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THE IMPACT OF HIV INFECTION AND AIDS ON INSURANCE IN THE UNITED KINGDOM

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1. INTRODUCTION

1.1 In March 1987 the Futures Committee of the Institute considered a preliminary report (Daykin, 1987) on the possible impact of AIDS in the United Kingdom and the consequences for life insurance. The Committee recommended the setting up of a Working Party to study the problem. The Working Party on AIDS was accordingly established, under the auspices of the Research Committee. The authors of this paper formed the membership of the Working Party, under the chairmanship of C. D. Daykin.

1.2 The terms of reference of the Working Party were:

1. To collect information about the current state of knowledge of the potential impact of Human Immunodeficiency Virus (HIV) and Acquired Immune Deficiency Syndrome (AIDS) and to keep the profession informed.
2. To produce a comprehensive report which will be of interest and use to the actuarial profession, including an assessment of the possible consequences of HIV for the U.K. population as a whole, and for insured persons and members of pension funds in particular.
3. To comment on the underwriting implications of HIV and on aspects of insurance business which may be particularly vulnerable to the potential effects, including particular types of contract and policy options.
4. To show the potential impact of HIV on mortality and morbidity and the implications for the use of existing actuarial bases and standard tables for premium rating and reserving.

1.3 In order to fulfil the remit which was given to the Working Party to keep the profession informed about HIV infection and AIDS, Bulletin No. 1 was issued in September 1987, Bulletin No. 2 in December 1987 and Bulletin No. 3 in July 1988 (Institute of Actuaries Working Party on AIDS, 1987, 1987a and 1988a).

1.4 A meeting on The Implications of AIDS for Life Assurance Companies was arranged at Staple Inn Hall on 1 February 1988 in order to give the profession an early opportunity to discuss the findings in the first two AIDS Bulletins. A report of the Proceedings of the meeting was issued in April 1988 as a

supplement to Bulletin No. 2 (Institute of Actuaries Working Party on AIDS, 1988).

1.5 This Report is intended to consolidate the material already made available to the profession in the first three AIDS Bulletins, as a more permanent record of the first phase of activity of the AIDS Working Party, and to provide some supplementary material and references.

2. HIV AND AIDS

2.1 *What is AIDS?*

2.1.1 AIDS is a relatively new problem. The first cases were reported by the Center for Disease Control (CDC) in the United States of America in 1981, with cases being reported in Europe, including the U.K., shortly afterwards. It is probable that there were a number of cases prior to 1981 which were not recognized as such.

2.1.2 AIDS is not a disease but a collection of symptoms which are thought to appear as a result of the activity of a particular type of virus, known as a human retrovirus. The virus thought to be responsible for AIDS was first isolated in 1983 by two groups of scientists. In Paris Barre-Sinoussi *et al.* (1983) named it lymphadenopathy-associated virus (LAV), while Gallo *et al.* (1984) in the U.S.A. described it as the human T-cell lymphotropic virus type III (HTLV-III). Following a recommendation by the International Committee on the Taxonomy of Viruses, it is now generally known as Human Immunodeficiency Virus (HIV). At least two distinct but related strains of HIV have been identified, known as HIV-1 and HIV-2.

2.1.3 HIV is a member of a class of retroviruses which are distinguished by their ability to reprogramme the DNA of the host's cells (Gallo, 1987). This prevents the cells from performing their normal function and has the effect of encouraging them to replicate the intruding virus. Once having invaded the host cells, the virus may remain latent for many years before the process of viral replication is stimulated by a secondary infection. When this happens the new virus particles escape from the cell, damaging the outer membrane and thereby killing the cell. Apart from this direct loss of cells, infected cells do not multiply at the normal rate, so that in the later stages of HIV infection there is a severe reduction in the number of T4 cells, which are responsible for organizing the body's immune response. This leaves the body unable to provide adequate resistance to any opportunistic infections which take hold.

2.1.4 Most deaths from AIDS are caused by opportunistic infections, in particular a form of pneumonia known as pneumocystis carinii, or by particular forms of cancer associated with cellular immune deficiency, such as Kaposi's sarcoma. However, there are many other illnesses associated with HIV infection, which are not in themselves necessarily fatal. These fall into two groups: PGL (persistent generalized lymphadenopathy, i.e. swollen lymph glands) and ARC (AIDS-related complex, characterized by weight loss, sweating and minor

infections). HIV can also cause direct damage to the nervous system, which may give rise to a form of progressive dementia known as HIV disease.

2.1.5 The development of symptoms in an HIV-infected person may take some years. In the early stages the patient may be entirely asymptomatic, but, as time goes on, various symptoms may begin to appear on a more or less regular basis. Patients will usually develop symptoms such as those associated with PGL or ARC before developing AIDS. Others may progress more rapidly, missing one or more stages, or may develop dementia and then AIDS. It is not yet known whether all those who are infected with HIV will ultimately develop AIDS and die from it, but there is an increasing body of evidence that the impact of HIV infection is progressive and that, over any significant time period, an individual at any particular stage of infection is likely to progress to a subsequent phase (see for example Helm *et al.* (1987), Eyster *et al.* (1987) and Redfield (1988)).

2.1.6 The original case definition for AIDS was extended in June 1985 and again in the summer of 1987. As a result of the latest change of definition, which was effective in the U.K. from January 1988, an increased number of cases, which would previously have been diagnosed as AIDS-related complex, might now be expected to meet the definition for AIDS. Reports from the U.S.A. suggest that the new definition may be satisfied by about 20% more cases than the previous one, but there has been no evidence so far of a sudden jump of AIDS cases reported in the U.K.

2.1.7 When someone becomes infected with HIV, antibodies are created. These form the basis for the standard tests for the presence of HIV infection. The most frequently used test is the enzyme-linked immunosorbent assay test (ELISA), which is quick and economic. A technically more difficult test is the Western Blot, which uses electrophoretic separation of virus proteins and glycoproteins to give a profile of bands characteristic of HIV when antibodies to HIV are present. Recommended test protocols usually involve carrying out two or more tests, preferably including tests of a different type such as the ELISA and Western Blot. This reduces the possibility of a false positive result to an extremely low level. A person who registers a positive result from an appropriate series of antibody tests is described as HIV-positive. The event of becoming HIV-positive is termed seroconversion.

2.1.8 Antibody tests may fail to detect someone infected with HIV. This is particularly likely in the first few weeks after infection when antibodies may not have appeared. This 'window' period is thought to be normally some 6 to 8 weeks in duration. However, Ranki *et al.* (1987) have suggested that there might on occasions be a much longer period between the date of acquisition of HIV and the formation of antibodies which can be detected by the ELISA test.

2.2 *Causes of death given for AIDS patients*

2.2.1 AIDS as such is rarely mentioned as the cause of death on the face of a death certificate. Many of the reported cases have been identified by the Office of Population Censuses and Surveys as a result of going back to the certifying

doctor on the strength of a suspicion that the death is related to AIDS or an indication on the confidential reverse side of the certificate that further relevant information is available. McCormick (1988) identifies 95 conditions which might be stated as the underlying causes of death for patients with HIV-infection. These include opportunistic and other infections, relevant cancers, immune deficiency, mental illnesses, meningitis, encephalitis and intracranial abscesses, cerebrovascular accidents, pneumonias and poisonings, as well as less specific conditions, such as cardiac, hepatic and renal failure. It is clear that the range of manifestation of HIV infection is quite wide.

