24	21	18	16	14	12	10	9	7	6	4
1977	0	0	2	8	21	38	58	84	108	118	114	104	94	84	74	65	57	50	43	37	32	28	24	21	18
1978	0	0	0	6	25	62	112	173	249	322	352	339	311	280	249	221	194	170	148	129	111	96	83	71	61
1979	0	0	0	0	14	63	154	280	432	621	803	877	846	775	697	622	550	484	423	369	321	278	240	207	178
1980	0	0	0	0	0	29	133	324	588	907	1,305	1,688	1,844	1,777	1,628	1,465	1,306	1,156	1,016	890	775	674	583	504	434
1981	0	0	0	0	0	0	52	236	575	1,044	1,612	2,319	2,999	3,276	3,157	2,893	2,603	2,320	2,053	1,806	1,581	1,378	1,197	1,036	895
1982	0	0	0	0	0	0	0	80	363	886	1,608	2,483	3,571	4,619	5,044	4,862	4,455	4,008	3,573	3,162	2,781	2,434	2,122	1,843	1,596
1983	0	0	0	0	0	0	0	0	112	508	1,240	2,251	3,475	4,998	6,464	7,059	6,803	6,234	5,609	5,001	4,425	3,892	3,407	2,969	2,579
1984	0	0	0	0	0	0	0	0	0	149	676	1,649	2,993	4,621	6,646	8,595	9,387	9,047	8,290	7,459	6,650	5,884	5,176	4,530	3,948
1985	0	0	0	0	0	0	0	0	0	0	202	918	2,240	4,067	6,278	9,029	11,677	12,753	12,291	11,263	10,134	9,034	7,994	7,032	6,154
1986	0	0	0	0	0	0	0	0	0	0	0	260	1,185	2,892	5,248	8,102	11,653	15,071	16,459	15,863	14,535	13,079	11,659	10,317	9,075
1987	0	0	0	0	0	0	0	0	0	0	0	0	336	1,529	3,731	6,772	10,455	15,037	19,447	21,239	20,469	18,756	16,876	15,045	13,313
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	367	1,670	4,075	7,396	11,418	16,422	21,238	23,194	22,354	20,483	18,430	16,431
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	370	1,682	4,103	7,447	11,497	16,536	21,385	23,356	22,510	20,626	18,559
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	346	1,573	3,839	6,967	10,756	15,470	20,008	21,851	21,060	19,297
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	303	1,380	3,367	6,110	9,433	13,567	17,547	19,163	18,469
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	251	1,142	2,786	5,057	7,807	11,229	14,522	15,860
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	196	892	2,177	3,952	6,101	8,775	11,349
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	143	650	1,586	2,879	4,445	6,393
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	93	422	1,030	1,869	2,886
1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46	207	506	918
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	1	5	22	74	213	539	1,215	2,470	4,598	7,951	12,924	19,925	29,309	41,280	55,807	72,534	90,679	108,958	125,690	139,286	148,640	153,206	152,978	148,418

TABLE 3–*Continued*

$$\text{Deaths}_{it} = \text{HIV}_i \left(\sum_{j=0}^{t-i} r_{j+1}\, q_{1+(t-i)-j} \right)$$

where t = calendar year of AIDS death
i = calendar year of infection
HIV_i = total number of new infections in year i
r_j = percent contracting AIDS j years after infection
q_j = percent dying from AIDS j years after contracting AIDS.

Example

$\text{Deaths}_{91\ 88}$ = number of AIDS deaths in 1991 from those who were infected in 1988
= $\text{HIV}_{88}(r_1 q_4 + r_2 q_3 + r_3 q_2 + r_4 q_1)$
= 271,873 (0.000 × 0.04916 + 0.003 × 0.10588 + 0.012 × 0.2475 + 0.026 × 0.45)
= 4,075

J	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
r	.00000	.00300	.01200	.02600	.04300	.06200	.08600	.10400	.09960	.08466	.07196	.06117	.05199	.04419	.03756	.03193	.02714	.02307	.01961	.01667	.01417	.01204	.01024	.00870	.00000
q	.45000	.24750	.10588	.04916	.03687	.02765	.02074	.01555	.01167	.00875	.00656	.00492	.00369	.00277	.00208	.00156	.00117	.00088	.00066	.00049	.00037	.00028	.00021	.00000	.00000

I	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
HIV	504	1,383	4,124	10,284	21,609	38,396	59,129	82,744	110,032	149,488	192,926	248,947	271,873	273,764	256,127	224,621	185,908	145,283	105,836	68,714	33,741	0	0	0	0

TABLE 4

COMPANY PROJECTIONS FOR ERA 1 AND ERA 2

Year	(1) Male 18–54 Lives	(2) Insured % of Gen. Pop.	(3) Antiselection	(4) Gen. Pop. AIDS Mort. Rate	(5) AIDS Deaths 1×2×3×4	(6) Av. Death Benefit	(7) AIDS Claims 5×6
Era 1 — Business Sold Prior to 1/1/84							
1988	100,000	0.40%	1.00	0.00032	13	$50,000	$650,000
1989	96,000	0.42	1.00	0.00046	19	52,500	997,500
1990	92,160	0.44	1.00	0.00064	26	55,000	1,430,000
1991	88,474	0.46	1.00	0.00086	35	57,500	2,012,500
1992	84,935	0.48	1.00	0.00110	45	60,000	2,700,000
1993	81,537	0.50	1.00	0.00137	56	62,500	3,500,000
1994	78,276	0.51	1.00	0.00163	65	65,000	4,225,000
1995	75,145	0.52	1.00	0.00186	73	67,500	4,927,500
1996	72,139	0.53	1.00	0.00204	78	70,000	5,460,000
1997	69,253	0.54	1.00	0.00215	80	72,500	5,800,000
1998	66,483	0.55	1.00	0.00220	80	75,000	6,000,000
1999	63,824	0.56	1.00	0.00217	78	77,500	6,045,000
2000	61,271	0.57	1.00	0.00209	73	80,000	5,840,000
Era 2 — Business Sold from 1/1/84 to 12/31/87							
1988	30,000	0.40%	1.25	0.00032	5	$60,000	$300,000
1989	28,500	0.42	1.25	0.00046	7	62,500	437,500
1990	27,075	0.44	1.25	0.00064	10	65,000	650,000
1991	25,721	0.46	1.25	0.00086	13	67,500	877,500
1992	24,435	0.48	1.25	0.00110	16	70,000	1,120,000
1993	23,213	0.50	1.25	0.00137	20	72,500	1,450,000
1994	22,053	0.51	1.25	0.00163	23	75,000	1,725,000
1995	20,950	0.52	1.25	0.00186	25	77,500	1,937,500
1996	19,903	0.53	1.25	0.00204	27	80,000	2,160,000
1997	18,907	0.54	1.25	0.00215	27	82,500	2,227,500
1998	17,962	0.55	1.25	0.00220	27	85,000	2,295,000
1999	17,064	0.56	1.25	0.00217	26	87,500	2,275,000
2000	16,211	0.57	1.25	0.00209	24	90,000	2,160,000

TABLE 5

COMPANY PROJECTIONS FOR ERA 3 UNTESTED
DETAILED EXAMPLE OF 1988 AND 1989 SALES

Year	(1) Male 18–54 Lives	(2) Insured % of Gen. Pop.	(3) Antiselection	(4) Gen. Pop. AIDS Mort. Rate	(5) AIDS Deaths 1 × 2 × 3 × 4	(6) Av. Death Benefit	(7) AIDS Claims 5 × 6
Era 3 — New Business Sold *Only in* 1988 — Untested							
1988	7,500	0.40%	2.00	0.00032	2	$50,000	$100,000
1989	6,975	0.42	2.00	0.00046	3	52,500	157,500
1990	6,487	0.44	2.00	0.00064	4	55,000	220,000
1991	6,033	0.46	2.00	0.00086	5	57,500	287,500
1992	5,610	0.48	2.00	0.00110	6	60,000	360,000
1993	5,218	0.50	2.00	0.00137	7	62,500	437,500
1994	4,852	0.51	2.00	0.00163	8	65,000	520,000
1995	4,513	0.52	2.00	0.00186	9	67,500	607,500
1996	4,197	0.53	2.00	0.00204	9	70,000	630,000
1997	3,903	0.54	2.00	0.00215	9	72,500	652,500
1998	3,630	0.55	2.00	0.00220	9	75,000	675,000
1999	3,376	0.56	2.00	0.00217	8	77,500	620,000
2000	3,139	0.57	2.00	0.00209	7	80,000	560,000
Era 3 — New Business Sold *Only in* 1989 — Untested							
1988	0	0	0	0.00032	0	0	0
1989	7,875	0.40	2.00	0.00046	3	$50,000	$150,000
1990	7,324	0.42	2.00	0.00064	4	52,500	210,000
1991	6,811	0.44	2.00	0.00086	5	55,000	275,000
1992	6,334	0.46	2.00	0.00110	6	57,500	345,000
1993	5,891	0.48	2.00	0.00137	8	60,000	480,000
1994	5,479	0.50	2.00	0.00163	9	62,500	562,500
1995	5,095	0.51	2.00	0.00186	10	65,000	650,000
1996	4,738	0.52	2.00	0.00204	10	67,500	675,000
1997	4,407	0.53	2.00	0.00215	10	70,000	700,000
1998	4,098	0.54	2.00	0.00220	10	72,500	725,000
1999	3,811	0.55	2.00	0.00217	9	75,000	675,000
2000	3,545	0.56	2.00	0.00209	8	77,500	620,000

Similar outputs for new business sold in 1990–2000.

TABLE 6

SUMMARY OF COMPANY PROJECTIONS FOR ERA 3 UNTESTED

Year	Male 18–54 Lives	AIDS Deaths	AIDS Claims
New Business Sold after 12/31/87			
1988	7,500	2	$ 100,000
1989	14,850	6	307,500
1990	22,079	12	630,000
1991	29,216	22	1,177,500
1992	36,287	34	1,857,500
1993	43,319	52	2,897,500
1994	50,337	73	4,142,500
1995	57,367	100	5,770,000
1996	64,432	120	7,027,500
1997	71,557	143	8,502,500
1998	78,765	164	9,895,000
1999	86,079	175	10,690,000
2000	93,522	185	11,427,500

TABLE 7

COMPANY PROJECTIONS FOR ERA 3 TESTED
DETAILED EXAMPLE OF 1988 AND 1989 SALES

Year	(1) Male 18–54 Lives	(2) Insured % of Gen. Pop.	(3) Antiselection	(4) Gen. Pop. AIDS Mort. Rate	(5) AIDS Deaths 1×2×3×4	(6) Av. Death Benefit	(7) AIDS Claims 5×6
Era 3 — New Business Sold *Only in* 1988 — Tested							
1988	2,500	0.40%	1.25	0.00000	0	$200,000	0
1989	2,325	0.42	1.25	0.00001	0	210,000	0
1990	2,162	0.44	1.25	0.00003	0	220,000	0
1991	2,011	0.46	1.25	0.00009	0	230,000	0
1992	1,870	0.48	1.25	0.00020	0	240,000	0
1993	1,739	0.50	1.25	0.00037	0	250,000	0
1994	1,617	0.51	1.25	0.00059	1	260,000	$260,000
1995	1,504	0.52	1.25	0.00086	1	270,000	270,000
1996	1,399	0.53	1.25	0.00113	1	280,000	280,000
1997	1,301	0.54	1.25	0.00135	1	290,000	290,000
1998	1,210	0.55	1.25	0.00149	1	300,000	300,000
1999	1,125	0.56	1.25	0.00155	1	310,000	310,000
2000	1,046	0.57	1.25	0.00155	1	320,000	320,000
Era 3 — New Business Sold *Only in* 1989 — Tested							
1988	0	0	0	0.00000	0	$200,000	0
1989	2,625	0.40%	1.25	0.00000	0	210,000	0
1990	2,441	0.42	1.25	0.00001	0	220,000	0
1991	2,270	0.44	1.25	0.00003	0	230,000	0
1992	2,111	0.46	1.25	0.00009	0	240,000	0
1993	1,964	0.48	1.25	0.00019	0	250,000	0
1994	1,826	0.50	1.25	0.00035	0	260,000	0
1995	1,698	0.51	1.25	0.00055	1	270,000	$270,000
1996	1,579	0.52	1.25	0.00079	1	280,000	280,000
1997	1,469	0.53	1.25	0.00102	1	290,000	290,000
1998	1,366	0.54	1.25	0.00119	1	300,000	300,000
1999	1,270	0.55	1.25	0.00129	1	310,000	310,000
2000	1,182	0.56	1.25	0.00132	1	320,000	320,000

Similar outputs for new business sold in 1990–2000.

TABLE 8

SUMMARY OF COMPANY PROJECTIONS FOR ERA 3 TESTED

Year	Male 18–54 Lives	AIDS Deaths	AIDS Claims
	New Business Sold after 12-31-87		
1988	2,500	0	0
1989	4,950	0	0
1990	7,360	0	0
1991	9,739	0	0
1992	12,096	0	0
1993	14,440	0	0
1994	16,779	1	$ 260,000
1995	19,122	2	540,000
1996	21,477	3	840,000
1997	23,852	3	870,000
1998	26,255	4	1,200,000
1999	28,693	5	1,550,000
2000	31,174	5	1,600,000

TABLE 9

SUMMARY OF AIDS PROJECTION MODEL

	AIDS Deaths					AIDS Claims (Mils)				
			Era 3					Era 3		
Year	Era 1	Era 2	Untested	Tested	Total	Era 1	Era 2	Untested	Tested	Total
1988	13	5	2	0	20	$ 0.6	$ 0.3	$ 0.1	0	$ 1.0
1989	19	7	6	0	32	1.0	0.4	0.3	0	1.7
1990	26	10	12	0	48	1.4	0.6	0.6	0	2.7
1991	35	13	22	0	70	2.0	0.9	1.2	0	4.1
1992	45	16	34	0	95	2.7	1.1	1.9	0	5.7
1993	56	20	52	0	128	3.5	1.4	2.9	0	7.8
1994	65	23	73	1	162	4.2	1.7	4.1	$0.3	10.4
1995	73	25	100	2	200	4.9	1.9	5.8	0.5	13.2
1996	78	27	120	3	228	5.5	2.2	7.0	0.8	15.5
1997	80	27	143	3	253	5.8	2.2	8.5	0.9	17.4
1998	80	27	164	4	275	6.0	2.3	9.9	1.2	19.4
1999	78	26	175	5	284	6.0	2.3	10.7	1.5	20.6
2000	73	24	185	5	287	5.8	2.2	11.4	1.6	21.0
Total	721	250	1,088	23	2,082	$49.6	$19.6	$64.4	$6.9	$140.5

HYPOTHETICAL LIFE MODEL EXAMPLE 3

This model has been developed for the purpose of estimating future individual life insurance AIDS claims by using assumptions that reproduce known and projected population data from the CDC and other acknowledged experts. To the extent that the model tracks known and authoritative projected data, some degree of credibility can be assumed. However, there is much that is still unknown about AIDS, and there are many variables that can affect projected results.

The model can be used to test a variety of assumptions to determine the effect that different scenarios have on claims and at what point in the future the maximum effect may occur. This will permit planning to mitigate this effect.

The hypothetical examples attached give AIDS claims projections for two risk groups that are of primary concern to life insurance companies:

1. Homosexual and bisexual males, which constitute most of our exposure to AIDS currently, and
2. Heterosexual males and females, which present a future problem if there is a significant spread of the AIDS virus in the heterosexual population.

A description of these and other risk groups is given in Table 10. The assumptions used in making the homo-bisexual and heterosexual projections and the basis for those assumptions are given in Tables 11 and 12.

TABLE 10

DESCRIPTION OF AIDS RISK GROUPS IN POPULATION AND INSURANCE PROJECTIONS

The percentage distribution of AIDS victims according to November 16, 1987 CDC data is as follows (excludes undetermined):

	Males	Females	Children
IV drug user	21%	4%	—
Homosexual/bisexual	67	—	—
Heterosexual			
Infected Overseas	1.5	0.5	—
Infected in U.S.	0.5	1.5	—
Contaminated Blood	2	1	1
	92%	7%	1%

Two projections have been made to estimate future AIDS claims from the groups that are significant to individual life insurance experience: homo-bisexual males, which represents the current problem, and heterosexual males and females, which represent a possible future problem.

IV drug users, which constitute a significant proportion of AIDS victims, are not included in the insurance projections because we feel that only an insignificant proportion of such risks are insured. For the same reason, heterosexual males who were infected with the AIDS virus in Africa or Haiti are excluded.

Persons who become infected with contaminated blood (including children) are also not directly included in the projections, but expected claims from this group are added to the results to approximate such persons in the insurance population that will die from AIDS. This amount should not be large because very few additional persons should become infected now that blood donors are being checked for exposure to the AIDS virus. Nevertheless, we have added a constant 5 percent to the homo-bisexual projection.

TABLE 11

MODEL ASSUMPTIONS FOR PROJECTIONS OF HOMO-BISEXUAL AND HETEROSEXUAL CLAIMS IN HYPOTHETICAL LIFE MODEL—EXAMPLE 3
(See Table 12 for Explanation of Assumptions)

	Homo-bisexual Males Ages 20–59	Heterosexual Males and Females Ages 20–59
Population		
1. % AIDS susceptible	6%	10%
2. % AIDS susceptible infected by 1996	59.5%	25%
2A. % AIDS susceptible who tested negative at issue infected by 1996	16.7%	4.8%
3. % Infected getting AIDS within 20 years	90.6%	90.6%
4. % With AIDS dying		
Within 1 year	45.0%	45.0%
Within 2 years	69.8%	69.8%
Within 3 years	80.3%	80.3%
Company — AIDS		
5. % AIDS susceptible assuming no antiselection	2.4%	2%
6. Annual termination rate among AIDS susceptible (excluding AIDS deaths)	0%	0%
7. Antiselection factor among AIDS susceptible	1.5X	1.5X
8. Testing factor		
1/1/87 to 7/1/87	30%	30%
7/1/87 and later	50%	50%
Company — General		
9. In force 1/1/87		
Total	$100 billion	$100 billion
Ages 20–59	$65 billion (M)	$85 billion (M&F)
10. New issues		
1987	$10 billion	$10 billion
Ages 20–59	$6.5 billion (M)	$8.5 billion (M&F)
Annual increase	5%	5%
11. Annual death rate		
1987–1990 IF	3.0%	3.0%
1991–1995 IF	2.9%	2.9%
1996–2000 IF	2.8%	2.8%
12. Annual termination rate		
In force	7.5%	7.5%
New issues	7.5%	7.5%

TABLE 12

BASIS FOR ASSUMPTIONS IN PROJECTION OF CLAIMS
FOR HYPOTHETICAL LIFE MODEL — EXAMPLE 3

Homo-Bisexual

1. *U.S. AIDS-Susceptible Population.* We have assumed that 6% of males, ages 20–59, are AIDS susceptible because of homosexual activity (80%) or IV drug use (20%).
2. *U.S. Population Infected.* Line 5 of Table 13 is from Cowell paper, Appendix 2. Assumes no new infections after 1996.
3. *% Getting AIDS after Infection.* Derived from Cowell data.
4. *% Dying after Getting AIDS.* From Cowell paper.
5. *AIDS-Susceptible Insurance Population.* It is reasonable to assume that there is a lower percentage of AIDS-susceptible risks among insureds than in the general population because of a lesser desire or need for insurance. We have assumed that IV drug users (20%) are not included in the insurance population and that the pre-AIDS proportion of homo-bisexuals is one-half of that in the general population (one-half of 80% = 40%).
6. *Antiselection Termination Factor.* It is reasonable to assume that AIDS-susceptible insureds will have a low lapse rate. Therefore, we have assumed no terminations other than AIDS deaths on the assumption that increases through paid-up additions and option exercises will offset terminations and non-AIDS deaths.
7. *Antiselection at Issue Factor.* It is expected that AIDS-susceptible risks will have a greater incentive to buy than heretofore. We have assumed that this incentive will increase by 50% the percentage of AIDS-susceptible applicants.
8. *Testing Factor.* This is the proportion by amount for which HIV testing is performed. This protective factor does not account for those jurisdictions where HIV testing is not permitted.
9. *In Force.* Assumes $100,000,000 in force 1/1/87 with 65% on males ages 20–59.
10. *New Issues.* Assumes $10,000,000 new issues in 1987, increasing 10% per year, with 65% on males ages 20–59.
11. *Annual Death Rate.* This is total death rate (excluding AIDS deaths) projected for some mortality improvement (can be obtained from annual statement data).
12. *Annual Termination Rate.* This is a total termination rate (excluding AIDS deaths) and is assumed to remain constant (can be obtained from annual statement data).

Heterosexual

1. AIDS-susceptible heterosexuals include (1) persons who have regular activity with a single infected partner and (2) persons who have heterosexual activity with a variety of partners, thus having a possiblity of exposure to one or more infected partners. We estimate that such persons (i.e., AIDS susceptible) may constitute 10% of the heterosexual population, ages 20–59.
2. Because the transmission of the AIDS virus is less likely in vaginal sex than anal sex, the spread of infection is assumed to be at a lower rate for heterosexuals than for homo-bisexuals, reaching 25% of AIDS susceptibles by 2000. Assumes that new infections continue after 1996.
5. The pre-AIDS proportion of AIDS-susceptible heterosexuals among insureds is estimated at only 20% of that in the general population (as compared to 40% for AIDS susceptible homo-bisexuals). The proportion is lower than for homo-bisexuals because a high proportion of AIDS-susceptible heterosexuals are partners of IV drug users and thus have a lifestyle inconsistent with the purchase of insurance.

9–10. New issues and in force are 85% of total for males and females ages 20–59, as compared to 65% for males ages 20–59 in the homo-bisexual projection.

Assumption 3–4, 6–8 and 11–12 are the same as those in the homo-bisexual projection.

Although data are still limited and immature, the assumptions used in the homo-bisexual population projection are reasonable. However, for the heterosexual projection, data are virtually nonexistent, and the projection is extremely hypothetical. To the present, only 2 percent of AIDS victims have been heterosexual non-IV drug users infected within the U.S., and this percentage has not grown. Nevertheless, it is expected that this percentage will increase as the rate of AIDS infection among homo-bisexuals and IV drug users decreases. The progression in the heterosexual population is slow because very few heterosexuals are currently infected and a promiscuous heterosexual encounter has a low probability of AIDS infection. The assumptions used in the heterosexual projection illustrate a scenario in which the spread to the heterosexual population begins to have a major impact in the late 1990s.

This model has been developed on a PC using a Lotus 1-2-3 spreadsheet. The examples are not subdivided by age or by other risk characteristics, which would produce greater refinement. However, such subdivisions can be readily made. Of course, changes in both the population and company assumptions currently used can also be readily made.

The company assumptions are hypothetical and are not necessarily representative of any company's experience. Therefore, the results are illustrative and not predictive. In using this type of model, the company actuary should select assumptions that will produce results that reproduce actual claims experience. There are also refinements that could be made to improve the accuracy of the projections. However, given the questionable nature of many of the assumptions, the emphasis in this illustration has been on simplicity of presentation in lieu of refinement.

In Tables 13 and 14, the model projects the number of AIDS-susceptibles in the population that become infected. In this projection, the numbers infected have been set to equal those in the Cowell model. In Tables 15 and 16, rates of conversion (i.e., rate of getting AIDS after infection) are applied to obtain the number of AIDS cases in each calendar year.

TABLE 13

ESTIMATE OF AIDS-SUSCEPTIBLE HOMOSEXUAL-BISEXUAL AND IV DRUG USER MALES IN GENERAL POPULATION BECOMING INFECTED WITH THE AIDS VIRUS
(Numbers in Thousands)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Assumption 1: AIDS-Susceptible = 6.0% of Males Ages 20–59																				
1. U.S. population (males 20–59)	60,731	61,339	61,918	62,484	63,047	63,614	64,187	64,765	65,348	65,936	66,529	67,128	67,732	68,342	68,957	69,577	70,203	70,835	71,473	72,116
2. AIDS-susceptible (0.06 × line 1)	3,644	3,680	3,715	3,749	3,783	3,817	3,851	3,886	3,921	3,956	3,992	4,028	4,064	4,100	4,137	4,175	4,212	4,250	4,288	4,327
Assumption 2: Infected Population Increases as Indicated to 59.5% in 1996 (no additional infections after 1996)											48.8%	52.9%	56.0%	58.1%	59.3%	59.5%	59.0%	58.5%	57.9%	57.4%
3. % of AIDS-susceptible population infected	2.1%	3.7%	5.9%	8.7%	12.6%	17.6%	23.9%	30.6%	37.4%	43.5%	5.3%	4.1%	3.1%	2.1%	1.2%	0.3%	0.0%	0.0%	0.0%	0.0%
											1,946	2,132	2,277	2,383	2,452	2,485	2,485	2,485	2,485	2,485
4. % Infected in year	2.1%	1.6%	2.8%	2.8%	3.9%	5.0%	6.3%	6.7%	6.8%	6.1%										
5. AIDS-susceptible population infected line 2 × line 3 (from Cowell paper)	76	135	218	328	478	671	920	1,191	1,465	1,721	225	186	145	106	69	33	0	0	0	0
6. Number becoming infected in year (1978 = 4, 1979 = 10, 1980 = 22)	40	59	83	110	150	193	249	271	274	256										

TABLE 14

ESTIMATE OF AIDS-SUSCEPTIBLE HETEROSEXUAL NON-IV DRUG USER MALES AND FEMALES AGES 20–59 IN GENERAL POPULATION BECOMING INFECTED WITH THE AIDS VIRUS (Numbers in Thousands)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Assumption 1: AIDS-Susceptible = 10% of Males and Females, 20–59																				
1. U.S. population (males and females, 20–59)	123,533	124,769	125,947	127,098	128,244	129,398	130,563	131,738	132,923	134,120	135,327	136,545	137,774	139,014	140,265	141,527	142,801	144,086	145,383	146,691
2. AIDS-susceptible (.10 × line 1)	12,353	12,477	12,595	12,710	12,824	12,940	13,056	13,174	13,292	13,412	13,533	13,654	13,777	13,901	14,026	14,153	14,280	14,409	14,538	14,669
Assumption 2: Infected Population Increases as Indicated to 59.5% in 1996 (no additional infections after 1996)																				
3. % of AIDS-susceptible population infected	0.035%	0.050%	0.070%	0.10%	0.14%	0.20%	0.28%	0.40%	0.56%	0.80%	1.10%	1.50%	2.20%	3.10%	4.40%	6.20%	8.80%	12.50%	17.60%	25.00%
4. % Infected in year	0.035%	0.015%	0.02%	0.03%	0.04%	0.06%	0.08%	0.12%	0.16%	0.24%	0.3%	0.4%	0.7%	0.9%	1.3%	1.8%	2.6%	3.7%	5.1%	7.4%
5. AIDS-susceptible population infected line 2 × line 3 (from Cowell paper)	4	6	9	13	18	26	37	53	74	107	149	205	303	431	617	877	1,257	1,801	2,559	3,667
6. Number becoming infected in year (1980 and prior = 0)	4	2	3	4	5	8	11	16	22	33	42	56	98	128	186	260	379	544	758	1,109

TABLE 15

NUMBER OF HOMOSEXUAL-BISEXUAL AND IV DRUG USER MALES IN GENERAL POPULATION GETTING AIDS YEAR BY YEAR AFTER INFECTION IN YEAR INDICATED (Numbers in Thousands)

Assumption 3																								
Year	% Getting AIDS after Infected	Infected in Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.0%	1978	0	12	48	104	172	248	344	416	400	336	288	244	208	180	148	128	108	92	80	68	56	48	40
2	0.3%	1979		0	30	120	260	430	620	860	1,040	1,000	840	720	610	520	450	370	320	270	230	200	170	140	120
3	1.2%	1980			0	66	264	572	946	1,364	1,892	2,288	2,200	1,848	1,584	1,342	1,144	990	814	704	594	506	440	374	308
4	2.6%	1981				0	120	480	1,040	1,720	2,480	3,440	4,160	4,000	3,360	2,880	2,440	2,080	1,800	1,480	1,280	1,080	920	800	680
5	4.3%	1982					0	177	708	1,534	2,537	3,658	5,074	6,136	5,900	4,956	4,248	3,599	3,068	2,655	2,183	1,888	1,593	1,357	1,180
6	6.2%	1983						0	249	996	2,158	3,569	5,146	7,138	8,632	8,300	6,972	5,976	5,063	4,316	3,735	3,071	2,656	2,241	1,909
7	8.6%	1984							0	330	1,320	2,860	4,730	6,820	9,460	11,440	11,000	9,240	7,920	6,710	5,720	4,950	4,070	3,520	2,970
8	10.4%	1985								0	450	1,800	3,900	6,450	9,300	12,900	15,600	15,000	12,600	10,800	9,150	7,800	6,750	5,550	4,800
9	10.0%	1986									0	579	2,316	5,018	8,299	11,966	16,598	20,072	19,300	16,212	13,896	11,773	10,036	8,685	7,141
10	8.4%	1987										0	747	2,988	6,474	10,707	15,438	21,414	25,896	24,900	20,916	17,928	15,189	12,948	11,205
11	7.2%	1988											0	813	3,252	7,046	11,653	16,802	23,306	28,184	27,100	22,764	19,512	16,531	14,092
12	6.1%	1989												0	822	3,288	7,124	11,782	16,988	23,564	28,496	27,400	23,016	19,728	16,714
13	5.2%	1990													0	768	3,072	6,656	11,008	15,872	22,016	26,624	25,600	21,504	18,432
14	4.5%	1991														0	675	2,700	5,850	9,675	13,950	19,350	23,400	22,500	18,900
15	3.7%	1992															0	558	2,232	4,836	7,998	11,532	15,996	19,344	18,600
16	3.2%	1993																0	435	1,740	3,770	6,235	8,990	12,470	15,080
17	2.7%	1994																	0	318	1,272	2,756	4,558	6,572	9,116
18	2.3%	1995																		0	207	828	1,794	2,967	4,278
19	2.0%	1996																			0	99	396	858	1,419
20	1.7%	1997																				0	0	0	0
21	1.4%	1998																					0	0	0
22	1.2%	1999																						0	0
23	1.0%	2000																							0
	94.2%	1. Total	0	12	78	290	816	1,907	3,907	7,220	12,277	19,530	29,401	42,175	57,901	76,293	96,562	117,367	136,708	152,328	162,593	166,852	165,142	158,137	146,984
2. Cumulative			0	12	90	380	1,196	3,103	7,010	14,230	26,507	46,037	75,438	117,613	175,514	251,807	348,369	465,736	602,444	754,772	917,365	1,084,217	1,249,359	1,407,496	1,554,480
3. CDC Data			—	—	—	337	1,337	4,119	9,697	15,948	29,003	55,000	88,000	133,000	191,000	265,000									
4. Ratio of line 2 to line 3			—	—	—	113%	89%	75%	72%	89%	91%	84%	86%	88%	92%	95%									

TABLE 16

NUMBER OF NON-IV DRUG USER MALES AND FEMALES AGES 20–59 IN GENERAL POPULATION GETTING AIDS YEAR BY YEAR AFTER INFECTION IN YEAR INDICATED (Numbers in Thousands)

Assumption 3																								
Year	% Getting AIDS after Infected	Infected in Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.0%	1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.3%	1979		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	1.2%	1980			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	2.6%	1981				0	13	52	112	186	268	372	450	432	363	311	264	225	195	160	138	117	99	86	74
5	4.3%	1982					0	6	23	50	82	119	165	199	191	161	138	117	100	86	71	61	52	44	38
6	6.2%	1983						0	8	31	67	111	160	222	268	258	217	186	157	134	116	95	82	70	59
7	8.6%	1984							0	12	47	101	167	241	335	405	389	327	280	238	202	175	144	125	105
8	10.4%	1985								0	16	63	136	226	325	451	545	524	441	378	320	273	236	194	168
9	10.0%	1986									0	24	95	206	341	491	682	824	793	666	571	483	412	357	293
10	8.4%	1987										0	32	128	278	459	662	918	1,111	1,068	897	769	651	555	481
11	7.2%	1988											0	48	194	420	694	1,001	1,388	1,678	1,614	1,356	1,162	984	839
12	6.1%	1989												0	65	261	565	935	1,348	1,870	2,261	2,174	1,826	1,565	1,326
13	5.2%	1990													0	99	394	854	1,413	2,037	2,826	3,417	3,286	2,760	2,366
14	4.5%	1991														0	125	499	1,081	1,787	2,577	3,574	4,323	4,156	3,491
15	3.7%	1992															0	168	671	1,455	2,406	3,469	4,812	5,820	5,596
16	3.2%	1993																0	295	1,179	2,555	4,226	6,094	8,453	10,222
17	2.7%	1994																	0	384	1,534	3,324	5,497	7,926	10,994
18	2.3%	1995																		0	559	2,235	4,842	8,008	11,546
19	2.0%	1996																			0	781	3,124	6,768	11,193
20	1.7%	1997																				0	1,138	4,550	9,859
21	1.4%	1998																					0	1,633	6,533
22	1.2%	1999																						0	2,273
23	1.0%	2000																							0
	94.2%	1. Total	0	0	0	0	13	58	143	278	480	789	1,205	1,703	2,360	3,315	4,675	6,578	9,271	13,119	18,647	26,530	37,780	54,054	77,456
2. Cumulative			0	0	0	0	13	71	214	492	972	1,761	2,966	4,669	7,029	10,345	15,019	21,597	30,868	43,987	62,635	89,165	126,945	180,999	258,454
3. 2% of CDC Data (Heterosexual U.S. born M & F)			—	—	—	7	27	82	194	319	580	1,100	1,760	2,660	3,820	5,300									
4. Ratio of line 2 to line 3			—	—	—	0%	49%	86%	110%	154%	168%	160%	169%	176%	184%	195%									

In Tables 17 and 18, the rates of death among those who have AIDS are applied to produce AIDS deaths; these deaths are compared to projected CDC deaths in the last line.

In Tables 19 and 20, population death rates for AIDS infected, ages 20–59, are calculated by taking the ratio of AIDS deaths to AIDS infected. These death rates are applied in Tables 21–24 to AIDS-infected insureds to determine company AIDS claims.

Also shown in Tables 19 and 20 (line 3A) are the cumulative death rates for persons who tested HIV − at time of issue but who became infected after issue. These are the same rates as in line 3 but starting in 1987 instead of 1979 (we assume 1979 = 0, 1980 = 1.0 and 1981 = 2.0). That is, they are the rates that applied at the start of the epidemic when virtually none of the AIDS-susceptibles was infected.

We assume those who are tested have the same proportions of infected-noninfected as those who are not tested. Hence, the death rates in line 3 are applicable to those not tested. Those who are tested but test negative will have a lesser rate of infection (as indicated in assumption 2A) and after infection will have a deferred death rate as indicated in line 3A.

The infection rates in assumption 2A are cumulative; that is, the rate of infection for 1987 applies, of course, only to 1987 issues. The rate for 1988 applies to 1987 and 1988 issues and has been taken, for simplicity, as the average for those two years of issue. The rate for 1989 is the average of the rate for 1987, 1988 and 1989 issues, and so on. The rate of infection in 1997–2000 decreases (but is greater than zero) because although there are no new infections after 1996, there are persons who become infected after issue but before 1996 who are included among those infected in 1997–2000.

TABLE 17

NUMBER OF HOMOSEXUAL-BISEXUAL AND IV DRUG USER MALES IN GENERAL POPULATION DYING YEAR BY YEAR AFTER GETTING AIDS IN YEAR INDICATED (Numbers in Thousands)

Assumption 4		Getting																			
Year	% Dying after Getting AIDS	AIDS in Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	45.000%																					
2	24.750%																					
3	10.588%	1981 & Prior	171	94	40	19	14	11	8	6	4	3	2	2	1	1	1	1	0	0	0	0
4	4.916%	1982		367	202	86	40	30	23	17	13	10	7	5	4	3	2	2	1	1	1	1
5	3.687%	1983			858	472	202	94	70	53	40	30	22	17	13	9	7	5	4	3	2	2
6	2.765%	1984				1,758	967	414	192	144	108	81	61	46	34	26	19	14	11	8	6	5
7	2.074%	1985					3,249	1,787	764	355	266	200	150	112	84	63	47	36	27	20	15	11
8	1.555%	1986						5,525	3,039	1,300	604	453	339	255	191	143	107	81	60	45	34	26
9	1.167%	1987							8,789	4,834	2,068	960	720	540	405	304	228	171	128	96	72	54
10	0.875%	1988								13,230	7,277	3,113	1,445	1,084	813	610	457	343	257	193	145	108
11	0.656%	1989									18,979	10,438	4,465	2,073	1,555	1,166	875	656	492	369	277	208
12	0.492%	1990										26,055	14,330	6,131	2,846	2,135	1,601	1,201	900	676	507	380
13	0.369%	1991											34,332	18,883	8,078	3,751	2,813	2,110	1,582	1,186	890	668
14	0.277%	1992												43,453	23,899	10,224	4,747	3,560	2,670	2,003	1,502	1,127
15	0.208%	1993													52,815	29,048	12,427	5,770	4,327	3,245	2,434	1,825
16	0.156%	1994														61,519	33,835	14,475	6,721	5,040	3,780	2,835
17	0.117%	1995															68,548	37,701	16,128	7,488	5,616	4,212
18	0.088%	1996																73,167	40,242	17,215	7,993	5,995
19	0.066%	1997																	75,083	41,296	17,66	8,202
20	0.049%	1998																		74,314	40,873	17,485
	—	1999																			71,162	39,139
	99.855%	2000																				66,143
1. Total			171	461	1,100	2,335	4,472	7,860	12,884	19,939	29,358	41,343	55,875	72,600	90,739	109,001	125,714	139,291	148,635	153,200	152,974	148,425
2. Cumulative			171	632	1,733	4,068	8,540	16,399	29,284	49,222	78,580	119,923	175,798	248,398	339,136	448,138	573,852	713,143	861,778	1,014,978	1,167,952	1,316,377
3. CDC Data			146	528	1,753	4,582	8,161	16,301	30,000	51,000	81,000	122,000	176,000									
4. Ratio of line 2 to line 3			117%	120%	99%	89%	105%	101%	98%	97%	97%	98%	100%									

TABLE 18

NUMBER OF NON-IV DRUG USER MALES AND FEMALES AGES 20–59 IN GENERAL POPULATION DYING YEAR BY YEAR AFTER GETTING AIDS IN YEAR INDICATED (Numbers in Thousands)

Assumption 4		Getting																			
Year	% Dying after Getting AIDS	AIDS in Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	45.000%																					
2	24.750%	1981 & Prior	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	10.588%	1982		6	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	4.916%	1983			26	14	6	3	2	2	1	1	1	1	0	0	0	0	0	0	0	0
5	3.687%	1984				64	35	15	7	5	4	3	2	2	1	1	1	1	0	0	0	0
6	2.765%	1985					125	69	29	14	10	8	6	4	3	2	2	1	1	1	1	0
7	2.074%	1986						216	119	51	24	18	13	10	7	6	4	3	2	2	1	1
8	1.555%	1987							355	195	84	39	29	22	16	12	9	7	5	4	3	2
9	1.167%	1988								542	298	128	59	44	33	25	19	14	11	8	6	4
10	0.875%	1989									766	421	180	84	63	47	35	26	20	15	11	8
11	0.656%	1990										1,062	584	250	116	87	65	49	37	28	21	15
12	0.492%	1991											1,492	821	351	163	122	92	69	52	39	29
13	0.369%	1992												2,104	1,157	495	230	172	129	97	73	55
14	0.277%	1993													2,960	1,628	696	323	243	182	136	102
15	0.208%	1994														4,172	2,295	982	456	342	256	192
16	0.156%	1995															5,904	3,247	1,389	645	484	363
17	0.117%	1996																8,391	4,615	1,974	917	688
18	0.088%	1997																	11,939	6,566	2,809	1,304
19	0.066%	1998																		17,001	9,351	4,000
20	0.049%	1999																			24,324	13,378
		2000																				34,855
	99.855%																					
1. Total			0	6	29	80	167	303	513	809	1,187	1,679	2,367	3,341	4,709	6,639	9,382	13,309	18,915	26,916	38,431	54,998
2. Cumulative			0	6	35	115	282	586	1,099	1,908	3,095	4,774	7,141	10,482	15,191	21,829	31,212	44,520	63,436	90,352	128,783	183,781
3. 2% of CDC Data (Heterosexual U.S. born M & F)			3	11	35	92	163	326	600	1,020	1,620	2,440	3,520									
4. Ratio of line 2 to line 3			0%	55%	100%	126%	173%	180%	183%	187%	191%	196%	203%									

TABLE 19

ESTIMATE OF INFECTED POPULATION DEATH RATE DUE TO AIDS FOR MALES AGES 20–59 (EXCLUDING HETEROSEXUALS)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. AIDS deaths [line 1 from Table 17]	171	461	1,100	2,335	4,472	7,860	12,884	19,939	29,358	41,343	55,875	72,600	90,739	109,001	125,714	139,291	148,635	153,200	152,974	148,425
2. Live infected (000's) [line 1 from Table 17]	76	135	217	326	474	663	907	1,171	1,436	1,680	1,890	2,059	2,186	2,274	2,326	2,346	2,336	2,332	2,332	2,337
3. Death rate per 1,000 live infected line 1 ÷ line 2	2.255	3.428	5.073	7.171	9.444	11.852	14.204	17.026	20.449	24.614	29.562	35.253	41.504	47.934	54.041	59.381	63.618	65.700	65.597	63.522
3A. Death rate per 1,000 live infected (for those testing negative at issue)	–	–	–	–	–	–	0.0000	1.000	2.000	3.428	5.073	7.171	9.444	11.852	14.204	17.026	20.449	24.614	29.562	35.253

TABLE 20

ESTIMATE OF INFECTED POPULATION DEATH RATES DUE TO AIDS FOR HETEROSEXUAL MALES AND FEMALES AGES 20–59

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. AIDS deaths [line 1 from Table 18]	0	6	29	80	167	303	513	809	1,187	1,679	2,367	3,341	4,709	6,639	9,382	13,309	18,915	26,916	38,431	54,998
2. Live infected (000's) [line 5 from Table 18]	4	6	9	13	18	26	36	52	73	106	146	201	298	424	608	864	1,238	1,774	2,520	3,612
3. Death rate per 1,000 live infected line 1 ÷ line 2	0.000	0.937	3.317	6.338	9.412	11.858	14.231	15.597	16.208	15.899	16.156	16.581	15.781	15.646	15.437	15.401	15.282	15.171	15.249	15.225
3A. Death rate per 1,000 live infected (for those testing negative at issue)	–	–	–	–	–	–	0.000	0.000	0.000	0.937	3.317	6.338	9.412	11.858	14.231	15.597	16.208	15.899	16.156	16.581

In Tables 21 and 22, AIDS-susceptibles among the 1/1/87 in force are estimated. In the homo-bisexual projection, it is estimated that insurance on males ages 20–59 constitutes 65 percent of total insurance in force and that 2.4 percent of this amount is on AIDS-susceptibles (40 percent of the 6.0 percent in the U.S. population). This 2.4 percent figure is obtained by eliminating IV drug users (1.2 percent) and assuming that the pre-AIDS proportion of AIDS-susceptible homo-bisexuals is only one-half of that in the general population. Rates of infection from Tables 13 and 14 are then applied to the AIDS-susceptibles to determine the number infected. Then the death rates from line 3 of Tables 19 and 20 are applied. A similar approach is used in the heterosexual projection.