2.2.2 This complex of disease associated with HIV infection raises considerable difficulties when one comes to look at the possibility of an exclusion clause for AIDS in life assurance policies.

2.2.3 The pathogenesis of the infection seems to vary considerably from person to person. In some cases of HIV infection, the patient remains asymptomatic for many years, whereas in others debilitating symptoms develop at quite an early stage. Even in cases diagnosed as AIDS, some patients may be much better able to carry on their normal way of life than others. Sickness associated with AIDS appears often to be intermittent, rather than continuous, so that there may be significant periods for which a patient is not seriously ill, interspersed by periods for which intensive treatment, including hospitalization, may be needed.

2.3 *Treatment of AIDS*

2.3.1 A considerable amount of research is being carried out with a view to finding drugs that can be used in the treatment of people with AIDS. A front-runner at this stage is zidovudine (formerly known as azidothymidine or AZT and also as Retrovir). Fischl, Richman *et al.* (1987) presented the results of a double-blind placebo-controlled trial of zidovudine in patients with AIDS and AIDS-related complex. The trial was not in fact carried to completion, because there was evidence that the state of health of those receiving zidovudine was markedly better than those receiving the placebo and it was determined by the researchers to be unethical to withhold the treatment from the control group. The evidence seemed fairly clear that zidovudine could be effective in increasing the life expectancy of people with AIDS.

2.3.2 Unfortunately, the drug is highly toxic and exhibits unpleasant side effects, as reported by Richman *et al.* (1987). Various further trials are now in progress to examine its efficacy in conjunction with other drugs, in order to lessen the toxic effects, and in patients infected with HIV but not yet diagnosed with AIDS. Much work is being done on developing other drugs of possible therapeutic value, but there are few definite alternatives at this stage. A number of the possible candidates have been shown to have unacceptable toxicity or serious side effects and in other cases the efficacy of the drugs in the treatment of AIDS has not yet been demonstrated. The basic strategy of most of these drugs is to slow down the development of the virus within the cell.

2.4 *Vaccines for HIV*

2.4.1 A number of possible vaccines are also under investigation, primarily focusing on the possibility of activating antigens on the surface envelope of the cells which HIV attacks. There are considerable problems in developing suitable vaccines, not least because of the shortage of suitable laboratory animals on which to test them. Traditional inactivated viral vaccines have not proved to be useful, since they may be immunosuppressive. They have to be completely inactivated before they can be used and even then they may give rise to more serious disease if the patient is exposed to live virus. Some researchers have pointed to the possible usefulness of vaccines produced by genetic engineering, such as vaccinia, which was used in the global eradication of smallpox. There is some suggestion that this same vaccine may form the basis of a successful strategy to combat HIV. However, experts are agreed that there is no cause for optimism and that it is unlikely that an effective vaccine will be available for at least 5 years and quite probably for much longer.

2.5 *Transmission of HIV*

2.5.1 In considering the possible spread of HIV, it is important to have regard to the principal modes of transmission (see for example Melbye (1986)). In spite of its apparent virulence, the virus is a fragile organism and cannot survive long outside the human body. It is transmitted only through bodily fluids, in particular blood, semen and mucus. It is most commonly transmitted by sexual contact and can be transmitted from male to male, male to female or female to male. It can also be transmitted in blood products, e.g. blood transfusions or factor concentrates. Transmission may occur by means of infected needles or syringes being used for injecting into the blood stream. It can also be passed from mother to foetus and, apparently, although this is less well substantiated, through breast-feeding.

2.5.2 The efficiency of transmission of the virus is very low, so that infection through isolated incidents, e.g. accidental injuries with contaminated needles, is extremely rare. Those most at risk of acquiring the virus are those who have frequent sexual contacts with a large number of people, some of whom may be infected, and drug users who share needles with others who may be carrying the virus. The disease has spread most rapidly in certain sections of the homosexual population and amongst intravenous drug users. An already high incidence of the virus in these risk groups implies that others in the risk group who do not make radical changes to their lifestyle continue to be at high risk of becoming infected with the virus.

2.5.3 A high incidence of infection with the virus has been reported in haemophiliacs who have received contaminated Factor VIII and IX concentrates, often imported from the U.S.A. However, transmission by this means and by ordinary blood transfusion is now very unlikely in the U.K. in view of the precautions that are taken to screen blood products and to ensure the elimination of HIV.

2.5.4 Interest amongst medical and epidemiological experts has increasingly been focused on the potential for heterosexual spread of HIV infection, with the important consequences which this has for the ultimate size of the epidemic. There are now a considerable number of papers reporting research in this area, both of the general prevalence of HIV infection in the heterosexual population, such as can be deduced from mass screening programmes, like that in the U.S.A. for military personnel (Burke *et al.*, 1987), and studies of the partners of individuals known to be infected with HIV. Such studies include the partners of drug addicts (France *et al.*, 1988), transfusion cases (Peterman *et al.*, 1988) and mixed populations including drug addicts, bisexuals and transfusion cases (Fischl, Dickinson *et al.*, 1987) and Padian *et al.* (1987). Some of the evidence has been brought together in review articles by Chamberland & Dondero (1987) and Johnson (1988).

2.5.5 Suffice it to say at this stage that HIV infection clearly can and does spread by means of heterosexual intercourse, but that the evidence points towards the probability of transmission per contact being relatively low. Other contributory factors, such as the presence of genital ulcers, may significantly increase the probability of transmission. Some studies seem to show a high proportion of regular partners of HIV-positive individuals sero-converting over a period, whilst others have shown a significant number of partners remaining sero-negative in spite of frequent unprotected intercourse with a sero-positive partner.

2.5.6 The reasons for the variation in results are not understood, although a contributing factor may be the variation in infectiousness of sero-positive individuals according to the duration since the acquisition of the infection. A theory has been advanced (see, for example, Anderson (1987) and Hyman & Stanley (1988)) that there is a peak of infectiousness shortly after becoming infected with HIV, but that thereafter the infected person is hardly infectious at all for some time. Then the level of infectiousness gradually begins to build up, subsequently increasing quite rapidly as the virus takes a hold and the patient progresses towards AIDS. There is some evidence which tends to support this hypothesis but it remains a theory.

2.5.7 Whilst some information is emerging about the likelihood of transmission of HIV from a sero-positive individual to a regular sero-negative partner, heterosexual transmission to spouses in steady relationships is not going to give rise to a massive epidemic in the heterosexual population. A key factor in determining how far the disease will spread will be the rate of partner change in the heterosexual population and the extent to which there is an interface between the general heterosexual population and the populations of intravenous drug users and bisexuals, who might already have been exposed to HIV through contact with groups where the infection is widespread. A further avenue of research, with a view to elucidating these aspects, is to make use of behavioural surveys. A major survey of sexual behaviour is now being planned in the U.K.

under government sponsorship. It will, however, be a little while before information is available from this survey.

3. THE GLOBAL SITUATION

3.1 Reports from the World Health Organization (W.H.O.) show that by the end of September 1988 there had been about 120,000 reported cases of AIDS worldwide, of which almost two-thirds had been in the U.S.A. However, the figures for many developing countries may be significantly under-reported, partly as a result of a lack of infrastructure to facilitate comprehensive reporting and partly because of political obstacles to admitting how widespread HIV infection is.