TABLE 21

ESTIMATE OF COMPANY DEATH CLAIMS CAUSED BY AIDS ON 1986 AND PRIOR ISSUES FOR AIDS-SUSCEPTIBLE HOMO-BISEXUAL MALES AGES 20–59
(Dollar Amounts in Thousands)

Year	(1) AIDS-Susceptible (Beginning of Year) Prior Year (2) − (6)	(2) Terminations (Assumption 6)	(3) Percentage of AIDS-Susceptible Infected (line 3, Table 13)	(4) AIDS Infected (1) × (3)	(5) Death Rate per Thousand (line 3, Table 19)	(6) AIDS Death Claims (4) × (5)
1987	1,560,000	0	23.9%	372,661	14.204	$5,293
1988	1,554,707	0	30.6%	476,509	17.026	8,113
1989	1,546,594	0	37.4%	577,875	20.449	11,817
1990	1,534,777	0	43.5%	667,659	24.614	16,434
1991	1,518,343	0	48.8%	740,202	29.562	21,882
1992	1,496,462	0	52.9%	792,135	35.253	27,925
1993	1,468,537	0	56.0%	822,816	41.504	34,150
1994	1,434,386	0	58.1%	833,593	47.934	39,957
1995	1,394,429	0	59.3%	826,399	54.041	44,659
1996	1,349,770	0	59.5%	803,466	59.381	47,711
1997	1,302,059	0	59.0%	768,152	63.618	48,868
1998	1,253,191	0	58.5%	732,728	65.700	48,140
1999	1,205,050	0	57.9%	698,296	65.597	45,806
2000	1,159,244	0	57.4%	665,761	63.522	42,291
						$443,047

Assumptions 1 and 5

1. U.S. AIDS-susceptible 6.0%

5. Company AIDS-susceptible 2.4%

Assumption 6

Antiselection termination factor 0.0

Assumption 9

In force for males ages 20–59 is 65% of total in force
1/1/87 Total in force $100,000,000
1/1/87 Infected males ages 20–59 $65,000,000
AIDS-susceptible (see assumption 5)
0.0240 × $65,000,000 = $1,560,000

TABLE 22

ESTIMATE OF COMPANY DEATH CLAIMS CAUSED BY AIDS ON 1986 AND PRIOR ISSUES FOR AIDS-SUSCEPTIBLE HETEROSEXUAL MALES AND FEMALES AGES 20–59
(Dollar Amounts in Thousands)

Year	(1) AIDS-Susceptible (Beginning of Year) Prior Year (2) − (6)	(2) Terminations (Assumption 6) 0.0 × (1)	(3) Percentage of AIDS-Susceptible Infected (line 3, Table 14)	(4) AIDS Infected (1) × (3)	(5) Death Rate per Thousand (line 3, Table 20)	(6) AIDS Death Claims (4) × (5)
1987	1,700,000	0	0.3%	4,760	14.231	68
1988	1,699,932	0	0.4%	6,800	15.597	106
1989	1,699,826	0	0.6%	9,519	16.208	154
1990	1,699,672	0	0.8%	13,597	15.899	216
1991	1,699,456	0	1.1%	18,694	16.156	302
1992	1,699,154	0	1.5%	25,487	16.581	423
1993	1,698,731	0	2.2%	37,372	15.781	590
1994	1,698,141	0	3.1%	52,642	15.646	824
1995	1,697,318	0	4.4%	74,682	15.437	1,153
1996	1,696,165	0	6.2%	105,162	15.401	1,620
1997	1,694,545	0	8.8%	149,120	15.282	2,279
1998	1,692,266	0	12.5%	211,533	15.171	3,209
1999	1,689,057	0	17.6%	297,274	15.249	4,533
2000	1,684,524	0	25.0%	421,131	15.225	6,412
						$21,888

Assumptions 1 and 5

1. U.S. AIDS-susceptible 10.0%

5. Company AIDS-susceptible 2.0%

Assumption 6

Antiselection termination factor 0.0%

Assumption 9

In force for males and females ages 20–59 is 85% of total in force

1/1/87 Total in force $100,000,000

1/1/87 In force M and F, ages 20–59 $85,000,000

AIDS-susceptible (see assumption 5) $85,000 × 0.02 = $1,700,000

In Tables 23–26, AIDS-susceptibles among 1987 and later issues are estimated. In the homo-bisexual projection, the 2.4 percent estimate of AIDS-susceptibles is, in effect, increased by an antiselection factor of 1.5 (to reflect the greater incentive of AIDS-susceptibles to obtain insurance) and reduced by a testing factor that equals the proportion of new insurance being tested. Rates of infection from Tables 13 and 14 are then applied to the AIDS-susceptibles who were not tested. For those who were tested, the rates of infection from assumption 2A are applied to those who tested negative (those testing positive were declined for insurance) and then the death rates from line 3A of Tables 16 and 17 are applied.

In Table 27, company death claims excluding AIDS are obtained by applying estimated total company death rates to total in force. The ratios of total AIDS claims to total death claims including AIDS claims are then obtained as a measure of the incidence and cumulative effect of AIDS claims on total company experience.

TABLE 23

ESTIMATE OF COMPANY DEATH CLAIMS CAUSED BY AIDS ON 1987 AND LATER ISSUES FOR AIDS-SUSCEPTIBLE HOMO-BISEXUAL MALES AGES 20–59

Year	(1) Total New Issues during Year	(2) AIDS-Susceptible (1) × 0.65 × 0.024 × Assumption 7	(3) AIDS-Susceptible Not Tested (2) × (1-Z)	(4) AIDS-Susceptible Not Tested (Beginning of Year) Prior Year of (7)	(5) AIDS-Susceptible Exposure (4) + (3)/2	(6) Terminations 0.0 × (5)	(7) AIDS-Susceptible (End of Year) (4) + (3) − (6) − (10)	(8) AIDS-Susceptible Infected (5) × (line 3, Table 13)	(9) Death Rate per Thousand (line 3, Table 19)	(10) AIDS Death Claims (Not Tested) (8) × (9)	(11) AIDS Death Claims (Tested Negative at Issue) (from Table 25)	(12) Total AIDS Death Claims (10) + (11)
1987	10,000,000	234,000	140,000	0	70,200	0	140,162	16,770	14.204	238	0	238
1988	10,500,000	245,700	122,900	140,162	201,612	0	262,010	61,793	17.026	1,052	11	1,063
1989	11,025,000	258,000	129,000	262,010	326,510	0	388,515	121,998	20.449	2,495	53	2,548
1990	11,576,250	270,900	135,500	388,515	456,265	0	519,130	198,484	24.614	4,885	152	5,037
1991	12,155,063	284,400	142,200	519,130	590,230	0	652,823	287,741	29.562	8,506	323	8,829
1992	12,762,816	298,600	149,300	652,823	727,473	0	788,548	385,080	35.253	13,575	583	14,158
1993	13,400,956	313,600	156,800	788,548	866,948	0	925,188	485,748	41.504	20,161	907	21,068
1994	14,071,004	329,300	164,700	925,188	1,007,538	0	1,061,821	585,530	47.934	28,067	1,277	29,344
1995	14,774,554	345,700	172,900	1,061,821	1,148,271	0	1,197,945	680,515	54.041	36,776	1,629	38,404
1996	15,513,282	363,000	181,500	1,197,945	1,288,695	0	1,333,894	767,111	59.381	45,552	1,982	47,534
1997	16,288,946	381,200	190,600	1,333,894	1,429,194	0	1,470,854	843,156	63.618	53,640	2,396	56,036
1998	17,103,394	400,200	200,100	1,470,854	1,570,904	0	1,610,608	918,491	65.700	60,345	2,905	63,250
1999	17,958,563	420,200	210,100	1,610,608	1,715,658	0	1,755,493	994,180	65.597	65,215	3,526	68,741
2000	18,856,491	441,200	220,600	1,755,493	1,865,793	0	1,908,027	1,071,536	63.522	68,066	4,277	72,343
										408,573	20,019	428,593

Assumptions 1 and 5

1. U.S. AIDS-susceptible 6.0%
5. Company AIDS-susceptible (pre-1/1/87) 2.4%

Assumptions 6–8

6. Antiselection termination factor 0.0
7. Antiselection at issue factor 1.5
8. Testing factor Z
   1/1/87–7/1/87 0.30
   after 7/1/87 0.50

Assumption 10

New issues are $10,000,000 in 1987 and increase by 5% per year. New issues for males 20–59 are 65% of total new issues.

TABLE 24

ESTIMATE OF COMPANY DEATH CLAIMS CAUSED BY AIDS ON 1987 AND LATER ISSUES
FOR AIDS-SUSCEPTIBLE HETEROSEXUAL MALES AND FEMALES AGES 20–59
(Dollar Amounts in Thousands)

Year	(1) Total New Issues during Year	(2) AIDS-Susceptible New Issues (1) × 0.85 × 0.024 × Assumption 7	(3) AIDS-Susceptible Not Tested (2) × (1 − Z)	(4) AIDS-Susceptible Not Tested (Beginning of Year) Prior Year of (7)	(5) AIDS-Susceptible Exposure (4) + [(3)/2]	(6) Terminations 0.0 × (5)	(7) AIDS-Susceptible End of Year (4) + (3) − (6) − (10)	(8) AIDS-Susceptible Infected (5) × (line 3, Table 14)	(9) Death Rate per Thousand (line 3, Table 20)	(10) AIDS Death Claims (Not Tested) (8) × (9)	(11) AIDS Death Claims (Tested Negative at Issue) from Table 26	(12) Total AIDS Death Claims (10) + (11)
1987	10,000,000	255,000	153,000	0	76,500	0	152,997	214	14.231	3	0	3
1988	10,500,000	267,800	133,900	152,997	219,947	0	286,883	880	15.597	14	0	14
1989	11,025,000	281,100	140,600	286,883	357,183	0	427,451	2,000	16.208	32	0	32
1990	11,576,250	295,200	147,600	427,451	501,251	0	574,987	4,010	15.899	64	2	66
1991	12,155,063	310,000	155,000	574,987	652,487	0	729,871	7,177	16.156	116	13	129
1992	12,762,816	325,500	162,800	729,871	811,271	0	892,469	12,169	16.581	202	45	247
1993	13,400,956	341,700	170,900	892,469	977,919	0	1,063,030	21,514	15.781	340	130	470
1994	14,071,004	358,800	179,400	1,063,030	1,152,730	0	1,241,871	35,735	15.646	559	287	846
1995	14,774,554	376,800	188,400	1,241,871	1,336,071	0	1,429,363	58,787	15.437	907	589	1,496
1996	15,513,282	395,600	197,800	1,429,363	1,528,263	0	1,625,704	94,752	15.401	1,459	1,072	2,532
1997	16,288,946	415,400	207,700	1,625,704	1,729,554	0	1,831,078	152,201	15.282	2,326	1,830	4,156
1998	17,103,394	436,100	218,100	1,831,078	1,940,128	0	2,045,499	242,516	15.171	3,679	2,909	6,588
1999	17,958,563	457,900	229,000	2,045,499	2,159,999	0	2,268,702	380,160	15.249	5,797	4,664	10,461
2000	18,856,491	480,800	240,400	2,268,702	2,388,902	0	2,500,009	597,225	15.225	9,093	7,512	16,605
										24,591	19,052	43,644

Assumptions 1 and 5

1. U.S. AIDS-susceptible 10%
5. Company AIDS-susceptible (pre-1/1/87) 20%

Assumptions 6–7

6. Antiselection termination factor 0.0
7. Antiselection at issue factor 1.5
8. Testing factor Z
   1/1/87–7/1/87 0.30
   after 7/1/87 0.50

Assumption 10

New issues are $10,000,000 in 1987 and increase 5% per year. New issues for males and females 20–59 are 85% of total new issues.

TABLE 25

AIDS CLAIMS ON THOSE WHO TESTED NEGATIVE AT ISSUE FOR AIDS-SUSCEPTIBLE HOMO-BISEXUAL MALES AGES 20–59
(Dollar Amounts in Thousands)

Year	(1) AIDS-Susceptible New Issues Tested (2) - (3) from Table 23	(2) Those from (1) Infected (Declined) (1) × (line 3, Table 13)	(3) Those from (1) Not Infected (1) − (2)	(4) AIDS-Susceptible Beginning of Year Prior Year of (7)	(5) AIDS-Susceptible Exposure (4) + (3)/2	(6) Terminations (Assumption 6) 0.0 × (5)	(7) AIDS-Susceptible End of Year (4) + (3) − (6) − (10)	(8) AIDS-Susceptible Infected during Year (5) × Assumption 2A	(9) Death Rate per Thousand line 3A, Table 19	(10) AIDS Death Claims (Tested Negative at Issue) (8) × (9)
1987	93,600	22,360	71,240	0	35,620	0	71,240	2,244	0.000	0
1988	122,800	37,638	85,162	71,240	113,822	0	156,392	11,268	1.000	11
1989	129,000	48,200	80,800	156,392	196,792	0	237,139	26,370	2.000	53
1990	135,400	58,902	76,498	237,139	275,388	0	313,485	44,337	3.428	152
1991	142,200	69,323	72,877	313,485	349,923	0	386,039	63,686	5.073	323
1992	149,300	79,030	70,270	386,039	421,173	0	455,726	81,286	7.171	583
1993	156,800	87,855	68,945	455,726	490,198	0	523,764	96,079	9.444	907
1994	164,600	95,657	68,943	523,764	558,235	0	591,429	107,739	11.852	1,277
1995	172,800	102,409	70,391	591,429	626,625	0	660,192	114,672	14.204	1,629
1996	181,500	108,040	73,460	660,192	696,922	0	731,670	116,386	17.026	1,982
1997	190,600	112,445	78,155	731,670	770,748	0	807,430	117,154	20.449	2,396
1998	200,100	116,996	83,104	807,430	848,982	0	887,629	118,008	24.614	2,905
1999	210,100	121,748	88,352	887,629	931,805	0	972,455	119,271	29.562	3,526
2000	220,600	126,692	93,908	972,455	1,019,409	0	1,062,087	121,310	35.253	4,277
										20,019

Assumption 2A

Infection Subsequent to Issue

1987	6.3%	1994	19.3%
1988	9.9%	1995	18.3%
1989	13.4%	1996	16.7%
1990	16.1%	1997	15.2%
1991	18.2%	1998	13.9%
1992	19.3%	1999	12.8%
1993	19.6%	2000	11.9%

where 1987 = 6.3 [1987 issues]
1988 = (0.5 × 13.0) [1987 issues]
+ (0.5 × 6.7) [1988 issues]
etc.

Assumption 6
Antiselection termination factor 0.0

TABLE 26

AIDS CLAIMS ON THOSE WHO TESTED NEGATIVE AT ISSUE
(Dollar Amounts in Thousands)

Year	(1) AIDS-Susceptible New Issues Tested (2) − (3) from Table 24	(2) Those from (1) Infected (Declined) (1) × (line 3, Table 14)	(3) Those from (1) Not Infected (1) − (2)	(4) AIDS-Susceptible Beginning of Year Prior Year of (7)	(5) AIDS-Susceptible Exposure (4) + (3)/2	(6) Terminations 0.0 × (5)	(7) AIDS-Susceptible End of Year (4) + (3) − (6) − (10)	(8) AIDS-Susceptible Infected during Year (5) × Assumption 2A	(9) Death Rate per Thousand (line 3A, Table 20)	(10) AIDS Death Claims (Tested Negative at Issue) (8) × (9)
1987	102,000	286	101,714	0	50,857	0	101,714	41	0.000	0
1988	133,900	536	133,364	101,714	168,397	0	235,079	269	0.000	0
1989	140,500	787	139,713	235,079	304,935	0	374,792	823	0.000	0
1990	147,600	1,181	146,419	374,792	448,002	0	521,209	1,971	0.937	$ 2
1991	155,000	1,705	153,295	521,209	597,857	0	674,491	3,886	3.317	13
1992	162,700	2,441	160,260	674,491	754,621	0	834,706	7,093	6.338	45
1993	170,800	3,758	167,042	834,706	918,227	0	1,001,618	13,865	9.412	130
1994	179,400	5,561	173,839	1,001,618	1,088,537	0	1,175,170	24,166	11.858	287
1995	188,400	8,290	180,110	1,175,170	1,265,225	0	1,354,692	41,373	14.231	589
1996	197,800	12,264	185,536	1,354,692	1,447,460	0	1,539,156	68,754	15.597	1,072
1997	207,700	18,278	189,422	1,539,156	1,633,867	0	1,726,748	112,900	16.208	1,830
1998	218,000	27,250	190,750	1,726,748	1,822,123	0	1,914,589	182,941	15.899	2,909
1999	228,900	40,286	188,614	1,914,589	2,008,896	0	2,098,539	288,678	16.156	4,664
2000	240,400	60,100	180,300	2,098,539	2,188,689	0	2,271,327	453,059	16.581	7,512
										$19,052

Assumption 2A

Infection Subsequent to Issue

1987	0.08%	1994	2.22%
1988	0.16%	1995	3.27%
1989	0.27%	1996	4.27%
1990	0.44%	1997	6.91%
1991	0.65%	1998	10.04%
1992	0.94%	1999	14.37%
1993	1.51%	2000	20.70%

where 1987 = 0.08 [1987 issues]
1988 = (0.5 × 0.2) [1987 issues]
+ (0.5 × 0.12) [1988 issues]
etc.

Assumption 6

Antiselection termination factor 0.0

TABLE 27

ESTIMATE OF TOTAL COMPANY DEATH CLAIMS AND RATIO OF AIDS TO TOTAL DEATH CLAIMS
(Dollar Amounts in Thousands)

Year	(1) In Force Beginning of Year	(2) Mid-Year In Force (Year i + year i + 1)/2	(3) Total Death Claims Excluding AIDS $q \times (2)$	(4) AIDS Death Claims on '86 and Prior Issues Col. (6) of Tables 21 and 22	(5) AIDS Death Claims on '87 and Later Issues Col. (12) of Tables 23 and 24	(6) Heterosexual AIDS Death Claims (4) + (5)	(7) Homo-Bisexual AIDS Death Claims (from Homo-Sexual Proj.)	(8) Contaminated-Blood AIDS Death Claims $0.05 \times (7)$	(9) Total AIDS Death Claims (6) + (7) + (8)	(10) Total Death Claims (3) + (9)	(11) Percentage of Heterosexual AIDS Death Claims to Total Death Claims (6)/(10)	(12) Percentage of Total AIDS Death Claims to Total Death Claims (9)/(10)
1987	$100,000,000	100,875,000	302,625	68	3	71	5,531	277	5,878	308,503	0.02%	1.9%
1988	101,750,000	102,790,625	308,372	106	14	120	9,176	459	9,755	318,126	0.04%	3.1%
1989	103,831,250	105,036,641	315,110	154	32	187	14,365	718	15,270	330,380	0.06%	4.6%
1990	106,242,031	107,611,971	322,836	216	66	282	21,471	1,074	22,826	345,662	0.08%	6.6%
1991	108,981,910	110,516,805	320,499	302	129	431	30,711	1,536	32,677	353,176	0.12%	9.3%
1992	112,051,700	113,752,563	329,882	423	247	669	42,083	2,104	44,856	374,739	0.2%	12.0%
1993	115,453,427	117,321,866	340,233	590	470	1,060	55,218	2,761	59,039	399,272	0.3%	14.8%
1994	119,190,304	121,228,507	351,563	824	846	1,669	69,301	3,465	74,435	425,998	0.4%	17.5%
1995	123,266,710	125,477,440	363,885	1,153	1,496	2,649	83,064	4,153	89,866	453,751	0.6%	19.8%
1996	127,688,170	130,074,757	364,209	1,620	2,532	4,151	95,244	4,762	104,157	468,367	0.9%	22.2%
1997	132,461,343	135,027,681	378,078	2,279	4,156	6,435	104,904	5,245	116,584	494,661	1.3%	23.6%
1998	137,594,018	140,344,562	392,965	3,209	6,588	9,797	111,390	5,570	126,757	519,721	1.9%	24.4%
1999	143,095,106	146,034,875	408,898	4,533	10,461	14,994	114,548	5,727	135,269	544,167	2.8%	24.9%
2000	148,974,644	152,109,222	425,906	6,412	16,605	23,017	114,634	5,732	143,383	569,288	4.0%	25.2%
	155,243,800											
						Cumulative						
1991			1,569,441	846	244	1,090	81,254	4,063	86,407	1,655,848	0.1%	5.2%
1996			3,319,214	5,455	5,834	11,289	426,164	21,308	458,761	3,777,975	0.3%	12.1%
2000			4,925,060	21,888	43,644	65,531	871,640	43,582	980,753	5,905,813	1.1%	16.6%

Assumption 9

Total in force as of 1/1/87 = $100,000,000

Assumption 10

New issues are $10,000,000 in 1987 and increase 5% per year.

Assumption 11

q = Total company death rate per thousand

3.0 for 1987–1990
2.9 for 1991–1995
2.8 for 1996–2000

Assumption 12

Persistency rates

In force	92.5%
New issues	92.5%

CHAPTER 5

PROJECTING AIDS MORTALITY FOR INDIVIDUAL ORDINARY LIFE INSURANCE IN FORCE

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I. INTRODUCTION

This research update presents the results of several projections using a model developed to estimate AIDS and AIDS-related mortality based on U.S. AIDS population statistics and current medical knowledge. The goal of the model is to present a simple, yet credible method that permits any company to project extra mortality due to AIDS claims. The model and assumptions used herein are presented so that the actuary may adjust any one or more of the basic input assumptions to arrive at his/her own projection of extra AIDS mortality.

For illustrative purposes and to show the sensitivity of results to selected assumptions, the model projects extra AIDS mortality under three scenarios (described more fully below). These are referred to as scenario I, scenario II, and scenario III.

The report includes a numerical example wherein specific adjustments are made to basic population data to better fine-tune results to reflect an insurance-oriented situation. From this example, the actuary should begin to appreciate the flexibility of the model and can further this appreciation and understanding by experimenting with the various input parameters. The Appendix contains a list of these parameters.

It should be noted at the outset that the use of the words "extra AIDS mortality" is more indicative of "premature" in the context of the model. For example, attempting to analyze true "extra" insured mortality requires an analysis that includes considering changes in anticipated persistency, term conversion rates, and application of guaranteed insurability features by insureds who select adversely against insurance companies. The model does not attempt to analyze such changes directly; it projects future AIDS and AIDS-related deaths and then suggests how companies might translate these population statistics into more useful and relevant insurance data based on their unique situations.

The discussion herein applies solely to the U.S. Further, we did not attempt to employ sophisticated modeling techniques because we felt that the

available data have many interpretations, and hence, many models might fit.

The model uses data on AIDS diagnoses, deaths, and mortality rates gleaned from information published weekly by the Centers for Disease Control (CDC) of the Public Health Service in Atlanta, Georgia. Unfortunately, such data are not reported in a format that is readily usable by actuaries, and we (and others) have necessarily had to make certain assumptions in order to use the CDC data for actuarial purposes.

II. DEFINITIONS

"Human Immunodeficiency Virus (HIV)" is the AIDS virus that attacks T-4 lymphocytes in the body, rendering it unable to combat even routine infections. It was originally designated Human T-Lymphotropic Virus, Type III (HTLV-III) in the U.S. and Lymphadenopathy-Associated Virus (LAV) in France.

"AIDS"—Acquired Immune Deficiency Syndrome—is the condition resulting from T-4 lymphocyte destruction by the HIV. Most individuals with the HIV do not immediately develop AIDS; rather there can be a fairly lengthy latent period. Whether all individuals infected with the HIV ultimately develop AIDS is still unknown at this time, but medical thinking is leaning more and more in that direction. Note that AIDS is not a disease like measles that has well-defined symptoms. Rather, it is a *condition* that allows disease-causing organisms to infect the body.

"Exposed population" (or "exposures") means a group of individuals infected with the HIV (also called HIV+, meaning HIV positive). So far it appears that once infected, one remains infected.

"Conversion" is the *process* of the HIV (in an infected population) actively destroying the T-4 cells, leading to a full-blown AIDS condition. Any disease-causing organism increases T-4 cell production. Thus, any subsequent infection may cause HIV-reproduction as well, speeding up the conversion process.

"Conversion rate" is the annual percentage of HIV+ individuals who convert to an AIDS condition in the years following infection (see Section IV, no. 5). The rate is applied on a select basis to the HIV+ individuals still living who have not yet been diagnosed as having AIDS.

"AIDS-related complex" (ARC) is now called "persistent generalized lymphadenopathy" (PGL), a condition of generally nonfatal illnesses (fever, diarrhea, etc.), which seems to precede AIDS.

"AIDS-related causes" are conditions that can cause death, but have not necessarily been defined as AIDS by the CDC. The model assumes that *all* HIV+ individuals who have not converted to AIDS are exposed to increased mortality risk, and the level of such increased risk varies by scenario. These conditions include brain disease and miscellaneous other conditions that were not initially recognized as AIDS-related because of a lack of knowledge about AIDS. Certain brain diseases have now been deemed diagnostic of AIDS by CDC; however, such conditions were not included in CDC AIDS statistics prior to 1987 unless an autopsy proved the presence of the HIV.

III. SUMMARY OF SCENARIOS

Table 1 summarizes the assumptions used in each of the three modeled scenarios.

Tables 2A, 2B, and 2C show the new annual HIV infections assumed to occur in each of the following three scenarios, respectively:

a. *Scenario I.* Annual historic and future infections are low because it is assumed that most infected persons eventually convert to AIDS. That is, observed AIDS deaths to date are not the tip of the iceberg, but rather a large portion of it. New annual HIV infections may have already peaked, and in the model these are further assumed to decline to zero over the next 20 years.

b. *Scenario II.* As with scenario I, the heterosexual component of HIV infections is assumed to not expand beyond current levels. In fact, because of widespread publicity and increasing safety precautions, new infections are also assumed to ultimately diminish to zero, although not as fast as in scenario I. Scenario II might also be representative of the future spread of AIDS if a means of inoculative prevention (*not* a cure) is found in the near future. Scenario II most closely reproduces CDC data to date.

c. *Scenario III.* The heterosexual component of HIV infections will continue to grow, but not at the exponential rate experienced by homosexual males in the last 10 years. Current (and future) educational efforts will slow the rate of HIV spread experienced to date, but not stop it. This scenario assumes a peak of 2,000,000 new annual infections from 1992 to 1996, with diminishing new annual infections after that, ultimately reaching zero by 2040.

IV. MODEL ASSUMPTIONS

1. Current HIV Infections

Unfortunately for statistical and medical purposes, there are no national registers of individuals with HIV infection. The model's estimates of infected individuals reflect those in the press, tempered by estimated incidence rate

TABLE 1

SUMMARY OF MODEL ASSUMPTIONS

Assumption*	Scenario I	Scenario II	Scenario III
	Scenario		
Heterosexuals will become infected	No	Not generally	Yes
Cumulative HIV infections			
1986	813,000	1,245,000	2,033,000
2006	1,848,000	3,653,000	33,883,000
Conversion pattern to AIDS of HIV-infected lives by year since infection†			
1	1.5 %	1.0%	0.6%
2	2.25	1.5	0.9
3	3.0	2.0	1.2
4	3.75	2.5	1.5
5	4.5	3.0	1.8
6	6.0	4.0	2.4
7	7.5	5.0	3.0
8	9.0	6.0	3.6
9	10.5	7.0	4.2
10	12.0	8.0	4.8
11	13.5	9.0	5.4
12	15.0	10.0	6.0
13	16.5	11.0	6.6
14	18.0	12.0	7.2
15	19.5	13.0	7.8
16	21.0	14.0	8.4
17+	22.5	15.0	9.0
Mortality in the model of HIV-infected individuals dying annually from other AIDS-related causes (percentage of standard population mortaltiy)‡	100%	300%	700%
Annual AIDS death rate by year since diagnosis of AIDS (all scenarios)		Year	Rate
		1	45%
		2	45
		3	29
		4+	21
Standard population mortality (all scenarios) 85% of 1965–80 Male, Ultimate Table, age last birthday			

*See Model Assumptions and Summary of Scenarios sections for a more detailed explanation of this table.

†Medical studies initially indicated total conversion to AIDS within 9 years, with a median time of 5 years. This time frame is now expanding as studies of longer durations become available. The conversion rate also appears to be flatter than originally envisioned.

‡These multiples are illustrative only.

TABLE 2A

NEW ANNUAL HIV INFECTIONS ACCORDING TO SCENARIO I

Year	New Annual Exposures	Conversions to AIDS		AIDS Deaths		AIDS-Related Deaths		Other Deaths		HIV+ Still Living and Not Yet Converted to AIDS
		Yearly	Cumulative	Yearly	Cumulative	Yearly	Cumulative	Yearly	Cumulative	
1976	200	0	0	0	0	0	0	0	0	200
1977	500	3	3	1	1	0	0	0	0	697
1978	667	12	15	4	4	1	1	1	1	1,350
1979	2,000	27	42	11	15	2	2	2	2	3,320
1980	10,000	66	108	26	42	4	6	4	6	13,247
1981	50,000	239	347	82	124	14	20	14	20	62,981
1982	100,000	1,082	1,429	340	464	65	85	65	85	161,768
1983	116,667	3,027	4,456	1,104	1,568	169	254	169	254	275,070
1984	150,000	5,905	10,361	2,585	4,154	293	546	293	546	418,581
1985	183,333	10,036	20,396	4,909	9,063	454	1,000	454	1,000	590,972
1986	200,000	15,628	36,025	8,261	17,324	654	1,653	654	1,653	774,037
1987	175,000	22,807	58,832	12,821	30,145	876	2,529	876	2,529	924,478
1988	150,000	31,185	90,017	18,625	48,770	1,079	3,608	1,079	3,608	1,041,134
1989	125,000	40,400	130,417	25,523	74,292	1,263	4,871	1,263	4,871	1,123,210
1990	100,000	50,154	180,571	33,297	107,589	1,423	6,294	1,423	6,294	1,170,210
1991	90,000	60,110	240,680	41,712	149,301	1,559	7,852	1,559	7,852	1,196,983
1992	80,000	70,023	310,703	50,531	199,832	1,682	9,534	1,682	9,534	1,203,596
1993	70,000	79,274	389,977	59,445	259,277	1,789	11,323	1,789	11,323	1,190,744
1994	60,000	87,320	477,297	68,035	327,312	1,877	13,200	1,877	13,200	1,159,670
1995	50,000	93,716	571,013	75,863	403,175	1,941	15,141	1,941	15,141	1,112,072
1996	40,000	98,140	669,154	82,538	485,713	1,979	17,120	1,979	17,120	1,049,973
1997	30,000	100,490	769,644	87,763	573,476	1,988	19,108	1,988	19,108	975,506
1998	20,000	100,762	870,406	91,357	664,832	1,967	21,075	1,967	21,075	890,811
1999	15,000	98,993	969,399	93,221	758,054	1,915	22,990	1,915	22,990	802,987
2000	10,000	95,401	1,064,800	93,346	851,400	1,840	24,830	1,840	24,830	713,906
2001	8,000	90,311	1,155,111	91,829	943,229	1,744	26,574	1,744	26,574	628,108
2002	6,000	84,064	1,239,175	88,856	1,032,085	1,634	28,207	1,634	28,207	546,778
2003	4,000	76,979	1,316,154	84,653	1,116,738	1,513	29,720	1,513	29,720	470,773
2004	2,000	69,300	1,385,544	79,466	1,196,204	1,387	31,107	1,387	31,107	400,609
2005	0	61,683	1,447,226	73,576	1,269,780	1,259	32,366	1,259	32,366	336,409
2006	0	54,125	1,501,352	67,266	1,337,045	1,132	33,498	1,132	33,498	280,020
Total	1,848,367									

Conversion Rates (in %): 1.5, 2.25, 3, 3.75, 4.5, 6, 7.5, 9, 10.5, 12, 13.5, 15, 16.5, 18, 19.5, 21, 22.5 thereafter.
Yearly AIDS-related deaths are 1 times the assumed population mortality.

TABLE 2B

NEW ANNUAL HIV INFECTIONS ACCORDING TO SCENARIO II

Year	New Annual Exposures	Conversions to AIDS		AIDS Deaths		AIDS-Related Deaths		Other Deaths		HIV + Still Living and Not Yet Converted to AIDS
		Yearly	Cumulative	Yearly	Cumulative	Yearly	Cumulative	Yearly	Cumulative	
1976	300	0	0	0	0	0	0	0	0	300
1977	750	3	3	1	1	1	1	0	0	1,046
1978	1,000	12	15	4	5	3	4	1	1	2,030
1979	3,000	27	42	11	16	7	11	2	4	4,994
1980	15,000	66	108	27	43	16	27	5	9	19,907
1981	75,000	240	348	82	125	62	89	21	30	94,586
1982	150,000	1,085	1,433	341	466	293	382	98	127	243,114
1983	175,000	3,037	4,470	1,108	1,574	761	1,143	254	381	414,075
1984	225,000	5,936	10,406	2,596	4,170	1,320	2,463	440	821	631,404
1985	275,000	10,119	20,525	4,941	9,111	2,053	4,516	684	1,505	893,592
1986	325,000	15,817	36,342	8,338	17,449	2,966	7,482	989	2,494	1,198,889
1987	300,000	23,447	59,789	13,047	30,496	4,067	11,549	1,356	3,850	1,470,125
1988	275,000	32,679	92,468	19,223	49,719	5,135	16,684	1,712	5,561	1,705,752
1989	250,000	43,275	135,743	26,815	76,534	6,171	22,855	2,057	7,618	1,904,456
1990	225,000	55,066	190,809	35,709	112,243	7,172	30,027	2,391	10,009	2,065,098
1991	200,000	67,837	258,646	45,779	158,022	8,137	38,164	2,712	12,721	2,186,758
1992	180,000	81,333	339,979	56,873	214,895	9,055	47,219	3,018	15,740	2,273,779
1993	160,000	94,984	434,963	68,731	283,626	9,932	57,151	3,311	19,050	2,326,066
1994	140,000	108,215	543,178	80,969	364,595	10,752	67,903	3,584	22,634	2,344,114
1995	120,000	120,493	663,671	93,143	457,738	11,498	79,401	3,833	26,467	2,328,973
1996	100,000	131,347	795,018	104,811	562,549	12,148	91,549	4,049	30,516	2,282,180
1997	90,000	140,378	935,396	115,554	678,103	12,682	104,231	4,227	34,744	2,215,698
1998	80,000	147,374	1,082,770	125,017	803,120	13,111	117,342	4,370	39,114	2,131,682
1999	70,000	152,065	1,234,835	132,905	936,025	13,419	130,761	4,473	43,587	2,032,573
2000	60,000	154,294	1,389,129	138,959	1,074,984	13,598	144,359	4,533	48,120	1,920,978
2001	50,000	154,167	1,543,296	143,016	1,218,000	13,643	158,002	4,548	52,667	1,799,406
2002	40,000	151,782	1,695,078	145,028	1,363,028	13,557	171,559	4,519	57,186	1,670,265
2003	30,000	147,359	1,842,437	145,025	1,508,053	13,348	184,907	4,449	61,636	1,535,738
2004	20,000	141,158	1,983,595	143,109	1,651,162	13,025	197,932	4,342	65,977	1,397,738
2005	10,000	133,635	2,117,230	139,479	1,790,641	12,605	210,537	4,202	70,179	1,257,708
2006	8,000	125,165	2,242,395	134,409	1,925,050	12,098	222,635	4,033	74,212	1,114,847
Total	3,653,050									

Conversion Rates (in %): 1, 1.5, 2, 2.5, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 thereafter.
Yearly AIDS-related deaths are 3 times the assumed population mortality.

TABLE 2C

NEW ANNUAL HIV INFECTIONS ACCORDING TO SCENARIO III

Year	New Annual Exposures	Conversions to AIDS		AIDS Deaths		AIDS-Related Deaths		Other Deaths		HIV+ Still Living and Not Yet Converted to AIDS
		Yearly	Cumulative	Yearly	Cumulative	Yearly	Cumulative	Yearly	Cumulative	
1976	500	0	0	0	0	0	0	0	0	500
1977	1,250	3	3	1	1	4	4	1	1	1,743
1978	1,667	12	15	4	4	12	16	2	2	3,383
1979	5,000	27	42	11	15	25	40	4	6	8,328
1980	25,000	66	108	27	42	61	102	9	15	33,191
1981	125,000	240	348	83	124	242	344	35	49	157,675
1982	250,000	1,085	1,433	341	466	1,142	1,486	163	212	405,285
1983	291,667	3,038	4,472	1,108	1,574	2,961	4,447	423	635	690,529
1984	375,000	5,943	10,415	2,599	4,172	5,138	9,585	734	1,369	1,053,714
1985	458,333	10,143	20,558	4,949	9,121	7,997	17,581	1,142	2,512	1,492,766
1986	500,000	15,883	36,441	8,363	17,484	11,568	29,149	1,653	4,164	1,963,663
1987	750,000	23,351	59,793	13,053	30,538	15,587	44,736	2,227	6,391	2,672,498
1988	1,000,000	34,138	93,931	19,531	50,069	21,582	66,318	3,083	9,474	3,613,695
1989	1,250,000	48,902	142,832	28,579	78,648	29,626	95,944	4,232	13,706	4,780,936
1990	1,500,000	68,348	211,180	40,901	119,550	39,802	135,746	5,686	19,392	6,167,100
1991	1,750,000	93,100	304,279	57,135	176,684	52,217	187,963	7,460	26,852	7,764,323
1992	2,000,000	123,582	427,861	77,847	254,531	66,966	254,930	9,567	36,419	9,564,209
1993	2,000,000	160,698	588,559	103,641	358,172	84,141	339,070	12,020	48,439	11,307,349
1994	2,000,000	203,720	792,279	134,886	493,058	102,065	441,136	14,581	63,019	12,986,983
1995	2,000,000	252,553	1,044,832	171,598	664,657	120,777	561,913	17,254	80,273	14,596,399
1996	2,000,000	306,985	1,351,817	213,738	878,395	140,293	702,206	20,042	100,315	16,129,079
1997	1,920,000	366,681	1,718,498	261,210	1,139,605	160,605	862,811	22,944	123,259	17,498,848
1998	1,840,000	430,685	2,149,183	313,706	1,453,311	181,110	1,043,921	25,873	149,132	18,701,180
1999	1,760,000	497,368	2,646,551	370,501	1,823,812	201,734	1,245,655	28,819	177,951	19,733,258
2000	1,680,000	565,110	3,211,661	430,509	2,254,321	222,345	1,468,001	31,764	209,714	20,594,040
2001	1,600,000	632,554	3,844,215	492,532	2,746,853	242,786	1,710,787	34,684	244,398	21,284,016
2002	1,520,000	698,320	4,542,535	555,376	3,302,229	262,853	1,973,640	37,550	281,949	21,805,293
2003	1,440,000	760,924	5,303,459	617,800	3,920,029	282,308	2,255,948	40,330	322,278	22,161,731
2004	1,360,000	819,124	6,122,583	678,548	4,598,577	300,896	2,556,844	42,985	365,263	22,358,726
2005	1,280,000	871,408	6,993,991	736,343	5,334,920	318,350	2,875,193	45,479	410,742	22,403,490
2006	1,200,000	916,586	7,910,578	789,900	6,124,820	334,424	3,209,617	47,775	458,517	22,304,705
Total	33,883,417									

Conversion Rates (*in %*): 0.6, 0.9, 1.2, 1.5, 1.8, 2.4, 3, 3.6, 4.2, 4.8, 5.4, 6, 6.6, 7.2, 7.8, 8.4, 9 thereafter.
Yearly AIDS-related deaths are 7 times the assumed population mortality.

by group (homosexuals, etc.), and all assumptions produce results that closely match historical CDC AIDS diagnoses and deaths through July 1987. For example, the last column of Table 3 is the model's estimate of the current and future annual HIV infections for scenario II over the next 20 years. This scenario assumes that widespread AIDS publicity and the increasing saturation of certain high-risk groups have caused the number of new HIV infections to decline beginning in 1987, with the decline continuing in subsequent years, ultimately reaching zero new infections by the year 2012.