3.2 Table 1 shows a summary of the countries which have reported the greatest number of cases to the W.H.O. Table 2 shows how the league table changes when the prevalence is related to the size of the population.

3.3 Dr Jonathan Mann, Director of the AIDS Programme at W.H.O., (1988) distinguishes three different patterns of spread in the worldwide epidemic. The first pattern is that experienced in North America, Western Europe, South Africa (amongst the white population), Australia and New Zealand, where the spread has so far been predominantly homosexual, although heterosexual spread has also occurred. Infection through blood is now largely limited to intravenous drug users and there are only relatively few cases of vertical transmission from mother to child.

3.4 The second pattern is that seen in Africa and the Caribbean, where the spread has been mainly through heterosexual transmission, although homosexual spread has also occurred. A considerable amount of infection has been spread through blood transfusions and through the reuse of needles for medical purposes. As a result of the much higher proportion of females infected, relatively large numbers of babies have been born carrying the virus. This vertical

Table 1. *AIDS cases reported to W.H.O. as at 30 September 1988*

United States of America	73,394	Canada	1,918
France	4,211	United Kingdom	1,669
Uganda	4,006	Mexico	1,502
Brazil	3,687	Spain	1,471
Tanzania	3,055	Haiti	1,455
Kenya	2,732	Burundi	1,408
Malawi	2,586	Congo	1,250
Federal Republic of Germany	2,307	Zambia	993
Italy	2,233	Australia	988

Source: W.H.O. AIDS update to 30 September 1988. Figures relate to earlier effective reporting dates, which differ from country to country. The U.K. figure is as at 31 July 1988.

Table 2. *AIDS cases reported to W.H.O. as at 30 September 1988 relative to size of population*

	Cases	Cases per 100,000		Cases	Cases per 100,000
Bermuda	81	141	Central African Republic	432	16
French Guyana	113	126	Rwanda	987	14
Bahamas	214	88	Zambia	993	13
Congo	1,250	66	Tanzania	3,055	12
Malawi	2,586	33	Martinique	38	12
United States of America	73,394	30	Kenya	2,732	12
Burundi	1,408	27	Dominican Republic	566	8
Barbados	63	24	Switzerland	502	8
Trinidad & Tobago	302	24	France	4,211	8
Uganda	4,006	23	Gambia	52	8
Guadeloupe	74	22	Canada	1,918	7
Haiti	1,455	20	Australia	988	6
		*** ***** ***			
Denmark	301	5·9	Belgium	368	3·7
Italy	2,233	3·9	United Kingdom	1,669	3·0
Netherlands	573	3·9	Austria	202	2·7
Federal Republic of Germany	2,307	3·8	Sweden	217	2·6
Spain	1,471	3·7	New Zealand	89	2·6

Note: Countries with fewer than 10 cases have been omitted, even though the number of cases per 100,000 population is high.

Source: AIDS update to 30 September 1988. Figures relate to earlier effective reporting dates, which differ from country to country. The U.K. figure is as at 31 July 1988.

mode of transmission has potentially very serious demographic effects and could substantially reduce population growth rates, as shown by Anderson *et al.* (1988).

3.5 The third pattern of spread is seen in Asia, where the virus has only begun to appear more recently and where the spread so far has been mainly as a result of the contact of individuals with infected people in others parts of the world and through imported infected blood products.

4. AIDS CASES AND DEATHS IN THE UNITED KINGDOM

4.1 The number of cases of AIDS reported to the Communicable Disease Surveillance Centre (C.D.S.C.) in the U.K. has continued to grow inexorably, reaching a cumulative total of 1,862 by the end of October 1988, of whom 1,002 were reported to have died. Figure 1 shows the development so far of new cases of AIDS and AIDS deaths in the U.K. and illustrates the approximately exponential shape of the pattern of growth in the early stages of the epidemic. Table 3 shows the development of new cases of AIDS by quarter of report and Table 4 shows the estimated number of deaths from AIDS that have occurred

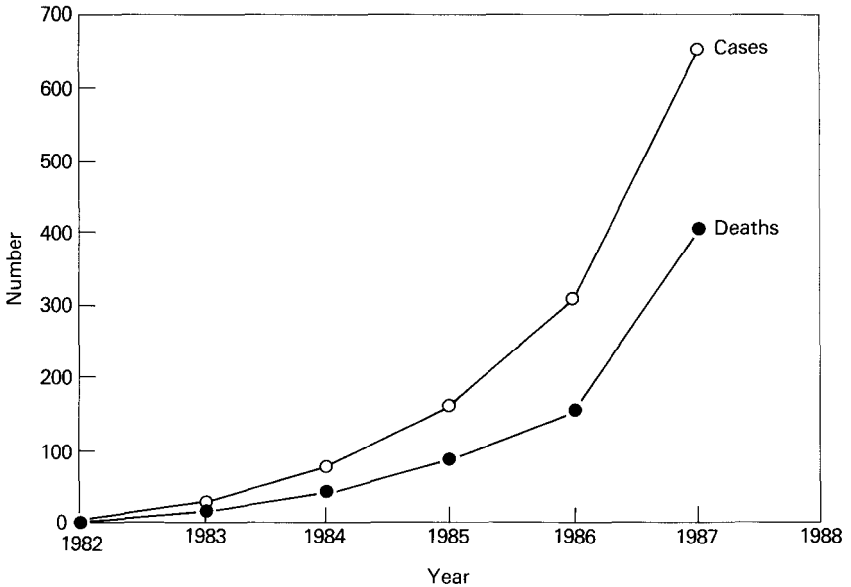

Figure 1. Reported cases of AIDS and deaths from AIDS in the U.K. 1982–87.

each year. Actual diagnosed cases of AIDS are likely to exceed these figures significantly in the more recent years, there being on average a reporting lag of two to three months. It is also probable that there is a substantial degree of under-reporting due to cases not being recognized as AIDS or to the necessary paperwork not being completed.

4.2 McCormick (1988) studied mortality by cause of death for single males and revealed increases in mortality from a number of causes in the last three or

Table 3. *New reported cases of AIDS in the U.K. by quarter year of report*

Year	First quarter	Second quarter	Third quarter	Fourth quarter	Total
1982					3
1983					26
1984	12	9	28	28	77
1985	35	32	46	47	160
1986	50	61	99	95	305
1987	150	144	198	162	653
1988	205	169	196		

Source: Weekly reports of C.D.S.C.

Table 4. *Deaths from AIDS in the U.K. by year of report*

1983 and earlier	15
1984	40
1985	85
1986	153
1987	404
1988 (to October)	305
Total	1,002

Source: Estimated from C.D.S.C. monthly reports.

four years. This evidence is at least suggestive that the official figures for AIDS deaths may understate the true position.

4.3 Reported cases of AIDS in the U.K. continue to be dominated by cases amongst homosexual or bisexual men, with 84% of the cases in that category. Some 4% of cases have a recorded history of intravenous drug use, half of these being also homosexuals. About 8% of cases are amongst haemophiliacs or where the mode of transmission of the virus is thought to have been through blood transfusion. Fewer than 4% of cases appear to have arisen so far as a result of

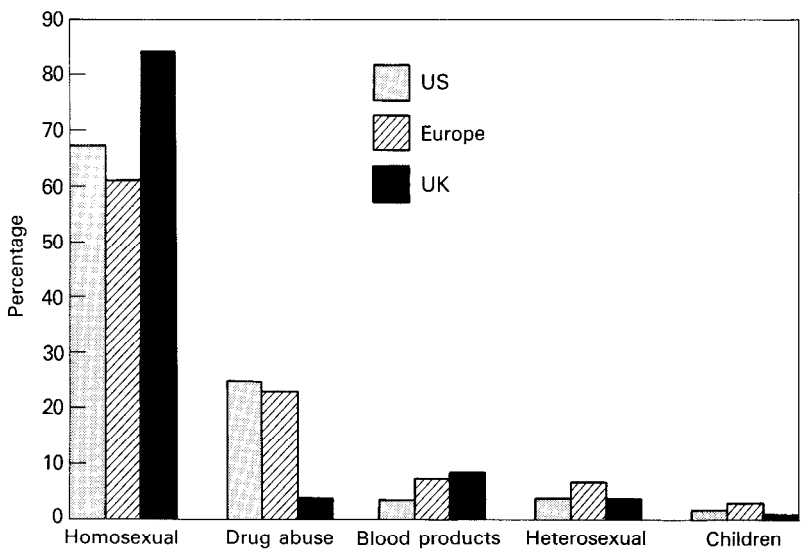

Figure 2. AIDS cases to the end of 1987 by transmission category.

heterosexual spread, with the majority of these thought to have been infected outside the U.K. Only about 60 cases have been reported so far amongst females. This pattern differs from the experience in the U.S.A. primarily in relation to the smaller proportion of cases amongst intravenous drug users and a correspondingly higher proportion of homosexual cases. Some European countries (e.g. Italy and Spain) differ from the experience in the U.S.A. in the opposite direction, with an even higher proportion of cases amongst intravenous drug users. Figure 2 compares the proportions of AIDS cases in the main groups for the U.S.A., Europe as a whole (including the U.K.) and the U.K. alone.

5. PROJECTING THE SPREAD OF AIDS

5.1.1 In the light of the relatively small numbers of cases of AIDS so far reported in the U.K., it is perhaps surprising that the disease should have caused so much alarm and that it should have become the subject of a massive government education campaign. There are two main reasons for this. The first is that AIDS itself, once acquired, is invariably fatal. The second is that the cases of AIDS that have been reported are only the 'tip of the iceberg'. Many thousands of people may be infected with HIV and may be unwittingly passing it on to others. Only some 9,000 people in the U.K. have been identified as HIV carriers by means of an antibody test, but many of those who are infected may be unaware of the fact and many have been actively discouraged from having a test. Estimates of the numbers currently infected in the U.K. range from 20,000 to 100,000 (see for example Social Services Committee (1987)). Representatives from W.H.O. talk of some 5 to 10 million people being infected worldwide (see Mann (1988a)).

5.1.2 Since many, if not all, of the people infected with HIV are likely to develop AIDS over the next few years and to die from it, there is clearly enormous potential for growth in the numbers of AIDS cases and deaths. It is important, for example for planning health services and for the insurance industry, to have some projections of how the epidemic might develop. Projecting the spread of an epidemic is a hazardous business. The complicated process by which infection spreads amongst a variety of groups of people at different levels of risk cannot adequately be represented by mathematical equations. Simplistic models will give unsatisfactory answers because they do not take into account the realities of the situation. Complicated models may begin to give a better representation of the dynamics of the epidemic, but most of the parameters needed to drive such models will be unknown, so that they can be of only very limited use for making projections.

5.1.3 It could be argued that any projections, particularly for more than a year or two ahead, are essentially speculative. Many of the major parameters needed to predict the spread of the disease in any satisfactory way are as yet unknown or known only within fairly wide bounds. Any projection is subject, therefore, to an

unusually wide degree of uncertainty and this should be borne in mind when making use of any projections.

5.1.4 Notwithstanding the difficulties and uncertainties, the Working Party believes it to be essential to build up a plausible model for the spread of AIDS and to investigate the impact of parameter values that appear to be consistent with information that is available so far.

5.1.5 A thorough study of the epidemiological literature on the development and likely progression of AIDS has been carried out by the Working Party. Although much has been written on this subject, very few authors have ventured to publish any projections of the spread of AIDS beyond the next three or four years.

5.1.6 Short-term projections, based on an extrapolation of the existing data for reported cases of AIDS in the U.K., have been published by McEvoy & Tillett (1985), Mortimer (1985), Tillett & McEvoy (1986) and by Healy & Tillett (1988). Similar projections have been made for the U.S.A. by Curran *et al.* (1985, 1988).

5.1.7 Professor Knox (1986) demonstrated some results from a model which showed the consequences of the AIDS epidemic reaching a steady state. However, perhaps the most comprehensive analysis of the factors involved in projecting the spread of the disease appears in a series of papers by Anderson and co-authors (Anderson *et al.* (1986), Anderson & May (1987), May & Anderson (1987), Anderson *et al.* (1987), Anderson *et al.* (1988) and Anderson & May (1988)). Although these papers explore in some detail ways of modelling different aspects of the AIDS epidemic, the projections presented are primarily illustrative and do not offer a prognosis for the likely future spread of AIDS in any particular country. Some projections for the U.K. are, however, given by Anderson in D.H.S.S. (1987).

5.1.8 Some work had already been under development in the actuarial profession in the U.K. on the study of multiple state models, described in Haberman (1983, 1984), Waters (1984) and Waters & Wilkie (1987). This work has been applied to the development of models for the Permanent Health Insurance Sub-committee of the Continuous Mortality Investigation Bureau (see Sansom & Waters (1988)), and proved to be capable of ready adaptation to the problem of modelling transitions between different states for the purposes of projecting the future spread of AIDS. The model is similar in concept to the models proposed by Anderson *et al.* (1986) and other epidemiologists.

5.2 *The Working Party Model*

5.2.1 The model has been described in detail by Wilkie (1987). It is a deterministic approximation to a Markov stochastic process, with time-varying transition intensities between states. The model used so far by the Working Party is a single sex model, in which it is assumed that each age cohort can be modelled independently of the other cohorts. The model tracks the progress of groups of individuals through a series of statuses, the population being subdivided into four categories as follows:

—clear, that is not at risk of becoming infected with HIV
—at risk of becoming infected with HIV
—HIV-positive
—sick with AIDS

5.2.2 In using a deterministic model rather than a stochastic model it is assumed that the numbers of persons at risk and infected are sufficiently large that they can be approximated by continuous variables and that the spread of any infection starting from specified initial values will always take exactly the same course. We obtain only an approximation to the average behaviour of the underlying stochastic model and, in some situations, the variation between realizations of the epidemic could be such that knowledge of the behaviour of the average is not particularly helpful. This would be true for small subgroups of the population or at the very beginning of the epidemic.

5.2.3 The justification for the deterministic approach (and it is worth noting that a deterministic approach has been used by most others in this field) is threefold:

(a) firstly, solutions are more difficult to find for stochastic than for deterministic models;
(b) secondly, for the large populations involved in the AIDS epidemic and, once the epidemic is established, the numbers infected, the deterministic models should give results that are approximately valid, especially when modelling is at its present embryonic stage; and
(c) thirdly, the considerable uncertainty attaching to estimates of the important parameters means that further sophistication may not be warranted.

A stochastic simulation model has, however, been developed by Barrett (1988).