2. Current Infected Population Groups

The CDC inventory of diagnosed AIDS cases can provide an estimate of current infection if all infected population groups (i) follow the same conversion path to full-blown AIDS and (ii) are correctly labeled as such by CDC. That is, the already-*infected* group totals are assumed to be proportional to the CDC AIDS *diagnosed* totals through 1986. For example, since about 72 percent of diagnosed AIDS cases are homosexual or bisexual males, the model assumes 72 percent of HIV infections are homosexual or bisexual as well.

This assumption is certainly open to some debate since CDC experiences varying lag times in collecting and assimilating data from many parts of the country. Also, percentages can (and do) change as figures are updated because of the manner and format in which they are reported. Further, it can be argued that different risk categories might have varying conversion patterns due to duplicity of factors that make some groups more susceptible than others. These arguments are potentially valid. Nevertheless, this assumption eliminates the need to project conversion and diagnosis patterns by risk group.

Table 3 also shows estimated future annual infections for other various risk groupings.

3. Future Infected Population

Scenarios I and II assume the heterosexual population will generally not become infected. This follows from the assumption that "straight" sex between males and females is not a major method of transmission. The medical argument for this presumes that the HIV primarily enters the body through lesions in the skin (blood) or by penetrating thin membranes, such as in the rectum. IV drug abusers, transfusions, and hemophiliac CDC categories are blood-related transmission categories. Isolated examples of health-worker

TABLE 3

ESTIMATE OF ANNUAL NUMBER OF HIV INFECTIONS
SCENARIO II*

Year	(1) Homosexual/ Bisexual Males (72%)	(2) IV Drug Abusers (17%)	(3) Female Partners (3%)	(4) Blood Recipients/ Hemophiliacs (3%)	(5) Other (5%)	Total
1976						300
1977						750
1978						1,000
1979						3,000
1980						15,000
1981						75,000
1982						150,000
1976–1982†	176,450	41,650	7,350	7,350	12,250	245,050
1983	126,000	29,750	5,250	5,250	8,750	175,000
1984	162,000	38,250	6,750	6,750	11,250	225,000
1985	198,000	46,750	8,250	8,250	13,750	275,000
1986	234,000	55,250	9,750	9,750	16,250	325,000
1987	216,000	51,000	9,000	9,000	15,000	300,000
1988	198,000	46,750	8,250	8,250	13,750	275,000
1989	180,000	42,500	7,500	7,500	12,500	250,000
1990	162,000	38,250	6,750	6,750	11,250	225,000
1991	144,000	34,000	6,000	6,000	10,000	200,000
1992	130,000	30,600	5,400	5,400	9,000	180,000
1993	115,000	27,200	4,800	4,800	8,000	160,000
.	.	.	.	.	.	.
.	.	.	.	.	.	.
2006	6,000	5,760	240	240	400	8,000
Total infections through 2006	2,630,000	621,000	110,000	110,000	182,000	3,653,050
Assumed 1986 population	4,000,000	750,000				240,000,000
Percentage of assumed 1986 population infected by 2006	66%	83%				1.5%

(1) CDC categories "homosexual" and "homosexual/IV drug abuser "
(2) CDC category "IV drug abuser."
(3) CDC female category "heterosexual" and "undetermined."
(4) CDC "transfusion" and "hemophiliac"—includes children.
(5) All others (male heterosexual, male/children undetermined, children with parents at risk of AIDS).

*See Summary of Scenarios and Model Assumptions sections.
†Because the early numbers are so small, years 1976–1982 are not broken down by group. Since the disease may not necessarily follow parallel infection curves, credible extrapolation back to 1976 is difficult.

HIV infection through skin breaks (dermatitis, open sores) are also in this category. Homosexual males are undoubtedly susceptible to transmission through thin rectal membranes; medical studies seem to indicate that heterosexuals are much less efficient at transmitting the HIV.

4. Ultimate Level of AIDS Conversions

Again, medical science provides no single answer, and unfortunately, it may be many years before the correct answer is known with any certainty. In 1984, it was commonly estimated that 2–20 percent of HIV-infected individuals would ultimately develop AIDS. More recent estimates are much higher.

The model uses a higher conversion pattern for scenario I than for scenarios II or III, but applies it to a lower estimated HIV-infected pool. This was done to illustrate the fact that a low number of HIV infections combined with a high conversion rate can match the CDC AIDS statistics just as well as having more infections and a lower conversion rate.

5. Pattern of Conversion to AIDS

The model assumes the following patterns of AIDS conversion over the first 17 years following infection by the HIV:

CONVERSION TO AIDS
(by year since infection)

Year Following Infection by the HIV	Percentage of Infected Individuals Remaining Alive Who Subsequently Convert to AIDS Each Year		
	Scenario I	Scenario II	Scenario III
1	1.50%	1.0%	0.6%
2	2.25	1.5	0.9
3	3.00	2.0	1.2
4	3.75	2.5	1.5
5	4.50	3.0	1.8
6	6.00	4.0	2.4
7	7.50	5.0	3.0
8	9.00	6.0	3.6
9	10.50	7.0	4.2
10	12.00	8.0	4.8
11	13.50	9.0	5.4
12	15.00	10.0	6.0
13	16.50	11.0	6.6
14	18.00	12.0	7.2
15	19.50	13.0	7.8
16	21.00	14.0	8.4
17+	22.50	15.0	9.0

Early medical studies indicated a variety of conversion patterns over the first 10 years following infection. Current studies seem to suggest a lengthening of the conversion period and a flattening of the conversion rate. The above patterns are based on these studies. Since these are input parameters to the model, they can be varied as desired.

6. AIDS Annual Death Rate

CDC data to date indicate that 20–45 percent of AIDS-diagnosed cases die each year. A difficulty with determining a pattern of true death rates is that one must first know when conversion from initial infection to a full-blown AIDS condition occurs. This is seldom known with any great precision because it depends, in part, on when a person is diagnosed as having an AIDS condition, and there can be, and are, some significant time lags in seeking medical diagnosis. CDC registers an AIDS case as soon as it is reported (sometimes not until after death) and records the date of conversion to AIDS; however, CDC must oftentimes try to reconstruct when conversion to AIDS actually occurred. The death rate appears to start at 40–50 percent in the first year or two after conversion and declines somewhat thereafter. The model uses a mortality rate pattern of 45 percent in each of the first two years after conversion, 29 percent in year 3, and 21 percent thereafter (years 4+). This, too, is a variable input parameter.

7. Other Deaths

The HIV also infects the brain. Initially CDC did not include brain disease as conclusive evidence of AIDS (they now do). The model includes AIDS-related deaths to add conservatism, since other deaths currently not regarded as AIDS-related may in fact be due to AIDS. Some AIDS deaths have also been purposely misreported so as not to "hurt" family or friends.

Each scenario assumes that AIDS-related deaths are a certain multiple of standard population mortality. This is not a forecast. This parameter is included in the model for both illustrative purposes and conservatism. Nevertheless, such a parameter does improve the flexibility of the model.

The model assumes standard population mortality is equal to 85 percent of the 1975–80 Modified Basic Ultimate Mortality Table for males, age last birthday. This is another variable input parameter. (See Table 1 for the multiple of this table used in the various scenarios for AIDS-related deaths.)

V. LIMITATIONS OF THE ASSUMPTIONS

There is little long-term experience measuring AIDS mortality to date. Although assumptions used in the model reasonably reproduce current statistics, existing data are still rather scanty and subject to change, such as when different definitions are used, or when definitions change. Medical knowledge on AIDS is still at such an elementary level that projections of future deaths based on extrapolations of past experience cannot be made with a high degree of statistical confidence (at least not compared to traditional actuarial mortality projections). The following questions and comments illustrate some of the difficulties in projecting the HIV populations and subsequent death rates:

1. How many individuals are now HIV+ (often estimated between 1 and 2 million)? Techniques used to determine positive infection vary in degree of certainty, and obviously, not everyone in the U.S. has been tested.
2. What percentage of persons infected with the HIV will actually convert to AIDS? Early estimates of ultimate conversion to AIDS varied from 2 percent to 20 percent or more of the HIV infection pool. The Surgeon General, however, recently suggested that 100% of all HIV-infected individuals may eventually progress to more serious stages of the disease and die prematurely of AIDS or other opportunistic infections.
3. The "experts" can be completely wrong about the total infected pool, the ultimate AIDS conversion rate, and the pattern of conversion to AIDS, and yet their calculations can still match the observed AIDS cases to date. Credible projections of future deaths depend upon refining the accuracy of each of these variables. We are, in effect, trying to solve a single equation with at least three unknown variables.
4. What happens to infected persons who do not develop AIDS in the first few years following infection to the virus? Many could die or be handicapped by progressive brain disease. But how fast? And what proportion? Will other abnormalities manifest themselves later that we are not even aware of now?
5. Can "straight" sex transmit the virus among heterosexuals? Similar to hepatitis B, there is a medical question as to whether bleeding or skin breaks must occur to allow viral entry. This question is extremely important in projecting the ultimate spread of the HIV, especially into the heterosexual community. If one concludes that bleeding is necessary and that vaginal sex does not spread the disease (or at least not very efficiently), then HIV infection in the heterosexual population will not expand as rapidly as it has in the homosexual population.
6. When (if ever) will preventive vaccines be developed? This may not help the current HIV-infected groups, but it could limit or even eliminate future infections in all other groups.
7. The impact of widespread educational efforts and subsequent changes in sexual practices and IV-drug abuse could materially decelerate the spread of the HIV virus.

8. Can the HIV be aspirated like tuberculosis? If so, is it contagious? Current studies indicate the virus must penetrate the skin, so it would probably not be contagious. However, could it somehow be absorbed in the mouth or other soft tissues?

VI. VALIDATION OF RESULTS OF THE MODEL

The previous section listed some of the limitations in determining the true path of the spread of the HIV and AIDS. Table 4 shows how the scenario II projections compare to current CDC figures. It is important to note that diagnoses may be reported to CDC many months after real diagnosis, although reported deaths usually are only several weeks late. In fact, in many cases CDC first learns of an AIDS diagnosis *after* a death is reported.

TABLE 4

CUMULATIVE CONFIRMED AND PROJECTED AIDS CASES
AS OF JULY 27, 1987

	Diagnoses		Deaths		
				M&R Model	
Year	CDC*	M&R Model†	CDC*	AIDS Deaths‡	AIDS-Related Deaths§
1979	—		—		
1980	75	108	63	43	27
1981	342	348	N/A	125	89
1982	1,353	1,433	317	466	382
1983	4,159	4,470	1,292	1,574	1,143
1984	9,782	10,406	3,665	4,170	2,463
1985	19,557	20,525	8,161	9,111	4,516
1986	33,254	36,342	16,481	17,449	7,482
1987	39,263‖	59,789	22,548‖	30,496	11,549

*CDC-defined AIDS diagnoses as of July 27, 1987. Note that CDC retroactively increases previous years' diagnoses as new diagnoses are reported (which often is not until deaths are reported). For example, the 1982 diagnoses increased by 7 during 1986 and by 12 so far in 1987. The CDC *deaths* listed above, however, are taken from the CDC year-end reports and are not subsequently adjusted for deaths reported to the CDC in following years.
†Projection based on scenario II assumptions (complete years).
‡The model assumes mortality rates for AIDS victims are 45%, 45%, 29%, and 21% thereafter for select years after diagnosis of AIDS.
§Assumes mortality rates for other AIDS-related deaths are equal to three times standard population mortality rates.
‖Through 7/27/87.

Scenario II tracks historical CDC data fairly well, particularly if one assumes an underreporting of current diagnoses of about 20–25 percent because of time lag. It is also important to note that historical CDC figures can change as additional data are received. For example, published data on prior

years' diagnoses can and do increase because diagnoses are reported by year of diagnosis, not year of reporting.

VII. PROJECTING AIDS MORTALITY

The model projects three scenarios of future annual incidence of HIV infection in the general population and subsequent annual deaths from AIDS and other AIDS-related causes (Tables 2A, 2B, and 2C). The resulting general population AIDS mortality rates per 100,000 U.S. lives as of year-end 1986, shown in Tables 5A, 5B, and 5C, can be further adjusted to be more representative of the AIDS risk inherent in a company's in-force file as of 1986.

TABLE 5A

AIDS AND AIDS-RELATED DEATHS FOR SCENARIO I

Year	Initial Population	Yearly Deaths		AIDS Only Deaths per 100,000 of Initial Population	AIDS and AIDS-Related Deaths per 100,000 of Inital Population
		AIDS	AIDS-Related*		
1986	240,000,000				
1987		12,821	876	5.34	5.71
1988		18,625	1,079	7.76	8.21
1989		25,523	1,263	10.63	11.16
1990		33,297	1,423	13.87	14.47
1991		41,712	1,559	17.38	18.03
1992		50,531	1,682	21.05	21.76
1993		59,445	1,789	24.77	25.51
1994		68,035	1,877	28.35	29.13
1995		75,863	1,941	31.61	32.42
1996		82,538	1,979	34.39	35.22
1997		87,763	1,988	36.57	37.40
1998		91,357	1,967	38.07	38.89
1999		93,221	1,915	38.84	39.64
2000		93,346	1,840	38.89	39.66
2001		91,829	1,744	38.26	38.99
2002		88,856	1,634	37.02	37.70
2003		84,653	1,513	35.27	35.90
2004		79,466	1,387	33.11	33.69
2005		73,576	1,259	30.66	31.18
2006		67,266	1,132	28.03	28.50

*This column is illustrative only; for this scenario the assumed AIDS-related mortality is 1 times standard population mortality.

TABLE 5B

AIDS AND AIDS-RELATED DEATHS FOR SCENARIO II

Year	Initial Population	Yearly Deaths		AIDS Only Deaths per 100,000 of Initial Population	AIDS and AIDS-Related Deaths per 100,000 of Initial Population
		AIDS	AIDS-Related*		
1986	240,000,000				
1987		13,047	4,067	5.44	7.13
1988		19,223	5,135	8.01	10.15
1989		26,815	6,171	11.17	13.74
1990		35,709	7,172	14.88	17.87
1991		45,779	8,137	19.07	22.46
1992		56,873	9,055	23.70	27.47
1993		68,731	9,932	28.64	32.78
1994		80,969	10,752	33.74	38.22
1995		93,143	11,498	38.81	43.60
1996		104,811	12,148	43.67	48.73
1997		115,554	12,682	48.15	53.43
1998		125,017	13,111	52.09	57.55
1999		132,905	13,419	55.38	60.97
2000		138,959	13,598	57.90	63.57
2001		143,016	13,643	59.59	65.27
2002		145,028	13,557	60.43	66.08
2003		145,025	13,348	60.43	65.99
2004		143,109	13,025	59.63	65.06
2005		139,479	12,605	58.12	63.37
2006		134,409	12,098	56.00	61.04

*This column is illustrative only; for this scenario the assumed AIDS-related mortality is 3 times standard population mortality.

The following section highlights examples of such adjustments. Although we personally believe that scenario II is reasonable in light of current statistics and medical thinking, scenarios I and III are included to show the sensitivity of mortality to differences in underlying assumptions.

VIII. INDIVIDUAL COMPANY ADJUSTMENTS

Tables 5A, 5B, and 5C illustrate future AIDS death rates per 100,000 U.S. lives as of December 31, 1986 for each scenario. For example, the projected number of AIDS and AIDS-related deaths in 1987 using scenario II assumptions is estimated to be 13,047 and 4,067, respectively (Table 5B). As a ratio to a total population of 240 million, this is 7.13 deaths per 100,000 lives. However, the Table 5B death rates are probably not directly applicable to an insurance company's in force because that would presume the company insures a "uniform slice" of the U.S. population (i.e., the company in force has the same proportion of current and future infected individuals as observed or estimated in the entire country). Instead, there are a number of adjustments

TABLE 5C

AIDS AND AIDS-RELATED DEATHS FOR SCENARIO III

Year	Initial Population	Yearly Deaths		AIDS Only Deaths per 100,000 of Initial Population	AIDS and AIDS-Related Deaths per 100,000 of Initial Population
		AIDS	AIDS-Related*		
1986	240,000,000				
1987		13,053	15,587	5.44	11.93
1988		19,531	21,582	8.14	17.13
1989		28,579	29,626	11.91	24.25
1990		40,901	39,802	17.04	33.63
1991		57,135	52,217	23.81	45.56
1992		77,847	66,966	32.44	60.34
1993		103,641	84,141	43.18	78.24
1994		134,886	102,065	56.20	98.73
1995		171,598	120,777	71.50	121.82
1996		213,738	140,293	89.06	147.51
1997		261,210	160,605	108.84	175.76
1998		313,706	181,110	130.71	206.17
1999		370,501	201,734	154.38	238.43
2000		430,509	222,345	179.38	272.02
2001		492,532	242,786	205.22	306.38
2002		555,376	262,852	231.41	340.93
2003		617,800	282,308	257.42	375.05
2004		678,548	300,896	282.73	408.10
2005		736,343	318,350	306.81	439.46
2006		789,900	334,424	329.13	468.47

*This column is illustrative only; for this scenario the assumed AIDS-related mortality is 7 times standard population mortality.

that companies might consider making to transform this population-oriented mortality into insurance-oriented mortality.

Some of the possible adjustments are as follows:

1. Adjust Death Rates by Age

AIDS is primarily a disease of people aged 20–50 (see table below for actual age distribution). The heavily infected groups (such as IV drug abusers, active homosexuals, etc.) are, not coincidentally, also mostly aged 20–50. Because of resulting high mortality, most infected persons will not survive another 20 years. Thus, an attained-age breakdown of a company's in force is desirable so that a weighted average age factor can be developed and applied to this in force.

We suggest that the factors below be considered to adjust the AIDS population death rates if the in force can be grouped by attained age:

Ages	CDC AIDS Distribution*	U.S. Population Distribution (1984)	Factor†
0–19	1.8%	30%	0.060
20–29	20.9	18	1.161
30–39	46.6	15	3.107
40–49	20.7	11	1.882
50–59	9.9	9	1.100
60+	0.0 (assumed)	17	0.000
	100.0%	100.0%	

*Diagnosed as of 7/27/87.
†(CDC percentage) ÷ (U.S. population distribution).

The example in the next section illustrates this adjustment for a single age for each of the two plans highlighted in the example.

2. Adjust Death Rates by Sex

Females are only 7 percent of the current HIV-infected population. Making the simplistic assumption that the female age distribution is identical to that of males, the factors required to adjust the Table 5 death rates by sex are approximately:

$$\text{Male:} \quad 93\% \div 50\% = 1.86$$
$$\text{Female:} \quad 7\% \div 50\% = 0.14$$

Thus, to estimate death rates for an in-force file consisting of 80 percent males and 20 percent females, Table 5 rates would need to be multiplied by 1.52 (equals 0.8×1.86 plus 0.2×0.14).

3. Adjust Death Rates for Infected Populations Not Insured

Most companies have never intentionally marketed to chronic IV drug abusers, nor would significant numbers of IV drug abusers probably have applied for insurance in the past. Further, many companies market only in geographic areas where there appears to be a low HIV incidence (e.g., rural communities). These types of adjustments are admittedly subjective, but an attempt should be made to estimate the impact of such factors. The following should, therefore, only be considered as rough guidelines:

- Business issued prior to 1984. The general public did not really understand the AIDS threat before 1984, and willful adverse-selection by new applicants was probably minimal. Adjusting population experience by, say, 50 percent would appear to be reasonable for pre-1984 issues to reflect the reduced anticipated insurance risk versus the general population risk. Tables 5A–5C should be adjusted to reflect the potential number of AIDS victims that would actually be part of an in-force file (as opposed to the general population), and in the example below, a

rate of 50 percent was used for pre-1984 business issued. The intention, of course, is to exclude IV drug abusers and other largely high-risk noninsured groups from the company's pre-1984 in force.

- Issues of 1984 and later. The following are some of the factors that companies are exploring to help reduce their potential exposure to the AIDS risk:
  - Required blood tests on medically underwritten policies.
  - Reduction in nonmedical limits.
  - The proportion of high net-amount-at-risk products being offered in the portfolio.
  - The proportion of direct-marketed products (especially guaranteed-issue products) being offered in the portfolio, and the age distribution of the target market.

  If a company feels it has minimized the recent-issue adverse-selection risks, the same adjustment factors used for pre-1984 issues might be used here also. If not, higher factors are called for. For example, a direct response or simplified issue product may need an adjustment of about 1.50 or more to reflect little or no underwriting on applications solicited via such distribution methods.

  Of course, if a company believes it is getting more than its proportionate share of HIV+ individuals (between 1–2 percent of recent applications are reported to be HIV+), then a more substantial adjustment factor should be used (e.g., 2.00 or higher).
- Geographic issues. Companies with heavy concentrations of in-force business in high-risk areas should use adjustment factors greater than 1.0 to assist them in projecting future AIDS claims. Areas identified by the CDC as high-risk areas are California, Texas, New York, New Jersey, and Florida. Companies with an in-force distribution that roughly mirrors the general population geographically should probably not make a specific adjustment for geographic risk. The example below assumes the adjustment factor for geographic risk is 1.0 (general population mirrors in force).

IX. EXAMPLE OF USE OF EXTRA AIDS CLAIMS RATES/ADJUSTMENTS

To illustrate how the adjustment factors can be applied to Table 5B, assume a company has the following business in force as of December 31, 1986:

Total In-force Face Amount	Average Attained Age
$100,000,000 Term (direct mail)	35 (70% male)
$100,000,000 Universal life (agent sold)	55 (85% male)

Assume further that the company has asked AIDS-related questions and requires blood tests on its recent UL policy applications and that, of its business currently in force, 25 percent was issued after 1983.

Illustrative Adjustment Factors	Term	UL
Age	3.107	1.100
Sex	1.344*	1.602†
Issues prior to 1984	0.500	0.500
1984 + issues	1.500‡	0.400§
Geographic issues	1.000	1.000

*(0.70 × 1.86) + (0.30 × 0.14) = 1.344.
†(0.85 × 1.86) + (0.15 × 0.14) = 1.602.
‡With no AIDS questions, adverse selection could have occurred. The 1.5 factor is illustrative only.
§The AIDS questions reduce potential adverse selection. The 0.4 factor is illustrative only.

Therefore, for issues prior to 1984 the adjustments are:

$$3.107 \times 1.344 \times 0.50 = 2.088 \text{ for the term policy}$$

and

$$1.100 \times 1.602 \times 0.50 = 0.881 \text{ for the UL policy.}$$

For issues of 1984–86, the adjustments are:

$$3.107 \times 1.344 \times 1.50 = 6.264 \text{ for the term policy}$$

and

$$1.100 \times 1.602 \times 0.4 = 0.705 \text{ for the UL policy.}$$

From Table 5B, the 1987 AIDS death rate per 100,000 lives as of December 31, 1986, is 7.13. Thus, the estimated 1987 extra AIDS and AIDS-related death claims are:

	Term	UL
1983 and prior issues	$11,166*	$4,711†
1984 + issues	11,166‡	1,257§
Subtotal	$22,332	$5,968
Grand total	$28,300, or $0.14 per $1000 in force as of 1986.	

*$1,000 × 0.75 × 2.088 × 7.13 = $11,166.
†$1,000 × 0.75 × 0.881 × 7.13 = $ 4,711.
‡$1,000 × 0.25 × 6.264 × 7.13 = $11,166.
§$1,000 × 0.25 × 0.705 × 7.13 = $ 1,257.

This same methodology is followed for all future years as well.

It is also possible to relate these expected values to anticipated benefit costs. For example, if standard mortality rates at ages 35 and 55 are 1.02 and 6.49 deaths per 1,000, respectively, then anticipated benefit costs for the two policies in 1987 are:

Term: $100,000,000 \times 0.00102 = \$102,000$

UL: $100,000,000 \times 0.00649 = \$649,000.$

Thus, as a percentage of expected claims, the AIDS claims are approximately an additional 22 percent for the term policy and only about 1 percent for the UL policy.

If an existing-business projection is available, Tables 5A–5C should be modified to produce factors readily usable in the projection. For example, since a projection considers both future lapsation and mortality, the current Table 5 factors need to be *divided by* the ratio of each future year's in-force business to the company's 1986 in-force business. This approach then yields AIDS death rates per 100,000 as a function of *future* in-force data, not 1986 in-force data. The example in the following section should help clarify this concept.

X. SAMPLE PROJECTION

To illustrate the concept of adjustments, the simplified term/UL distribution illustrated in the previous section was projected over the years 1987 through 1996. Tables 6A and 6B show the input assumptions and sample output for this projection using the assumptions of Scenario II. In addition, the following assumptions were made:

(i) Age distribution:

Age Group	Adjustment Factor	Distribution	
		Term	UL
Under 20	0.060	0%	0%
20–29	1.161	20	10
30–39	3.107	50	25
40–49	1.882	25	30
50–59	1.100	5	30
60–69	0.000	0	5
Composite Factor:		2.3112	1.7875

(ii) Even though an age distribution was assumed to reflect increased exposure to the AIDS risk by age group, for simplicity the model assumes each plan experiences overall mortality identical to that of a single issue age. That is, standard mortality for the term plan is a function of age 35 mortality in 1987, age 36 mortality in 1988, etc. For the UL plan, the mortality pattern begins with age 55 in 1987. More refined calculations could use composite mortality based on actual age distributions.

(iii) The adjustment factors for the male/female splits are 1.34 (70 percent male) for the term plan and 1.602 (85 percent male) for the UL plan.

(iv) The adjustment factor for underwriting selection for issues prior to 1984 is 50 percent for both plans. The adjustment factors for 1984 and later issues are 150 percent for the term plan and 40 percent for the UL plan.

TABLE 6A

EXAMPLE OF PROJECTED AIDS DEATHS

Year	(1) Total Termination Rate	(2) Projected Insurance In Force (000)	(3) Standard Mortality (q_x) per 1,000	(4) AIDS and AIDS-Related Deaths per 100,000
		Term		
1987	0.30	100,000	1.0200	7.13
1988	0.20	70,000	1.0625	10.15
1989	0.15	56,000	1.1220	13.74
1990	0.15	47,600	1.1985	17.87
1991	0.15	40,460	1.2835	22.46
1992	0.15	34,391	1.3855	27.47
1993	0.15	29,232	1.5215	32.78
1994	0.15	24,847	1.6745	38.22
1995	0.15	21,120	1.8615	43.60
1996	0.15	17,952	2.0825	48.73
		UL		
1987	0.12	100,000	6.4940	7.13
1988	0.10	88,000	7.1570	10.15
1989	0.09	79,200	7.8880	13.74
1990	0.08	72,072	8.7040	17.87
1991	0.07	66,306	9.6220	22.46
1992	0.06	61,665	10.6505	27.47
1993	0.05	57,965	11.7895	32.78
1994	0.05	55,067	13.0220	38.22
1995	0.05	52,313	14.3565	43.60
1996	0.05	49,698	15.8185	48.73

(v) 75 percent of all in-force business was issued prior to 1984, and 25 percent was issued from 1984 to 1986.

(vi) The total termination rate column includes terminations for both lapses and standard mortality.

(vii) 100 percent persistency is assumed for in-force policyholders who have been or ever will be infected with the HIV.

Column 4 of Table 6B shows the percentage of AIDS and AIDS-related deaths as a function of standard deaths. The major reason for the huge difference between the term and the UL plan relates to the assumed differences in age distribution for each type of policy.

Column 5 of Table 6B illustrates the annual gross cost per $1000 of insurance in force for AIDS and AIDS-related deaths by plan. Note here that we are not referring to true claims costs, but rather to claim dollars as a ratio to remaining in-force amounts of insurance (i.e., reserves were ignored).

TABLE 6B

EXAMPLE OF PROJECTED AIDS DEATHS

Year	(1) Projected Insurance In Force (000)	(2) Projected Other Deaths (in Dollars)	(3) Projected AIDS and AIDS-Related Deaths (in Dollars)	(4) AIDS Deaths as Percentage of Other Deaths	(5) AIDS Deaths per $1,000 In Force (in Dollars)
			Term		
1987	$100,000	$102,000	$ 16,613	16.3%	$0.17
1988	70,000	74,375	23,644	31.8	0.34
1989	56,000	62,832	32,019	51.0	0.57
1990	47,600	57,049	41,625	73.0	0.87
1991	40,460	51,930	52,336	100.8	1.29
1992	34,391	47,649	63,996	134.3	1.86
1993	29,232	44,477	76,359	171.7	2.61
1994	24,847	41,607	89,034	214.0	3.58
1995	21,120	39,316	101,575	258.4	4.81
1996	17,952	37,386	113,532	303.7	6.32
			UL		
1987	$100,000	$649,400	$ 9,699	1.5%	$0.10
1988	88,000	629,816	13,805	2.2	0.16
1989	79,200	624,730	18,695	3.0	0.24
1990	72,072	627,315	24,303	3.9	0.34
1991	66,306	637,999	30,557	4.8	0.46
1992	61,665	656,761	37,364	5.7	0.61
1993	57,965	683,377	44,582	6.5	0.77
1994	55,067	717,078	51,983	7.2	0.94
1995	52,313	751,036	59,305	7.9	1.13
1996	49,698	786,143	66,286	8.4	1.33
			Combined		
1987	$200,000	$751,400	$ 26,312	3.5%	$0.13
1988	158,000	704,191	37,449	5.3	0.24
1989	135,200	687,562	50,714	7.4	0.38
1990	119,672	684,363	65,928	9.6	0.55
1991	106,766	689,929	82,893	12.0	0.78
1992	96,056	704,410	101,361	14.4	1.06
1993	87,197	727,854	120,941	16.6	1.39
1994	79,914	758,685	141,016	18.6	1.76
1995	73,434	790,352	160,880	20.4	2.19
1996	67,650	823,528	179,819	21.8	2.66

APPENDIX

INPUT PARAMETERS TO THE MODEL

1. Number of years to be projected (up to 100).
2. Initial population (report uses 240,000,000).
3. Yearly infections (1976 to end of projection period).
4. Mortality table for general population (report uses 85 percent of 1975–80 male, ultimate, age last birthday).
5. Percentages of standard population mortality for other AIDS-related deaths (report uses 100 percent, 300 percent, and 700 percent for scenarios I, II, and III, respectively).
6. Conversion pattern to AIDS from HIV infections.
7. AIDS mortality rates (report uses 0.45, 0.45, 0.29, and 0.21 thereafter).

Notes: Assumption 7 is based on years since conversion.
Assumption 6 is based on years since infection.

CHAPTER 6

A GROUP LONG-TERM DISABILITY MODEL OF THE IMPACT OF AIDS

ROBERT W. BEAL

This chapter illustrates a simple application of the Cowell-Hoskins paper to measure the impact of AIDS on group long-term disability (LTD) benefits in the U.S. The key components of the model are explained below. The projected costs for calendar years 1985 through 200 are then presented for three scenarios.

This particular model illustrates some of the main components of any model that projects the cost of AIDS on group LTD benefits, whether for the industry in total or for individual companies. Most of the assumptions described herein are in need of better data and often are set arbitrarily in order to illustrate the model's results. The reader should not conclude that the results of the three scenarios necessarily represent realistic projections of the impact of AIDS on the industry's group LTD business.

The Spread of AIDS throughout the Population

To project the spread of AIDS throughout the population, a model must first project the spread of HIV and then assume a pattern of progression from HIV infection to AIDS. For both of these items, the LTD model uses results developed by Michael J. Cowell and Walter H. Hoskins in their paper, "AIDS, HIV Mortality and Life Insurance" (see Chapter 3 of this Task Force report), which assume that the number of new infections declines to zero by 1997. Cowell and Hoskins limited these projections to infected persons in the insured population, which they concluded consists primarily of homosexuals and bisexuals. Table 1 shows the development of the estimate of new U.S. AIDS cases for years 1976 to 2000.

Total Number Qualifying for Disability in a Year

The model assumes that 50 percent of those getting AIDS in a year satisfy the definition of disability in the same year and the other 50 percent in the following year.

Percentage of AIDS Cases Covered for Group LTD

The model assumes that 20 percent of the AIDS cases are covered by LTD insurance. This is based upon the 1985 ratio of the number of LTD covered insureds to the working population in the U.S. This allows the model to assume the same progression rates as in the general population.

Effective Covered Wages

The effective covered wage per claimant is assumed to be $25,000 annually in 1986 and increases at a 5 percent annual rate.

Average Disability Benefit as Percentage of Covered Wages

The model also assumes that LTD benefits are equal to 60 percent of covered wages. Companies that offer a range of products should take the distribution of business by product into consideration.

Average Social Security Offset

The average Social Security offset for annual wages of $25,000 is assumed to be 50 percent.

Present Value of Disability Benefits

The present value of disability benefits depends upon when the first LTD benefits are received in relation to the time AIDS is diagnosed, the mortality rates during disability, and the interest rate for discounting benefits.

The first two scenarios assume mortality follows the Cowell-Hoskins AIDS death rates of 45 percent in each of the first two years following progression to AIDS, 35 percent in year 3, and 25 percent in each year thereafter. The third scenario assumes that a medical breakthrough occurs in the treatment of AIDS, reducing the annual death rate to 25 percent in each of the first five years following progression to AIDS and 10 percent each year thereafter for new AIDS cases in years 1993 and later.

The first and third scenarios assume benefits begin six months after the commencement of AIDS. The second scenario benefits begin at the same time AIDS is contracted, assuming the waiting period is satisfied while the claimant has ARC. The disability benefits in all three scenarios are discounted at 7 percent.

The resulting present values of the LTD benefits to the date of disablement for the three scenarios are as follows:

Scenario	Present Value LTD Benefits*
1	$17.02
2	21.71
3	17.02 (through year 1992) 35.47 (for years 1993 and later)

*Per $1.00 of monthly benefit.

Tables 5, 6, and 7 illustrate the calculations of the present value of LTD benefits factors.

Cumulative LTD Benefits Due to AIDS

Tables 2, 3, and 4 provide the results of the three scenarios. The following table compares the projected cumulative disability benefits incurred in years 1986 through 2000 under the three scenarios.

CUMULATIVE LONG-TERM DISABILITY BENEFITS DUE TO AIDS
($ MILLIONS)

Year	Scenario 1	Scenario 2	Scenario 3
1986	$ 20.9	$ 26.7	$ 20.9
1987	56.5	72.1	56.5
1988	113.8	145.1	113.8
1989	201.7	257.3	201.7
1990	330.8	422.0	330.8
1991	512.8	654.1	512.8
1992	758.9	968.1	758.9
1993	1,078.9	1,376.3	1,425.8
1994	1,478.1	1,885.4	2,257.7
1995	1,995.0	2,493.8	3,251.6
1996	2,500.7	3,189.8	4,388.9
1997	3,100.2	3,954.5	5,638.2
1998	3,734.5	4,763.5	6,960.0
1999	4,382.9	5,590.7	8,311.5
2000	5,025.6	6,410.4	9,650.7

Many of the LTD model assumptions are set arbitrarily. Again, the reader is cautioned not to interpret the results in the above table as necessarily reasonable projections of the group LTD benefits due to AIDS. As more information is developed, these assumptions can be improved, leading to possibly more realistic projections. This model was originally developed by Arthur Baldwin of Paul Revere Life and has been somewhat enhanced by David Holland.

TABLE 1

DISABILITY MODEL BASED ON COWELL PAPER
INFECTED POPULATION: INFECTION DECLINES TO 0 BY 1997

		1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Number HIV Infected		0.504	1.887	6.011	16.295	37.904	76.300	135.429	218.173	328.205	477.693	670.619	919.566
Number Becoming Infected in Year		0.392	1.383	4.124	10.284	21.609	38.396	59.129	82.744	110.032	149.488	192.926	248.947
Years from Infection	Percentage with AIDS	Year of Infection	Number Getting AIDS Year by Year, After Infection in Year Indicated at Left										
			Pre-1978	1978	1979	980	1981	1982	1983	1984	1985	1986	1987
1	0.0000%	1975	1	3	5	7	10	12	11	10	8	7	6
2	0.3000	1976	1	5	10	17	24	34	41	39	33	28	24
3	1.2000	1977	0	4	17	36	59	86	119	144	138	117	100
4	2.6000	1978		0	12	49	107	177	256	355	429	411	349
5	4.3000	1979			0	31	123	267	442	638	884	1,070	1,024
6	6.2000	1980				0	65	259	562	929	1,340	1,858	2,247
7	8.6000	1981					0	115	461	998	1,651	2,381	3,302
8	10.4000	1982						0	177	710	1,537	2,543	3,666
9	9.9600	1983							0	248	993	2,151	3,558
10	8.4660	1984								0	330	1,320	2,861
11	7.1961	1985									0	448	1,794
12	6.1167	1986										0	579
13	5.1992	1987											0
14	4.4193	1988											
15	3.7564	1989											
16	3.1929	1990											
17	2.7140	1991											
18	2.3069	1992											
19	1.9609	1993											
20	1.6667	1994											
21	1.4167	1995											
22	1.2042	1996											
23	1.0236	1997											
24	0.8700	1998											
	—	1999											
	95.0697	2000											
Total			3	12	44	140	389	950	2,069	4,070	7,343	12,334	19,510
(1) Cumulative			3	14	58	198	587	1,538	3,606	7,676	15,020	27,354	46,863
(2) CDC Data			—	—	—	—	337	1,337	4,119	9,697	15,948	29,003	55,000
(3) Ratio (1) to (2)							174%	115%	88%	79%	94%	94%	85%

TABLE 1 — *Continued*

			1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Number HIV Infected			1191.439	1465.203	1721.330	1945.951	2131.859	2277.142	2382.978	2451.692	2485.433	2485.433	2485.433	2485.433	2485.433
Number Becoming Infected in Year			271.873	273.764	256.127	224.621	185.908	145.283	105.836	68.714	33.741	0.000	0.000	0.000	0.000
Years from Infection	Percentage with AIDS	Year of Infection	Number Getting AIDS Year by Year, After Infection in Year Indicated at Left												
			1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.0000%	1975	5	4	4	3	3	2	2	2	1	1	1	1	1
2	0.3000	1976	20	17	15	13	11	9	8	7	6	5	4	3	3
3	1.2000	1977	85	72	61	52	44	38	32	27	23	20	17	14	12
4	2.6000	1978	297	252	214	182	155	132	112	95	81	69	58	50	42
5	4.3000	1979	871	740	629	535	454	386	328	279	237	202	171	146	124
6	6.2000	1980	2,152	1,829	1,555	1,322	1,123	955	812	690	586	498	424	360	306
7	8.6000	1981	3,993	3,824	3,251	2,763	2,349	1,996	1,697	1,442	1,226	1,042	886	753	640
8	10.4000	1982	5,085	6,149	5,889	5,006	4,255	3,617	3,074	2,613	2,221	1,888	1,605	1,364	1,159
9	9.9600	1983	5,130	7,116	8,605	8,241	7,005	5,954	5,061	4,302	3,657	3,108	2,642	2,246	1,909
10	8.4660	1984	4,731	6,822	9,463	11,443	10,959	9,315	7,918	6,730	5,721	4,863	4,133	3,513	2,986
11	7.1961	1985	3,887	6,428	9,268	12,856	15,547	14,889	12,656	10,757	9,144	7,772	6,606	5,615	4,773
12	6.1167	1986	2,315	5,016	8,296	11,961	16,592	20,064	19,215	16,333	13,883	11,801	10,031	8,526	7,247
13	5.1992	1987	747	2,987	6,473	10,705	15,435	21,409	25,890	24,795	21,076	17,914	15,227	12,943	11,002
14	4.4193	1988	0	816	3,262	7,069	11,691	16,856	23,381	28,275	27,079	23,017	19,564	16,630	14,133
15	3.7564	1989		0	821	3,285	7,118	11,772	16,973	23,544	28,471	27,267	23,177	19,700	16,745
16	3.1929	1990			0	768	3,074	6,659	11,013	15,880	22,027	26,637	25,510	21,684	18,431
17	2.7140	1991				0	674	2,695	5,840	9,659	13,927	19,317	23,361	22,372	19,016
18	2.3069	1992					0	558	2,231	4,834	7,994	11,526	15,988	19,334	18,516
19	1.9609	1993						0	436	1,743	3,777	6,247	9,008	12,494	15,109
20	1.6667	1994							0	318	1,270	2,752	4,551	6,562	9,102
21	1.4167	1995								0	206	825	1,787	2,955	4,260
22	1.2042	1996									0	101	405	877	1,451
23	1.0236	1997										0	0	0	0
24	0.8700	1998											0	0	0
	—	1999												0	0
	95.0697	2000													0
Total			29,318	42,074	57,806	76,204	96,487	117,308	136,680	152,324	162,613	166,872	165,155	158,143	146,972
(1) Cumulative			76,181	118,255	176,062	252,266	348,753	466,060	602,740	755,065	917,677	1,084,549	1,249,704	1,407,847	1,554,819
(2) CDC Data			88,000	133,000	191,000	265,000									
(3) Ratio (1) to (2)			87%	89%	92%	95%									

TABLE 2

SCENARIO 1*
DISABILITY MODEL BASED ON COWELL PAPER
INFECTED POPULATION: INFECTION DECLINES TO 0 BY 1997

Year	AIDS Cases		Total Number Qualifying for Disability in Year†	Percentage of AIDS Cases Covered for Group LTD	Total Number of AIDS Cases That Are Insured	Projected Inflation Rate for Wages	Effective Monthly Covered Wages	Average Disability Benefit			Present Value of Disability Benefit	PV Benefit Times Number Disabled (Millions)	Cumulative Disability Benefits Incurred (Millions)
								As Percentage of Covered Wages	Before Social Security Offset	After 50% Social Security Offset			
	Total No.	Cumulative											
Pre-1978	3	3											
1978	12	14											
1979	44	58											
1980	140	198											
1981	389	587											
1982	950	1,538											
1983	2,069	3,606											
1984	4,070	7,676											
1985	7,343	15,020											
1986	12,334	27,354	9,839	20.00%	1,968		$2,083	60.00%	$1,250	$625	$10,637	$20.9	$20.9
1987	19,510	46,863	15,922	20.00	3,184	5.00%	2,188	60.00	1,313	656	11,169	35.6	56.5
1988	29,318	76,181	24,414	20.00	4,883	5.00	2,297	60.00	1,378	689	11,720	57.3	113.8
1989	42,074	118,255	35,696	20.00	7,139	5.00	2,412	60.00	1,447	724	12,314	87.9	201.7
1990	57,806	176,062	49,940	20.00	9,988	5.00	2,532	60.00	1,519	760	12,930	129.1	330.8
1991	76,204	252,266	67,005	20.00	13,401	5.00	2,659	60.00	1,595	798	13,576	181.9	512.8
1992	96,487	348,753	86,346	20.00	17,269	5.00	2,792	60.00	1,675	838	14,255	246.2	758.9
1993	117,308	466,060	106,897	20.00	21,379	5.00	2,931	60.00	1,759	879	14,968	320.0	1,078.9
1994	136,680	602,740	126,994	20.00	25,399	5.00	3,078	60.00	1,847	923	15,716	399.2	1,478.1
1995	152,324	755,065	144,502	20.00	28,900	5.00	3,232	60.00	1,939	970	16,502	476.9	1,955.0
1996	162,613	917,677	157,469	20.00	31,494	5.00	3,394	60.00	2,036	1,018	17,327	545.7	2,500.7
1997	166,872	1,084,549	164,742	20.00	32,948	5.00	3,563	60.00	2,138	1,069	18,194	599.5	3,100.2
1998	165,155	1,249,704	166,013	20.00	33,203	5.00	3,741	60.00	2,245	1,122	19,103	634.3	3,734.5
1999	158,143	1,407,847	161,649	20.00	32,330	5.00	3,928	60.00	2,357	1,179	20,058	648.5	4,382.9
2000	146,972	1,554,819	152,557	20.00	30,511	5.00	4,125	60.00	2,475	1,237	21,061	642.6	5,025.6

*Scenario 1: Cowell-Hoskins AIDS mortality; AIDS claimants must satisfy six-month waiting period.
†Average of AIDS cases in current and prior years.