5.2.4 Death may occur from each of the four groups described in §5.2.1, but a special decrement is included for dying from AIDS for those in the sick with

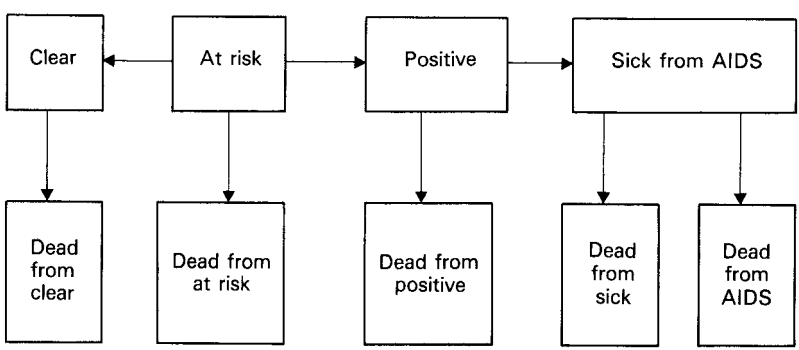

Figure 3. Structure of model.

AIDS category. Figure 3 shows the basic structure of the model and the directions in which transitions can take place. It is assumed that those in the at risk category can transfer to the clear category as a result of a change in behaviour. No allowance is made for those in the clear category becoming at risk, other than a small proportion of those entering the sexually active years, taken to be at age 15.

5.2.5 The model subdivides the population by individual ages and by the duration since entering into the categories HIV-positive and sick with AIDS. Rates of transition from one status to another may depend on age, duration in the status where relevant and calendar year. The model is, therefore, able to allow for changes in the parameter values consequent on projected changes in behaviour, infectivity and treatment.

5.2.6 New HIV-positive cases are generated by assuming interaction between those in the at risk category and those who are already HIV-positive, but not those who are sick with AIDS. The model is intended to represent homosexual transmission and does not give any indication of the spread amongst intravenous drugs users, haemophiliacs, transfusion cases or heterosexuals. Apart from the last category, the numbers involved in these other groups in the U.K. are likely to remain small in relation to the number of male homosexuals affected; separate projections could be made for these categories.

5.2.7 The potential for spread into the promiscuous heterosexual population is quite large but there is even greater uncertainty about the parameters needed to model this than about the parameters for a model for the spread of HIV infection in the male homosexual population. Little is known about the current incidence of HIV-positivity amongst heterosexuals, the extent and frequenty of partner change and the probability of transmission from male to female and female to male. Any projections of the potential impact of HIV infection and AIDS in the heterosexual population would be extremely speculative, so we have not so far made any such projections. The uncertainties extend to the fundamental question of whether there will be a significant level of heterosexual spread in the U.K., but the possibility of it should be kept in mind.

5.2.8 The results from the model depend critically on the assumptions made. Information is available from published research to inform the choice of some of the parameters. Others have to be guessed. The model has, however, been calibrated to the numbers of cases of AIDS and deaths from AIDS that have been reported to C.D.S.C.

5.2.9 Projection A was taken as representing a reasonably pessimistic scenario (apart from the possibility of wider heterosexual spread). Four of the most important parameters about which there is a considerable degree of uncertainty were varied, one at a time, in each case taking a more optimistic assumption, to produce Projections B, C, D and E. Projection F allowed for all four of the optimistic assumptions at once. Projection BC, which was used in Bulletins Nos 2 and 3, allows for the optimistic assumptions in respect of two of the parameters. The main assumptions are described below.

5.3 *Total population*

5.3.1 The initial population, taken as at the end of 1983, was based on the mid-1983 official population estimates for the U.K.-New entrants to the model at age 15 in subsequent years were taken from the mid-1983 based official population projections for the U.K. by the Government Actuary's Department (1985).

5.4 *At risk population*

5.4.1 A proportion of the male population between ages 15 and 70 was assumed to be at risk of becoming infected with HIV. This is not the same as an assumption about the size of the male homosexual population, which may include people in permanent relationships who have not had and continue not to have any sexual contact outside the steady relationship. Little is known about the sexual propensities of the U.K. population and it is difficult to know what is an appropriate assumption to make for this key parameter. We assumed for Projection A that the proportion of the male population at risk was 5% between ages 21 and 50, reducing linearly to 2% at age 15 and at age 70. The proportion for new entrants at age 15 was taken to be 2%. In Projections E and F each of these proportions was assumed to be halved.

5.5 *Transfer from at risk to clear*

5.5.1 In Projection A no transfers were assumed to take place from at risk to clear. However, in Projections B, BC and F a constant transition intensity of ·1 was assumed from 1 January 1987. This is equivalent, other things being equal, to assuming that 40% of those in the at risk group at any time leave the at risk group over the course of the succeeding 5 years. No information is available to justify this particular assumption, which needs to be taken in conjunction with the assumed size of the population at risk. However, it does seem reasonable to assume some reduction in the size of the at risk group as the publicity associated with the spread of HIV infection has its effect.

5.6 *Transfer from at risk to positive*

5.6.1 The rate of transfer from at risk to HIV-positive depends on the number at risk and on the number who are HIV-positive at that particular age. The model adopts the simplifying assumption that spread occurs within each age cohort, rather than across cohorts. Those who are already sick with AIDS are assumed not to pass on the infection to others, since potential partners are likely to be more conscious of the risk. In Projection A a peak intensity of ·7 was assumed for this transfer between ages 25 and 50, reducing linearly to zero at age 15 and at age 70. This corresponds to a doubling time of 1 year in the number of people HIV-positive during the early stages of the epidemic, when the number of those susceptible to infection is very much larger than the number already infected. In Projections C, BC and F this intensity was assumed to reduce linearly to ·35 over the 5 years from the beginning of 1987 to the beginning of 1992. This can be interpreted as representing a change in behaviour which reduces the rate at which

infection passes, but is also to be expected because of the heterogeneity of the population and the fact that the virus will spread less rapidly as it reaches parts of the population where partner change is less frequent.

5.7 *Transfer from positive to sick*

5.7.1 The intensity of transfer from positive to sick was assumed to vary by duration but not by age or calendar year. Some evidence of the progression from HIV-positive to sick with AIDS is available from studies such as those by Brodt *et al.* (1986) and Helm *et al.* (1987). Lui *et al.* (1986) postulated a Weibull formula, and used data from transfusion cases to estimate the parameters. Anderson *et al.* (1986) and Anderson & May (1988) also used a Weibull formula. Panjer (1987) used the results from the study at the University of Frankfurt (Brodt *et al.* 1986) to construct a model based on a convolution of three exponential densities. We assumed a Gompertz formula, of the form,

$$\mu(d) = \exp(-8{\cdot}4 + 1{\cdot}4d)$$

5.7.2 However, $\mu(d)$ was assumed to have an upper limit of ·25. This formula implies that 16% will have progressed to AIDS after 5 years, 76% after 10 years and 93% after 15 years. The proportions at each duration (including those who have subsequently died) are illustrated in Figure 4 for our model, and for those of Anderson & May (1988) and Panjer (1987). It is assumed that all those who are