TABLE 3

SCENARIO 2*
DISABILITY MODEL BASED ON COWELL PAPER
INFECTED POPULATION: INFECTION DECLINES TO 0 BY 1997

Year	AIDS Cases		Total Number Qualifying for Disability in Year†	Percentage of AIDS Cases Covered for Group LTD	Total Number of AIDS Cases That Are Insured	Projected Inflation Rate for Wages	Effective Monthly Covered Wages	Average Disability Benefit			Present Value of Disability Benefit	PV Benefit Times Number Disabled (Millions)	Cumulative Disability Benefits Incurred (Millions)
	Total No.	Cumulative						As Percentage of Covered Wages	Before Social Security Offset	After 50% Social Security Offset			
Pre-1978	3	3											
1978	12	14											
1979	44	58											
1980	140	198											
1981	389	587											
1982	950	1,538											
1983	2,069	3,606											
1984	4,070	7,676											
1985	7,343	15,020											
1986	12,334	27,354	9,839	20.00%	1,968		$2,083	60.00%	$1,250	$625	$13,569	$26.7	$26.7
1987	19,510	46,863	15,922	20.00	3,184	5.00%	2,188	60.00	1,313	656	14,247	45.4	72.1
1988	29,318	76,181	24,414	20.00	4,883	5.00	2,297	60.00	1,378	689	14,960	73.0	145.1
1989	42,074	118,255	35,696	20.00	7,139	5.00	2,412	60.00	1,447	724	15,707	112.1	257.3
1990	57,806	176,062	49,940	20.00	9,988	5.00	2,532	60.00	1,519	760	16,493	164.7	422.0
1991	76,204	252,266	67,005	20.00	13,401	5.00	2,659	60.00	1,595	798	17,318	232.1	654.1
1992	96,487	348,753	86,346	20.00	17,269	5.00	2,792	60.00	1,675	838	18,183	314.0	968.1
1993	117,308	466,060	106,897	20.00	21,379	5.00	2,931	60.00	1,759	879	19,093	408.2	1,376.3
1994	136,680	602,740	126,994	20.00	25,399	5.00	3,078	60.00	1,847	923	20,047	509.2	1,885.4
1995	152,324	755,065	144,502	20.00	28,900	5.00	3,232	60.00	1,939	970	21,050	608.3	2,493.8
1996	162,613	917,677	157,469	20.00	31,494	5.00	3,394	60.00	2,036	1,018	22,102	696.1	3,189.8
1997	166,872	1,084,549	164,742	20.00	32,948	5.00	3,563	60.00	2,138	1,069	23,207	764.6	3,954.5
1998	165,155	1,249,704	166,013	20.00	33,203	5.00	3,741	60.00	2,245	1,122	24,367	809.1	4,763.5
1999	158,143	1,407,847	161,649	20.00	32,330	5.00	3,928	60.00	2,357	1,179	25,586	827.2	5,590.7
2000	146,972	1,554,819	152,557	20.00	30,511	5.00	4,125	60.00	2,475	1,237	26,865	819.7	6,410.4

*Scenario 2: Cowell-Hoskins AIDS mortality; AIDS claimants receive disability benefits at commencement of AIDS.
†Average of AIDS cases in current and prior years.

TABLE 4

SCENARIO 3*
DISABILITY MODEL BASED ON COWELL PAPER
INFECTED POPULATION: INFECTION DECLINES TO 0 BY 1997

Year	AIDS Cases		Total Number Qualifying for Disability in Year†	Percentage of AIDS Cases Covered for Group LTD	Total Number of AIDS Cases That Are Insured	Projected Inflation Rate for Wages	Effective Monthly Covered Wages	Average Disability Benefit			Present Value of Disability Benefit	PV Benefit Times Number Disabled (Millions)	Cumulative Disability Benefits Incurred (Millions)
								As Percentage of Covered Wages	Before Social Security Offset	After 50% Social Security Offset			
	Total No.	Cumulative											
Pre-1978	3	3											
1978	12	14											
1979	44	58											
1980	140	198											
1981	389	587											
1982	950	1,538											
1983	2,069	3,606											
1984	4,070	7,676											
1985	7,343	15,020											
1986	12,334	27,354	9,839	20.00%	1,968		$2,083	60.00%	$1,250	$625	$10,637	$20.9	$20.9
1987	19,510	46,863	15,922	20.00	3,184	5.00%	2,188	60.00	1,313	656	11,169	35.6	56.5
1988	29,318	76,181	24,414	20.00	4,883	5.00	2,297	60.00	1,378	689	11,728	57.3	113.8
1989	42,074	118,255	35,696	20.00	7,139	5.00	2,412	60.00	1,447	724	12,314	87.9	201.7
1990	57,806	176,062	49,940	20.00	9,988	5.00	2,532	60.00	1,519	760	12,930	129.1	330.8
1991	76,204	252,266	67,005	20.00	13,401	5.00	2,659	60.00	1,595	798	13,576	181.9	512.8
1992	96,487	348,753	86,346	20.00	17,269	5.00	2,792	60.00	1,675	838	14,255	246.2	758.9
1993	117,308	466,060	106,897	20.00	21,379	5.00	2,931	60.00	1,759	879	31,194	666.9	1,425.8
1994	136,680	602,740	126,994	20.00	25,399	5.00	3,078	60.00	1,847	923	32,753	831.9	2,257.7
1995	152,324	755,065	144,502	20.00	28,900	5.00	3,232	60.00	1,939	970	34,091	993.9	3,254.6
1996	162,613	917,677	157,469	20.00	31,494	5.00	3,394	60.00	2,036	1,018	36,111	1,137.3	4,388.9
1997	166,872	1,084,549	164,742	20.00	32,948	5.00	3,563	60.00	2,138	1,069	37,916	1,249.3	5,638.2
1998	165,155	1,249,704	166,013	20.00	33,203	5.00	3,741	60.00	2,245	1,122	39,812	1,321.9	6,960.0
1999	158,143	1,407,847	161,649	20.00	32,330	5.00	3,928	60.00	2,357	1,179	41,802	1,351.5	8,311.5
2000	146,972	1,554,819	152,557	20.00	30,511	5.00	4,125	60.00	2,475	1,237	43,893	1,339.2	9,650.7

*Scenario 3: Cowell-Hoskins AIDS mortality; AIDS claimants must satisfy six-month waiting period.
†Average of AIDS cases in current and prior years.

TABLE 5

SCENARIO 1

DISABILITY MODEL BASED ON COWELL PAPER

CALCULATION OF AN ANNUITY OF $1 PER MONTH VALUED AT BENEFIT COMMENCEMENT DATE

Year	Annual P [Death] q	Interest Rate	Effective Monthly q'	Monthly i	Equivalent j	Benefit Months	1-Year Annuity $1/mo.	Probability of Survival	PV of $1 at Benefit Start	PV of 1 Year Annuity	PV of t Year Annuity
1	0.45	0.07	0.05108	0.0056	0.0567	6	5.25	0.7416	1	3.89	3.89
2	0.45	0.07	0.05108	0.0056	0.0567	12	9.02	0.5500	0.96673	4.80	8.69
3	0.35	0.07	0.03655	0.0056	0.0422	12	9.66	0.3025	0.90349	2.64	11.33
4	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.1966	0.84438	1.70	13.03
5	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.1475	0.78914	1.19	14.23
6	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.1106	0.73751	0.84	15.06
7	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0830	0.68926	0.59	15.65
8	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0622	0.64417	0.41	16.06
9	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0467	0.60203	0.29	16.35
10	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0350	0.56264	0.20	16.55
11	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0262	0.52584	0.14	16.69
12	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0197	0.49143	0.10	16.79
13	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0148	0.45928	0.07	16.86
14	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0111	0.42924	0.05	16.91
15	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0083	0.40116	0.03	16.94
16	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0062	0.37491	0.02	16.97
17	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0047	0.35038	0.02	16.98
18	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0035	0.32746	0.01	17.00
19	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0026	0.30604	0.01	17.00
20	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0020	0.28602	0.01	17.01
21	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0015	0.26731	0.00	17.01
22	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0011	0.24982	0.00	17.02
23	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0008	0.23347	0.00	17.02
24	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0006	0.21820	0.00	17.02

Present value of a disabled life annuity of $1 per month commencing 6 months after contracting AIDS = $17.02

Annuity calculation procedure:

1-year annuity = sum[$(v\hat{}t)*{}_tp_x$] for t = 0/12, 1/12, 2/12, . . . , 11/12
calculate $i[12] = [(1+i)\hat{}(1/12)] - 1$

assume constant force of mortality over the year such that
${}_tp_x = (1-q_x)\hat{}t$ for $0 \leqq t \leqq 1$ and
$p[12] = 1 - q[12] = (1-q_x)(1/12)$

1-year annuity = sum$\{[(1+i[12])\hat{}(-t)] * [(1-q[12])\hat{}t]\}$ for t = 0, 1, 2, . . . , 11
and let $q'[12] = q[12]/(1+q[12]) = (1-q_x)\hat{}(-1/12) - 1$ and it can be shown that

1-year annuity = sum$[(1+i[12]+q'[12])\hat{}(-t)]$ for t = 0, 1, 2, . . . , 11
which is a simple annuity due at $j = i[12] + q'[12]$

TABLE 6

SCENARIO 2

DISABILITY MODEL BASED ON COWELL PAPER

CALCULATION OF AN ANNUITY OF $1 PER MONTH VALUED AT BENEFIT COMMENCEMENT DATE

Year	Annual P [Death] q	Interest Rate	Effective Monthly q'	Monthly i	Equivalent j	Benefit Months	1-Year Annuity $1/mo.	Probability of Survival	PV of $1 at Benefit Start	PV of 1 Year Annuity	PV of t Year Annuity
1	0.45	0.07	0.05108	0.0056	0.0567	12	9.02	1.0000	1	9.02	9.02
2	0.45	0.07	0.05108	0.0056	0.0567	12	9.02	0.5500	0.93457	4.64	13.66
3	0.35	0.07	0.03655	0.0056	0.0422	12	9.66	0.3025	0.87343	2.55	16.21
4	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.1966	0.81629	1.65	17.85
5	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.1475	0.76289	1.15	19.01
6	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.1106	0.71298	0.81	19.82
7	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0830	0.66634	0.57	20.38
8	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0622	0.62274	0.40	20.78
9	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0467	0.58200	0.28	21.06
10	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0350	0.54393	0.20	21.26
11	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0262	0.50834	0.14	21.39
12	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0197	0.47509	0.10	21.49
13	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0148	0.44401	0.07	21.56
14	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0111	0.41496	0.05	21.60
15	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0083	0.38781	0.03	21.64
16	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0062	0.36244	0.02	21.66
17	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0047	0.33873	0.02	21.68
18	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0035	0.31657	0.01	21.69
19	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0026	0.29586	0.01	21.69
20	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0020	0.27650	0.01	21.70
21	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0015	0.25841	0.00	21.70
22	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0011	0.24151	0.00	21.71
23	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0008	0.22571	0.00	21.71
24	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0006	0.21094	0.00	21.71

Present value of a disabled life annuity of $1 per month commencing 0 months after contracting AIDS = $21.71

Annuity calculation procedure:

1-year annuity = sum[$(v\hat{}t)*tpx$] for t = 0/12, 1/12, 2/12, . . . , 11/12
calculate $i[12] = [(1+i)\hat{}(1/12)] - 1$

assume constant force of mortality over the year such that
$tpx = (1-qx)\hat{}t$ for $0 \leqq t \leqq 1$ and
$p[12] = 1 - q[12] = (1-qx)\hat{}(1/12)$

1-year annuity = sum$\{[(1+i[12])\hat{}(-t)] * [(1-q[12])\hat{}t]\}$ for t = 0, 1, 2, . . . , 11
and let $q'[12] = q[12]/(1+q[12]) = (1-qx)\hat{}(-1/12) - 1$ and it can be shown that

1-year annuity = sum$[(1+i[12]+q'[12])\hat{}(-t)]$ for t = 0, 1, 2, . . . , 11
which is a simple annuity due at $j = i[12] + q'[12]$

TABLE 7

SCENARIO 3

DISABILITY MODEL BASED ON COWELL PAPER

CALCULATION OF AN ANNUITY OF $1 PER MONTH VALUED AT BENEFIT COMMENCEMENT DATE

Year	Annual P [Death] q	Interest Rate	Effective Monthly q'	Monthly i	Equivalent j	Benefit Months	1-Year Annuity $1/mo.	Probability of Survival	PV of $1 at Benefit Start	PV of 1 Year Annuity	PV of t Year Annuity
1	0.45	0.07	0.05108	0.0056	0.0567	6	5.25	0.7416	1	3.89	3.89
2	0.45	0.07	0.05108	0.0056	0.0567	12	9.02	0.5500	0.96673	4.80	8.69
3	0.35	0.07	0.03655	0.0056	0.0422	12	9.66	0.3025	0.90349	2.64	11.33
4	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.1966	0.84438	1.70	13.03
5	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.1475	0.78914	1.19	14.23
6	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.1106	0.73751	0.84	15.06
7	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0830	0.68926	0.59	15.65
8	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0622	0.64417	0.41	16.06
9	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0467	0.60203	0.29	16.35
10	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0350	0.56264	0.20	16.55
11	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0262	0.52584	0.14	16.69
12	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0197	0.49143	0.10	16.79
13	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0148	0.45928	0.07	16.86
14	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0111	0.42924	0.05	16.91
15	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0083	0.40116	0.03	16.94
16	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0062	0.37491	0.02	16.97
17	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0047	0.35038	0.02	16.98
18	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0035	0.32746	0.01	17.00
19	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0026	0.30604	0.01	17.00
20	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0020	0.28602	0.01	17.01
21	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0015	0.26731	0.00	17.01
22	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0011	0.24982	0.00	17.02
23	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0008	0.23347	0.00	17.02
24	0.25	0.07	0.02426	0.0056	0.0299	12	10.26	0.0006	0.21820	0.00	17.02

Present value of a disabled life annuity of $1 per month commencing 6 months after contracting AIDS = $17.02 use through 1992

Annuity calculation procedure:

1-year annuity = sum{$(v\hat{}t)*tpx$} for t = 0/12, 1/12, 2/12, . . . , 11/12
calculate $i[12] = [(1+i)\hat{}(1/12)] - 1$

assume constant force of mortality over the year such that
$tpx = (1-qx)\hat{}t$ for $0 \leqq t \leqq 1$ and
$p[12] = 1 - q[12] = (1-qx)\hat{}(1/12)$

1-year annuity = sum{$[(1+i[12])\hat{}(-t)] * [(1-q[12])\hat{}t]$} for t = 0, 1, 2, . . . , 11
and let $q'[12] = q[12]/(1+q[12]) = (1-qx)\ (-1/12) - 1$ and it can be shown that

1-year annuity = sum{$[(1+i[12]+q'\ [12])\hat{}(-t)]$} for t = 0, 1, 2, . . . , 11
which is a simple annuity due at $j = i[12] + q'[12]$

TABLE 7 — *Continued*

Year	Annual P [Death] q	Interest Rate	Effective Monthly q'	Monthly i	Equivalent j	Benefit Months	1-Year Annuity $1/mo.	Probability of Survival	PV of $1 at Benefit Start	PV of 1 Year Annuity	PV of r Year Annuity
1	0.25	0.07	0.024263	0.005654	0.029917	6	5.58	0.8660	1	4.83	4.83
2	0.25	0.07	0.024263	0.005654	0.029917	12	10.26	0.7500	0.9667364	7.44	12.27
3	0.25	0.07	0.024263	0.005654	0.029917	12	10.26	0.5625	0.9034920	5.21	17.48
4	0.25	0.07	0.024263	0.005654	0.029917	12	10.26	0.4219	0.8443850	3.65	21.14
5	0.25	0.07	0.024263	0.005654	0.029917	12	10.26	0.3164	0.7891449	2.56	23.70
6	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.2373	0.7375186	1.94	25.64
7	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.2136	0.6892697	1.63	27.27
8	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.1922	0.6441773	1.37	28.65
9	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.1730	0.6020348	1.16	29.81
10	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.1557	0.5626494	0.97	30.78
11	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.1401	0.5258405	0.82	31.60
12	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.1261	0.4914398	0.69	32.28
13	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.1135	0.4592895	0.58	32.86
14	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.1022	0.4292425	0.49	33.35
15	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.0919	0.4011612	0.41	33.76
16	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.0827	0.3749170	0.34	34.10
17	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.0745	0.3503897	0.29	34.39
18	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.0670	0.3274670	0.24	34.64
19	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.0603	0.3060440	0.20	34.84
20	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.0543	0.2860224	0.17	35.01
21	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.0489	0.2673106	0.14	35.16
22	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.0440	0.2498230	0.12	35.28
23	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.0396	0.2334795	0.10	35.38
24	0.1	0.07	0.008818	0.005654	0.014472	12	11.10	0.0356	0.2182051	0.09	35.47

Present value of a disabled life annuity of $1 per month commencing 6 months after contracting AIDS = $35.47 use for 1993 onward

CHAPTER 7

MODELING THE IMPACT OF HIV ON GROUP MEDICAL, DISABILITY, AND LIFE INSURANCE PLANS

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ABSTRACT

This paper describes the development of a model that projects group insurance plan costs attributable to HIV-related diseases. Following the explanation of the development of the model and its assumptions is a summary of its projected results, including costs by duration, a claim cost table, and five-year projections. The stochastic, as opposed to deterministic, nature of the model distinguishes it from the typical spread-sheet type of model. Many of the associated cost patterns as well as the progression through the various stages of HIV disease are simulated using Monte Carlo techniques. The application of stochastic simulation has the advantages of providing a means of measuring the expected variability of the modeled results for a given set of assumptions and allowing the integration of a multitude of cost and progression distributions into a single simulation.

INTRODUCTION

The impact of HIV on group insurance plans has not received as much attention as the impact on individual life insurance. This probably has occurred because of the ability of insurers to rerate group plans at least once a year. Insurers anticipate increasing rates each year as necessary so that premiums will adequately cover the expected HIV costs. However, the ability to rerate does not necessarily guarantee adequate premiums, as is illustrated by historical cycles. The rerating process will be successful only to the extent that historical cost levels are known and future trends can be predicted — neither of which is the case with HIV. Also, medical claims are incurred over the course of the disease, not at a single point in time as with life coverages.

A group HIV model will provide an estimation of the HIV costs under a given set of assumptions. This information will be valuable because the use of internal claims data as the basis for projecting future claims may not be reliable due to the inherent difficulties in identifying an HIV-related claim.

Additionally, a model will provide the ability to test the impact of alternative assumptions and scenarios.

The model presented in this paper comprises two components. The first component is the prevalence module. This module develops the number of HIV-infected insured employees by current HIV-disease stage and duration within that stage given the geographic distribution of a block of in-force group insureds. It also projects the number of insureds that are modeled to become seropositive in future years. The output of the first module provides input to the second, the cost module. In this module, the future progression through the HIV stages and the associated costs are calculated for each HIV-infected life. Each infected life enters the model in the month, year, stage, and duration as determined in the prevalence module. The progression paths and costs are derived using monthly formulations and stochastic processes.

Following the detailed description of the components of the model, analysis of the modeled results is presented. The analysis includes the development of various costs by duration since infection, a five-year projection of group plan costs assuming an initial cohort of 1,000 infected lives, sensitivity testing to the five-year projection changing assumptions such as progression rates and cost patterns, and estimated medical claim costs by deductibles.

It is important to note while reviewing this paper that all "costs," except for life benefits, represent full charges to the claimant rather than insurance company benefit costs. There have been no assumptions made as to the plan design features of the group insurance coverage (that is, costs have not been adjusted for deductibles, coinsurance, plan eligibility, coordination of benefits, and so on). Also, the life benefits are those paid at time of death; they do not include any waiver-of-premium benefits. Finally, the medical coverage is assumed to continue until death, even if disability occurs. There is no differentiation as to whether coverage is extended due to the employer continuing to pay the premiums, COBRA, or other means.

The reader should keep in mind that the utility of this model, like any other model, is largely derived from the assumptions that drive the model and the data from which the assumptions are developed. In many instances, the assumptions were not generated from the analysis of hard data, but rather from the "guesstimates" of well-informed actuaries, medical doctors, and others with practical experience in HIV-related medical practice patterns. In other cases, the bases of the assumptions were recognized studies such as the Cowell-Hoskins report (see Chapter 3 of this Task Force report). The assumptions are generally validated with the per-life modeled costs, the only actual insurance data presently available to test results for reasonableness.

This certainly emphasizes the need for improved identification, collection, and analysis of group insurance HIV-claim data.

The results of the model are still valuable notwithstanding these validation limitations. In many instances, the relative comparisons of the projected cost data and the relative changes seen under alternative assumptions provide more value than the actual dollar amount variations. The greatest strengths of the model are in its structure and processes. As more research, studies, and data become available, the flexibility of the model will allow the incorporation of the new information, increasing the reliability of the modeled results.

MODEL DEVELOPMENT AND ASSUMPTIONS

I. *Prevalence Module*

The prevalence module develops the expected number of HIV-infected lives by geographic region for a given block of group insured employees. The HIV-related costs these lives will generate are subsequently modeled in the cost module. The prevalence module actually consists of three steps. First, a deterministic approach is used to derive the number of HIV-infected employees for each geographic region. Next, stochastic processes allocate those lives to an HIV stage and duration within that stage. Lastly, in-force lives currently seronegative that will become seropositive in future modeled years are "cloned" from in-force infected lives, again by a stochastic process.

A. Number of HIV-Infected Lives by Region

The number of HIV-infected lives by each geographic region is calculated using the following formula:

Insured Infected Lives = (Insured Males) * {Insured Regional Prevalence Rate}

= (Number of Insured Employees in Region * Percentage of Employees That Are Male) * {General Population Male Prevalence Rate * AIDS Normalized Factor * HIV+ Normalized Factor * Percentage of HIV-Infected Lives Insured and Employed}

The model develops infected lives based on male employees only (that is, no females, dependent males, or dependent children). Dependent males have been excluded because of their marital status. Females and dependent children were excluded because they currently represent a low percentage

of total AIDS cases (probably even lower on an insured basis). These assumptions will have to be reviewed for appropriateness as conditions change. The other factors of the formula are discussed more fully below.

The seropositive prevalence rate for males in the general population was developed using the following technique, similar to that presented by Mast [1]. It assumes that the distribution of HIV-infected lives by age and sex follows that of reported AIDS cases. The prevalence rates by age categories are weighted by a group insurance male employee distribution to calculate the age-weighted rate (only insured lives between 20–59 were considered, comprising 95 percent of male employees). The seropositive prevalence rate is obviously driven by the estimated national number of cases. An example assuming 1,250,000 total U.S. seropositives of which 93 percent are male (1,162,500) will generate a 1.67 percent prevalence rate as follows:

	Age in Years				Males
	20–29	30–39	40–49	50–59	20–59
AIDS male distribution	21.0%	46.6%	20.8%	8.0%	96.4%
Number of seropositive cases	244,000	542,000	242,000	93,000	1,121,000
Males in U.S. population (million-1986 estimate)	21.3	19.6	12.8	10.6	64.3
Prevalence of seropositive cases	1.15%	2.76%	1.89%	0.88%	1.74%
Group insured male employee distribution	31.5%	29.2%	19.5%	14.6%	95.0%
Employee age-weighted prevalence rate	0.36%	0.81%	0.37%	0.13%	1.67%

The AIDS normalized factor is simply the ratio of 1987 reported new cases of AIDS from the CDC Weekly Surveillance Report [2] to the 1986 estimated population for each geographic region (Table 1), normalized to the national average. The factor was calculated for each of the metropolitan areas in the CDC report. A value was estimated for all other metropolitan areas and several high-risk states. The balancing value was used for all the other states.

The HIV+ normalized factor is used to adjust the AIDS factor to account for the fact that the number of reported AIDS cases in a geographic region is somewhat a function of the age of the epidemic in that region. Using the iceberg analogy to illustrate (the tip of the iceberg representing AIDS cases and the portion underwater representing all non-AIDS seropositive cases), a region with an initial infection year of 1975 would expect to have a larger percentage of the iceberg exposed (and a smaller percentage underwater) than a region where the epidemic began in 1980. Projecting the region-specific prevalence rate based on the reported AIDS cases by applying the

TABLE 1

MODEL GEOGRAPHIC REGION FACTORS

Area	Cost Region	Area Factor	Alternative Care Group	Area	Cost Region	Area Factor	Alternative Care Group
New York City	1	1.43	2	Delaware	7	1.00	4
Los Angeles	2	1.33	3	Minn/St. Paul	7	1.00	4
Long Island	2	1.33	3	Virginia	7	1.00	4
Miami	2	1.33	3	Wisconsin	7	1.00	4
Ft. Lauderdale	2	1.33	3	Maine	7	1.00	4
Chicago	2	1.33	3	Denver	7	1.00	4
Philadelphia	2	1.33	3				
				Atlanta	8	0.88	4
San Fran/Oakl	3	1.20	1	Seattle	8	0.88	4
				Alabama	8	0.88	4
Newark/Jers C	4	1.16	2	Colorado-O	8	0.88	4
				Illinois-O	8	0.88	4
Boston	5	1.21	3	Indiana	8	0.88	4
Wash. D.C.	5	1.21	3	Kentucky	8	0.88	4
Detroit	5	1.21	3	Louisiana-O	8	0.88	4
Anaheim/Rivers	5	1.21	3	Arkansas	8	0.88	4
Houston	5	1.21	3	Arizona-O	8	0.88	4
				Maryland-O		0.88	4
Pittsburgh	6	1.09	3	Minnesota	8	0.88	4
Baltimore	6	1.09	3	Missouri-O	8	0.88	4
Cleveland	6	1.09	3	Nebraska	8	0.88	4
San Diego	6	1.09	3	N. Dakota	8	0.88	4
San Jose	6	1.09	3	Oklahoma	8	0.88	4
Nevada	6	1.09	3	Oregon	8	0.88	4
New Orleans	6	1.09	3	Tennessee	8	0.88	4
Alaska	6	1.09	3	Texas-O	8	0.88	4
Tampa/St. Pete	6	1.09	3	W. Virginia	8	0.88	4
Michigan-O	6	1.09	3	Kansas-O	8	0.88	4
Mass-O	6	1.09	3				
St. Louis	6	1.09	3	Georgia-O	9	0.77	4
Dallas/Ft. W	6	1.09	3	Idaho	9	0.77	4
California-O	6	1.09	3	Mississippi	9	0.77	4
				Montana	9	0.77	4
Kansas City	7	1.00	4	New Hampshire	9	0.77	4
New York-O	7	1.00	4	New Mexico	9	0.77	4
Ohio-O	7	1.00	4	N. Carolina	9	0.77	4
Phoenix	7	1.00	4	S. Carolina	9	0.77	4
Cincinnati	7	1.00	4	S. Dakota	9	0.77	4
Penns-O	7	1.00	4	Utah	9	0.77	4
Connecticut	7	1.00	4	Vermont	9	0.77	4
Rhode Island	7	1.00	4	Washington-O	9	0.77	4
Hawaii	7	1.00	4	Wyoming	9	0.77	4
New Jersey-O	7	1.00	4	Iowa	9	0.77	4
Florida-O	7	1.00	4				

*Inpatient hospital costs = {inpatient costs/month * geographic factor * diagnosis & duration factor * alternative care factor * life-extending drug adjustment factor * trend}

*		Probabilities Levels of Alternative Care				Expected Savings Levels of Alternative Care				Total Expected
Group	Areas	None	Low	Med.	High	None	Low	Med.	High	Savings
1	San Fran	0%	5%	15%	80%	0%	10%	20%	40%	35.5%
2	NYC/Newark	30	35	25	10	0	4	8	15	4.9
3	Other Met	15	20	45	20	0	4	8	15	7.4
4	Rural	40	40	15	5	0	3	6	10	2.1

AIDS normalized factor to the national prevalence rate would overstate the estimate of seropositives in the "1975" region and understate the estimate in the "1980" region. The HIV+ factor attempts to adjust the AIDS factor in each region to reflect the percentage of the iceberg underwater relative to its exposed tip. For example, a region might have a normalized AIDS factor of 3.0, but since the tip of the iceberg is greater than the national norm because of an earlier initial infection year, the HIV+ adjusted factor might be only 2.6.

These factors were developed using the progression rates presented in Table 8 of the Cowell-Hoskins paper [3] in combination with the number of new HIV infections by year from Appendix 1 [4]. The ratio of reported new AIDS cases in 1987 to total seropositives was determined for the initial infection years of 1975, 1977, 1978, and 1980. These ratios were the basis for the HIV+ factors for these years. The actual factors were derived after assigning an initial infection year to each geographic region.

The employed and insured percentage is also region-specific, adjusting the general population prevalence rate to reflect the likelihood of the infected individual being employed and having group insurance. The factors were based on a process developed by Todd Swim for the HIAA/ACLI AIDS Task Force, which reviewed regional AIDS claims by risk group and race using data obtained from the CDC Public Information Data Set. He then assigned probabilities of employment and insurance to each cell to develop regional probabilities. For example, California would exhibit a high relative probability because of the low incidence of IV drug user AIDS cases. Conversely, New York would have a low relative probability because of the higher incidence of IV drug users. The aggregate mean for the toal U.S. was that 64 percent of AIDS cases were expected to be covered by a group medical plan.

Assuming a block of insured group employees is 62.5 percent male, the aggregate expected prevalence rate for this block is 0.67 percent using the 1.67 percent male rate calculated above (0.67% = 1.67% * 62.5% * 64% employed and insured). The modeled geographic region prevalence rates will vary around this aggregate rate due to the region-specific assumptions.

B. HIV Stage and Duration within Stage

It is important in modeling the medical costs associated with HIV to also model the progression through the HIV stages as costs will vary by stage. In modeling an in-force block of group insurance lives, an assumption must be made as to the HIV stage at which the infected lives will enter the model.

Using the same methodology developed for the HIV+ normalized factor, the distribution by the four stages as presented in Cowell-Hoskins (HIV+, LAS, ARC, and AIDS) can be determined for each geographic region given an assumed initial infection year. In addition, estimates can be made for the distribution of duration within stage. Each HIV-infected life is assigned a stage and duration using random numbers, and this information is then passed to the cost module.

C. New Seropositives

The model implicitly assumes that there is no change in the total number of insured employees throughout the projection period. However, the model does provide for seronegative lives that will become seropositive (that is, seroconversion) in future years. These lives will enter the cost module in the seroconversion year beginning in the first stage and duration.

The methodology used was to develop ratios of new seropositive lives for each future year to the living 1987 seropositives using the Cowell-Hoskins report [5]. For example, the number of new seropositives in 1988 is 34 percent of the infected population alive at the end of 1987. The model generates a random number between zero and one for each 1987 in-force infected life, and if it is less than 0.34, a new seropositive is "cloned" to enter the model in 1988 (with the same geographic region as the in-force life). This same process is repeated for each infected in-force life for every projection year allowing for new seropositives to enter the model throughout the projection period. The month of the year the cloned life enters the model is determined randomly.

II. *Cost Module*

The cost module determines the infection path and rate of progression for each infected life passed from the prevalence module. The cost module also calculates monthly medical and disability charges and a death benefit if death occurs prior to the end of the projection period. These costs are summarized allowing various types of analysis. The characteristics of each modeled life, its path, and its rate of progression can be saved to permit deterministic sensitivity testing of alternative assumptions.

A. Progression through the HIV Stages

The progression through the HIV stages is modeled independently for each life using Monte Carlo techniques. Monthly progression rates were

derived from the periodic rates as presented in Table 5 of the Cowell-Hoskins report [6]. The monthly rates will therefore vary by HIV stage and duration within stage and are constrained by the assumptions documented by Hoskins in Section 4 of his report [7]. The starting point in the model of an infected life can be any stage or duration, and the life is modeled until the end of the projection period or death.

Within each HIV stage, substages have been defined to allow cost variations resulting from the several manifestations of the virus in terms of diagnosis and/or symptoms (Table 2). The virus is assumed to manifest itself by affecting either the central nervous system or the immune system. The probability of progressing to the next HIV stage is assumed to not vary by substage (except in the AIDS stage as explained below), and the substage within a stage is determined randomly. The AIDS substage distribution is based on the CDC Weekly Surveillance Report, adjusted for the assumption that dementia is the primary diagnosis of 5 percent of the AIDS cases.

The progression rates from AIDS to death (Table 3) are adjusted to reflect the different expected lifetimes by AIDS diagnosis. The adjustment is made using relative factors applied to the aggregate AIDS-stage progression rates. These factors vary by duration and will result in significant variation by diagnosis, even though the expected aggregate rate remains unchanged. The adjustment factors for PCP, Kaposi's sarcoma, and "other" diseases were derived from the paper by Rothenberg et al. [8] and ignores the influence of other risk variables on the diagnosis. The dementia factors were calculated assuming a uniform rate of progression that produces an expected lifetime from AIDS until death equal to nine months.

There is also an adjustment made to the progression rates if the modeled life is being administered a life-extending drug (LED), such as AZT. The factors (Table 3) assume the effectiveness of the drug wears off over time. They were developed in part based on a paper by Fischl et al. [9]. The model assumes the drug is used only in the ARC and AIDS stages with differing utilization rates that vary by substage. Utilization is determined randomly for each life, and if used, the drug is assumed to be used until death. The initial utilization of the drug is assumed to be the first month of the ARC or AIDS stage.

B. Monthly HIV Costs

Each month, costs are determined for several types of group life, medical, and disability coverages. These costs will vary according to the HIV stage

TABLE 2

Model Treatment Stages

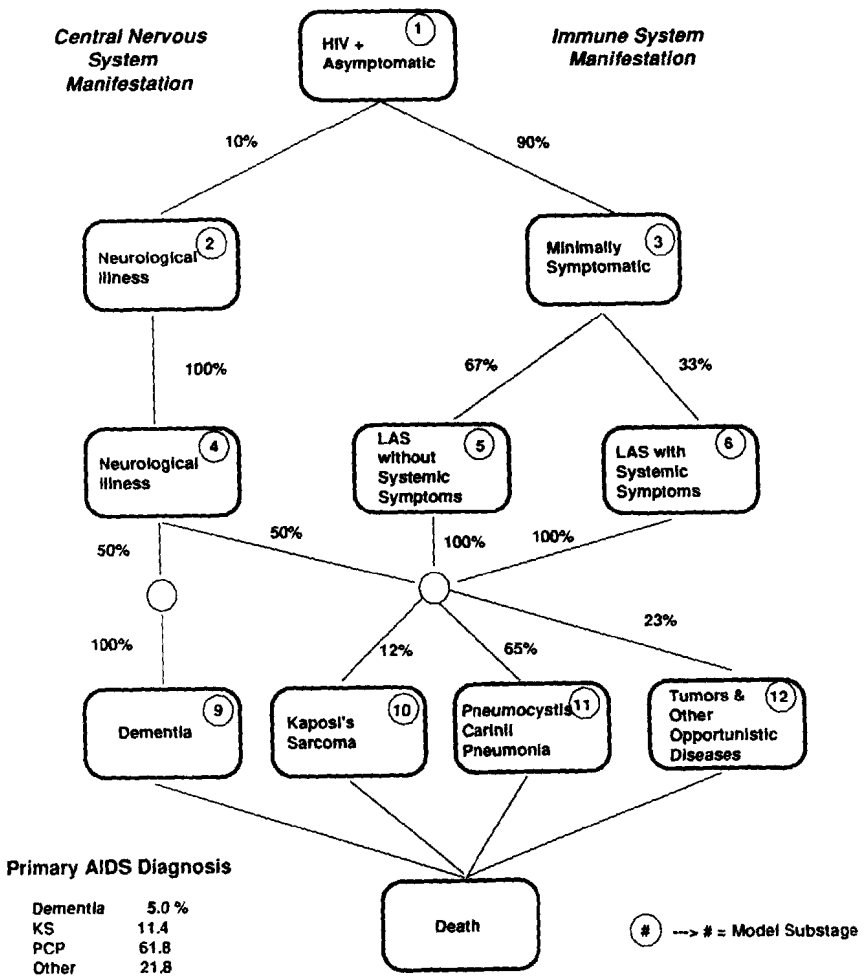


TABLE 3

MODEL PROGRESSION RATE FACTORS

Progression Rates to Next Stage (Cowell-Hoskins) (A)

	Stage 1b (HIV+)	Stage 2a (LAS)	Stage 2b (ARC)	Stage 3 (AIDS)	Cumulative Mortality at End of Period since Onset of AIDS
First six months	10%	15%	5%	26%	26.0%
Second six months	50	30	5	26	45.2
Second year	45	35	45	45*	69.1
Third year	20	35	15	35	80.4
Fourth year+	20	20	20	25	85.3 (4th)
					89.0 (5th)

Progression Rate Reduction Factors If Life-Extending Drug Used (B)

	Stage 1b (HIV+)	Stage 2a (LAS)	Stage 2b (ARC)	Stage 3 (AIDS)	Cumulative Mortality at End of Period since Onset of AIDS
First six months	0%	0%	80%	80%	5.2%
Second six months	0	0	60	60	15.1
Second year	0	0	40	30*	41.8
Third year	0	0	20	10	60.1
Fourth year+	0	0	10	0	70.1 (4th)
					77.6 (5th)

Progression Adjustment Factors during AIDS by HIV-Related Disease (C)

	Dementia	Kaposi's	PCP	Other
First six months	1.42	0.52	0.98	1.15
Second six months	1.42	0.52	0.98	1.15
Second year	2.27	0.77	1.10*	0.70
Third year	5.54	1.07	0.94	0.85
Fourth year+	6.89	0.92	0.81	1.43

Expected Number of Months to Progress to Next Stage

HIV+ Cowell-Hoskins	27.0 months	
LAS Cowell-Hoskins	32.9	
ARC Cowell-Hoskins	47.6	
AIDS Cowell-Hoskins	25.2	HIV+ to Death = 11.1 years
AIDS C-H – LED	41.7	

Monthly Progression Rate Formula

[1 – {1 – [A * (1 – B)]} ** 1/6 (or 1/12)] * C

"**" example = [1 – {1 – [0.45 * (1 – 0.3)]} ** 1/12] * 1.10

= [1 – {1 – [0.315]} ** 1/12] * 1.10

= [1 – 0.969] * 1.10 = 0.0341

the life is in and the diagnosis/symptom (substage) within the stage. Additionally, the costs will be adjusted for items such as geographic area, level of alternative care applied within that area, trend factors, duration within stage, life-extending drug usage, income, and antiselection. Some of the charges are calculated as a fixed cost per month; for others, whether or not the cost is incurred is determined on a random basis. The medical costs are assumed to be the additional costs that are caused by the HIV infection before the application of any plan design factors such as coinsurance and deductibles. A detailed discussion of each modeled cost type is provided below. The actual dollar assumptions are displayed in Table 4. Unless otherwise noted, the cost and probability estimates are based upon Lincoln National data and/or estimates.

Outpatient Drugs. These charges represent prescription drugs taken on an outpatient basis. They are a fixed monthly cost with an annual trend factor applied.

Psychological/Psychiatric Treatment. These charges represent the monthly cost of psychological or psychiatric counseling. The costs are assumed to be $50 per session. The utilization of counseling services is determined randomly each month for each life based on probabilities that increase as the life progresses through the HIV stages. Also, higher probabilities are assumed for patients with central nervous system symptoms. A trend factor is applied annually.

Hospital Inpatient. These charges represent all costs associated with inpatient hospital confinement. The model was originally designed to calculate costs based on probability of admission, average length of stay, and cost per day but was modified for simplicity to a monthly fixed cost that varies by substage. The monthly fixed costs are adjusted for the following factors: geographic area, AIDS diagnosis and duration, level of alternative care, adjustment for LED, and a trend factor. The formula is shown in Table 1.

The geographic area of the modeled life is determined in the prevalence module. The geographic areas have been reduced to nine "cost areas" to simplify the reflection of area cost differences. These cost areas are made up of geographic areas that have been grouped together based on similar area cost factors.

The AIDS diagnosis factor and the AIDS duration factor have been combined into one factor. It is used to adjust inpatient hospital costs for two variables in the AIDS stage. The first is to adjust the standard monthly cost assumption to reflect differing levels of costs, utilization, and treatment patterns by AIDS diagnosis. The second adjustment reflects the higher costs

TABLE 4

MODEL MONTHLY COST ASSUMPTIONS

Frankfurt Stage	Stage 1b (HIV+)	Stage 2a (LAS)		Stage 2b (ARC)			Stage 3 (AIDS)				Annual Trend
Model Substage	1 HIV+	2 CNS	3 Min. Sym	4 CNS	5 w/o Sym	6 w/Sym	9 Demen	10 KS	11 PCP	12 Other	Years 2-4/5-10
Outpatient drugs ($)	10	40	10	40	10	40	75	50	60	75	8%/5%
Psychl/psycho trmt ($)	50	50	50	75	50	50	150	150	50	100	4%/4%
Probability*	0.02	0.35	0.05	0.50	0.05	0.20	0.75	0.60	0.40	0.50	
Hospital inpatient ($)	0	300	0	600	0	300	1250	1250	1250	1250	8%/5%
Disease adj factors											
First 2 months	—	—	—	—	—	—	1.4	1.2	3.8	1.6	
Other months	—	—	—	—	—	—	0.6	0.3	1.0	0.4	
Last 4 months	—	—	—	—	—	—	2.5	2.0	3.2	2.3	
Outpatient/diagnostic	10	100	20	100	40	80	240	160	200	160	12%/5%
Disease adj factors											
First 2 months	—	—	—	—	—	—	1.0	0.6	0.5	0.6	
Other months	—	—	—	—	—	—	1.0	1.0	1.0	1.0	
Last 4 months	—	—	—	—	—	—	1.0	0.75	0.5	0.75	
Life-extending drug ($)	0	0	0	0	0	800	800	800	800	800	0%/0%
Probability†	0	0	0	0.05	0	0.20	0.05	0.30	0.60	0.30	
Hosp. in savings (%)	0	0	0	35	0	0	35	50	50	50	
STD probabilities*	0	0	0	0.08	0.02	0.04	0.25	0.08	0.12	0.10	
LTD probabilities†	0	0	0	0	0	0	0.80	0.20	0.40	0.30	

*Probabilities of utilization determined monthly.

†Probabilities of utilization determined only once per stage; once utilization begins, continues for remainder of life.

TABLE 4 — *Continued*

"Other" Benefit Assumptions:

LIFE — Death Benefit = $20,000 (1 × salary). Probability of AIDS claimant having life coverage = 100%. Annual Trend = 4%.

STD (Weekly Income) — Monthly Benefit = $750 (assumes 60% payout for 3/4 of month). If AIDS claimant has STD coverage but no LTD coverage, a random number is generated each month to determine whether STD benefits are paid that month. If the claimant has STD and LTD coverages and the LTD benefit will be paid (see below), then STD benefits are assumed to be paid for the six months prior to the LTD benefits beginning. If no LTD benefits will be paid, STD continues to be determined each month randomly. Annual Trend = 4%.

LTD — Monthly Benefit = $667 (assumes 40% payout). If AIDS claimant has LTD coverage, a random number is generated when the claimant reaches the AIDS stage and is compared to the probability of being disabled under the substage within the AIDS stage. If the claimant will be disabled, LTD benefits are assumed to begin seven months after the onset of AIDS and continue until death. Annual Trend = 4% (trend is not applied once benefits commence).

All three benefits are also adjusted to recognize that these benefits vary by the income of the claimant. The following income distribution is used to adjust the $20,000 average salary assumed in all the benefit above. It is determined randomly for each claimant. The expected income level using the distribution below is $26,850.

Factor	Income	Probability	Cumulative Probability
0.50	$10,000	5%	5%
0.65	13,000	10	15
0.85	17,000	15	30
1.00	20,000	35	65
1.50	30,000	15	80
2.00	40,000	10	90
3.00	60,000	5	95
4.00	80,000	5	100

The death benefit is additionally adjusted to reflect that there is the possibility of some antiselection resulting from choices group insureds can often make in terms of multiples of salary for their death benefit. This is reflected using the factors from the following selection distribution, once again determined randomly for each claimant.

Factor	Probability	Cumulative Probability	
1.0	80%	80%	
1.5	10	90	
2.0	5	95	(exp. factor = 1.2)
2.5	2	97	
3.0	2	99	
4.0	1	100	

that are usually incurred immediately after diagnosis and immediately preceding death. The model assumes such factors are applicable in the first two months after diagnosis and the four months prior to death. The factors were based on studies published by Kizer [10] and Scitovsky and Rice [11].

Each modeled life is randomly determined to utilize one of four levels of alternative care (Table 1). These levels — no care, low, medium, and high — vary by geographic region. Corresponding to the level of care for each region is the assumed savings in terms of the percentage reduction in hospital inpatient costs due to the use of alternative care facilities and alternative care treatment. The alternative care network in the San Francisco area is assumed to have the greatest utilization and savings, while alternative care in "rural" areas is assumed to be less utilized and developed. These factors would be significantly modified if a specific company was being modeled to reflect the company's ability to manage large claims.

A life-extending drug factor is applied to hospital inpatient costs if the life is using such a drug. The hospital costs are assumed to be reduced because of less frequent admissions and severity. The assumptions are a 35 percent reduction during the ARC stage and a 50 percent reduction during AIDS.

Hospital Outpatient/Diagnostic. These charges represent the costs incurred for hospital outpatient visits, physician visits, home health care, and laboratory/diagnostic testing costs. The geographic factor and a trend factor are applied. Additionally, a diagnosis and duration factor is applied during the AIDS stage. These factors are greatest during the months when the inpatient diagnosis and duration factors are the least severe. These factors were based on the Scitovsky and Rice study.

Life-Extending Drug. The costs of using a drug like AZT are assumed to be $650/month plus an additional $150/month for increased physician visits, tests, transfusions, and complications arising from side effects. These costs reflect the recently announced price reduction by the manufacturer of the drug. Utilization probabilities vary by substage, and usage is assumed to be only during the ARC and AIDS stages (Table 4). The utilization of the drug is determined randomly for each modeled life, and if the drug is used, it is assumed to be used until death. Using the assumed LED utilization probabilities, approximately 50 percent of the modeled infected lives will ultimately use the drug. This is probably a reasonable result currently, but most likely will understate utilization rates in the future. Offsetting this understatement, however, is some indication that many users will be forced to discontinue use of the drug due to the severity of the side effects.

Life and Disability. The model calculates monthly short-term and long-term disability benefits using a stochastic process, and a death benefit is calculated upon progression to death from the AIDS stage. All three benefits have an income factor applied, and the death benefit has a selection factor as well. The assumptions and processes for these benefits are documented in Table 4.

The model can vary the percentage of insureds eligible for the life and disability benefits vis-a-vis medical coverage (if used for company specific modeling), but for this paper it was assumed 100 percent of the modeled lives were eligible for all benefits.

ANALYSIS OF MODELED RESULTS

III. *Analysis of Mean HIV Lifetime Costs and Costs by Duration*

This analysis of modeled results centers on the average progression rates and costs that are obtained when a large number of lives are run through the model from seroconversion until death. The review of these averages provides an idea of the implicit progression and cost assumptions the model will produce from the consolidation of all the explicit assumptions. The mean rates and costs should be viewed as the lifetime expected values in terms of year-end 1987 rates of progressions, treatment patterns and cost structure, drug usage, and so on. Therefore, these values will be different than averages based on 1986 knowledge and certainly will be different from estimates made in 1989 or later.

A cohort of 1,000 lives was run through the model with all lives entering the model as new seropositives (stage 1, duration 1) and continuing until death. There were no new seropositive lives entering the model in future years, and costs were kept in year-end 1987 terms by disengaging trend or inflation assumptions. The assumed geographical distribution of the cohort was the expected HIV+ distribution if a block of group insured lives had the same distribution as the U.S. general population. Each modeled life was assumed to be eligible for all life, disability, and medical benefits.

A. Mean HIV Lifetime Costs and Durations

Table 5 shows the mean lifetime costs (in year-end 1987 terms) for the 1,000 lives for medical, disability, and life coverages. The mean lifetime cost for all three coverages was $117,600. The mean lifetime medical cost

TABLE 5

MEAN LIFETIME COSTS AND PATH DURATIONS
1,000 NEWLY INFECTED HIV LIVES — YEAR-END 1987 ASSUMTIONS

	Lifetime Costs ($000's)					
			Values from 1,000 Modeled Lives			
	Mean	Standard Deviation	Min.	5%	95%	Max.
All Cases (1,000)						
Total life	$30.3	$23.1	$10.0	$10.0	$80.0	$320.0
Short-term disability	6.2*	7.3	0.4	0.6	19.5	87.0
Long-term disability	8.8*	33.3	0.4	1.3	109.4	696.3
Medical excluding LED	50.8	45.9	1.9	9.3	150.4	335.7
Life-extending drug	21.5	36.2	0.8	5.6	127.2	229.6
Total medical	72.3	74.5	1.9	9.3	210.0	468.6
Cases w/o LED (497)						
Medical excluding LED	39.7	38.3	1.9	226.1		
Life-extending drug	0.0	0.0	0.0	0.0		
Total medical	39.7	38.3	1.9	226.1		
Cases with LED (503)						
Medical excluding LED	61.8	50.0	4.0	335.7		
Life-extending drug	42.8	41.3	0.8	229.6		
Total medical	104.6	89.5	4.8	468.6		

	Path Durations (in Months)			
	Mean	Standard Deviation	Minimum	Maximum
All Cases (1,000)				
HIV+	29.1	43.9	1.0	412.0
LAS	33.5	40.4	1.0	255.0
ARC	48.8	48.1	1.0	273.0
AIDS	35.7	42.6	1.0	286.0
Total	147.1	86.5	21.0	516.0
Cases w/o LED (497)†				
ARC	46.7	49.4	1.0	268.0
AIDS	24.7	34.2	1.0	243.0
Total	136.1	84.7	21.0	451.0
Cases with LED (503)†				
ARC	50.8	46.8	1.0	273.0
AIDS	46.6	47.2	1.0	286.0
Total	157.9	87.0	21.0	516.0

*For the 956 cases actually incurring a STD claim, the mean was $6,500. For the 295 cases actually incurring an LTD claim, the mean was $29,900.
†The life-extending drug is assumed to be used only in the ARC and AIDS stages, so no path durations are shown for the HIV+ and LAS stages.

totals $72,300, consisting of $50,800 for all medical benefits except the life-extending drug, and $21,500 for the drug. The $72,300 value must be interpreted with the following considerations. The costs are lifetime costs rather than annual and represent total charges before the application of coinsurance, deductibles, and so on. Also, over 20 percent of the costs were incurred prior to reaching the AIDS stage; a good percentage of these pre-AIDS costs historically have probably not been identified as HIV claims when collecting per life data. Finally, the costs include, for approximately 50 percent of the cohort, the full lifetime impact of taking a life-extending drug. The full lifetime cost of the drug would not yet be reflected in present average cost data collected by insurance companies. The mean cost for the lives that did not use the LED was $39,700. Those lives using the drug had costs averaging more than 2.5 times the costs of those who did not; the mean of $104,600 includes an average LED cost of $42,800.

The mean short-term disability (STD) benefits were $6,200 per life for the entire cohort (41 percent of disability costs), while the mean long-term benefits (LTD) were $8,800 per life (59 percent of disability costs). For the 956 lives actually incurring a STD claim, the mean benefit was $6,500. The model produced 295 lives incurring a LTD claim averaging $29,900 per life. The mean life benefit was $30,300 (all 1,000 lives remained in the model until death). Also shown in Table 5 is the mean duration in each HIV stage for all lives, lives using LED, and lives not using LED. For this trial of 1,000 lives, the duration in the AIDS stage is 22 months longer when using the LED.

Table 6 provides a percentage breakdown of the Table 5 lifetime medical costs by various categories. These categories are HIV stage, AIDS stage manifestation, medical benefit, and region. Of particular note is the 22.7 percent of medical costs incurred in the pre-AIDS stages of the disease. Also note the much higher mean costs for PCP are largely due to the greater utilization of the LED than the other diagnoses.

B. Lifetime HIV Costs by Duration

Table 7 shows the cumulative percentage of ultimate incurred costs by year since seroconversion for life, disability, and medical. Also shown is the breakdown of medical costs by HIV stage. The table indicates that 50 percent of ultimate costs are not incurred for the life, disability, and medical coverages until the eleventh year following seroconversion.

TABLE 6

BREAKDOWN OF TOTAL LIFETIME MEDICAL COSTS, INCLUDING LED
1,000 NEWLY INFECTED HIV LIVES

HIV Stage	HIV +	LAS	ARC	AIDS	Total
Distribution (%)	0.9	4.1	17.7	77.3	100.0
Mean ($)	650	2,950	12,800	55,900	72,300
AIDS Stage Diagnosis	Dementia	Kaposi's	PCP	Other	Total
Distribution (%)	4.0	8.0	73.7	14.3	100.0
Mean ($)	66,100	59,800	84,000	46,000	72,300

Medical Benefit	Outpatient Drugs	Psychiatric Treatment	Inpatient Hospital	Outpatient Diangosis	LED	Total
Distribution (%)	5.6	2.5	45.7	16.4	29.8	100.0
Mean ($)	4,000	1,800	33,100	11,900	21,500	72,300

Cost Region	Distribution (%)	Mean ($)*
New York City	14.4	86,600
Very high	17.1	80,300
S.F./Oakland	7.6	64,700
Newark/J.C.	2.3	75,200
High	12.8	75,500
Medium high	15.5	70,700
Medium low	11.1	68,800
Low	15.0	63,800
Very low	4.2	59,300
	100.0	72,300

*All regions include $21,500 for life-extending drug costs.

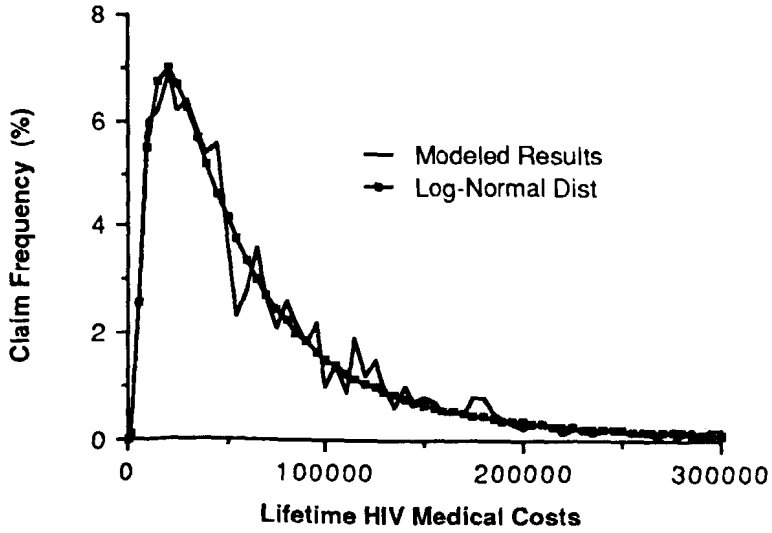
TABLE 7

CUMULATIVE PERCENT OF ULTIMATE INCURRED COST BY YEAR OF INCURRAL
1,000 NEWLY INFECTED HIV LIVES

Year Since Seroconversion	Life	Total Disability	Total Medical	Total Medical by HIV Stage			
				HIV +	LAS	ARC	AIDS
1	0.0%	0.0	0.6%	33.8%	5.5%	0.3%	0.0%
2	0.5	0.7	2.2	48.2	21.3	3.7	0.4
3	1.9	3.0	5.5	57.8	34.6	10.6	2.2
4	6.1	7.4	11.0	65.8	45.4	18.7	6.7
5	12.3	13.0	17.3	72.4	55.0	26.7	12.5
6	19.1	19.1	23.8	77.8	63.8	33.9	18.8
7	27.0	25.3	30.4	82.1	71.2	40.8	25.3
8	32.7	31.4	36.5	85.7	77.3	47.3	31.3
9	40.5	38.3	42.7	88.6	82.2	53.3	37.6
10	46.6	44.3	48.4	90.6	85.8	59.2	43.5
11	51.8	50.7	53.9	92.2	88.6	65.0	49.1
12	56.0	56.7	59.0	93.4	90.8	70.3	54.4
13	62.0	61.9	63.9	94.5	92.6	74.9	59.6
14	65.8	66.6	68.6	95.3	94.1	78.4	64.7
15	71.4	70.8	72.8	96.1	95.2	81.2	69.5
16	75.2	74.9	76.6	96.7	96.1	83.6	73.7
17	78.2	78.3	79.7	97.2	97.0	85.8	77.2
18	80.9	81.5	82.7	97.5	97.9	87.6	80.5
19	83.5	84.1	85.2	97.9	98.4	89.5	83.3
20	86.7	86.3	87.4	98.2	98.8	91.2	85.7
21	88.0	88.0	89.3	98.4	99.1	92.9	87.9
22	90.0	89.5	91.0	98.7	99.4	94.3	89.8
23	91.4	90.9	92.4	98.9	99.7	95.4	91.2
24	92.5	92.1	93.5	99.1	99.8	96.4	92.5
25	93.2	93.1	94.5	99.3	99.8	97.3	93.5
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Percentage after 25 Years	6.8%	6.9%	5.5%	0.7%	0.2%	2.7%	6.5%
Total Cost (000,000)	$30.3	$15.0	$72.3	$0.6	$3.0	$12.8	$55.9

C. Lifetime HIV Medical Cost Distribution

The frequency distribution by total (including LED) lifetime medical costs is shown in Table 8. The mean and median values were $72,300 and $46,100, respectively, with a mode of $24,000. The distribution exhibits properties of a log-normal distribution with parameters of 10.760 for the mean and 0.9528 for the standard deviation. The following graph illustrates the modeled lifetime claim frequency distribution plotted against the log-normal distribution.



D. Lifetime HIV Duration Distribution

The stochastic progression processes used in the model add a degree of continuity to the possible progression paths infected lives can follow from seroconversion to death. Each life follows a unique progression path that varies by duration within the four stages, HIV manifestation, and LED utilization. Even though the model requires passage through all four HIV-disease stages prior to death, the stochastic progression model more effectively simulates the many possible paths and durations an actual HIV case could follow than a deterministic model.

TABLE 8

TOTAL LIFETIME HIV MEDICAL CLAIM DISTRIBUTION
1,000 NEWLY INFECTED HIV LIVES

Total Lifetime Medical Cost	Percentage	Cumulative Percentage	Total Lifetime Medical Cost	Percentage	Cumulative Percentage
$ 1,250	0.1%	0.1%	180,000	0.8%	93.0%
5,000	2.7	2.8	185,000	0.5	93.5
10,000	6.0	8.8	190,000	0.4	93.9
15,000	6.2	15.0	195,000	0.3	94.2
20,000	6.9	21.9	200,000	0.2	94.4
25,000	6.2	28.1	205,000	0.3	94.7
30,000	6.4	34.5	210,000	0.3	95.0
35,000	5.8	40.3	215,000	0.3	95.3
40,000	5.4	45.7	220,000	0.1	95.4
45,000	5.6	51.3	225,000	0.2	95.6
50,000	3.6	54.9	230,000	0.2	95.8
55,000	2.3	57.2	235,000	0.1	95.9
60,000	2.8	60.0	240,000	0.2	96.1
65,000	3.6	63.6	245,000	0.2	96.3
70,000	2.7	66.3	250,000	0.2	96.5
75,000	2.1	68.4	255,000	0.1	96.6
80,000	2.6	71.0	260,000	0.1	96.7
85,000	2.2	73.2	265,000	0.1	96.8
90,000	1.8	75.0	280,000	0.1	96.9
95,000	2.2	77.2	285,000	0.2	97.1
100,000	1.0	78.2	295,000	0.5	97.6
105,000	1.4	79.6	310,000	0.2	97.8
110,000	0.9	80.5	320,000	0.2	98.0
115,000	1.9	82.4	330,000	0.1	98.1
120,000	1.2	83.6	340,000	0.1	98.2
125,000	1.5	85.1	350,000	0.1	98.3
130,000	1.0	86.1	360,000	0.2	98.5
135,000	0.6	86.7	370,000	0.1	98.6
140,000	1.0	87.7	390,000	0.1	98.7
145,000	0.7	88.4	400,000	0.3	99.0
150,000	0.8	89.2	410,000	0.3	99.3
155,000	0.7	89.9	420,000	0.1	99.4
160,000	0.5	90.4	430,000	0.2	99.6
165,000	0.5	90.9	440,000	0.1	99.7
170,000	0.5	91.4	460,000	0.2	99.9
175,000	0.8	92.2	470,000	0.1	100.0

Table 9 presents the lifetime HIV duration distribution (seroconversion to death) for the 1,000 lives modeled. The durations range from 21 to 516 months with a mean of 147 months and a median of 125 months.

TABLE 9

TOTAL LIFETIME HIV DURATION DISTRIBUTION
(SEROCONVERSION TO DEATH)
1,000 NEWLY INFECTED HIV LIVES

Total Lifetime HIV Duration (Months)	Percentage	Cumulative Percentage	Total Lifetime HIV Duration (Months)	Percentage	Cumulative Percentage
1–10	0.0%	0.0%	261–270	1.7%	90.5%
11–20	0.0	0.0	271–280	1.0	91.5
21–30	0.8	0.8	281–290	1.2	92.7
31–40	2.0	2.8	291–300	0.5	93.2
41–50	5.0	7.8	301–310	0.3	93.5
51–60	5.5	13.3	311–320	0.3	93.8
61–70	6.1	19.4	321–330	1.0	94.8
71–80	5.6	25.0	331–340	0.7	95.5
81–90	6.7	31.7	341–350	0.9	96.4
91–100	4.7	36.3	351–360	0.8	97.2
101–110	5.0	41.3	361–370	1.0	98.2
111–120	5.3	46.7	371–380	0.4	98.6
121–130	4.7	51.4	381–390	0.3	98.9
131–140	4.2	55.6	391–400	0.1	99.0
141–150	3.5	59.1	401–410	0.3	99.3
151–160	4.2	63.3	411–420	0.0	99.3
161–170	3.6	66.9	421–430	0.0	99.3
171–180	4.7	71.6	431–440	0.1	99.4
181–190	3.2	74.8	441–450	0.2	99.6
191–200	2.9	77.7	451–460	0.2	99.8
201–210	2.5	80.2	461–470	0.0	99.8
211–220	2.7	82.9	471–480	0.0	99.8
221–230	1.9	84.8	481–490	0.0	99.8
231–240	1.5	86.3	491–500	0.0	99.8
241–250	1.1	87.4	501–510	0.1	99.9
251–260	1.4	88.8	511–520	0.1	100.0

IV. *Analysis of Five-Year, In-Force Block Projection*

The second analysis of modeled results looks at the expected charges incurred by an in-force block of group insurance over a five-year projection period of 1988 to 1992. This projection will provide an estimate of the total costs the block of HIV-infected lives will incur by calendar year of incurral.

This type of information is valuable for several reasons. First, these estimates can be useful in developing trend factors for the rerating process. Second, the projections can be used in both the financial and strategic planning functions. The additional claim costs can be incorporated into the financial planning process and can provide an "expected" measure to which actual HIV claim experience can be monitored. On the strategic side, the modeled results give an estimate as to the total costs of HIV on a block of business and alert management as to the full extent of their potential impact. With these projections, management can better plan its response to HIV in terms of rerating, underwriting, alternative care management, product design, and regulatory, legislative, and social implications. Finally, sensitivity testing of the results can provide some validation of the financial and strategic responses management might choose to implement.

The block of group business modeled for this analysis is assumed to be made up of 150,000 employees distributed geographically the same as the U.S. general population. With prevalence module assumptions (see Section IIA) of 1,250,000 total U.S. seropositives at year-end 1987 and a 62.5 percent male employee distribution, the module calculates the current number of in-force seropositives to be 1,000 (a prevalence rate of 0.67%). These lives are also assigned an HIV stage and a duration within the HIV stage. Although the size of the in-force block is assumed to remain the same over the projection period, lives becoming seropositive in future years are modeled. New seropositives entering the model in years 1988 through 1992 are approximately 350, 400, 425, 390, and 390, respectively. These lives enter the model in a random month during the year of seroconversion starting in the HIV+ stage with a duration of one. All the modeled lives were eligible for all coverages. Trend factors were applied to benefits in 1989 and beyond (Table 4).

Following are four types of analysis performed on the five-year projections. First, an HIV claim cost distribution is developed and compared to a major medical distribution. Second, the projected total costs are presented by year and coverage. Also shown is a breakdown of medical costs by several categories. Next, sensitivity analysis is performed to the base projection using alternative assumptions. Finally, the variability of the total costs of the cohort for 1988 is analyzed.

A. 1988 HIV Claim Cost Analysis

The annual claim costs for the 1,346 HIV infected lives (1,000 in-force and 346 new seropositives) were developed for the first year (1988) of the projection. Table 10 shows the medical cost distribution by frequency for the 1,346 HIV lives. The costs include the life-extending drug charges if utilized. By frequency, more than 50 percent of the annual costs were under $350 and 90 percent were under $5,000. This reflects the large percentage of pre-AIDS stage lives.

From this claim probability distribution (and the 99.1 percent of employees not incurring an HIV claim), a claim cost table by deductible was developed for the HIV lives. This is presented in Table 11. The HIV claim probability distribution was then convoluted with a projected 1988 adult, comprehensive major medical claim probability distribution. The last column in Table 11 represents the additional claim cost percentage by deductible of the convoluted HIV and major medical distribution claim costs relative to the major medical distribution claim costs. The additional HIV morbidity of 2.47 percent is greatest at the $5,000 deductible, declining to no additional morbidity at the $50,000 deductible. (The maximum annual claim in 1988 that could be generated with the model assumptions is around $55,000.) The additional annual morbidity is also shown for plans with various deductibles and stop-loss limits, all close to the 2.0 percent mark. Although no specific claim cost analysis was performed, the additional morbidity would be expected to increase at a rate in the neighborhood of 40 percent per year in the years beyond 1988 (see below).

B. Five-Year Projection of Costs

Table 12 shows the 1988–1992 projection of total HIV costs by coverage for the 150,000-insured-employee cohort (the projections are actually the means of five independent trials). Again the medical amounts are the total additional charges for the modeled lives before applying any plan design features. The annual rates of increase over the the projection period are 45 percent for life, 50 percent for disability, and 49 percent for medical. Taking out the impact of trend, the rates become 41 percent for life, 44 percent for disability, and 39 percent for medical.

For the five-year period, the additional HIV-related medical charges for the 150,000 insured lives were $32.5 million, or $217 per employee. Short-term and long-term disability costs for the five years were $5.5 million, or $37 per employee. The total life benefits were $11.0 million, or $73 per

TABLE 10

1988 ANNUAL HIV MEDICAL CLAIM PROBABILITY DISTRIBUTION
1,346 IN-FORCE HIV-INFECTED LIVES FROM 150,000 INSURED EMPLOYEES

Total Annual Medical Cost	Annual Percentage	Cumulative Annual Percentage
$25	4.23%	4.23%
75	4.83	9.06
125	4.98	14.04
175	3.86	17.90
225	9.81	27.71
275	15.16	42.87
325	10.48	53.34
375	6.84	60.18
425	5.27	65.45
475	4.83	70.28
550	4.75	75.04
650	3.27	78.31
750	2.75	81.05
850	1.86	82.91
950	0.15	83.06
1,125	0.45	83.51
1,375	0.30	83.80
1,625	0.22	84.03
1,875	0.30	84.32
2,250	0.59	84.92
2,750	0.89	85.81
3,500	2.23	88.04
4,500	2.01	90.04
5,500	1.11	91.16
6,500	1.19	92.35
7,500	0.89	93.24
8,500	0.89	94.13
9,500	0.30	94.43
10,500	0.52	94.95
11,500	0.37	95.32
12,500	0.45	95.77
13,500	0.45	96.21
14,500	0.67	96.88
15,500	0.15	97.03
16,500	0.07	97.10
17,500	0.37	97.47
18,500	0.15	97.62
19,500	0.15	97.77
21,000	0.45	98.22
23,000	0.30	98.52
25,000	0.37	98.89
27,000	0.15	99.03
29,000	0.30	99.33
31,250	0.07	99.41
33,750	0.15	99.55
36,250	0.22	99.78
38,750	0.07	99.85
41,250	0.07	99.93
46,250	0.07	100.00

TABLE 11

1988 HIV MEDICAL CLAIM COST AND ADDITIONAL MORBIDITY

Annual Deductible	Annual Claim Cost	Percentage of $0 Deductible Cost	Monthly Claim Cost	Percentage Additional HIV Morbidity
$ 0	$16.68	100.00%	$1.39	1.72%
250	14.70	88.16	1.23	1.91
500	13.68	82.02	1.14	1.94
1,000	12.74	76.37	1.06	2.01
1,500	12.00	71.97	1.00	2.12
2,000	11.30	67.73	0.94	2.22
2,500	10.61	63.64	0.88	2.30
3,000	9.97	59.76	0.83	2.35
5,000	7.85	47.02	0.65	2.47
7,500	5.96	35.72	0.50	2.37
10,000	4.62	27.67	0.38	2.24
15,000	2.70	16.21	0.23	1.95
20,000	1.55	9.32	0.13	1.51
25,000	0.82	4.90	0.07	1.07
30,000	0.42	2.50	0.03	0.73
35,000	0.17	1.00	0.01	0.42
40,000	0.05	0.30	0.00	0.20
45,000	0.01	0.05	0.00	0.10
50,000	0.00	0.00	0.00	0.00

ADDITIONAL HIV MEDICAL CLAIM COST FOR SEVERAL PLAN TYPES

Deductible	80/20 Up To	Percentage Additional HIV Morbidity
$ 100	$ 2,500	1.89%
250	2,500	1.96
500	5,000	2.00
1,000	5,000	2.06

employee. The additional mortality per $1000 of benefit for each of the five years 1988 to 1992 was 18.9 cents, 23.1 cents, 34.8 cents, 52.5 cents, and 71.0 cents, respectively.

Also shown in Table 12 are the medical cost distributions by year for the HIV stage, medical benefits, and cost region. The HIV stage breakdown shows the AIDS costs relative to all HIV medical costs, increasing from 51.3 percent to 64.8 percent over the projection period as the HIV-infected population begins to mature. Another way to look at this is to recognize that between 40 percent and 50 percent of medical costs are incurred in the pre-AIDS stages for an in-force block. However, the actual percentage of benefits paid for pre-AIDS claimants would be lower after the application of deductibles and coinsurance. The LED costs hover around the 20 percent

TABLE 12

FIVE-YEAR PROJECTION OF HIV COSTS AND BREAKDOWN OF MEDICAL COSTS
150,000 IN-FORCE GROUP INSURED EMPLOYEES

	1988	1989	1990	1991	1992
	Total Projected Costs ($000)				
Total Life	$ 931	$1,182	$1,853	$2,907	$ 4,087
Long-term dis.	134	240	449	645	863
Short-term dis.	255	419	598	771	1,103
Total Disability	$ 389	$ 659	$1,047	$1,416	$ 1,966
Total Medical	$2,464	$3,955	$5,744	$8,316	$12,051
	Medical Cost Breakdown (includes LED)				
HIV Stage					
HIV+	5.8%	4.4%	3.8%	3.1%	2.4%
LAS	13.5	12.5	11.0	10.2	8.2
ARC	29.4	28.7	29.2	28.5	24.6
AIDS	51.3	54.4	56.0	58.2	64.8
	100.0	100.0	100.0	100.0	100.0
Medical Benefit					
Outpatient drugs	9.3%	8.7%	8.1%	7.9%	6.8%
Psych. treatment	3.2	3.1	3.0	2.8	2.4
Inpatient hospital	47.5	46.5	45.2	47.0	53.5
Outpatient/diagnostic	21.9	22.0	23.1	22.7	19.3
Life-extending drug	18.1	19.7	20.6	19.6	18.0
	100.0	100.0	100.0	100.0	100.0
Cost Region					
New York City	16.9%	15.9%	14.7%	14.7%	15.0%
Very high	18.7	17.4	16.7	17.7	17.4
S.F./Oakland	7.9	7.7	7.2	6.8	6.9
Newark/J.C.	4.0	3.0	3.0	3.1	3.5
High	12.3	13.2	12.1	10.6	10.8
Medium high	15.0	16.7	16.6	15.7	15.4
Medium low	10.1	11.4	12.4	13.5	12.8
Low	11.8	11.5	13.2	13.7	13.6
Very low	3.3	3.2	4.1	4.2	4.6
	100.0	100.0	100.0	100.0	100.0

range for the projection period. The benefit breakdown shows consistent percentages by benefit throughout the five years. The cost region distribution shows a small relative decrease in costs in the currently high-HIV-incidence regions.

C. Five-Year Projections under Alternative Assumptions

Table 13 shows the relative cost comparisons of the five-year projections using alternative assumptions to the "standard" projection. The standard projection results were presented in Tables 10, 11, and 12. Table 13 provides the ratio of life, disability, and medical costs by year to the corresponding costs presented in Table 12. It should be noted that the alternative assumption

TABLE 13

FIVE-YEAR PROJECTION — ALTERNATIVE ASSUMPTIONS
RELATIVE COMPARISON TO STANDARD PROJECTION*

	1988	1989	1990	1991	1992
Panjer Progression Rates					
Total life	182%	209%	201%	161%	161%
Total disability	115	110	121	118	107
Medical excluding LED	104	106	113	112	104
Life-extending drug	84	92	103	112	105
Total medical	100%	103%	111%	112%	104%
LED Alternative Assumption					
Total life	50%	74%	86%	90%	74%
Total disability	91	100	104	105	105
Medical excluding LED	65	66	69	71	71
Life-extending drug	200	203	200	224	226
Total medical	89%	93%	96%	101%	99%
Alternative Care Alternative Assumption					
Inpatient hospital	87%	92%	97%	90%	87%

*Ratio of annual projected costs of the alternative assumption trials to the mean costs of the trials presented in Table 12, which were based on "standard assumptions."

projections were based on only one run due to time constraints. Because of the variability built into the model (see Section IVD), multiple runs would provide a better estimate as to the expected differences between assumptions. However, these results provide an idea as to the relative differences in costs using alternative assumptions. In many instances the results will be difficult to interpret as many factors offset one another.

This is only a small sample of the many types of alternative scenarios that could be tested; other progression rates could be modeled, cost and utilization factors updated, and geographic distributions modified. Of course, making a different assumption as to the total seropositive population in the U.S. would impact the number of modeled insured seropositives and their attendant costs proportionately.

The first alternative scenario is the prospective impact of using progression rates from the paper by Panjer [12], instead of the Cowell-Hoskins rates. The Panjer model of the Frankfurt data uses a continuous time Markov process with a constant intensity for each HIV stage. Consequently, it requires no assumption about the duration in a stage before entering the study. Cowell-Hoskins used the maximum length of the observation period in making their assumption as to the duration before entering the study. The Panjer progression rates result in a life expectancy of 7.3 years from seropositivity until death. This is substantially less than the life expectancy of 11.1 years

using the Cowell-Hoskins rates. Additionally, the Panjer AIDS stage life expectancy is 0.93 years, compared to Cowell-Hoskins' 2.10 years.

For the alternative scenario run, the Panjer data were converted to monthly progression rates, constant across all durations within a stage. Comparing the projected costs using the Panjer progression rates to the standard Cowell-Hoskins costs, Table 13 indicates the life costs are significantly greater for the Panjer rates. This would be expected with the shorter life expectancies, especially in the final AIDS stage. Disability and medical costs are slightly higher as well. This results from the infected lives progressing to the ARC and AIDS stages at a faster pace and shifting the incurral of the more severe medical costs assumed to occur near death to earlier projection years when compared to the standard projection. This is offset somewhat by the shorter duration in the AIDS stage.

A second alternative scenario involves changing the assumptions related to the life-extending drug. The cost was increased from $800 per month to $1500, and the inpatient hospital cost reduction factor was increased to 75 percent from 50 percent. The utilization was increased to 10 percent, 25 percent, 35 percent, and 75 percent for the HIV+, LAS, ARC, and AIDS stages, respectively. Also, the effectiveness of the drug in prohibiting progression to the next stage was increased to 10 percent, 25 percent, 50 percent, and 75 percent for the four HIV stages, respectively. In general, the effectiveness, utilization, and cost were significantly increased over the standard assumptions, while the cost savings for reduced hospital care were also increased.

As expected, life costs were much lower under this scenario as the progression to death slowed. Somewhat surprisingly, total medical costs were slightly lower compared to the standard projection even though the LED costs were over two times greater. The higher LED costs were offset by the hospital savings and by the slower progression into the higher cost ARC and AIDS stages. Total ultimate costs would be expected to be higher under this alternative scenario, but the higher costs seem to have been pushed back beyond the five-year projection period. Under this scenario then, total five-year costs (life, disability, and medical) are less than the standard costs.

The final scenario shows the impact on inpatient hospital costs by increasing the utilization and effectiveness of alternative care management. The utilization factors were changed for all regions to be the same as the San Francisco area assumptions. The effectiveness factors (inpatient cost savings) were modified to be 50 percent as effective as the San Francisco area. The resulting inpatient savings averaged 9 percent for the five-year period, which would translate to total medical savings in the 5 percent range.

One analysis that was not performed due to time constraints was a five-year projection using progression rates based on information provided from a San Francisco City Clinic study [13]. The expected time of progression from seroconversion to AIDS is 18–24 months longer using the SFCC data than using Cowell-Hoskins progression rates. This would impact modeled results in two ways. First, the percentage of infected lives in the AIDS stage (the tip of the iceberg) would be relatively lower than the Cowell-Hoskins percentage due to the longer progression period. Therefore, fewer modeled lives in the in-force projection would have AIDS as the beginning HIV stage, producing a decrease in projected costs over the five-year projection period. Second, the progression to the ARC and AIDS stages would be slower, resulting in the delay of the higher costs in these stages to later years. The progression rate assumption is an important consideration when making the total U.S. seropositives assumption as the two are directly related.

D. Variability in 1988 Modeled Results

To develop a sense of the variability in the total costs modeled for an in-force cohort of lives, forty trials of the model were run using the standard assumptions for the first projection year. The variability can come from several sources. In the prevalence module, the major source is the HIV-disease stage at which lives will enter the model. Although the distribution by stage would be expected to remain relatively constant from trial to trial if modeling a large block of lives, the distribution by region will change with each trial, which will impact medical costs.