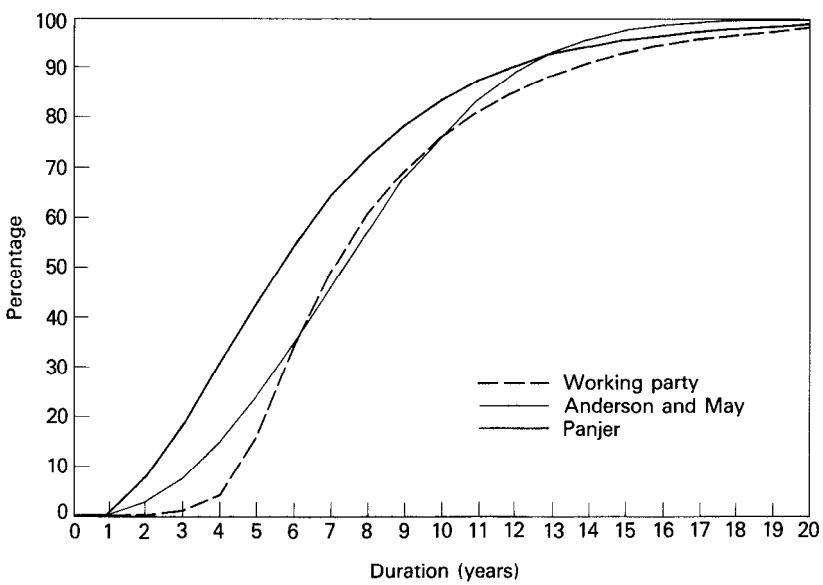

Figure 4. Proportions of HIV positives who have progressed to AIDS by duration.

HIV-positive will eventually develop AIDS (unless they die of something else first). It was originally considered that only 20% to 30% with HIV would ultimately develop AIDS, but medical opinion seems increasingly to support the view that all those with HIV have the potential to develop into full AIDS cases, although the time taken to progress may be quite long. The assumed progression from HIV-positive to sick agrees reasonably well with empirical data which have been published, but such data relate only to the early years of development, and the ultimate shape of the tail remains very uncertain.

5.8 *Mortality*

5.8.1 For the projections of the spread of AIDS in the population, normal population mortality was assumed, taken as the first year mortality from the mid-1983 based population projections for the U.K. by the Government Actuary's Department (1985). No allowance was made for future mortality improvement in ordinary mortality rates (i.e. apart from AIDS). In the projections of insured persons for Bulletin No. 2, the mortality basis assumed was that implied by the Continuous Mortality Investigation experience for 1979–82 for Assured Lives Males Durations 2 and over (*C.M.I.R. No. 9*, 1988).

5.8.2 In addition to normal mortality (or insured lives' mortality) applying to all groups, those sick with AIDS were assumed to die from AIDS, using a

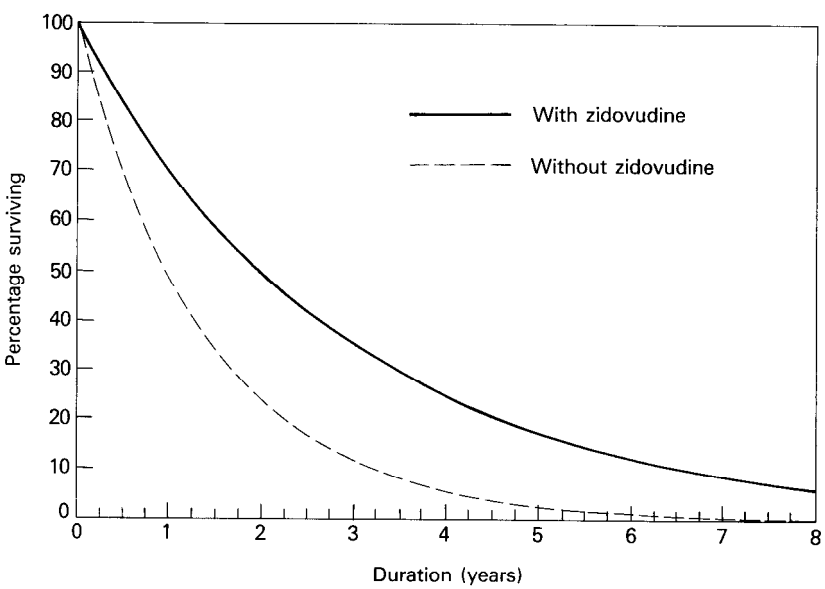

Figure 5. Survival curve for people with AIDS.

Table 5. *Summary of projection bases*

Assumption	Projection A	Projection BC	Projection F
Initial population	mid-1983 estimates for U.K.	mid-1983 estimates for U.K.	mid-1983 estimates for U.K.
Initial at risk population	5% of males 21–50	5% of males 21–50	$2\frac{1}{2}$% of males 21–50
Transfer from at risk to clear	—	Intensity ·1 from 1 January 1987	Intensity ·1 from 1 January 1987
Mortality from clear, at risk and positive	E. & W. population mortality for projections of incidence in the population; C.M.I. male assured lives experience for 1979–82 for insurance applications	As for projection A	As for projection A
New entrants	mid-1983 based population projection for U.K. (at age 15)	mid-1983 based population projection for U.K. (at age 15)	mid-1983 based population projection for U.K. (at age 15)
New entrants at risk	2% of males attaining 15	2% of males attaining 15	1% of males attaining 15
Transfer from at risk to positive	Intensity ·7 for ages 25–50, reducing to zero at 15 and 70	As for Projection A, but reducing linearly from 1987 to 1992 to half initial intensity at all ages.	As for Projection A, but reducing linearly from 1987 to 1992 to half initial intensity at all ages.
Transfer from positive to sick	Intensity varies by duration (d) according to: $\mu = \exp(-8{\cdot}4 + 1{\cdot}4d)$ with a maximum value of ·25	As for Projection A	As for Projection A
Mortality from sick	Normal mortality as from clear plus a constant intensity of ·7 for AIDS mortality	As for Projection A	Normal mortality as from clear plus a constant intensity of ·35 for AIDS mortality

constant force of mortality of ·7. This implies that 50% of those alive at the start of each year will survive one further year, as shown in Figure 5. In Projection F it was assumed that this force of mortality would reduce linearly to ·35 between 1987 and 1992 as a result of the increased use of zidovudine and other drugs.

5.9 *Summary of Projection Assumptions*

5.9.1 The principal assumptions used for Projections A, BC and F, the projections on which we have based our analysis of the impact of AIDS on insurance, are summarized in Table 5. We described these as our high, moderate and low projections. The factors which are assumed to vary in each projection from the relatively pessimistic assumptions in Projection A are given below:

Projection B—steady transfer assumed from at risk to clear from 1987 onwards

Projection C—force of infectivity assumed to halve between 1987 and 1992

Projection BC—steady transfer assumed from at risk to clear from 1987 onwards and force of infectivity assumed to halve between 1987 and 1992.

Projection D—force of mortality from AIDS assumed to halve between 1987 and 1992

Projection E—initial population at risk and proportion of future generations at risk assumed to be half the level of Projection A

Projection F—assumes the modifications of all of Projections B to E

Table 6. *Projected numbers HIV-positive at 31 December each year (Thousands)*

	Projection						
Year	A	B	BC	C	D	E	F
1987	54	54	52	52	54	50	48
1988	95	94	84	85	95	83	74
1989	159	153	122	125	159	127	100
1990	244	222	160	169	244	173	122
1991	335	285	190	209	335	214	135
1992	413	326	211	243	413	239	141
1993	464	341	223	272	464	248	139
1994	483	333	224	293	483	242	132
1995	472	307	217	305	472	224	121
1996	439	270	203	309	439	200	108
1997	393	230	185	305	393	173	94
1998	341	192	164	294	341	146	80
1999	291	157	143	278	291	123	68
2000	247	128	122	257	247	103	57
2001	209	105	103	234	209	87	47
2002	178	85	86	210	178	74	38

6. RESULTS OF THE PROJECTIONS

6.1 Table 6 and Figure 6 show the projected numbers HIV-positive at the end of each year from 1987 to 2002 for each of the Projections A to F. The numbers rise to a peak in 1992 to 1996, ranging from 141,000 on Projection F to 483,000 on Projection A.

6.2 Table 7 and Figure 7 show the projected number sick with AIDS over a similar period. As would be expected, the peak occurs somewhat later than for numbers HIV-positive, in 1998 to 2000. Projection F shows a peak of some 42,000 people sick with AIDS, whilst Projection A has a peak of just over 80,000. The highest projection of numbers sick is Projection D, which rises to over 142,000 because of the combination of the pessimistic assumptions of Projection A regarding numbers at risk and rate of spread, and an optimistic assumption about the expectation of life of people with AIDS.

6.3 Table 8 and Figure 8 show the projected numbers of deaths from AIDS during each year. These rise to a peak shortly before the turn of the century, at just under 15,000 for Projection F and over 56,000 on Projection A. The projected deaths from AIDS may be compared with a current total of about 670,000 deaths a year in the U.K. and some 80,000 a year amongst males aged between 20 and 65.

6.4 Each projection was started in 1983 and was adjusted so that the projected

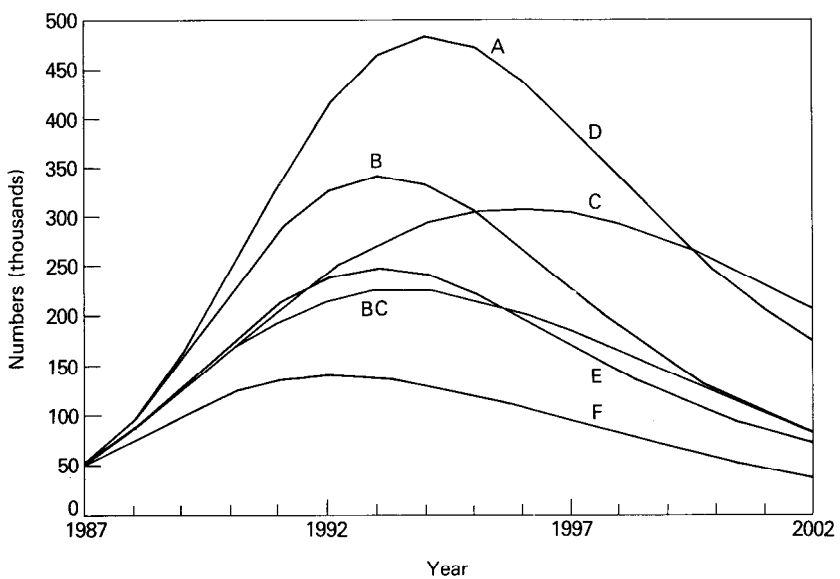

Figure 6. Projected numbers HIV-positive at 31 December each year. Projections A–F.

Table 7. *Projected numbers sick with AIDS at 31 December each year*

	Projection						
Year	A	B	BC	C	D	E	F
1987	621	621	621	621	636	619	633
1988	1,184	1,181	1,181	1,182	1,269	1,172	1,255
1989	2,174	2,173	2,158	2,159	2,462	2,126	2,396
1990	3,959	3,949	3,880	3,886	4,759	3,788	4,494
1991	7,142	7,092	6,798	6,826	9,156	6,602	8,205
1992	12,563	12,351	11,244	11,359	16,860	11,038	13,794
1993	21,131	20,357	17,087	17,477	29,095	17,306	20,735
1994	33,264	30,927	23,607	24,672	46,877	24,918	28,057
1995	48,049	42,362	29,637	31,974	69,644	32,514	34,492
1996	62,877	51,819	34,112	38,377	94,492	38,395	39,072
1997	74,451	56,995	36,713	43,524	117,000	41,430	41,542
1998	80,540	57,365	37,623	47,495	133,304	41,486	42,126
1999	80,846	53,912	37,031	50,199	141,604	39,175	41,146
2000	76,539	48,164	35,193	51,525	142,184	35,382	38,965
2001	69,338	41,499	32,440	51,463	136,595	30,927	35,955
2002	60,853	34,887	29,128	50,128	126,836	26,427	32,455

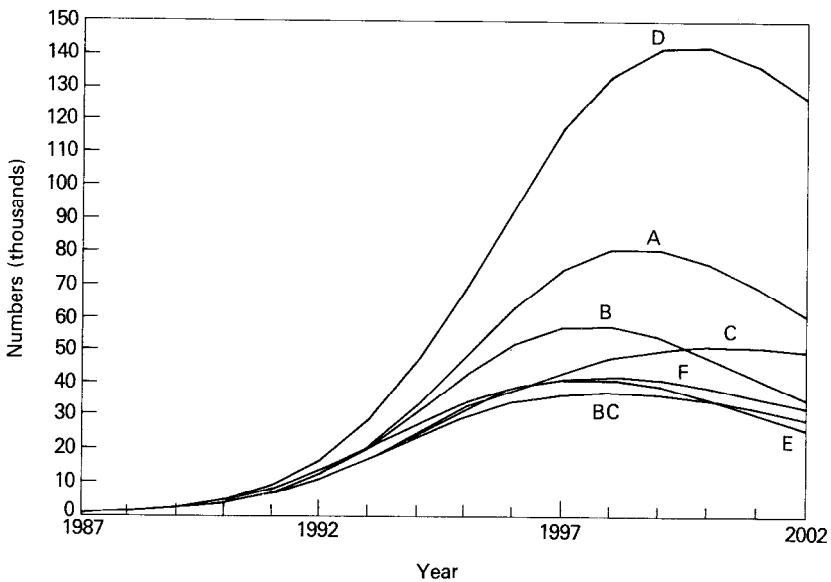

Figure 7. Projected numbers sick with AIDS at 31 December each year. Projections A–F.

Table 8. *Projected numbers of deaths from AIDS in year*

	Projection						
Year	A	B	BC	C	D	E	F
1987	317	317	317	317	302	316	301
1988	614	614	613	613	544	610	540
1989	1,144	1,144	1,139	1,139	940	1,126	923
1990	2,089	2,086	2,061	2,063	1,574	2,020	1,509
1991	3,788	3,770	3,659	3,670	2,566	3,560	2,361
1992	6,748	6,668	6,229	6,273	4,449	6,075	3,805
1993	11,600	11,290	9,853	10,014	7,900	9,825	6,016
1994	18,851	17,839	14,235	14,716	13,140	14,734	8,545
1995	28,371	25,677	18,696	19,850	20,283	20,150	10,986
1996	38,914	33,149	22,416	24,691	28,725	24,952	12,932
1997	48,322	38,353	24,886	28,730	37,136	28,108	14,163
1998	54,574	40,272	26,105	31,922	44,009	29,172	14,689
1999	56,780	39,115	26,205	34,266	48,333	28,337	14,610
2000	55,291	35,811	25,338	35,680	49,857	26,152	14,047
2001	51,168	31,401	23,712	36,120	48,928	23,225	13,129
2002	45,599	26,713	21,570	35,622	46,187	20,063	11,981