In the cost module, the medical cost variability sources include progression durations, HIV disease manifestation, LED utilization, alternative care utilization and effectiveness, and counseling treatment. The life, short-term disability, and long-term disability benefits are all affected by progression duration. In addition, these three benefits are impacted by the modeled income of the claimant ($20,000 adjusted by the income and selection distributions).

For the 1988 projection year, following are several statistics for total costs from the forty trials modeling the in-force block. Shown for each of the major coverages are the forty-trial mean, standard deviation, minimum value, ten and ninety percentile values, and the maximum value. For each of the coverages, the costs appear to be normally distributed. These statistics are for a beginning cohort of 1,000 infected in-force lives. A smaller or larger number of infected lives would be expected to have more or less variability accordingly. Tables 10 and 11 were based on a trial that generated total

medical costs of $2,557,000. This value should be kept in mind when reviewing the two tables.

TOTAL 1988 COSTS BY COVERAGE — FORTY TRIALS OF IN-FORCE BLOCK (000's)

Coverage	Mean	Standard Deviation	Minimum	10%	90%	Maximum
Life	$ 713.3	$201.8	$ 333.0	$ 457.3	$ 960.5	$1,131.5
STD	260.1	28.7	194.7	223.2	301.1	320.9
LTD	147.4	42.5	57.9	96.0	205.6	254.4
Medical	2,411.2	156.2	2,076.0	2,227.3	2,629.3	2,720.4
LED	451.8	69.9	328.0	367.2	543.6	669.6
Total Med.	2,863.0	202.3	2,459.6	2,559.4	3,165.3	3,219.4

OTHER CONSIDERATIONS

An attempt was made in the development of this model to account for the major factors that impact group insurance HIV-related claims. However, there are other alternative methods, enhancements, and related considerations that were not incorporated into the model because of time limitations. Some of the more important of these factors are:

HIV Regional Prevalence Factors. The factors developed for use in deriving regional prevalence factors assumed that all regions followed the same curve in modeling the spread of the epidemic, with regional variation (the iceberg effect) accounted for by the degree of progression along the curve (initial year of infection). In reality a regional curve is a composite of several underlying curves, representing multiple subepidemics, that vary significantly by risk class and size of risk class. Use of such curves developed at a regional level could provide a more accurate regional estimate of infected lives. Additionally, the future seroconversions were based on the slope of a national curve; thus, use of slopes recognizing regional curves would generate better estimates of future seroconversions by region.

Model HIV Stages. The progression stages used in the model were those defined in the Frankfurt Study [14]. The costs assumed in the second stage of the model did not totally follow the clinical definition of "LAS" from the Frankfurt staging, but more represented the types of costs incurred between asymptomatic infection and ARC. A model may be more widely accepted if the progression rates by HIV stage are consistent with an official staging convention (clinical or immunologic).

Life-Extending Drug. What is the impact on the pattern of disability incidence if a life-extending drug is being utilized? Some users of a life-extending drug cannot continue long-term administration of the drug due to side effects. How should this be reflected?

Annual Medical Costs. The maximum 1988 annual cost of $55,000 does not adequately provide for the very severe utilization of medical services that occur during the AIDS stage for a small percentage of insured lives. On the other hand, others will incur less

intense care than is assumed in the model. A random factor/distribution could be built into the model permitting infrequent higher (and lower) annual costs than the assumed monthly averages, reflecting differing intensity or frequency of utilization. The overall mean costs would not have to change.

Plan Design. The ability to incorporate and modify plan design features, such as deductibles and coinsurance, directly into the structure of the model would add value to its projection capabilities.

Other. How large is the impact of HIV-related costs from insured (employee or dependent) women and children and what is the best way to account for these costs? What is a realistic pattern of coverage continuation, taking into consideration disability, COBRA, conversions, and so on? What effect will cost-shifting due to government programs such as Medicaid and Medicare have on group insurance HIV costs?

CONCLUSION

There are basically only three questions in making a projection as to the impact of HIV on insurance plans. How many lives are infected? How fast are they progressing? What is the size of their claims? All three questions are of equal importance, although most of the emphasis in group insurance has been on the amount of the HIV-related claims. This model provides some new approaches to answering all three questions. Also, the ability to measure the variability around the mean values and the creation of probability distributions are two added dimensions provided by the use of stochastic processes throughout the model.

The results of the model presented in this paper provide useful insight to the patterns, distributions, and amounts of HIV-related group insurance claim costs. The results appear to be a realistic prediction of the real-world HIV-related costs that the model is attempting to simulate. However, these results represent the projections under a set of assumptions based on current knowledge, which is deficient in many areas. The predictive value and reliability of the model will increase as more is learned regarding the assumptions and relationships that are built into the structure of the model.

REFERENCES

1. MAST, JESS L., "HIV Infection: Its Impact on Mortality and Underwriting," *Reinsurance Reporter*, Fort Wayne, IN, July 1987, No. 113, p. 6.
2. "AIDS Weekly Surveillance Report," United States AIDS Program, Center for Infectious Diseases, Centers for Disease Control, Atlanta, GA, November 23, 1987, pp. 1–5.
3. HOSKINS, WALTER H., "HIV Mortality," *AIDS, HIV Mortality and Life Insurance*, Itasca, IL, August 1987, p. 26.

4. COWELL, MICHAEL J., "AIDS and Life Insurance," *AIDS, HIV Mortality, and Life Insurance*, Itasca, IL, August 1987, p. 28.
5. Ibid., p. 28.
6. Hoskins, p. 24.
7. Ibid., pp. 4–6.
8. ROTHENBERG, RICHARD, et al., "Survival with the Acquired Immunodeficiency Syndrome: Experience with 5833 Cases in New York City," *The New England Journal of Medicine,* November 19, 1987, Vol. 317, No. 21, pp. 1297–1302.
9. FISCHL, MARGARET A., et al., "The Efficacy of Azidothymidine (AZT) in the Treatment of Patients with AIDS and AIDS-Related Complex: A Double-Blind, Placebo-Controlled Trial," *The New England Journal of Medicine*, July 23, 1987, Vol. 317, No. 4, pp. 185–191.
10. KIZER, KENNETH W., et al. (State of California Department of Health Services), *A Quantitative Analysis of AIDS in California*, March 1986, pp. 19–25.
11. SCITOVSKY, ANNE A. AND DOROTHY P. RICE, "Estimates of the Direct and Indirect Costs of Acquired Immunodeficiency Syndrome in the United States, 1985, 1986, and 1991," *Public Health Reports*, January-February 1987, Vol. 102, No. 1, pp. 5–17.
12. PANJER, HARRY H., "AIDS: Survival Analysis of Persons Testing HIV+," *Working Paper Series in Actuarial Science*, ACTSC 87-14, Waterloo, Ontario, August 24, 1987, pp. 1–14.
13. HESSOL, NANCY A., et al., "The Natural History of Human Immunodeficiency Virus Infection in a Cohort of Homosexual and Bisexual Men: A 7-Year Prospective Study," Third International Conference on AIDS, Washington, D.C., June 1, 1987 (speech).
14. COWELL, pp. 8–9.

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APPENDIX
DEALING WITH THE IMPACT OF HIV ON GROUP INSURANCE PLANS

RONALD B. COLBY AND MICHAEL L. ZURCHER

ABSTRACT

What is commonly called the Acquired Immune Deficiency Syndrome (AIDS) epidemic may be appropriately identified as the Human Immunodeficiency Virus (HIV) epidemic, for it is the presence of the HIV that leads to AIDS and ultimately death. It is important while reviewing this report to keep in mind that the epidemic is caused by the HIV and that fully developed AIDS is but the final stage of the HIV infection. This is especially important for group medical insurance where a significant portion of the costs result from HIV-related conditions other than AIDS.

Beginning around 1985, the impact that AIDS has had and will continue to have on the individual life insurance industry has been a topic of numerous internal memorandums and external reports. An increasing amount of meaningful published material can be found on a multitude of subjects concerning individual life products. These subjects include financial and solvency impacts, mortality and pricing studies, seropositive and death projections, testing and nonmedical limit discussions, underwriting responses, product and marketing considerations, state regulatory and legislative environments, confidentiality and counseling issues, and application questions. In spite of all the individual life studies and research completed to date, there is still a vast amount of work to be done and knowledge to be gained.

On the other hand, there has been only a minimal amount of written discussion on the impact of HIV on group insurance products. The impact has usually been rather lightly dismissed because "you can increase your rates for the AIDS risk in group insurance." This is true in the sense that group products are typically written on a renewable-term basis and each year a group insurer has the opportunity to rerate products for the anticipated HIV costs. Additionally, because traditional group underwriting philosophies largely omit individual risk underwriting, most of the individual life underwriting issues are not relevant to group writers. Thus, the HIV impact on group insurance has been largely ignored because of the annual rerating ability and the seeming lack of underwriting issues.

The current decline in the group medical underwriting cycle illustrates that the ability to rerate does not necessarily guarantee an adequate premium.

Also, the rerating process relies heavily on the ability to project future trends based on historical data. The historical data available for HIV claims will be underreported because of the difficulty in identifying actual HIV and AIDS claims and will probably not include claims arising from HIV-related conditions other than AIDS (for example, AIDS-Related Complex). The rerating process will only be successful if past costs are known and future trends are predictable — neither of which is the case with HIV.

There are two other reasons the impact of HIV on group insurance should not be ignored. Although there are fewer underwriting issues in group insurance than in individual life and health, group underwriting issues do exist, and effectively addressing these issues can have a significant positive impact. Second, the HIV exposure group insurance exists while the claimant is still alive. Things such as more costly and effective drugs, more widespread and earlier utilization of drugs, and new technologies and treatments will likely result in higher medical costs.

The ability of a group insurer to successfully deal with the impact of HIV will largely depend on its ability to communicate the issues and responses throughout the organization. HIV issues will affect all functions of the group operation from underwriting to marketing to claims administration.

INTRODUCTION

This appendix represents a compilation of issues related to the impact of HIV on a group insurance operation. The appendix does not address the impact in terms of costs, trends, and projections. Instead, it will hopefully provide group insurance actuaries and management a resource in their efforts to better manage the risks presented by HIV.

The appendix is composed of five sections. The first section provides an overview of basic group underwriting and pricing methods and strategies, in order to assure that all readers will have sufficient context with which to frame subsequent issues. Those readers already familiar with group procedures may wish to proceed to the second section.

The remaining sections identify specific issues related to the impact of HIV and, for most issues, a possible response for effectively dealing with the issue. The second section identifies HIV-related data collection issues. The third and fourth sections deal with issues related to the pricing and underwriting of group products. Finally, the fifth section identifies several

other issues outside the sphere of pricing and underwriting, including case management of large HIV claims.

In general, the primary approach to dealing with HIV in group insurance lines will be through pricing and underwriting, although pricing mechanisms will probably be used to a much greater degree than selection mechanisms. Each group contract may be repriced each year (or more frequently, if necessary), thus providing an opportunity to cover near-term expectations of increasing HIV costs. At the same time, individual screening of employees and dependents within a group for asymptomatic conditions (such as HIV infection) is impractical.

As mentioned in the abstract, communication will also be a key ingredient if group insurers wish to successfully manage the HIV risk. One approach to better managing HIV would be to establish a Group HIV Task Force, with representatives from functional areas such as pricing, product development, underwriting, claims, and planning. The primary objectives of the Task Force would be to provide a comprehensive analysis of the current and future impact of HIV on the group operation, to develop plans for dealing with these impacts, and to ensure implementation of these plans. An additional objective would be to promote a broadly based understanding of the HIV issues throughout the organization, not forgetting field employees. This includes serving as a focal point for the identification of issues relating to HIV and as a clearing-house for the collection and dissemination of HIV information within the group operation.

HIV is an epidemic that will have unparalleled economic and social impact in the coming years. The execution of an action plan will not guarantee a successful response to the risks presented by HIV. The consideration of HIV impacts must become a standard part of all strategic and operational decision-making processes, and the implications of such HIV-related decisions to the group insurance operation must be understood by everyone making them. These are the challenges to be met.

Overview of Costs

Direct medical expenses incurred during the lifetime of an AIDS patient are variously estimated at $60,000 to $150,000. There are many uncertainties relating to cost patterns in the future. Treatment patterns emphasizing less inpatient care that are evolving are helping to reduce costs, but technology (for example, AZT) may continue to develop that will provide more expensive treatment and also prolong the life of the HIV patient, consequently

increasing the total cost of care. Most estimates of the direct medical costs in the year 1991 for AIDS patients range from $8 to $16 billion. Costs for ARC patients and asymptomatic HIV carriers may double those estimates.

It is unclear how much of the direct costs for HIV patients will be funded by private group insurance plans. Estimates of the amount funded by Medicaid range from 15 percent to 42 percent, with another 1–3 percent coming from Medicare. Costs paid by the individuals and unfunded costs may account for 25 percent. This would leave private insurers and Blue Cross/Blue Shield plans with 30–60 percent of the bill for HIV-related direct medical costs.

There may be indirect costs as well. HIV patients will place increasing burden on the capacity of hospitals and health care providers to deliver care, particularly in areas of high HIV concentration (for example, New York). Additional capacity may need to be funded in these areas. Both the pressure of HIV on Medicaid funding and the substantial unfunded medical cost of HIV patients will increase the magnitude of cost shifting to private payors.

I. OVERVIEW OF GROUP UNDERWRITING AND PRICING

This section discusses general background relating to pricing and underwriting of traditional group insurance products. The remaining sections deal with specific pricing, underwriting, and other issues related to HIV. Each section also identifies a potential response a group insurer could have to each issue. Some readers may wish to skip directly to Section II.

The overall philosophy underlying group pricing and underwriting rests on the principle that "groups" of people tend toward average mortality and morbidity characteristics. The larger the group, the more predictable that group's life and health insurance experience will be.

Case Selection

Case selection depends upon certain characteristics of the group, such as the age distribution within the group or the industry and/or the occupation of the people within the group. Some industries, for example, are not acceptable group risks, either because the people in the group are exposed to a high-risk work environment (for example, explosive manufacturers) or because the nature of their employed population is expected to be more transitory and/or unstable (for example, restaurants, which have high turnover and many part-time employees). In addition, if it can be determined

that the group being considered for insurance has had morbidity claim experience significantly higher than average, the group would not be written. As a general rule, information about the health characteristics of the individuals within a group are not part of the group underwriting process, except for the smallest groups (usually less than 10 employees) where short-form health questionnaires accompany the application for insurance.

Pricing

Virtually all group products are written on a guaranteed-renewable-term basis. Rates are typically guaranteed for the first year of the contract and can be raised anytime thereafter with 31 days notice. The insurer typically cannot cancel the policy except for nonpayment of premium. By convention, nearly all groups are rerated each year on the anniversary date of their policy.

At the time of rerating for a given group, the claim experience for that group over the past 12 months is examined. It is "projected" into the subsequent 12 months by making assumptions relative to changing conditions (for example, plan changes, census changes, and for medical insurance, expected changes in the average cost of medical services). Expected expenses and required risk and profit margins are added to the projected claims to determine the rate level that would be needed to profitably cover these projected costs. At the same time, "standard" rates (referred to as "manual rates") for the case in question are reviewed. On a small case, manual rates are used, with some consideration given to the rate suggested by the projected experience of the case. For a larger case, the rate suggested by the case's own projected experience is used with some consideration given to manual rates.

Manual rates are set by reviewing the claims experience of an entire class of business and projecting it forward to a future time period for which the rates will be effective. This process is completed two to four times per year for medical — less frequently for life pricing.

Entry and Exit from a Group

New hires typically become eligible for the group plan shortly after hire. If they join the plan within 31 days of becoming eligible, no underwriting is done. The medical plan typically limits payment for pre-existing conditions on such new hires to $1,000 or $2,500 within the first twelve months of coverage. (There is usually no pre-existing conditions limitation on original members of the group.) Someone entering the plan after the 31-day

window is subject to short-form health insurance questions and may be refused coverage if there are significant health impairments. A similar process applies to dependents seeking coverage under the plan. Any entrant to the group plan during the year is charged the same rate as others in the group.

For employers offering one or more HMOs in addition to traditional group medical plans, once each year an "open enrollment" period is held, during which time employees may move back and forth between the HMO plan and the traditional plan without being subjected to underwriting or pre-existing conditions limitations.

Recent legislation (dubbed COBRA) has mandated that medical coverage be offered to employees or dependents losing group coverage for any reason other than termination of the entire group plan or termination of employment for gross misconduct. Such coverage lasts for 18–36 months, depending upon the circumstances under which coverage was lost. Such coverage must provide the same benefits enjoyed by continuing members of the group and must be offered at a price no higher than 102 percent of the premiums being charged for continuing members. In lieu of or subsequent to COBRA continuation, a disabled employee typically may extend medical coverage for a period of 3–12 months. The extended coverage would apply to the disabling condition only. In addition, an employee may convert life and/or medical coverage to individual policies upon the cessation of group coverage or COBRA continuation. They may convert their term life coverage to any individual permanent plan, without being subjected to underwriting. The medical conversion plans usually have lower benefits than were available under the group plan, and premiums charged for medical conversions are significantly higher than group premiums. Medical conversion plans are subject to periodic rate increases, but are typically not cancelable by the insurer except for nonpayment of premium.

Underwriting for Benefit Selection

Traditional group plans offer little or no opportunity for employees to select benefit levels. Flexible benefit plans are an exception to this rule, however. Employees can often select from among several levels of medical coverage and several levels of term life coverage. Coverage options may be changed by the employee annually. Underwriting guidelines limit the amount of benefit upgrade that can be made by the employee without being subjected to individual underwriting and/or pre-existing conditions limitations.

Supplemental life insurance plans are sometimes sold. These allow individuals to elect life insurance amounts in addition to the amounts provided under the group term life program. Such elections are subject to individual underwriting.

Many term life insurance plans provide coverage at one, two, or three times the amount of annual salary for the employee. Highly compensated individuals may be eligible for very high amounts of life insurance under the group plan in these cases. Guidelines limit the amount of group term life that can be issued under these schedules without the benefit of individual underwriting.

II. GROUP HIV CLAIM DATA COLLECTION — ISSUES AND RESPONSES

Pricing for the overall impact of HIV will require complete, accurate and timely data upon which to base assumptions. Because the identification and collection of internal HIV claims are still somewhat infrequent, the use of internal data is typically not credible for purposes of making pricing distinctions such as factors for geographic regions. For this reason, internal data must be supplemented with data available from external sources (for example, CDC, HIAA/ACLI). At a minimum, internal sources need to identify calendar year AIDS experience by major product line (for example, life, health, and disability), geographic area and even individual case data (for example, age, sex, and employment/dependent status). Additionally, other internal information that will prove useful includes diagnosis, duration since diagnosis, costs by type of provider, costs by type of treatment, degree of alternative care provided, number of admissions, length of hospital stay, and whether the claimant is being treated with a life-extending drug like AZT. These latter data are usually more difficult to collect. An HIV data base can be constructed and procedures put in place to gather and store HIV claim data in detail. Periodic reports should be produced and distributed to key managers needing access to this information to make pricing and underwriting decisions. In addition, ad hoc reports may be designed and produced to gain more specialized information.

Issue: Obtaining complete data on HIV claims is difficult, due both to the difficulty in identifying any given claim as being directly attributable to HIV or AIDS and to the difficulty in maintaining consistently high attention to screening criteria on the part of claim examiners. In fact, it has been estimated that as many as 40–50 percent of group medical AIDS claims actually incurred will not be identified for inclusion in an HIV data base.

Response: Both the importance of identifying HIV claims and the guidelines for spotting HIV claims must be periodically reemphasized to claim examiners. Specific diagnoses strongly indicative of HIV should be distributed to the examiners, and the examiners should have procedures for following up on questionable claims. Where possible, HIV claim "templates" should be incorporated into the claim system to assist claim examiners in spotting potential HIV claims. Life claims can be cross-referenced to medical claims. Periodically, extracts can be taken from the overall claim file identifying claims that may be suggestive of HIV. Each is tracked back to the source for determination of whether it is an HIV claim. Benefits of this process are to be found both in terms of completing the data base and in providing direct feedback to examiners regarding HIV claims they failed to identify.

In addition, pricing assumptions must recognize that HIV data will remain incomplete. External data can be funneled through the HIV Task Force to pricing and underwriting staff to supplement internal data on HIV incidence. Pricing assumptions must include "completion factors" to account for the incomplete data.

Issue: ARC claims are particularly difficult to track. In addition, there are medical services being utilized by seropositive individuals, specifically arising from the knowledge or fear that they are seropositive, and these too are difficult to identify separately.

Response: Although it is possible to define certain typical treatment patterns (including the use of AZT) that may give some indication of the magnitude of these costs and the rate at which such costs are rising, it will not be possible to comprehensively identify claims for ARC patients and other seropositives in the internal data. It will be necessary to rely on modeled results and external data to make estimates of the magnitude of these costs.

III. GROUP PRICING — ISSUES AND RESPONSES

A group insurer can include explicit factors to reflect the anticipated cost of HIV-related conditions in the regular repricing of each group insurance product line. These can be established after an analysis of internal and external claims data, adjustment for "completion" (assumed unidentified AIDS, ARC and related claims), and projections of assumed trends in both frequency and average costs for HIV claims. Major lines for which such factors are developed include term life, major medical, short- and long-term disability, prescription drug coverages, and specific stop loss coverages.

Issue: Several geographic areas have had a much higher incidence of AIDS claims than others. At the same time, AIDS and HIV-related diseases are spreading to previously "low-risk" areas. CDC data by geographic area identify AIDS claims with the location in which the patient was diagnosed. However, many patients subsequently migrate to other locations. Internal data will not provide statistically credible samples when broken into small cells such as geographic locale. The treatment costs for HIV claimants vary significantly by geographic location and are changing at differing rates and sometimes even in opposite directions. The availability and utilization of alternative treatment facilities will vary both by location and over time for a given location. The underwriting standards permitted by each state will impact the expected HIV experience differently.

Response: For term life insurance rates, geographic differences in anticipated HIV experience can be reflected by raising life rates in the higher incidence areas. For medical manual rates, some type of "area factors" have always been a part of the rating process. Ideally, it would be possible to directly reflect location-specific HIV projections in the area factors and trend assumptions of the manual rates, but this approach would be difficult to implement and would require more credible data than are currently available.

An alternative approach would be to provide for adequate premium to cover the expected HIV claims in aggregate for the entire insured block and also allow some degree of equity among geographic regions. Because manual rate area factors are updated in response to observed rates of change in total medical claims in a given area, any increase in HIV claims experience in a particular locale will be indirectly reflected in the revised area factors. Additionally, an explicit loading for the anticipated aggregate cost of HIV claims can be included in the overall trend assumption for manual rates rather than varying trend assumptions by area.

If region-specific factors are developed (assuming use of zip code areas), a "geographic area" most likely would not be defined to be as small as a zip code within a major metropolitan area. Within New York City, for example, one or two zip codes for higher area factors would not be singled out. The whole of New York City proper might have a higher rate basis than the surrounding counties, however, owing to a higher incidence of HIV.

Issue: Manual rates usually provide for different rate levels by industry. Should industry factors specifically consider the HIV risk?

Response: Historically, specific claim diagnosis has not been a part of the industry rating process; instead, actual emerging total claims experience has been relied upon to adjust industry rating factors. As in area factors, poor

HIV claims experience in a specific industry will present itself in the review of total claims loss experience by industry. In this way, higher HIV claims in a specific industry would become part of the rating structure over time. In addition, industries that experience loss ratios outside of acceptable norms may be assigned to an underwriting "decline" list, implying insurance would not be offered in the future to groups within that industry.

Issue: The incidence of HIV claims has been much higher in the younger male population than in other populations. Should manual rates for younger males be adjusted to reflect this fact?

Response: Most likely both life and health rates for group insurance products are age- and sex-specific. They reflect the different mortality and morbidity expected for individuals in each age category and of each sex. This allows the rates of each category to as closely as possible reflect the expected claim costs of that category. Accordingly, a group insurer should plan to adjust both life and health rate structures to reflect the projected changes in mortality and morbidity by age and sex that are attributable to HIV.

Issue: Incidence of HIV claims has been much higher in the male homosexual population than in the population at large. Is it appropriate to develop rating classes for sexual orientation when it can be determined, or use sexual orientation in the case selection or individual underwriting process?

Response: It would not be appropriate to use sexual orientation or any surrogate for sexual orientation in the underwriting or rating process. Surrogates for sexual orientation include such things as marital status and beneficiary designation. It is clear that membership in a so-called "high-risk group," such as homosexual males, is not the determinant of the risk of HIV infection. Rather, it is engaging in high-risk behaviors that is at issue. A history of sexually transmitted disease is indicative of high-risk behavior. As such, a factually determined history of sexually transmitted disease is an example of a factor appropriate for use in the underwriting process. To distinguish further, the presence of HIV antitbodies is not a surrogate for either high-risk behavior or membership in a "high-risk group." The presence of HIV antibodies is indicative of the fact of HIV infection, an organic medical condition associated with extremely high mortality and morbidity. The presence of HIV antibodies is an appropriate underwriting factor.

Issue: Projecting HIV costs into the future is particularly difficult. Wide ranges of estimates exist as to the number of seropositives, the rate of progression from seroconversion to AIDS and then to death, and the percentage of seropositives ultimately developing AIDS. The cost of caring for an HIV patient is not definitively known and is likely to change rapidly in response

to new drugs, technologies, and the availability of alternative treatment facilities. There is little known about the progression of HIV disease beyond 5–7 years, and much uncertainty surrounds the prognosis for prevention or cure. The legislative environment remains uncertain. The ability to retain pricing and underwriting tools necessary to deal effectively with HIV is problematic. The extent to which COBRA continuation requirements will alter the insurance industry's share of the overall funding of HIV claims has not yet become clear.

Response: It is important to develop a comprehensive model of the impact of HIV on group medical costs for two reasons. First, a model will provide some indication as to what an insurer's HIV claims could be under the assumptions used in the model. Because of the problems discussed earlier with respect to a company's ability to collect data internally, utilizing internal data as a basis for projecting future claims is not reliable. A model can provide estimates of what a company's true HIV costs have been instead of relying on those claims that have been identified as HIV. This will further develop the company's ability to adequately price for future HIV claims. Second, a model will provide rapid analysis of the pricing impact of changes in assumptions relative to HIV, such as changes in HIV prevalence and progression rates. In addition, this provides the ability to test many alternative scenarios such as more effective and costly drugs in terms of life extension, new technology and treatment patterns, movement to increased treatment through alternative care facilities, and the impact of geographic mix. This sensitivity testing will enhance contingency planning capabilities. A model can also facilitate the development of more direct, area-specific analysis of potential future costs of HIV claims.

A company should also evaluate the advisability of establishing contingency reserves in light of the uncertainties stemming from the HIV epidemic. Pricing methodologies that recognize these inherent uncertainties may need to be tied to reserving changes to fully provide for these contingencies.

Issue: The cost of AZT on a direct basis (expected to average $8,000 annually per patient) and indirect basis (additional medical expenses as a direct result of complications from the drug, as well as costs associated with prolonged survival) may be very large. Initial policy restricts the usage of AZT, but pressure is likely to increase for earlier and wider distribution of the drug, perhaps to the limit of undermining patent protection to increase production capacity. New drugs are likely to be developed that alone or in combination with AZT will further increase longevity and add cost.

Response: A company should regularly reevaluate expected prescription drug costs for both major medical products and stand-alone prescription drug benefits. The indirect costs associated with AZT must be considered in all assumptions when projecting changing medical costs associated with HIV. It is advisable that the HIV Task Force serve as a clearing-house for HIV information and advise pricing and underwriting areas of developments relating to AZT (and other new drug therapies) availability and usage.

Issue: The impact of the HIV epidemic on funding mechanisms for health care (for example, Medicaid) and directly on providers (due to increases in unfunded care) will translate into considerably higher pressure to shift costs to the private payors. These impacts will be regional.

Response: HIV is but one of the factors adding to increased cost shifting and destabilized local pricing patterns on the part of providers. It is important to develop and maintain, if not already in place, a strong medical cost trend analysis process. This includes both techniques for comprehensively gathering and analyzing trend data from internal claims as well as utilizing external data sources and expertise. Once again, the HIV Task Force can be a clearing-house for relevant information relating to both national trends and specific local developments that may impact costs to private payors.

Issue: The degree of antiselection among COBRA continuees having conditions such as HIV has yet to be quantified.

Response: Specific pricing factors for assumed antiselection should be included in COBRA pricing. Data collection methods should be reviewed to ensure the availability of data on COBRA experience as it develops. The impact on conversion pricing should also be studied, and consideration might be given to limiting the Extension of Benefits provision where it is possible to do so.

IV. GROUP UNDERWRITING — ISSUES AND RESPONSES

Issue: The expected financial performance of a potential group case can be greatly impacted by the number of HIV patients in the group population. These can be active employees, dependents, or continuees. The number of seropositives is a predictor of future AIDS exposure, but the availability of information to the underwriter concerning seropositives in a particular group is problematic due to both the uncertain regulatory climate and the practical problems of obtaining such information in a group setting.

Response: Case selection for very small groups often relies on short-form individual medical information. In such cases, health questionnaires request information from the applicant regarding any history of immune disorder

and any known positive results of HIV antibody tests. (These questionnaires must, of course, be modified in several jurisdictions where one or both of those lines of inquiry is prohibited.) Guidelines for reviewing these applications now include attention to clinical parameters of HIV (for example, hemophilia or sexually transmitted disease).

On larger groups, case selection procedures can be strengthened by requiring more detailed information at the time of application regarding the claim history of the group and details of any active or continued disabled employees or dependents. Claims experience should be scrutinized wherever available for indications of HIV-related diseases. These techniques will provide an adequate screen for AIDS, but do not quantify exposure to seropositives within the group. The determination of the latter is probably not practical at this time in the group setting.

Issue: Exposure to the HIV risk may come from additions to the group coverage, particularly late applicants.

Response: Late applicant underwriting is typically addressed through short-form individual health questionnaires. These were discussed in the previous response as they relate to small group cases. In addition, the ability to identify pre-existing claims during the adjudication process should be reviewed and programs developed to strengthen any deficiencies. It must be recognized that identification of HIV claims during an investigation of pre-existing conditions is particularly difficult due to the sensitivities of both the claimant and many physicians relating to HIV.

Issue: During renewal underwriting, it will be critical to identify how rating actions should be modified on a particular case to reflect group-specific HIV risks.

Response: Like numerous other medical conditions, there is a need to identify HIV claims for the underwriter on a group-by-group basis. Consideration should be given to developing formulas for adjusting underwriting reserves and reserves established for end-of-policy-year refund calculations in the presence of identified large claim risks (such as HIV). Also, methods to avoid selection by policyholders opting for nonstandard medical pooling limits should be considered.

Issue: Group-specific information regarding HIV claims (and other catastrophic claims) is crucial to the underwriting process. In addition to HIV claim identification weaknesses that exist in traditional indemnity claim processes, insurers that offer multi-option plans are likely to have an even more difficult time identifying HIV claims that occur through the PPO or

HMO options. Business that is administered through third-party administrators may also lack the necessary procedures to identify and capture HIV claim information. Usually there is more than one claim "system" involved when plans are offered through multiple delivery systems or administrators.

Response: The identification of HIV claims in a traditional indemnity environment was addressed earlier in the section on data collection. Similarly rigorous collection and analysis techniques should be required when claim administration has been relegated by the insurer to an outside party such as a PPO, HMO, or TPA.

Issue: Some products allow benefit choices to be made by employees, potentially allowing antiselection. A few term life plans provide for high amounts of group term life insurance on a few individuals (usually the highly compensated members of the group).

Response: Because the significant upgrade of term life insurance amounts is usually the key area of concern, underwriting guidelines should be reviewed to assure antiselection within the flexible benefit plan for group term life amounts is precluded by pre-existing condition limitations. A review of the underwriting guidelines for supplemental and excess life may also be necessary. Consideration should be given in each of these reviews to the advisability of developing separate benefit restrictions or underwriting guidelines for some major metropolitan areas (high risk for HIV) than for other areas. A guiding principle of the review can be to preclude any availability of life insurance in amounts in excess of prudent nonmedical issue limits (as for individual products) without strict individual underwriting requirements.

Issue: There may be instances where clients ask for benefit limitations or exclusions for HIV risks.

Response: A company offering insured products that include either a benefit limitation for AIDS or any form of AIDS exclusions runs the risk of sending an inconsistent message to both regulators and the general public. This is especially so if the company has been espousing the necessity for individual products to underwrite HIV risks like any other medical impairments (that is, testing, questions, and MIB medical history). The exclusion of HIV benefit limitations or exclusions from plans is more consistent with a policy that approaches the underwriting of HIV like any other major illness or injury, making no special deviation from standard underwriting practices. An exception to this posture might be considered in jurisdictions where standard underwriting or pricing techniques are not available to prevent antiselection losses. A related question, that of whether to agree to administer a self-insured plan that had been defined by an employer to include such a

benefit limitation or exclusion, must be carefully reviewed. It may not be practical to distinguish between insured and self-insured plans in this regard, however. Regulators, media, and the public may view the issue of exclusions and limitations more broadly, without distinction between insured and self-insured approaches.

The Role of Blood Testing in Group Insurance Underwriting

There is much controversy surrounding the appropriate use of HIV antibody testing (that is, ELISA and Western blot). A good deal of this controversy surrounds the use of such tests by insurers in the underwriting process. Part of the argument centers on the issue of confidentiality, but the larger part of the argument concerns an insurer's right to use the presence of HIV antibodies as a basis to refuse to issue insurance.

Some jurisdictions have ruled on insurer's rights to use testing. California, for example, has ruled that antibody testing cannot be used. In California, insurers substitute a T-cell subset test that indicates ratios of certain types of white blood cells. This test does not detect HIV antibodies, but does detect abnormalities in the blood that are predictive of HIV infection. This test is a poor substitute for the HIV antibody tests. The District of Columbia has prohibited insurers from using any test results to determine the presence of HIV. This has caused most individual life insurers to exit the D.C. market.

The consideration of blood testing by an insurer must include not only the cost and procedures needed to accomplish the testing itself, but must also consider the notification process. Transmission of information in the nature of positive HIV test results must be done both confidentially and compassionately. The role of counseling should be considered.

Insurers writing individual products must use HIV antibody testing in their underwriting process. Level premiums and the potential for antiselection make it economically unfeasible to insure HIV-infected individuals. For most, this is a matter of "folding in" HIV blood tests and procedures to existing test regimens and lowering the limit for nonmedical issue.

The economics of group insurance are different, as are the traditional underwriting practices. The group underwriting process provides no opportunity to examine the health characteristics of individuals in the group. Medical exams or even blood tests of all the employees and dependents to be insured under an employer's group plan are not a feasible undertaking. Fortunately, the group pricing mechanism allows opportunity to cover costs

associated with changing claim costs. If the group insurer can predict the costs associated with HIV, it can cover those costs with prudent pricing.

Though not in the traditional group underwriting process, there are selected situations in which group underwriters do rely upon information relative to individual health characteristics. Some of these situations were outlined previously in this section. In a few of these situations, such as underwriting excess amounts of group term life coverage, the economics are quite similar to those of individual lines of insurance, with the exception that potential antiselection on the part of the insured is much less of a consideration. It is likely that in these types of situations, group insurers will have to use blood testing, wherever amounts at risk so warrant, to protect against unreasonably high HIV claims.

V. OTHER ISSUES

Managing Large HIV Claims

Issue: Treatment patterns and costs still vary widely for HIV claims, particularly by geographic area. Such patterns often provide opportunity for reducing claim outlays by intervening at the point of claim and attempting to influence treatment pattern, provide for alternative treatment facilities, and/or obtain lower cost prescriptions, services or supplies. For such a program of claim management to be effective, both early identification of intervention opportunities and access to lower cost alternatives are required, as well as skill in effectively intervening with patients, families, and physicians.

Response: A company (or its vendor) can strengthen its large claim management capabilities in a number of ways. Case management nurses can be added to increase capacity, and procedures for the referral of HIV cases from field claim offices can be improved. The identification of HIV cases through the utilization review process can promote quicker and more effective case management. In addition, improved processes to obtain discounted services from providers can be developed, and systems to organize information on such discounts for effective use within the claim management function can also improve case management effectiveness.

Additional Considerations and Issues

The identification and response to issues relating to the impact of HIV on group insurers must be met with an ongoing commitment to communication,

study, and action. Each day brings new research, new regulation and legislation, new technology and treatments, and new public perceptions and policies. Each day brings new issues. These issues must be identified before appropriate responses can be developed and implemented. Following are several potential issues that after further research and development may require some future response.

Issue: The regulatory environment is uncertain and rapidly changing. The recent developments in Texas provude an excellent case study in which apparently both the insurance lobby and the state insurance department were caught unaware by the broad implications of a legislative initiative dealing with HIV testing and discrimination. The HIV Task Force needs to work closely with the governmental relations department or the legal department to quickly identify the implications of HIV legislation (proposed or enacted) and quickly disseminate clear information to affected line areas. The Task Force may also play a role in distilling relevant issues pertaining to HIV and the group insurance business into position papers for lobbying efforts by a governmental relations area or other areas. The Task Force can also serve to clarify positions that can be advocated with industry counterparts.

Issue: The strategic implications of HIV must be considered, including key strategic questions such as:

1. What does the HIV epidemic imply about market entry or exit? What about product entry or exit?
2. Medical insurance is being equated in many HIV debates with access to care. What are the implications to policymakers? What is the impact on the likelihood of government health care initiatives?
3. How can/should the HIV epidemic be funded? What is the appropriate public policy? What is the role of pools for uninsurables, and who should fund them?
4. What structural changes may occur in the medical delivery industry in the next 5–10 years due to the burden of providing care to so many HIV victims?

HIV IN A LARGER CONTEXT

As difficult and complex as the HIV issue is for the group insurer, it must be considered within the even larger context in which the question is currently framed. Society at large is facing significant and fundamental questions concerning the cost and availability of health care in general in this country. The issue of HIV is intertwined with these fundamental societal issues, and all come to bear on the question of the shape of the continuing role to be played by group insurers in the financing of health care.

Total spending for health care in the U.S. exceeded $500 billion in 1987. This represents an increase of roughly 7 percent over the previous year, a rate of increase much higher than the general level of inflation in the economy. This, of course, is not new. For most or all of this decade, the increase in health care spending has outstripped the rate of inflation. Health care spending currently makes up in excess of 11 percent of total GNP, up by more than two percentage points over the ratio in 1980. Funding such cost increases is stressing all the primary underwriters of these costs—the Medicare system, the Medicaid system, and private payors (employers, either directly or through their group insurers).

At the same time, there remain perhaps as many as 35 million persons in this country who are uninsured or underinsured with respect to health insurance. And increasingly, access to adequate health insurance equates to access to the health care system itself. These uninsured and underinsured persons find it increasingly difficult to access high-tech, high-cost medical services, yet society does not appear ready to accept the idea of two-tiered health care (one level of care for those who can pay and a lesser level of care of those who cannot).

HIV impacts both aspects of the problem. By most accounts, HIV will add $8 to $16 billion annually to the total cost of health care by 1991, as well as putting much additional pressure on the medical delivery system. In addition, many HIV patients are uninsured or may lose employment-related insurance coverage after prolonged disability.

In many respects, the group insurer finds itself in the middle. On one hand, employers (who ultimately fund the cost of most health care) are largely looking to insurers to build solutions to the problem of escalating health care costs. At the same time, policymakers are wrestling not only with problems of the total cost of health care but also with questions of access to health care and of funding mechanisms, that is, the role of public funding versus private funding of health care costs.

In comparison to these fundamental questions of access and funding, the issues surrounding the funding of HIV medical costs and the related impacts on group insurance plans provide a more definable and immediate focus. However, such issues should be viewed as part of these larger questions as the questions are considered by employers, insurance companies, and policymakers.

CHAPTER 8

AIDS IN CANADA

DONALD C. MACTAVISH

AIDS IN THE GENERAL POPULATION

The Laboratory Centre for Disease Control (LCDC) publishes reports updating the spread of the disease in Canada, similar to those distributed by the Centers for Disease Control in the U.S. The most recent statistics are shown at the end of this chapter and reflect reporting to December 7, 1987. While the incidence of the disease in Canada is less than one-third of that in the U.S., it is still a cause for grave concern as it ranks in the top 10 percent among the nations that report to the World Health Organization. While the ratio of deaths/cases reported is slightly less than that in the U.S., it is still 53 percent. Only Great Britain and Australia, in addition to the U.S. and Canada, show a ratio of deaths to reported cases over 50 percent. This is probably indicative of a much more sophisticated reporting system.

About 89 percent of the AIDS cases in Canada have arisen in British Columbia, Ontario and Quebec. If the incidence was spread uniformly over all provinces, the expected results would be 73 percent. British Columbia has by far the highest incidence at 97 per million of population, followed by Quebec at 63 and Ontario at 61. The national average is 55. Reported cases are concentrated in the major metropolitan areas of Toronto, Montreal and Vancouver.

Table 1 compares the spread of the disease between the two countries. Canadian statistics are not available prior to the second quarter of 1986, so a comparison over the entire time frame is not possible.

The Canadian absolute numbers seem to be running fairly consistently at about 1/30th of the U.S. numbers, while, if population were the only consideration, the relationship would be expected to be about 1/10th. Whether this means that Canada is entering the AIDS cycle at a later time than U.S. or that the experience of the Canadian population will not mirror that of the U.S. is conjectural—likely a bit of both.

There are two important reasons why it is unlikely that Canadian experience will approach that in the U.S. In the U.S., the prevalence of AIDS among the black and hispanic populations is relatively high and AIDS cases involving IV drug abusers account for about 25 percent of the adult experience. These are not significant factors in Canada. Table 2 shows the distributions of reported

TABLE 1

	United States			Canada		
	No. of Reported Cases	Quarterly Increase	Rate of Increase	No. of Reported Cases	Quarterly Increase	Rate of Increase
1985						
End of 1st quarter	8,945		16.2%			
End of 2nd quarter	11,271	2,326	26.0			
End of 3rd quarter	13,611	2,340	20.8			
End of 4th quarter	15,948	2,337	17.2			
1986						
End of 1st quarter	18,883	2,935	18.4			
End of 2nd quarter	22,173	3,290	17.4	614		
End of 3rd quarter	25,650	3,477	15.7	743	129	21.0%
End of 4th quarter	29,003	3,453	13.1	830	87	11.7
1987						
End of 1st quarter	33,482	4,479	15.4	966	136	16.4
End of 2nd quarter	37,867	4,385	13.1	1,124	158	16.4
End of 3rd quarter	42,354	4,487	11.8	1,303	179	15.9

TABLE 2

	U.S. (28/9/87)			Canada (7/12/87)	
Category	Number	% (a)	% (b)	Number	%
Adults					
Homosexual/bisexual male	27,579	65.1	77.8	1,122	79.8
IV drug abuser	6,885	16.2		9	0.6
Homosexual male and IV drug abuser	3,138	7.4	8.8	42	3.0
Heterosexual cases	916	2.2	2.6	35	2.5
Recipient of blood or blood products	1,272	3.0	3.6	56	4.0
Person from an endemic area	744	1.8	2.1	73	5.2
Other	1,236	2.9	3.8	42	3.0
	41,770	98.6	98.4	1,379	98.1
*Children					
Parent at risk	458	1.1	1.3	22	1.6
Recipient of blood or blood products	102	0.2	0.2	4	0.3
Other	24	0.1	0.1	0	0.0
	584	1.4	1.6	26	1.9
Total	42,354	100.0	100.0	1,405	100.0

*U.S.—14 and under, Canada 12 and under.

cases in the two countries among various categories. Column % (b) in the U.S. statistics removes IV drug abusers from that country's statistics. With this adjustment, the Canadian statistics are relatively consistent with those in the U.S.

AIDS IN LIFE INSURANCE

Life insurance in Canada is provided by federally licensed companies, by provincially licensed companies and by fraternal benefit societies. Estimates of in force at the end of years 1986 and 1987 follow (in billions):

End of Year	1986	1987
Individual Insurance		
Federally licensed	$340	$375
Other	35	40
Total	$375	$415
Group Insurance		
Federally licensed	$425	$460
Other	25	30
Total	$450	$490

Amounts are in Canadian dollars.

The Canadian Life and Health Insurance Association conducted a survey of its members to determine the extent of AIDS on claims among Canadian lives insured. Responses were received from about 70 companies, and of the federal companies that responded, the percentages of individual and group insurance represented by those companies of the total Canadian market were 87 percent and 75 percent, respectively.

Individual Insurance

Claims for 1986 reported in the survey among the federally licensed companies were 58 policies for $3,768,000. Grossing those amounts up to approximate the total Canadian experience would result in about 75 policies for $4.8 million. The total Canadian death claims for the reporting companies amounted to about $540 million, so in 1986 AIDS claims represented about 0.7 percent of Canadian life insurance claims for those companies.

When experience is so scanty, wide fluctuations in results can occur. In particular, claims on two policyholders in which there was considerable evidence of antiselection accounted for over 55 percent of the total claims. If current blood testing limits had been in place at the time of these applications, there is a strong likelihood that the policies would never have been

issued. Removing these two claimants from the overall statistics would reduce the ratio of AIDS claims to total claims to 0.3 percent. This amount is probably a better indicator of the experience of companies who did not participate in the survey.

The number of AIDS deaths reported to LCDC during 1986 was approximately 225. Relating this to the estimate of policies terminating by death, indicates that about one-third of deaths resulting from AIDS involve individual life insurance.

Companies also contributed their claim statistics for the first six months of 1987. Projecting for the balance of 1987 on a linear basis using the same assumptions as for 1986 would result in 1987 claims of about 100 policies for $8.5 million. This would translate into about 1.1 percent of claims. Once again, two very large claims are distorting the experience. Removing the effect of these would reduce the ratio of AIDS to total to about 0.5 percent. Total reported AIDS deaths for 1987 are expected to be about 340, so the one-third ratio is still maintaining.

Many companies have not experienced any AIDS claims as yet. The following table indicates the distribution of ratios of AIDS claims to total claims:

No. of companies	56
AIDS claims	$3,768,000
Total claims	$540,000,000
Ratio	0.70%
Minimum ratio	nil
Maximum ratio	7.87%

Distribution of company responses by ratio

nil	30
less than 0.25%	9
0.25% but less than 0.50%	8
0.50% but less than 0.75%	2
0.75% but less than 1.00%	1
1.00% and over	6
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Group Insurance

1986 claims reported by the contributing companies totaled 42 certificates for $1,322,000. Using similar gross-up methods to those used for individual insurance results in estimated 1986 claims of 60 certificates for about $1.9

million. The ratio of AIDS to total claims in the group line is 0.2 percent of claims. Antiselection does not have the same impact on group experience as it has on individual. Again, the number of insured claims relative to the total AIDS deaths is in the 30 percent range.

As in the case of individual insurance, 1987 experience is proving to be worse than 1986. Estimates of 1987 experience are 100 certificates for $4.9 million. This would represent 0.5 percent of total claims.

The following table gives similar information for 1986 ratios of AIDS to total as was shown for individual insurance. Some companies were not able to provide group information, while others are not active in this line of business.

No. of companies	46
AIDS claims	$1,322,000
Total claims	$675,000,000
Ratio	0.20%
Minimum ratio	nil
Maximum ratio	3.22%

Distribution of company by ratio

nil	30
less than 0.25%	10
0.25% but less than 0.50%	2
0.50% but less than 0.75%	1
0.75% but less than 1.00%	1
1.00% and over	2
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VALUATION IMPLICATIONS

Valuation actuaries in Canada are required to comply with the valuation legislation in the Canadian and British Insurance Companies Act and to follow the financial reporting recommendations developed by the Canadian Institute of Actuaries. The pertinent requirements are outlined briefly in the following.

The Legislation

1. Assumptions must be appropriate to the circumstances of the company and the policies in force and must be acceptable to the Superintendent of Insurance.
2. Reserves are equal to present value of unmatured obligations less the present value of valuation premiums.

3. Gross premium less valuation premium must be greater than value of future expenses and also dividends on present scale, in the case of par insurance.
4. Reserves must make good and sufficient provision for unmatured obligations guaranteed under the terms of the policies.
5. Actuary must disclose in the report to the Superintendent any prospective changes in dividend scale assumed in the valuation.
6. Reserves published in any statement to the public must be the same as those used in any statement to the regulatory authority.

The Professional Recommendations:

Assumptions

1. Each assumption should be appropriate and is required for each contingency which materially affects the company's net income.
2. The effect of a change in valuation assumption should not be spread over more than one valuation date.
3. Each assumption is a combination of expected experience and provision for adverse deviations with a larger provision for adverse deviations where there is less confidence in the expected experience.
4. A statement of the valuation actuary to the effect that the amount of the reserves is proper and a proper charge with respect to the reserves has been reflected in the income statement is required in the company's report to shareholders and/or policyholders.

The Impact of AIDS on Valuation

The principal impact of AIDS will be felt on existing business. For new issues, it is likely that the effects of the disease will be reflected in the pricing, dividend scales and valuation, although it is doubtful if many Canadian companies are on this course as yet. The spread and incidence of the disease in Canada has not approached the magnitude it has in the U.S.

The liability under fixed-premium policies is the most far-reaching. Where premiums (costs) are adjustable, a company can reduce the effect of AIDS by increasing premiums, reducing the mortality component of the dividend scale or both. In group life and health operations, a part of the increased costs arising from AIDS can be passed on to the employer through the experience-rating mechanism. Also, rate guarantees are generally for not more than one year in the group lines so there is the opportunity to re-price the business as the knowledge about the disease increases. The cost of hospital and medical care does not have quite the same impact in Canada as in the U.S. because of provincial medicare plans. However, should the disease

spread as predicted, increased costs will surely result and existing treatment facilities will be severely strained.

Because of the valuation requirement that assumptions be appropriate, recognition of the AIDS threat in the reserving process will likely become essential to the key male ages of 20 through 50. The increase in the assumption may be postponed for a while because of the present relatively low effect of AIDS on the total claims picture. As experience unfolds, companies will be better able to respond to the problem. Until such time, however, the additional claims resulting from AIDS will be an indirect charge against surplus as the existing valuation assumptions do not anticipate an epidemic of these proportions.

Many uncertainties still exist that will impact upon the ultimate valuation assumptions. Will AIDS expand through a "select" insurance-buying population at the same rate as it does through the general population? From the limited experience available in Canada, it appears that fewer than 50 percent of AIDS deaths are insured. How effective will education be in changing the sexual habits of individuals? There is some indication that concentrated programs help. What effect will blood testing have on AIDS experience? Two years ago, virtually no Canadian company had blood profiles as a part of its normal underwriting requirements. Now most are in the $250,000 range for all policies, and many expect to be at $100,000 by the end of 1988. It does appear that a very few number of claimants are responsible for a significant part of the overall AIDS experience.

The Proposed Reserving Process in Canada

The whole matter of reserves in Canada has been under review for several years, and the recognition of AIDS does add some complications to the process. The Canadian Institute of Chartered Accountants has proposed that the policy premium method (gross premium) be GAAP for Canadian life companies. Conservatism in valuation margins is significantly reduced but coupled with the reduction are very substantial requirements for appropriated surplus. It is recognized that experience will fluctuate around that contemplated by the assumption and the margin in the assumption is intended to cover mis-estimation of the mean and possible deterioration of the mean. The greater the uncertainty of the expected experience, the greater the valuation margin. However, in material prepared to date, it is likely that the maximum mortality margin proposed will be inadequate should AIDS proceed unchecked.

In a similar vein, the surplus appropriation required for mortality risks involves the application of parameters to amounts at risk. Here again, the proposed formulas recognize some contagion but not to the extent of an AIDS epidemic. Some rethinking will likely be required in this area as well.

There are many actuaries in Canada who are uncomfortable with the ramifications of the proposed method. In particular, the required changes in the legislation to accommodate this method have not been made. AIDS adds another dimension to the concerns and will likely require changes in the thinking that has taken place to date.

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December 7, 1987

SURVEILLANCE UPDATE: AIDS IN CANADA

The Federal Centre for AIDS has received reports of 1405 cases which meet the surveillance case definition for AIDS (revised September 1, 1987). These include 1379 adults and 26 pediatric cases (< 15 years of age). A total of 730 deaths (52.0%) have been reported.

In this report, cases accepted for surveillance purposes which meet the revised definition but would not have been included under the previous case definition are indicated in Section VII to allow assessment of the effect of the expanded definition on the surveillance statistics.

I. All Cases

		Alive	Dead	Total
Adults	Males	638	672	1310
	Females	30	39	69
	Subtotal	668	711	1379
Children	Males	3	10	13
	Females	4	9	13
	Subtotal	7	19	26
Total		675	730	1405

Adult Cases

	Cases (%)	Deaths (% of cases)
1. Risk Factors*		
Homosexual/bisexual activity	1122 (81.4)	556 (49.6)
IV drug abuse	9 (0.7)	7 (77.8)
Both of the above	42 (3.0)	22 (52.4)
Recipient of blood/blood products	56 (4.1)	36 (64.3)
Heterosexual activity†:		
(a) origin in endemic area	73 (5.3)	52 (71.2)
(b) sexual contact with person at risk	35 (2.5)	16 (45.7)
No identified risk factors	42 (3.0)	22 (52.4)
Total	1379 (100.0)	711 (51.6)
2. Age Group (yrs)		
15–19	4 (0.3)	2 (50.0)
20–29	289 (21.0)	135 (46.7)
30–39	629 (45.6)	319 (50.7)
40–49	318 (23.1)	172 (54.1)
50 and over	137 (9.9)	83 (60.6)
Unknown	2 (0.1)	0 (0.0)
Total	1379 (100.0)	711 (51.6)
3. Primary Diagnosis		
KS without PCP	288 (20.9)	140 (48.6)
PCP without KS	763 (55.3)	378 (49.7)
Both KS and PCP	41 (3.0)	25 (61.0)
Other OI	241 (17.5)	146 (60.6)
Other malignancies	37 (2.7)	20 (54.1)
HIV wasting syndrome	6 (0.4)	2 (3.3)
HIV encephalopathy	3 (0.2)	0 (0.0)
Total	1379 (100.0)	711 (51.6)

*Risk factors listed in hierarchial order.
†Heterosexual activity includes (a) persons originating in or residing in countries with a high prevalence of HIV and where heterosexual transmission of HIV is common; and (b) persons reporting heterosexual activity with person(s) at risk of HIV infection.
Note: This applies to all risk factor breakdowns in this report.

III. Adult Males

	Cases (%)	Deaths (% of cases)
1. Risk Factors		
Homosexual/bisexual activity	1122 (85.6)	556 (49.6)
IV drug abuse	8 (0.6)	6 (75.0)
Both of the above	42 (3.2)	22 (52.4)
Recipient of blood/blood products	43 (3.3)	28 (65.1)
Heterosexual activity:		
(a) origin in endemic area	51 (3.9)	38 (74.5)
(b) sexual contact with person at risk	9 (0.7)	4 (44.4)
No identified risk factors	35 (2.7)	18 (51.4)
Total	1310 (95.0)	672 (51.3)
2. Age Group (yrs)		
15–19	4 (0.3)	2 (50.0)
20–29	264 (20.2)	122 (46.2)
30–39	606 (46.3)	305 (50.3)
40–49	311 (23.7)	167 (53.7)
50 and over	123 (9.4)	76 (61.8)
Unknown	2 (0.2)	0 (0.0)
Total	1310 (95.0)	672 (51.3)
3. Primary Diagnosis		
KS without PCP	286 (21.8)	139 (48.6)
PCP without KS	727 (55.5)	357 (49.1)
Both KS and PCP	41 (3.1)	25 (61.0)
Other OI	212 (16.2)	130 (61.3)
Other malignancies	35 (2.7)	19 (54.3)
HIV wasting syndrome	6 (0.5)	2 (3.3)
HIV encephalopathy	3 (0.2)	0 (0.0)
Total	1310 (95.0)	672 (51.3)

IV. Adult Females

	Cases (%)	Deaths (% of cases)
1. Risk Factors		
IV drug abuse	1 (1.4)	1 (100.0)
Recipient of blood/blood products	13 (18.8)	8 (61.5)
Heterosexual activity:		
(a) origin in endemic area	22 (31.9)	14 (63.6)
(b) sexual contact with person at risk	26 (37.7)	12 (46.2)
No identified risk factors	7 (10.1)	4 (57.1)
Total	69 (5.0)	39 (56.5)
2. Age Group (yrs)		
15–19	0 (0.0)	0 (0.0)
20–29	25 (36.2)	13 (52.0)
30–39	23 (33.3)	14 (60.9)
40–49	7 (10.1)	5 (71.4)
50 and over	14 (20.3)	7 (50.0)
Unknown	0 (0.0)	0 (0.0)
Total	69 (5.0)	39 (56.5)
3. Primary Diagnosis		
KS without PCP	2 (2.9)	1 (50.0)
PCP without KS	36 (52.2)	21 (58.3)
Both KS and PCP	0 (0.0)	0 (0.0)
Other OI	29 (42.0)	16 (55.2)
Other malignancies	2 (2.9)	1 (50.0)
HIV wasting syndrome	0 (0.0)	0 (0.0)
HIV encephalopathy	0 (0.0)	0 (0.0)
Total	69 (5.0)	39 (56.5)

V. Pediatric Cases

	Male	Female	Total (%)
1. Risk Factors			
Perinatal transmission	11	11	22 (84.6)
Recipient of blood/blood products	2	2	4 (15.4)
Total	13	13	26 (100.0)
	Male	Female	Total (%)
2. Age Group (yrs)			
<1	4	7	11 (42.3)
1–4	6	5	11 (42.3)
5–9	3	1	4 (15.4)
10–14	0	0	0 (0.0)
Total	13	13	26 (100.0)
	Cases (%)		Deaths (%)
3. Primary Diagnosis			
PCP	9 (34.6)		7 (77.8)
LIP	5 (19.2)		3 (60.0)
CMV	5 (19.2)		5 (100.0)
Other OI	7 (26.9)		4 (80.0)
Total	26 (100.0)		19 (73.1)

VI. Geographic Distribution

Province*	Male	Female	Total (%)	Deaths	Rate/Mill.† Population (cumulative)
British Columbia	275	7	282 (20.1)	158	97.4
Alberta	77	5	82 (5.8)	43	34.9
Saskatchewan	17	0	17 (1.2)	12	16.7
Manitoba	24	0	24 (1.7)	12	22.4
Ontario	537	14	551 (39.2)	256	60.7
Quebec	360	54	414 (29.5)	233	62.9
New Brunswick	6	1	7 (0.5)	5	9.7
Nova Scotia	20	1	21 (1.5)	8	23.8
P.E.I.	1	0	1 (0.1)	1	7.9
Newfoundland	5	0	5 (0.4)	2	8.6
N.W.T.	1	0	1 (0.1)	0	19.2
Yukon	0	0	0 (0.0)	0	0.0
Total	1,323	82	1,405 (100.0)	730	55.4

*Cases are attributed to the province where onset of the illness occurred.
†Population estimates from Statistics Canada (July 1, 1985).

VII. Cases Reported by Date of Diagnosis

Year	Number of Cases	* (revised case def'n)	Number of Deaths	Case-Fatality (%)
1979	1		1	100.0
1980	3		3	100.0
1981	6		6	100.0
1982	22		22	100.0
1983 01–03	14		12	85.7
04–06	15		15	100.0
07–09	11		9	81.8
10–12	14		14	100.0
Total	54		50	92.6
1984 01–03	28		21	75.0
04–06	33		28	84.8
07–09	40		29	72.5
10–12	41		36	87.8
Total	142		114	80.3
1985 01–03	60		44	73.3
04–06	74		56	75.7
07–09	90		64	71.1
10–12	94		60	63.8
Total	318		224	70.4
1986 01–03	89		52	58.4
04–06	118		59	50.0
07–09	117		64	54.7
10–12	134		51	38.1
Total	458		226	49.3
1987 01–03	123		31	25.2
04–06	147	(1)	29	19.7
07–09	110	(7)	24	21.8
10–12	21	(1)	—	0.0
Total	401		84	20.9
Total	1405		730	52.0

*Numbers in parentheses refer to those cases that have been accepted as AIDS under the revised case definition and would not have been included previously. They are included in the total frequencies presented for cases and deaths.

VIII. Frequencies over Time by Sex and Risk Factors

	Year of Diagnosis					
	pre-1983	1983	1984	1985	1986	1987
Adults						
Males	23	44	133	292	438	380
Females	6	6	5	15	18	18
Children						
Males	1	1	3	7	1	0
Females	2	3	1	4	1	2
Adult Risk Factors						
Homosexual/bisexual activity	11	31	109	255	382	334
IV drug abuse	2	0	0	0	2	5
Both of the above	1	3	4	9	9	16
Recipient of blood/blood products	1	1	1	13	23	17
Heterosexual activity:						
(a) origin in endemic area	11	11	17	16	12	6
(b) sexual contact with person at risk	3	2	4	7	11	8
No identified risk factors	0	2	3	7	17	13
Pediatric Risk Factors						
Perinatal transmission	2	4	4	9	1	2
Blood transfusion recipient	1	0	0	2	1	0

IX. Projected Cases of AIDS in Canada

Estimates of the number of new cases of AIDS that will occur in 1987–1991 have been derived using modeling techniques. Two empirical models, the logistic model and the polynomial model, have been applied to these data and estimates of new cases per year and cumulative totals are displayed below. Data used for these projections include AIDS cases reported to the FCA by September 14, 1987 and diagnosed to the end of 1986.

	Logistic Model		Polynomial Model	
Year	Cases	Cumulative	Cases	Cumulative
1987	552	1542	653	1643
1988	590	2132	890	2533
1989	604	2736	1161	3694
1990	608	3344	1469	5163
1991	609	3953	1811	6974

The number of reported cases is doubling every 13 months.

Country	Total Cases	Dead	Rate per 1,000,000†	
Canada	1,405	730	55.3	12/87
United States	47,298	26848	189.2	11/87
Total North America	48,703			
Brazil	2,013	—	14.9	09/87
Dominican Rep.	200	—	32.3	03/87
Haiti	912	88	140.3	09/87
Mexico	534	—	6.8	06/87
Remaining South and Central Americas	1,283	392	8.7	06/87
Total South and Central Americas	4,942			
Austria	93	—	12.4	06/87
Belgium	255	—	25.8	06/87
Czechoslovakia	7	—	0.4	03/87
Denmark	176	—	34.5	06/87
Finland	19	—	3.9	06/87
France	1,980	30	36.3	06/87
German Dem. Rep.	4	—	0.2	06/87
Germany	1,400	316	23.0	09/87
Greece	49	12	4.9	06/87
Hungary	5	—	0.5	06/87
Iceland	4	—	20.0	06/87
Ireland	19	—	5.3	06/87
Italy	1,025	—	17.9	08/87
Luxembourg	7	—	17.5	03/87
Malta	6	—	20.0	06/87
Netherlands	308	—	21.2	06/87
Norway	49	—	12.0	06/87
Poland	2	—	0.1	06/87
Portugal	67	—	6.6	06/87
Romania	2	—	0.1	03/87
Spain	508	—	13.2	06/87
Sweden	141	—	17.0	10/87
Switzerland	299	68	47.5	09/87
United Kingdom	1,123	624	20.0	10/87
U.S.S.R.	58	—	0.2	06/87
Yugoslavia	11	—	0.5	06/87
Total Europe	7,617			
China	2	—	0.0	04/87
China (Taiwan)	1	—	—	01/86
Cyprus	3	—	5.0	06/87
Eastern Med. Region	36	—	0.5	09/87
Hong Kong	4	—	0.7	12/86
India	9	—	0.0	05/87
Indonesia	1	—	0.0	04/87
Israel	42	—	10.0	09/87
Japan	50	13	0.4	10/87
Lebanon	3	—	1.2	06/87
Malaysia	1	—	0.1	09/87
Qatar	9	—	30.0	05/87
Rep. of Korea	1	—	0.0	04/87
Singapore	2	—	0.8	06/87
Sri Lanka	2	—	0.1	04/87
Thailand	11	—	0.2	06/87
Turkey	21	—	0.4	06/87
Total Asia	198			

Country	Total Cases	Dead	Rate per 1,000,000†	
Australia	648	347	41.3	11/87
New Zealand	54	—	16.4	09/87
Total Oceania	702			
Algeria	5	—	0.2	06/87
Angola	6	—	0.7	09/86
Benin	3	—	0.8	05/87
Botswana	13	—	11.8	06/87
Burundi	128	—	27.2	03/87
Cameroon	25	—	2.6	03/87
Central Africa	254	—	4.3	10/86
Chad	1	—	0.2	11/86
Congo	250	—	147.1	11/86
Cote D'Ivoire	118	—	12.0	11/86
Ethiopia	5	—	0.1	06/87
Gabon	13	—	11.8	07/87
Gambia	14	—	23.3	03/87
Ghana	145	—	10.7	05/87
Kenya	625	—	30.3	07/87
Lesotho	1	—	0.7	11/86
Liberia	2	—	1.0	06/87
Malawi	13	—	1.9	11/86
Mozambique	1	—	0.1	06/87
Nigeria	5	—	0.1	05/87
Rwanda	705	—	117.5	02/87
South Africa	81	—	2.2	09/87
Swaziland	7	—	11.7	07/87
Tanzania	1,130	—	50.4	04/87
Tunisia	2	—	0.3	05/86
Uganda	1,138	—	73.9	02/87
Zaire	335	—	11.2	06/87
Zambia	395	—	59.8	06/87
Zimbabwe	380	—	43.7	08/87
Total Africa	5,800			
Total Cases	67,962			

*Total cases reported based on currently available data.
†1985 population estimates provided by the population division of the Dept. of International Economic and Social Affairs of the United Nations Secretariat.
Source: W.H.O Surveillance Program
CDC Weekly Surveillance Report — U.S.
CDR — AIDS: United Kingdom
University of New South Wales — Australia

CHAPTER 9

MANAGEMENT STRATEGIES AND THE ROLE OF THE VALUATION ACTUARY

DAVID M. HOLLAND

1. STRATEGIES FOR MANAGEMENT IN RESPONDING TO THE AIDS EPIDEMIC

The AIDS epidemic will result in billions of dollars in claims for the life and health insurance industry. Prudent management requires planning to meet the AIDS claims on in-force business and to minimize the adverse impact of AIDS on new business issued. The actuary should recognize expected losses from this epidemic in valuing the business and should discuss with management strategies for dealing with these claims. In order to assess the impact of AIDS on a particular company, it is also important for the actuary to establish procedures for accurately tracking AIDS claims. Various strategies for management are described below.

1.1 *Strategies for In-Force Business*

Regardless of actions taken with respect to future issues, AIDS claims will emerge on in-force business. Based on an analysis of resources and projections of the timing and level of claims, management must decide on a strategy to meet these obligations.

1.1.1 Pay As You Go

Pay as you go is the default strategy; if management takes no specific actions, the claims will be charged against earnings as they emerge. Reduced earnings will also reduce the amount available for dividends to shareholders of stock companies or for the company to keep as retained earnings. Depending on the level of claims, there may be operating losses in statutory (and GAAP) statements. Any losses will be charged against surplus. Substantial losses could result in insolvency. If the pay-as-you-go strategy is adopted, it is especially important for the actuary to keep management appraised of the possible effects of this strategy.

1.1.2 Reduce Dividends to Policyholders

Participating policies share in the results of the operations of the company. To the extent gains are reduced as a result of adverse mortality from AIDS,

the amount available for distribution to policyholders will also be reduced. Experience factors such as mortality rates and claims factors are accepted elements of dividend determination (see also "Dividend Recommendations and Interpretations" of the American Academy of Actuaries). Traditionally, policyholder dividends have been reduced to reflect adverse mortality experience; consider the following from *Life Insurance* by Joseph B. MacLean (ninth edition, pp. 598–599):

> "*Epidemic*. The influenza epidemic which commenced in the fall of 1918 had a much more serious effect on the companies' mortality experience than either of the two wars. The epidemic, which was world-wide, probably accounted for more than 10 million deaths. In the United States the number of deaths directly attributable to the epidemic was estimated at more than 450,000, that is, more than 3 per 1,000 of the population. The financial effect on the life-insurance companies was greatly increased by the fact that death claims from the epidemic were mostly among the younger policyholders whose policies had been only a short time in force. The epidemic, however, affected all ages and all classes of the population and caused an increase in the companies' mortality cost of 50 to over 100 per cent. . . . The smaller and more recently organized companies, whose policyholders were mostly persons at the lower ages, were most severely affected, many of them experiencing an increase in mortality cost of considerably over 100 percent. The severity and cost of this epidemic were unprecedented in the history of life insurance and provided a striking demonstration of the necessity for adequate contingency funds. Nearly all companies found it necessary to reduce (and in some cases to eliminate) dividends on participating policies for a year or more. . . ."
>
> "*Depression*. . . The rate of interest had commenced the sustained fall which was to continue for about 15 years (until 1947). The mortality rate increased during the depression years. A feature of this increase was the large number of suicides, which rose to 30 percent above normal during the early 1930s. Much of this excess mortality was on policies of large amount. In addition, disability claims and losses had increased to such an extent that practically all companies had either abandoned the disability-income coverage or radically altered its terms. These unfavorable elements led to many reductions in dividends, which in most cases were the first reductions in 10 years or more. Premium rates for nonparticipating policies were also generally increased to reflect the lower interest rates obtainable."

When dividend decreases are considered, a number of questions relating to equity amongst classes of policyholders must be considered. One consideration is whether to charge additional mortality to the affected groups only or to spread the effects over all ages and both sexes. Another issue is whether only past experience will be reflected or if anticipated sharp future increases in mortality should be anticipated. Also, there is the question of adjusting

only the mortality component of the dividend formula versus an overall lowering of dividends.

1.1.3 Increase Premiums or Other Nonguaranteed Charges Where Permitted

For products for which the current premium is not guaranteed, it may be possible to increase the premium actually being charged to reflect additional mortality from AIDS. Premiums may be increased for certain ordinary life products, group life products, guaranteed renewable health products, and collectively renewable health products. For products such as Universal Life, charges for the cost of insurance and interest loads may be revised to the extent permitted. Although this strategy sounds straightforward, it may be difficult to implement. Increasing premiums to anticipate losses may result in lapses by those individuals who are in better health and can get a cheaper rate from another company. Thus, this option should not be considered lightly, but in the event the impact of AIDS on mortality becomes severe, many products do provide this most important tool for responding to adverse mortality results.

1.1.4 Renewal Actions

Products that are periodically renewable on nonguaranteed terms present opportunities for action to reflect increased experience costs such as AIDS mortality. For example, group insurance is often written on a one-year term basis with the company having the option to reprice or terminate coverage each year. Although credit insurance rates are generally regulated, this is often a short-term coverage, and the company could decide to get out of this market or file for a rate deviation if experience is adverse. Many health insurance products also present opportunities for renewal actions in which the insurance company could adjust for its exposure to extra AIDS costs.

1.1.5 Prefund Additional Claims via Extra Reserves

When faced with future contingent payouts that can be estimated, traditional actuarial methodology has been to establish reserves to provide for those payouts. It is possible to project the present value of future AIDS claims and to include this amount in reserves. However, because of the uncertain future of the long-term course of the AIDS epidemic, it would be desirable to have the flexibility to strengthen reserves over time as experience

emerges. It is expected that the impact of AIDS will be realized over many years, and thus there is time to spread out the cost.

1.2 *Strategies for New Business*

1.2.1 Risk Selection and Classification

Risk classification is an integral part of the life and health insurance process. Companies must be able to select risks if they are going to be able to price adequately and equitably. The expected mortality for someone who is infected with Human Immunodeficiency Virus (HIV) is extremely high. Companies must be able to test for infection with HIV or else they will be faced with the ultimate risk classification question of whether or not they can continue to accept any new business. There is no reason to consider AIDS and HIV infection differently from other high-risk conditions. With respect to specific risk classification issues, refer to the American Academy of Actuaries statement on "Risk Classification and AIDS."

1.2.2 Repricing

To the extent AIDS claims are anticipated on future new business, the acutary should consider this extra mortality in product pricing. Some jurisdictions do not permit the use of AIDS antibody tests, such as ELISA with confirmation by a Western Blot test; in some of those jurisdictions alternative tests that are not as effective (for example, T-cell ratio tests) are permitted. Pricing may need to vary by the efficacy of testing in such instances. Even with testing for HIV infection as part of the risk selection process, some new insureds will become infected after issue, and this extra mortality should be provided for. In cases in which the policy provides for both guaranteed maximum premiums and current premiums, an increase in the guaranteed premium would provide room for further revision in the event of adverse experience.

1.2.3 Product Evolution

Product evolution is a natural process particularly when facing adverse experience. Companies will have to decide if basic changes to policy terms and conditions can improve results in light of AIDS. For example, to dampen the effect of mortality fluctuation, there may be more emphasis on longer term plans with higher premiums than on competitive term products. There

may also be more interest in policies that are issued for short periods of time and for which there is no guarantee of renewal or conversion; such products could be completely reunderwritten if continuation of coverage is desired. There has been discussion of policy provisions such as an AIDS exclusion if evidence of HIV-free status is not provided at the time of underwriting; however, serious concerns have been expressed about the efficacy and desirability of an AIDS exclusion provision. In light of the long-term uncertainty regarding the impact of AIDS, products that charge a competitive current premium but that have the right to increase the premium at the option of the company should be attractive to the consumer but yet provide the company with the flexibility to increase premiums in the event mortality experience warrants such an action.

1.2.4 Reserving Procedures

Additonal reserves may be required to reflect the impact of AIDS. These reserves should be considered in pricing and profitability tests of new products. Possible approaches for developing reserves are discussed in subsequent portions of this chapter.

1.2.5 Reinsurance

When companies are uncertain of the ultimate level of mortality of a product, they often will seek a reinsurer to share the mortality risk. By reducing the amount retained on any one life, the direct company is also reducing the potential impact of excess claims. Such reinsurance may be used to transfer the risk of excess mortality from AIDS for in-force business as well as new business. It must be recognized that reinsurers are also susceptible to adverse experience from AIDS, possibly even more so than direct companies. Financial stability should be a key criterion in selecting a reinsurer. In addition, reinsurers cannot be the permanent loss absorbers for the insurance industry, but must be able to follow the fortunes of ceding companies, particularly in areas such as premium increases on in-force business as a response to adverse mortality experience.

In addition to traditional risk reinsurance, certain reinsurers are also developing special reinsurance programs that would cover risks such as catastrophic mortality including AIDS; advance funding via reinsurance may also result in financial advantages to the ceding company. Care should be taken by ceding companies that long-term commitments on the direct side are not supported by short-term reinsurance coverage such as a stop loss

cover that is cancelable at the option of the reinsurer and can thus be withdrawn when it is needed most.

1.2.6 Discontinuance of a Product Line

It may be that for some products, even changes in risk classification, pricing, and product design will not be sufficient to ensure that the product line can be written on a self-supporting basis. In this case, there should be serious consideration of whether or not to continue marketing of the product.

2. AIDS AND THE RESPONSIBILITY OF THE U.S. VALUATION ACTUARY

2.1 *The Responsibility of the Valuation Actuary*

In accordance with current requirements, the annual statement of a U.S. life insurance company must contain the opinion of a qualified actuary relating to the policy reserves and other actuarial items. The annual statement instructions state:

> "The Opinion paragraph should indicate that, in the actuary's opinion, the reserves and other actuarial items. . . make a good and sufficient provision for all unmatured obligations of the company guaranteed under the terms of its policies. . . ."

The Valuation Actuary in the U.S. must consider "Recommendation 7: Statement of Actuarial Opinion for Life Insurance Company Statutory Annual Statements" of the American Academy of Actuaries. This recommendation states:

> "In those instances wherein. . . the statutory reserves might not make good and sufficient provision for unmatured obligations, then the actuary should make further tests (possibly by a gross premium valuation as described in general terms below) before expressing an opinion as to such policy reserves and other actuarial items.
>
> "A gross Premium valuation may be made for an entire line of business or a major block of business. The results of such a gross premium valuation for a line or block of business are considered satisfactory for this purpose if the current reserve on the reserve basis being tested provides an appropriate margin over the excess of:
>
> (a) the then present value of future benefits and anticipated expenses, [over]
>
> (b) the then present value of future guaranteed gross premiums using interest, mortality, morbidity, lapse, expense and any other appropriate assumptions selected as of the valuation date reflecting actual and anticipated experience. . . ."

2.2 *Recognizing the Impact of AIDS in Valuations*

AIDS presents the Valuation Actuary with problems:

- Pricing and reserve standards at the time of issue of in-force business probably did not anticipate the AIDS risk.
- Margins that may have been included were included for a variety of adverse scenarios and cannot be fully allocated to AIDS without creating potential for failure to cover adverse deviation from these other scenarios.
- Since there is a long latency period with HIV infection, adverse AIDS claims are expected to emerge over time with increasing significance.
- Knowledge about the true impact of AIDS is still emerging.

Nevertheless, AIDS is a grim reality, and there is very little reason for optimism regarding a short-term eradication of the epidemic. The impact of the disease in the short run is becoming measurable, especially given that a large number of people are already infected with HIV. Accordingly, the Valuation Actuary should consider the impact of AIDS in determining whether or not the reserves make good and sufficient provision for guarantees provided.

The gross premium valuation process can be used to test the impact of AIDS. A gross premium valuation using traditional methods and assumptions could be performed without special consideration of AIDS. Additional AIDS claims could then be projected using methods as described elsewhere in this report. These additional AIDS claims could be used to adjust the results of the traditional gross premium valuation. The results of a gross premium valuation may range from the conclusion that the funds currently held are adequate to the conclusion that substantial losses can be anticipated already and should be provided for.

Gross-premium-type tests of certain plans performed by the Task Force produced somewhat problematic results. In some cases, gross premium valuations showed profits in the early years that dwindle down to break-even results for a few years and are ultimately followed by significant losses in the later years. For these cases, it is the responsibility of the actuary to describe this situation to management and to develop a strategy for making adequate provision for later years when significant losses are expected to emerge. This may result in the need for additional reserves or the development of targeted surplus.

Various questions arise regarding the selection of appropriate assumptions for a gross premium valuation and the recognition of the impact of strategies selected by management in responding to the AIDS epidemic (for example,

the use of "guaranteed" premiums as provided by the Academy Recommendation or the use of "current" premiums if there is no intention of increasing current premiums to the guaranteed level). Further work is needed on reserve techniques for valuing the impact of AIDS. Some possible reserve techniques are discussed subsequently, but until other methods are developed the gross premium valuation is an accepted standard.

2.3 *AIDS Reserves vs. Targeted Surplus*

A natural question is whether the impact of AIDS should be provided for as a reserve or as targeted surplus. The opinion of the actuary in the U.S. relates to "reserves and other actuarial items" or "policy reserves and related actuarial items." In addition to reserves, the items in the actuarial opinion usually include net deferred and uncollected premiums and policy and contract claims. Surplus is not explicitly specified as an item covered by the actuarial opinion.

A number of people would argue that the actuarial opinion does not and should not relate to surplus. Excerpts from the "Report of the Task Force on the Valuation Actuary to the ACLI Board of Directors, August 1986" were included in *The Valuation Actuary Handbook* published by the Society of Actuaries in June 1987. In discussing the evolution of the Valuation Actuary concept in the U.S., this ACLI Task Force recommended:

> ". . . the ACLI oppose any regulatory requirements that the valuation actuary report on the adequacy of surplus. . . ."

A further condition on the ACLI's overall support of the Valuation Actuary concept was:

> "The regulatory authorities would be no more involved in the oversight of company surplus levels than they are at the present time. . . ."

An interesting topic for debate might be "if the actuary is not supposed to report on the adequacy of surplus overall, is it proper for the actuary to render an opinion regarding surplus targeted for special contingencies such as AIDS?" This raises many questions regarding the nature of surplus and the actuary's opinion that are beyond the scope of this report on AIDS. However, the current requirement is that if "reserves and other actuarial items" are inadequate, the actuary's opinion should be qualified; a consistent interpretation would then require the provision for AIDS to be included in "reserves and other actuarial items."

2.4 *The Evolving Role of the Valuation Actuary*

The concept of the Valuation Actuary is undergoing evolution in the U.S. The responsibility is already much broader than the rote application of statutory reserve standards to a block of business and is becoming broader than the gross premium standard defined above. In recent discussions regarding the Valuation Actuary, various classes of risk have been enumerated as C-1 (asset default), C-2 (pricing inadequacy), C-3 (interest fluctuations), and C-4 (accounting risks not otherwise reflected). Writing in "A Potential Approach to Valuation of Reserves and Surplus in Statutory Financial Statements" (*The Valuation Actuary Handbook*), Donald D. Cody defines the C-2 risk as follows:

> "*C-2 Risk*: Losses from increases in claims and expenses and from pricing deficiencies, other than those from C-1 and C-3 risks. This is a large and varied category of classic concern by actuaries: Increases in aggregate death claims, disability claims, medical claims; decreases in annuitant deaths; epidemics and earthquakes; accidental catastrophes; inflated expenses; irrecoverable expenditures on products and systems; increased expense rates from inefficiency. Provision for smaller ('reasonable') deviations from expected should be made in reserves. But large ('plausible') deviations are matters for surplus provision; and losses from earthquakes, epidemics and magnitude increases in annuitant life expectancies are exclusively matters for surplus."

In discussing deviations in death claims other than stochastic deviations in total claims, Mr. Cody states:

> "Epidemics (e.g., influenza, AIDS), earthquakes, and quantum changes in life expectancy affecting life annuity losses are matters solely for surplus provision and not for reserve provision. They should be handled by appropriate scenarios of plausible deviations corresponding to ruin probability p_2, with offsets for tolerable reductions in policyholder dividends and credits, stockholder dividends, and retained earnings" (ibid, p. VI–25).

At the time the preceding quotes were originally written, there was very little information on the ultimate impact and long-term nature of the AIDS epidemic. Based on discussions within the Task Force and with a number of Valuation Actuaries, including Mr. Cody, the consensus is that surplus is to provide for *future* catastrophic events of an unknown nature. But once the event occurs and the impact of it becomes reasonably measurable, then it is appropriate to provide for this extra risk via reserves rather than surplus. For example, a sharp downturn in investment return is a risk that is covered by surplus; however, once such an event occurs, then reserve strengthening is an appropriate response. This interest downturn scenario actually occurred

in the late 1930s, and the response was to strengthen reserves (see "The Strengthening of Reserves" in *Transactions of the Actuarial Society of America,* Volume XLV, pp. 297–342).

3. RESPONDING TO CHANGE UNDER THE TRADITIONAL VALUATION ENVIRONMENT

In the current U.S. environment for statutory valuation, standards are specified that are generally expected to be adequate for a large number of situations; in the event that there is concern about adequacy, the question of developing new standards should be considered. However, new standards do not generally apply to in-force business, and for in-force, reserve strengthening may need to be considered. Both of these concepts are discussed further in this section.

3.1 *New Valuation Tables and Mortality Projection Scales*

Valuation mortality tables include an element of conservatism and are presumed to be a safe valuation basis across a wide spectrum of companies. Accordingly, valuations using statutory tables have typically made good and sufficient provision for unmatured obligations, at least from the expected mortality perspective. The general trend over most of the twentieth century has been for mortality improvement, and for life insurance, this means that the need for revisions in valuation mortality tables has not been driven by mortality deterioration.

However, it now appears that with AIDS there will be a deterioration at least at certain ages. As an alternative to developing the necessary increase in reserves for AIDS via gross premium valuation, consideration should be given to the development of a new valuation table. There have been a number of developments following the 1970–75 experience period underlying the development of the 1980 CSO Table including substantial improvements in mortality at certain ages.

Developing a new valuation table is a major undertaking in general and is beyond the scope of this Task Force. There will be a number of additional challenges in determining how to recognize the impact of AIDS in a new valuation table. Because the impact of AIDS is expected to be of increasing significance year by year, the tables may need to be in select and ultimate form to reflect this degradation by year. Also, because of the change over time, it may be necessary to develop new valuation tables more frequently than in the past; for example, it may be necessary to develop new tables

every five years or so. The net result practically becomes a series of generation tables.

As an alternative to the development of series of new tables, it may be possible to develop mortality projection scales that can be used to update an initial table. Mortality projection scales have been an accepted technique for annuities for some time. Also, projection scales have been used to provide flexibility to reflect individual company characteristics as well as future trends in mortality. Also, projection scales by their nature can define "generation" mortality tables as are needed to reflect the impact of AIDS over time.

As an historical example of use of mortality projection scales, consider the 1971 Individual Annuity Mortality (IAM) Table whose development is described in *The Transactions of the Society of Actuaries (TSA),* Volume XXIII. The 1971 IAM was considered to be a "safe" table for the valuation of all types of annuities based on 1971 levels of mortality and was proposed as a valuation standard without projection. However, its developers observed:

> "We feel that the minimum valuation standard should continue to allow flexibility with regard to provision for future decreases in mortality, since there are wide differences of opinion as to how future mortality levels will change over a long period of years. . . . The judgment of different companies with respect to provision for future mortality improvements will vary not only because of differences of opinion with regard to the average long-term trends but also because of differences in the nature and composition of annuity business sold by specific companies and differences in their actual past experience." (*TSA, XXIII,* pp. 518–519)

The sections of the Standard Valuation Law in the U.S. dealing with annuities specify certain valuation mortality tables and go on to say "or any modification of these tables approved by the Commissioner...." Presumably, the modification could be the application of a mortality projection scale.

For ordinary insurance, there is no specific reference to a "modification" of a valuation table; however, a new table could also be determined as a modification or projection of an existing table. The 1980 amendments to the Standard Valuation Law provide an option (for business issued after the effective date of Section five-c of the Standard Nonforfeiture Law) of

> "any ordinary mortality table, adopted after 1980 by the National Association of Insurance Commissioners, that is approved by regulation promulgated by the commissioner for use in determining the minimum standard of valuation for such policies."

The Task Force recommends that the possibility of developing new ordinary life valuation tables, possibly including mortality projection scales, be addressed by an appropriate committee of the Society. Because new valuation tables generally apply only to new issues after an effective date, some other approach may be needed to strengthen reserves for in-force business.

3.2 *Strengthening of Reserves*

Additional reserves that are required because of gross premium valuations that indicate that the statutory tabular reserves do not make good and sufficient provision for future unmatured obligations, result in a *de facto* strengthening of reserves. Reserve strengthening for in-force business was a major actuarial topic at the time Guertin wrote his *TASA* XLV paper on "The Strengthening of Reserves"; this paper is well worth consideration even though it deals with the need for strengthening due to a decline in interest yields. Guertin indicates that there does not have to be a quantum jump in reserve from one level to another; he indicates that

> "Ordinarily, the change would be made in steps of 1/4 percent or 1/2 percent, so that over a period of several years the required rate will have been dropped by the full fraction contemplated."

He even indicates that reserves at irregular interest rates could also be used in this grading process.

Guertin points out that although reserve-strengthening programs are typically thought of in terms of adopting a new valuation basis as if it had been the valuation basis at issue, other approaches are possible. For example, given an actual reserve as of a specified date, a new net premium could be calculated on the basis of the new valuation assumptions to fund the present value of future benefits net of the existing reserve over the remaining duration of the policy.

The regulatory reaction to allow reserve strengthening to occur over a period of years appears to be a very pragmatic approach. There are elements of the current situation with respect to AIDS that also call for pragmatic consideration. By the nature of the data available, it is not possible to have an extremely high level of confidence in long-term mortality projections regarding AIDS. Thus, for this situation, consideration should be given to programs that allow for reserve strengthening to occur over time as the nature of the extra mortality emerges.

In the appendixes to this chapter, two approaches are set out for general information. Neither approach is being proposed for adoption. Until there is

some change in accepted practice, the responsibility of the Valuation Actuary in rendering an opinion about the reserves and other actuarial liabilities will continue to have the gross premium valuation as set out by the Academy as the ultimate test.

APPENDIX 1 - AN AIDS MORTALITY RESERVE

In order to test current reserves, a gross premium valuation reflecting AIDS may be prepared. One approach would be to prepare the gross premium valuation using mortality that has been modified to take the impact of AIDS into account. Another approach may be to prepare a gross premium valuation without regard to AIDS and to adjust the results of that valuation by adjusting for additional mortality as a result of AIDS.

In lieu of performing special tests, some actuaries may want to consider the establishment of an AIDS Mortality Reserve as generally set out below. Note that this is not being recommended as a standard of practice but is included as a possible approach that should be investigated further.

Let AMR_t = AIDS Mortality Reserve at time t

then

$$AMR_{t+1} = (AMR_t + LC_t)^*(1 + j_t) - AM_t$$

where

LC_t = Level (annual) cost for AIDS mortality
j_t = Net interest earned during year t
AM_t = Actual AIDS mortality during year t that is, actual AIDS claims).

LC_t should be calculated as follows:

$$LC_t = (PVAM_t - AMR_t)/\ddot{a}_{\overline{n}|i}$$

where

$PVAM_t$ = The present value of AIDS mortality calculated at time t.

An annuity due at interest rate i, payable for n years certain is given by

$$\ddot{a}_{\overline{n}|i}$$

The value for n should be large enough so that there is a reasonable period to accumulate the necessary reserve but not so large that the accumulation is deferred indefinitely. Initially, a value of n of from 15 to 20 is suggested.

AIDS claims could be determined in accordance with models set out in other parts of this report and discounted at either interest or interest and survivorship. Because the present value of AIDS claims ($PVAM$) would be

redetermined each year, the reserve would be automatically updated for revisions regarding the impact of the AIDS epidemic.

By subtracting actual mortality (*AM*) for AIDS, in determining the reserve, the reserve would be written down as actual AIDS claims emerge and thus would match the reserve release with the time the excess mortality is incurred. The minimum value of the catastrophic mortality reserve could be set at zero.

Similarly, the level cost (*LC*) could go negative if AIDS experience improves so much that the present value of future claims is less than the reserve on hand. This would be the natural mechanism for gradually running off the reserve if experience improves.

In developing the AIDS mortality reserve, due consideration should be given to strategies adopted by management in providing funds to meet future AIDS claims. For example, if the gross premium valuation did not reflect management's decision to take actions such as revising dividends because of AIDS, this could be brought into consideration in calculating the AIDS mortality reserve.

A number of refinements could be applied to this approach such as the use of net amount at risk rather than face amount. Another refinement would be to provide only for the AIDS mortality in excess of otherwise expected mortality. Again, this approach is not being proposed as recommended for anything other than further consideration as a pragmatic approach to dealing with expected AIDS mortality.

APPENDIX 2 — THE APPROACH USED BY THE INSTITUTE OF ACTUARIES

The Institute of Actuaries' AIDS Working Party published "AIDS Bulletins" in September and December 1987. "Bulletin No. 1" included various projections of the possible impact of AIDS on insurance mortality; Projection A had the highest extra mortality and Projection F the lowest. Yet Projection A should not be considered highly pessimistic especially should there be a widespread expansion into the heterosexual community. "Bulletin No. 1" concluded that extra mortality from AIDS can be expected to be related to both age and calendar year; this greatly complicates modifying existing valuation mortality tables in that a separate generation table would be required for each year of birth.

"Bulletin No. 2" included, among other topics, recommendations regarding reserving for AIDS. This Bulletin indicated:

"Nevertheless, we are satisfied that the assumptions underlying Projection F are sufficiently moderate for it to be essential for insurance companies to have regard to the possibility of an incidence of HIV infection at least at this level. On the basis of information already available, there [is] no reason to delay making changes to reserves and to pricing structures to take this into account. At this level, there should not be any reliance placed on the presence of a solvency margin, which is needed to provide some protection against more adverse scenarios.

"We do not envisage, on the other hand, that companies need establish technical reserves at this stage to enable them to cope with a situation such as that described by Projection A, neither would it be sensible, nor commercially viable, to establish non-profit premium rates now on such pessimistic assumptions. Companies should, however, examine the possible implications of such a pessimistic scenario, particularly with regard to finding out whether the total resources available to the company, including margins in valuation bases, surplus carried forward, reserves and shareholders' funds, would be adequate to enable the company to survive, allowing for new business written on guaranteed premium terms over the next few years."

A net premium approach was used to determine the reserves needed to cover AIDS exposure. "Old" basis reserves and net premiums were calculated based on the mortality assumptions excluding loading for AIDS and other assumptions regarding interest, dividends, etc. "New" basis reserves were calculated using the additional mortality loading for AIDS but using the "old" basis net premiums. The excess of the "new" basis reserves over the "old" basis reserves was taken as the extra reserve required for AIDS.

Even though companies start out using Projection F (low), they recommend that companies develop a strategy for further strengthening reserves over the next year or two to a more moderate projection they call "BC."

The additional reserves using these bases appear to be quite substantial. Consider the following per thousand extra reserves at issue for policies issued in 1988 to an individual age 30:

Projection	F	BC	A
20-Year Term	7.32	13.06	22.21
Whole Life	8.69	15.38	25.90

This net premium approach and underlying U.K. valuation assumptions should be studied for information purposes. However, the purpose of this appendix is *not* to recommend this approach for adoption in the U.S. environment, but rather to make people aware of what is being done in other countries.

CHAPTER 10

WHAT IS A COMPANY TO DO?

BARBARA J. LAUTZENHEISER

The purpose of this paper is to provide the actuary with a summary of the prior chapters of the Society of Actuaries' AIDS Task Force report to enable him or her to alert company management to the fact that AIDS will have an impact on all life and health insurance companies, to better estimate the extent of that impact, and to provide a prescription for possible future actions that could lessen that impact.

By its very nature, this chapter deals with matters that are more practical than theoretical, in the hope that some of the directions will help management focus on an appropriate response to the impact of HIV infection and AIDS.

1.0 HIV INFECTION AND AIDS IMPACT ON ALL LIFE AND HEALTH INSURANCE COMPANIES

Information about HIV infection and AIDS has grown rapidly over the last few years. The more that is learned, the more there is concern about the initially slow and then rapid progression from infection to AIDS, the mortality and morbidity of the disease, its level of entrance into the heterosexual population, and its financial impact on life and health insurance companies.

Claims levels of many insurance companies are currently low. This, however, is not surprising because of the slowness of the progression of the disease. According to the San Francisco City Clinic (SFCC) Study, three years after infection with HIV, only 4 percent of those infected have AIDS. By year 5, 14 percent to 15 percent have AIDS, and by year 9, 45 percent have AIDS. Each year after infection, percentages have continued to climb. Thus, in spite of the fact that AIDS claims are not large and may even seem small, it is only because what is seen today is the result of HIV infections from years ago. What is seen today is only the beginning of the slowly increasing curve of progression from infection to AIDS. Insurance companies cannot wait until claims are large and use only those claims to quantify their impact, because by then it is too late to do something. Companies must take action today to minimize the impact tomorrow. Those insurance companies that do nothing will experience a growing financial impact with little or no control over their ability to moderate that impact.

Just as there is certainty that a company will be financially impacted, there is also certainty that that impact will differ from that of other companies. Each company must determine, therefore, its financial impact, review possible strategies for actions, and implement those determined as most appropriate.

1.1 *Knowledge about the Disease and Its Impact*

Much has been learned about HIV infection and AIDS since the first known cases were reported in the U.S. in 1981. Unfortunately, as more information has been recorded, analyzed, and reported, the effects of the disease have shown it to have even greater impact and a longer duration of impact than originally thought. For example, as time has passed, studies of the progression from infection to AIDS continue to show the percentages going up. In January of 1986, the Centers for Disease Control (CDC) stated that 5 percent to 19 percent of those infected had been observed to progress to AIDS in 2 to 5 years. In June 1986, the Public Health Service published an estimate of 20 percent to 30 percent in 5½ years; in July 1986, the National Institutes of Health estimated the figure to be 35 percent in 6 to 8 years; the National Academy of Sciences, in October 1986, estimated 25 percent to 50 percent within 5 to 10 years; and the SFCC study, in mid-1987, estimated 14 percent to 15 percent in 5 years, 22 percent to 25 percent in 6 years, and 33 percent to 36 percent in 7 years. The latest data from the SFCC study show 45 percent progressing to AIDS within 9 years of infection.

As a result of this latter study, the following observations were reported:

Paul O'Malley, director of the research project at the SFCC, was quoted in the *Orange County Register*, February 29, 1987, as saying: "What we're seeing now is that the risk of actually developing AIDS increases in the second five years compared to the first five years."

The New York Times of March 3, 1987, quoted Dr. George Rutherford, also of the SFCC, as saying: "The longer one is infected, the higher are the chances of developing AIDS."

In the same *Times* article, Dr. Harold S. Jaffe, an AIDS epidemiologist at the CDC, working on the study with the San Francisco Health Department, said they were unable to identify any factor other than time that triggers the onset of the disease.

Major Robert Redfield of the Walter Reed Army Institute of Research, in his presentation to the Society of Actuaries 1987 annual meeting, stated that 90 percent of those in their study progressed to AIDS over time.

Dr. James Mason, director of the CDC, indicated in his presentation to the 1987 annual meeting of the American Council of Life Insurance that "a figure approaching

100 percent of those infected will develop symptoms of this disease that is invariably fatal. . ."

The mortality rate for the known cases has also been studied and documented in the 1987 paper by Michael J. Cowell and Walter H. Hoskins, "AIDS, HIV Mortality and Life Insurance" (Chapter 3 of this report). From the time AIDS is diagnosed, mortality rates of 45 percent in the first year, 45 percent in the second year, 35 percent in the third year, and 25 percent in each year thereafter were determined. The average life expectancy of someone with AIDS is only 2.1 years. Combining progression rates projected from the study by the Center for Internal Medicine of the University of Frankfurt in West Germany and these mortality rates, Cowell and Hoskins produced mortality rates for persons newly infected with HIV of 19 percent for 5 years, 55 percent for 10 years, 77 percent for 15 years, 90 percent for 20 years, and 96 percent for 25 years. Using these combined rates produces an average life expectancy of 11 years for a 35-year-old newly infected male compared to an almost 43-year life expectancy for a healthy male age 35. The mortality of this 35-year-old male who newly tests positive for HIV is in excess of 5000 percent of standard, based on the 1980 CSO male nonsmoker table, if it were a level equivalent multiple of that table. As such, this level of mortality is ten times higher than the highest substandard rate generally considered insurable by companies today. The mortality, however, is not a level multiple of standard, because of the slow progression and then sharp increase from HIV infection to AIDS, making its impact even more severe.

Also known is the fact that the disease has a very long latency period. That, too, extends longer as time and knowledge of the disease increase. In 1986, the Public Health Service stated that there was an average 4-year latency period. In November 1987, Dr. Mason stated:

". . .after 9 years of observation, only about 45 percent of those individuals (cohorts infected and studied) have developed symptoms which would enable us to classify their disease as AIDS."

Thus, the average latency period may be even longer than 9 years.

What also is known is that the disease is most prominent at the sexually active ages. AIDS has been thought of as a young person's disease; however, a more accurate description is that it is a disease that is prominent at the sexually active ages. Consistently, 21 percent of the cases have been between the ages of 20 and 29, and 46 percent are between 30 and 39. However, almost one-third are 40 or over (21 percent are between 40 and 49, and 10

percent are over 49). The remaining 1 percent are children under the age of 5. Although through the end of 1987 there were some 300 cases diagnosed in children between the ages of 5 and 19, they did not even constitute 1 percent of the cases. Major Redfield has stated that "the most important variable is age for a sexually transmitted disease."

1.2 *Knowledge Not Yet Known, But of Concern, about the Disease*

Preliminary information is also available that, although not yet fully developed, is sufficiently credible and of such concern as to warrant consideration. The vast majority of our data comes from observation of males (93 percent of adult cases—that is, those 13 and above—are males). The limited data we have on women with AIDS indicate they are dying more quickly than men with AIDS. Males also have different mortality depending on the opportunistic disease they acquire. Estimates of entrance of the infection into the heterosexual population range from minimal to substantial.

Occupational data are not available from the CDC, but individual disability income data from 16 companies, representing 60 percent of the new individual disability premium issued in 1986 and 60 percent of the individual disability premium in force at the end of 1986, showed insured data may not be indicative of population data. In terms of monthly indemnity, the highest percentages of AIDS claims were in four occupations: doctors (31.9 percent), dentists (12.1 percent), executives (7.8 percent), and attorneys (4.6 percent).

Unfortunately, these data have the potential of aggravating rather than alleviating the impact of the disease on the insured population. As such, they increase a company's need not only to initially determine the financial impact of the disease, but also to continue to do so.

1.3 *Knowledge about the Disease That Must Be Estimated*

In addition, there is other information that is not known and that may never be known; it can be estimated, however. Two such numbers are the level of infection in the general population and in the insured population. Estimates for the general population are as low as 300,000 and as high as 3,000,000, with even greater divergence of projections into 1991 and 2000. The most current numbers available are the latest Public Health Service estimates of 945,000 to 1,400,000.

Although the exact prevalence of the infection is not known, the spread of AIDS is. As of year-end 1987 no state had fewer than fives cases, only

five states added less than a dozen cases in 1987, and only 12 states had no cases on children. Analysis of detailed data on all cases reported to the CDC by the end of the third quarter of 1987 also indicated that the rate of spread is significantly higher than the national average in areas where current prevalence is lower than the national average, that is, in the Central SMSA, the Mid-Atlantic SMSA, and among people living in the SMSA of one million or less inhabitants.

1.4 *Legislative and Regulatory Effect on Impact*

In addition, legislative and/or regulatory activity banning AIDS testing, or prohibiting asking questions regarding prior AIDS testing, limiting the amount levels at which AIDS testing can be done, requiring added costs of specialized informed consent forms or pre- or postcounseling for all who are tested, as well as the cost of AIDS testing itself, will all have an impact on the mortality, morbidity, and expense factors that enter all new business issued currently and in the future. This, too, must be addressed and its potential impact quantified.

1.5 *Need To Quantify the Financial Impact of the Disease*

All these data indicate that life and health companies have been and will continue to be impacted by HIV infection and AIDS. Also, because of the nature of this disease—that is, its long latency period causing its "invisible" spread—there will be no company whose impact from HIV infection will not have the potential of a significant increase in the future. The slow progression from infection to AIDS means companies cannot estimate the future by looking only at the past or even at today. Like looking at a star, by the time its light reaches our eyes, its impact has long since been established and is unchangeable. Looking only at a company's current or past claims is not an adequate determination of the future impact of HIV infection and AIDS.

The impact on each company has been differing and will continue to differ because of the company's marketing and underwriting actions. The impact is also affected by the ages at which business was and is written, the geographic areas in which the company markets and the extent of the business written in each area, the lines of business (for example, individual, group, or credit for life, health, or disability income), the products written within each line (for example, whole life, universal life, term, major medical, hospital indemnity, or long-term disability), the underwriting limits at which

AIDS testing has been and is being done, and how soon the limits were introduced and reduced. Indicative of this is that the impact of AIDS in 1986 on some companies has been less than 0.5 percent of total ordinary life claims in some companies, but over 4 percent of ordinary life claims in others.

Therefore, a detailed analysis of these factors—past, present, and expected in the future, as well as current claims experience and the reasons it is at the level that it is—is necessary to obtain an objective, quantitative measurement of the impact on a company.

2.0 NEED TO ADDRESS THE IMPACT FROM A COMPANY-WIDE PERSPECTIVE

Because those elements that impact the cost of HIV infection and AIDS to a life and health insurance company and the actions to minimize that cost cross so many lines, it is important to address the impact from a company-wide perspective. One of the ways to accomplish this is to establish a task force, comprised of all the specialties, to address the concerns in a total cohesive manner. These specialties include actuarial, underwriting, claims administration, sales, legal, medical, public relations, and government relations. If a task force is not formed, the person(s) responsible for the analysis should nonetheless address all these areas.

2.1 *Responsibilities of the Task Force of Person(s) Charged with the Analysis*

This task force of person(s) should be charged with:

- The quantification and determination of the impact on the company.
- The review and determination of the appropriate management strategies and actions that should be taken.
- The communication of the impact and recommended strategies and actions to top management.
- The pressing for approval from top management of the action steps necessary to reduce and minimize the impact.
- The implementation of the approved actions.
- The ongoing redetermination of the impact following the company's actions and as changes in knowledge about the disease become known.

2.2 *Benefits of a Task Force Approach*

With all specialties represented, several benefits arise:

- Quantification of the impact will be better because of utilization of the knowledge and perspectives of all the specialties involved to establish the assumptions to be

used, because quantifications will require determinations to be made about the underwriting standards, product mix, age, geographic mix, etc. of the business, as well as a determination of probable legislative actions on testing availability. A detailed analysis of past claims experience will also be necessary.

- Coordination of the project through the task force will facilitate the expediency and efficiency of the quantification of the impact, the determination of strategies to minimize the impact, and the implementation of actions arising from these strategies.
- Determination of the management strategies through the task force, especially in coordination with sales, also produces more balanced results. There are risks of over-conservatism as well as under-conservatism. Actions may be necessary on new business underwriting to maintain pricing competitiveness and on new business pricing to maintain adequacy. Such changes should be communicated to the field force and consumers in such a way as to explain their necessity because of fairness and in such a way as not to create undue concern.

  Abrupt, substantial pricing increases may also cause even more severe antiselection. When prices increase quickly and dramatically, it is more difficult to attract the better risks and to sell more and larger policies. This causes not only an increase in mortality and morbidity costs but also an increase in fixed expenses per policy, because fewer policies will be sold over which these expenses can be spread. What then results is the need for yet another price increase. If this continues over time, prices continue to rise, leading to the traditional assessment spiral.

  Overly conservative actions taken by companies selling participating and nonguaranteed premium policies can create an in-force problem as well from excess lapses. All the pricing competitiveness considerations identified above can affect the nonguaranteed premium and/or the dividends on in-force policies. If these premiums increase sharply and substantially or the dividends decrease dramatically, a larger number of policies could lapse. As with new business, better mortality and morbidity risks may not persist, fixed expense unit costs may rise, and sales costs may be impacted. In addition, unrecovered acquisition expenses will no longer be recoverable. Once again, an assessment spiral could occur.
- Recognition of any needed action and implementation of that action are facilitated because of the awareness of the issues involved and their impact on the company by all the areas of the company through their representatives on the task force.

3.0 DETERMINATION OF THE FINANCIAL IMPACT

The financial impact should be determined for both the in-force business and the new business. At a minimum, in the U.S., determinations need to be made for fulfillment of the U.S. Life Insurance Company Annual Statement requirements. Current requirements are that the annual statement must contain the opinion of a qualified actuary that the reserves and other actuarial items "make a good and sufficient provision for all unmatured obligations

of the company." In addition, the Valuation Actuary must consider *Recommendation 7* of the American Academy of Actuaries. This recommendation states:

> In those instances wherein. . .the statutory reserves might not make good and sufficient provision for unmatured obligations, then the actuary should make further tests (possibly by gross premium valuation. . .) before expressing an opinion as to such policy reserves and other actuarial items. (See Chapter 9 for further information.)

Pricing adequacy of all currently issued lines and products should also be determined. This is particularly important for products more sensitive to the HIV infection and AIDS impact, such as term insurance and for coverage at younger ages where prevalence of the disease is greatest.

3.1 *Determination of Claims Experience*

Initially, a determination should be made of the current impact on the company's business. This must be much more detailed than is normally undertaken because of:

- The long latency period of the virus.
- The fact that persons do not die of AIDS but rather from opportunistic diseases. These opportunistic diseases can be diseases other than the more frequently identified diseases such as Kaposi's sarcoma or pneumocystis carinii pneumonia (for example, meningitis or tuberculosis).
- Antiselection resulting from the applicant obtaining information about the company's AIDS testing limits and subsequently purchasing lower amounts just to avoid testing.
- Avoidance of notations of AIDS as a cause of death to "protect" family and friends.
- Restriction in jurisdictions, such as New York, that permit only three causes of death to be noted, that is, homicide, suicide, and natural causes.
- The number of health and disability income claims that are not attributed to AIDS until well into the disease; this is a more severe problem in cases of AIDS in women and heterosexuals, because the frequency of the infection to date is lower in these populations.

This detailed claims analysis should therefore involve a review of claims with:

- Any cause of death or disability that could have been contributed to by AIDS or HIV infections.
- All amounts including those below the AIDS testing limit and especially those just below the testing limit, and those at usual amounts (that is, multiples of 5,000, 10,000 or 25,000 for life, or of 1,000 or 2,5000 for disability).
- Death, disability, or claim beyond the contestable period as well as those within it.

The review should also include the normal analysis for both number of policies and volume of claims by geographic areas and sales areas, age, sex, policy duration, etc.

Some adjustment for underreporting may also be necessary in spite of the thoroughness of the claims review. The CDC has estimated that as many as 20 percent of deaths from HIV infection may be going unreported.

If AIDS testing limits were changed during the period(s) reviewed, separate analyses should be done for issues in each period.

3.2 *Determination of Antiselection in New Business*

Current antiselection should also be analyzed from the standpoint of any changes in new business. If more term, more large amounts, more policies just below the AIDS testing limit, or more policies or larger amounts at young male ages, or in more volume in areas of high AIDS concentration have been written with no intentional change in marketing to account for them, they may be indicators of antiselection.

Even more frequent use of the waiver-of-premium provision could be an indication of the need for doing further review. In disability income, changes toward shorter waiting periods could be an additional indicator. In medical expense policies, trends toward lower deductibles or sudden sales increases in a geographical area, a sales area or in general, could be additional indicators.

3.3 *Estimation of the Level of Infection in the Insured Population*

Once the claims review and new business review are done, the data therefrom should be used to estimate the level of infection in the company's insured population and the expected level of infection in the prospective insured population from new sales. In doing so, it must be remembered that the claims experience reflects infection levels of several years back, as well as current infection levels. Thus, low claims levels may indicate low levels of longer duration infections or larger levels of early infection, or both, since the progression to AIDS is very slow in early years.

The claims experience can reflect antiselection from as early as 1981, when the disease was first identified in the U.S. However, because widespread knowledge about the disease did not occur until 1984–1985, it is possible that little antiselection occurred before that time. Key in the assumptions of antiselection are the dates and levels at which a company began testing and the dates and levels at which it changed its testing. These actions not only affected the levels at which HIV infection was actually determined

by testing, but also influenced the frequency with which those who knew or suspected they were infected sought to buy insurance from the company.

This translation of claims experience to infection level in the company's insured population should also be made for different groups of risks. The two most significant are sex and age. Currently, 93 percent of adults with AIDS are males and the percentage of that male population that has AIDS varies dramatically by age. The CDC's "AIDS Weekly Surveillance Reports" have consistently shown 21 percent are ages 20 to 29, 46 percent are 30 to 39, 21 percent are 40 to 49, and 10 percent are 50 or over.

The male general population data further comprise cases caused by IV drug abuse and sexually transmitted AIDS. IV drug abusers are not likely to be in the insured population, not only because of their general disinterest in insurance but also because of companies' usual routines of underwriting for drug abuse.

The population data also contain a small proportion of AIDS cases contracted through contaminated blood or blood products, but this proportion is likely to be even smaller in the insured population because of uninsurability of some of the underlying diseases requiring the blood transfusion or blood products.

The insured population generally comprises, therefore, HIV infection contracted sexually. It is this prevalency of HIV infection due to sexually transmitted disease among heterosexuals and homosexuals that makes the age distribution so significant in estimates of HIV infection in the insured population.

The third factor of significance in the translation of the claims experience to the estimated level of infection in the insured population is the geographic distribution of the disease. This is particularly critical in the case of new issues and recent years' issues.

3.4 *Modeling the Financial Impact of the Disease*

This estimated level of infection in the insured population should then be combined with the progression rates of the infection and merged with the other data about the company—for example, age distribution, gender distribution, product line and product-type distribution, geographic distribution, average size policy above and below the AIDS testing limits, year of issue, persistency, etc.—to model the financial impact of the infection on the company.

The refinement used to determine the level of infection among those insured, as well as the level of detail as to the number of characteristics and cells utilized in the model for determining the financial impact, will depend on how critical each of these characteristics is in the company. The current level of knowledge about the disease, the extent of the changes possible in those areas where the knowledge is lacking, and the impact of those changes on overall results will also affect the level of refinement.

The model should be developed to allow adequate flexibility as new information is determined. This flexibility is especially critical in the areas that could most affect the company, that is, the infection level in the insured population, progression rates of the disease, the infection rate, mortality and morbidity among females and heterosexual males, treatment for the disease, and persistency, which could change because of antiselection and actions taken by the company in response to the impact of the disease. Because the data we have available are very new, long-term projections should be interpreted with caution.

The model used can be one developed in-house, one already developed by others (see Chapters 4–7), or a combination of both. The model used will be affected by the equipment it is to be run on, the level of detail desired, and the output format required. The ultimate use of the study may also affect the model selected.

4.0 DETERMINATION OF THE APPROPRIATE MANAGEMENT STRATEGIES AND ACTIONS THAT SHOULD BE TAKEN

Once the financial impact has been measured, the management strategies necessary to moderate and minimize the HIV infection and AIDS impact can then be addressed. These should include a review of the strategies available, followed by the identification, recommendation, approval, and implementation of one or more of them. Which strategies are more appropriate will, of course, depend on the level of the impact of HIV infection and AIDS without moderating action as determined in the financial impact analysis, as well as the potential impact of changes in the disease, its treatment, changes of the level of infection in the general and insured population, and changes in the legislative or regulatory environment. Each of these strategies has its own advantages and disadvantages and includes considerations such as:

- Equity among and within lines, products, ages, generations of policyholders, geographic areas, etc.
- Current and future net worth.
- Impact on sales force.

- Impact on competitiveness.
- Ability to obtain regulatory approval of actions if approval is necessary (for example, health insurance premium increases).
- Legislative or regulatory restrictions.

4.1 *Strategies for In-Force Business*

Options available for in-force business include the following:

- Pay as you go.
- Reduce dividends on participating policies.
- Increase premiums or other nonguaranteed charges and/or reduce nonguaranteed credits, where permitted.
- Strengthen reserves.
- Establish extra reserves.
- Earmark surplus.
- Set aside surplus.
- Purchase catastrophic reinsurance.

4.2 *Strategies for New Business*

Options available for new business include the following:

- Reprice products or lines.
- Modify underwriting.
- Reduce AIDS testing limits.
- Address viability of certain products or markets.
- Reduce retention limits.
- Purchase catastrophic reinsurance.
- Modify policy terms and conditions.
- Strengthen reserves.

4.3 *Legislative and Regulatory Strategies*

Risk classification is an integral part of the life and health insurance voluntary insurance mechanism. Companies must be able to select risks if they are going to be able to price adequately and equitably. The expected mortality of a 35-year-old male, newly infected with HIV, is more than ten times the level that is generally considered acceptable at even the highest substandard rating. If companies are not allowed to test for HIV infection, they will be faced with the ultimate risk classification question of whether or not they can continue to accept any new business.

Several states are challenging the right of insurance companies to do HIV testing. Additional regulatory activity is beginning to challenge the industry's

right to test for other diseases as well. Insurance (health, life and disability) is increasingly perceived by some as an entitlement. Although entitlement insurance may be appropriate in a social system (such as health, life and disability insurance contained in Social Security), it is not appropriate in a voluntary insurance system because it ultimately leads to inequitable premiums, market dislocations, and, in the case of imminently life-threatening diseases, possible insolvencies.

Some of the legislative and regulatory actions are reflecting this entitlement by disallowing testing for all or some fixed amounts of life, disability, and health insurance. To minimize the impact of HIV infection and AIDS on a company, proposed legislation and regulations restricting AIDS and other testing should be addressed not only in a company's domiciliary state but also in other jurisdictions as well.

4.4 *Educational Strategies*

4.4a Education on Insurance, Risk Classification, and Pricing

One of the main reasons entitlement and testing ban regulations and legislation are occurring is that regulators, legislators, and the general public do not understand how insurance, risk classification, and insurance pricing work. Education should be initiated to build that understanding. It should start with company personnel, including top management, many of whom are not familiar with risk classification principles. Education of the field force should also occur at sales meetings and through written materials. This can reap multiple rewards, because the field force is in constant contact not only with policyholders, but also with the general public as well. When well informed on the issue, field representatives also serve as excellent speakers at service organizations. Communication to policyholders should also be done by the home office. Stockholders, too, should receive communication on the issues. Directors not only need to understand risk classification issues, but they can become strong centers of influence in the legislative process if well informed on the issues.

4.4b Education on HIV Infection and AIDS

There is currently no known cure for HIV infection or AIDS and at present no vaccine. AZT prolongs short-term survival in some and reduces symptoms in others, but is not a cure. It will probably not extend life long enough to help life insurance costs, and it will likely increase healthcare costs. AZT

can also cause its own side effects, such as anemia and suppression of bone marrow production.

AIDS vaccines have just begun to be tested in humans, but even if successful the vaccines are not expected to be available for general use before the mid-1990s.

On the heels of the announcement of human tests of vaccines, however, comes research from Los Alamos National Laboratory in New Mexico, showing the AIDS virus is mutating its genetic code as much as five times faster than the flu virus. Gerald Myers, a molecular geneticist who measured the rate of change at the laboratory, said the Los Alamos finding "casts bewildering shadows" on prospects for reliable diagnosis, effective treatment, and a vaccine to block all forms of the virus. Therefore, were an AIDS vaccine developed, it is likely that new vaccines would have to be continually developed to keep up with the virus' behavior change.

As Dr. Jay Levy of the University of California has noted:

> "The virus that causes mononucleosis was discovered 20 years ago, and we still haven't got a vaccine for it."

With no known cure and no vaccine likely to be available in the next five years, education about the disease and how it is not transmitted is currently the only control of expansion of the disease in the general population and consequently in the insured population. Education, therefore, is a major element in controlling the impact of the disease on a life and health insurance company.

Because HIV infection and AIDS is a sexually transmitted or blood-to-blood transmitted disease, it can be contained if education is disseminated effectively enough to influence attitudes and behavior. As with education on insurance and risk classification, education on HIV infection and AIDS should be distributed to home office personnel, the field force, policyholders, stockholders, directors, and the general public.

5.0 NECESSITY FOR ONGOING DETERMINATION OF FINANCIAL IMPACT

Because much is yet unknown about the disease, because much is being continuously learned about the disease and its treatment, and especially because the level of infection in the general population, the insured population, and in a company is unknown, it is imperative that ongoing studies be conducted.

This is particularly appropriate because of the lack of data on females and on the level of entrance of the disease into the heterosexual population, and

the possible differences in mortality and morbidity between the heterosexual and homosexual infected populations.

As previously noted, the vast majority of our data comes from observation of male homosexuals and IV drug abusers. The limited data on females indicate that studies done on women with AIDS in New York, Miami, and California show women are sicker and are dying more quickly than men who have the disease. In New York, women diagnosed as having AIDS survived less than two years after diagnosis, while the average for the men diagnosed with AIDS was two and one-half years. Dr. Margaret Fischl's University of Miami study showed women survived an average of 6.6 months after diagnosis, while men survived 12 to 14 months. In Miami, the women not only died sooner but were sicker. Nearly one-third had several infections where men often had just one. In a California study, women with AIDS lived an average of 40 days after being diagnosed, while the men lived more than a year. Analysis of third-quarter 1987 data from the CDC showed substantially higher early mortality among adult females. The mortality was twice as high as among males in the first half-year after diagnosis, nearly 50 percent higher in the second half-year, nearly 33 percent higher in the third half-year, and nearly 10 percent higher in the fourth half-year. There could be nonbiological reasons for the difference, such as later identification and reporting of the disease, but some of these reasons have already been studied and rejected.

Also, as previously noted, the two leading opportunistic diseases (Kaposi's sarcoma and pneumocystic carinii pneumonia) have different mortality rates. *The New York Times* of January 5, 1988, reported:

> "Those who have Kaposi's sarcoma but no other AIDS-related infections 'tend to have a better prognosis' than those with other manifestations of AIDS, according to Dr. Jaffe of the CDC. But, he added, this cancer 'occurs almost entirely in gay men.' In addition, homosexual men as a group tend to live longer than other groups after they are diagnosed as having AIDS. Experts say they are not sure whether this is because the disease is different in homosexual men or because these men tend to seek medical care earlier than drug users or women."

Estimates of the entrance of the infection into the heterosexual population range from minimal to substantial. Most of those studying the disease agree that it can be transmitted heterosexually. As Nancy Padian, an epidemiologist at the University of California at Berkeley, has said,

> "Heterosexual transmission is not only plausible, it's well established."

At a Congressional hearing on February 19, 1988, Surgeon General C. Everett Koop stated:

> "It is just not true that there is no danger from normal vaginal intercourse. What is unknown is the level of that danger. But there is always a danger whenever people engage in casual sex. Even if their promiscuity is heterosexual."

Affecting the level of this entrance is whether or not the disease can be spread as easily from woman to man as from man to woman. Many feel, as Dr. Mason stated at the American Council of Life Insurance 1987 annual meeting, that

> "although men readily spread the disease to women, it is less readily spread back the other way, although it does occur."

Other studies, however, have shown the disease is equally efficiently transmitted between the sexes. For example, Major Redfield's studies at the Walter Reed Army Institute of Research showed that 44 percent of the wives of men with AIDS were infected. Forty-three percent of the husbands of women with AIDS were infected. He stated:

> "In a prospective study, the ability of a woman [who has AIDS] to give this virus to a man is equivalent to the ability of a man [who has AIDS] to give this to a woman."

In Dr. Fischl's study of 58 couples at the University of Miami, 16 AIDS patients continued to have unprotected intercourse, despite doctors' warnings, over periods ranging from one to three years. Thirteen of the partners (80 percent) became infected. The February 6, 1987, *JAMA* article, "Evaluation of Heterosexual Partners, Children, and Household Contact of Adults with AIDS," reporting Dr. Fischl's data, stated:

> "These data, along with those of Redfield et al. and others further document that HTLV-III/LAV is a bidirectionally transmitted virus. . . . Further we found that the seroconversion rate for male spouses (42 percent) was similar to that for female spouses (38 percent). These findings suggest that HTLV-III/LAV may be transmitted heterosexually in either direction with a similar efficiency."

Major Redfield has further stated:

> "The fact is that the sexual transmission is the major mode of transmission in society today. Heterosexual transmission actually is the major mode of transmission in the world today. . .in the absence of scientific solution, it will be the major mode of transmission in North America also."

Dr. Jaffe, who said in June 1987, "For most people the risk of AIDS is essentially zero," was quoted in November 1987 *Money* magazine as saying:

> "Clearly AIDS can be transmitted through heterosexual contact, and over time the risk to everyone is going to increase. Heterosexual contact could become the major means of transmission in this country. But we have an opportunity now to slow its spread, and we should take advantage of that."

All these data emphasize the need to continue to monitor the effect of the disease on different segments of the population, the effect of treatment and possible vaccines on the impact of the disease, and the changes in the spread of the disease within the general population, insured population, and a company's insured and new applicant population. Additionally, estimates of the level of infection in the company's insured and new applicant population could have initially been set too high or too low, so claims experience, too, must be monitored and reanalyzed. As new data become available, a new impact analysis should be determined, and if the impact on the company changes, strategies, too, must change. With a disease of such long-term significant impact, it will require continuous long-term analyses and solutions.