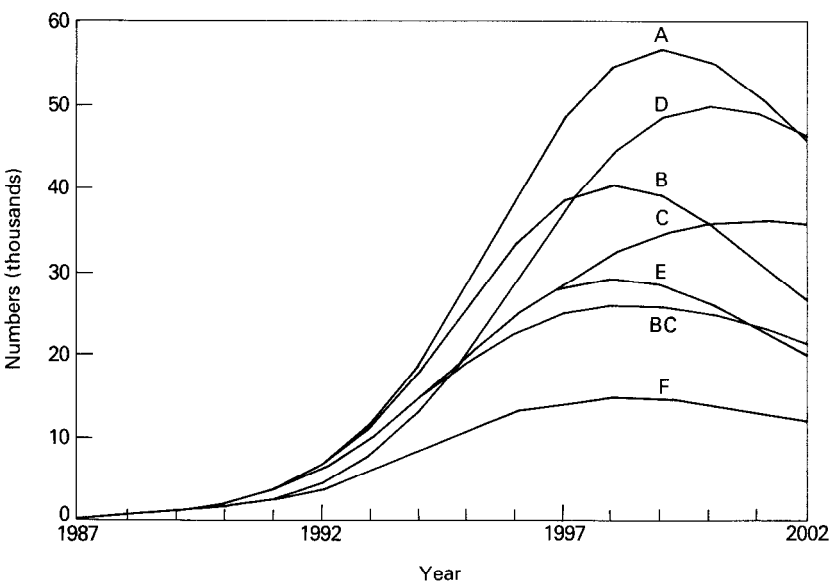

Figure 8. Projected numbers of deaths from AIDS each year. Projections A–F.

numbers of cases of AIDS and deaths from AIDS closely reproduced the published numbers of reported AIDS cases and AIDS deaths. It would be preferable for the model to be calibrated against diagnosed cases of AIDS and actual AIDS deaths, since there are considerable delays in reporting. However, figures by date of occurrence have not been published. Adjusting for this factor would not significantly affect the magnitude of the projected numbers of AIDS cases and AIDS deaths, but it would affect the timing of the spread of AIDS, perhaps by up to a year or so.

6.5 It can be seen that the model projects around 50,000 HIV-positives at the end of 1987, reflecting the assumptions made and the calibration of the model to reported AIDS cases and deaths in the years up to 1987. There is considerable uncertainty about the current prevalence of HIV infection, in the absence of any widespread testing programmes, but these figures do not seem inconsistent with what is known and they fall within the middle of the range that is often quoted (cf. § 5.1.1). Table 9 and Figure 9 show the projected numbers of new HIV-positives each year on Projections A, BC and F. In each case the peak is reached by 1991, reflecting saturation of the population assumed to be at risk, whether it be at the original level, as in Projection A, or at the reduced level following transfers to the clear group, as in Projections BC and F.

6.6 Table 10 and Figure 10 show the projected numbers of new cases of AIDS each year on Projections A, BC and F. These rise to over 17,000 in 1995 on Projection F, to 27,000 on Projection BC and to over 60,000 on Projection A.

6.7 The sharp rise in the numbers HIV-positive, the numbers sick with AIDS and the numbers of deaths from AIDS, followed by a fall almost as steep, is a consequence of the appearance of HIV on the scene in very recent times. A

Table 9. *Projected numbers of new HIV positives in year*

Year	Projection A	Projection BC	Projection F
1988	42,805	33,208	26,748
1989	66,384	40,575	28,721
1990	89,114	42,139	25,829
1991	99,582	37,485	20,073
1992	92,085	32,337	15,444
1993	72,859	28,503	12,393
1994	52,062	23,647	9,533
1995	35,347	18,710	7,117
1996	23,720	14,300	5,209
1997	16,368	10,669	3,765
1998	12,216	7,837	2,703
1999	10,200	5,698	1,941
2000	9,320	4,143	1,409
2001	8,877	3,043	1,046
2002	8,536	2,288	807

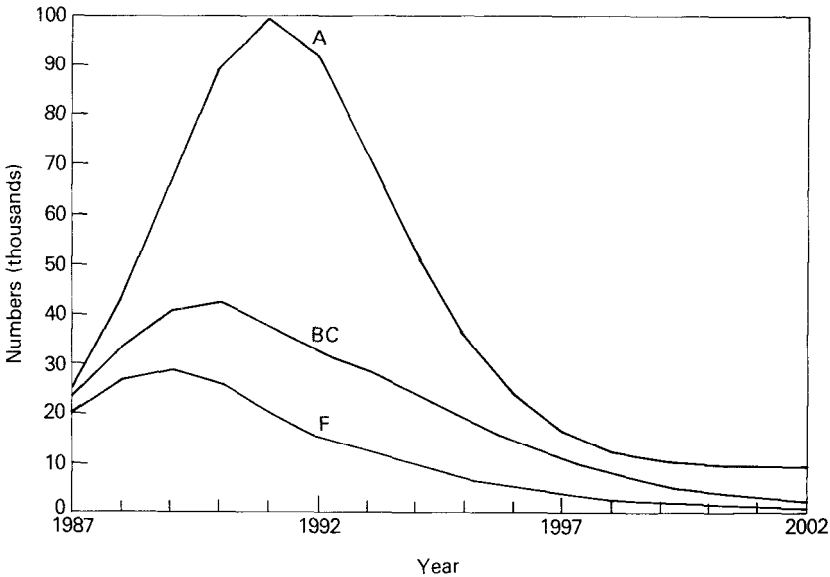

Figure 9. Projected numbers of new HIV positives.

proportion of males at all ages in the sexually active years are assumed to be at risk of becoming infected with HIV and the dynamics of the epidemic are such that they become infected quite quickly, unless they transfer from the at risk group to the clear group. The relative size of the peak depends directly, therefore, on the size of the population assumed to be at risk initially, subject to the assumption about people leaving the at risk group. In future only relatively small numbers of men will come to be at risk of becoming infected, as successive new generations reach the sexually active years. This assumption is particularly reflected in the ultimate level in Figures 6 to 10.

6.8 Although each of the other projections generally shows lower numbers than Projection A, the detailed pattern is not quite the same. If the 'force of infectivity' is reduced, but the same numbers remain at risk, as in Projection C, then the spread of the infection is delayed, but in due course there is an epidemic almost as great as that in Projection A. A transfer of individuals to the clear category, as in Projection B, is more effective in reducing the total number of cases. Improvements in treatment which only delay death, as in Projection D, increase considerably the numbers sick with AIDS, but do not reduce the total numbers of deaths, only postponing them for a short while. The assumption of a lower initial population at risk, as in Projection E, roughly halves the eventual numbers, but brings the peak of the epidemic forward.

Table 10. *Projected numbers of new cases of AIDS in year*

Year	Projection A	Projection BC	Projection F
1988	1,181	1,179	1,166
1989	2,143	2,124	2,073
1990	3,890	3,797	3,625
1991	6,998	6,605	6,104
1992	12,219	10,722	9,453
1993	20,255	15,771	13,053
1994	31,130	20,869	16,011
1995	43,386	24,884	17,617
1996	54,079	27,091	17,759
1997	60,346	27,726	16,924
1998	61,215	27,286	15,599
1999	57,712	25,905	13,981
2000	51,653	23,804	12,231
2001	44,645	21,267	10,487
2002	37,775	18,559	8,844

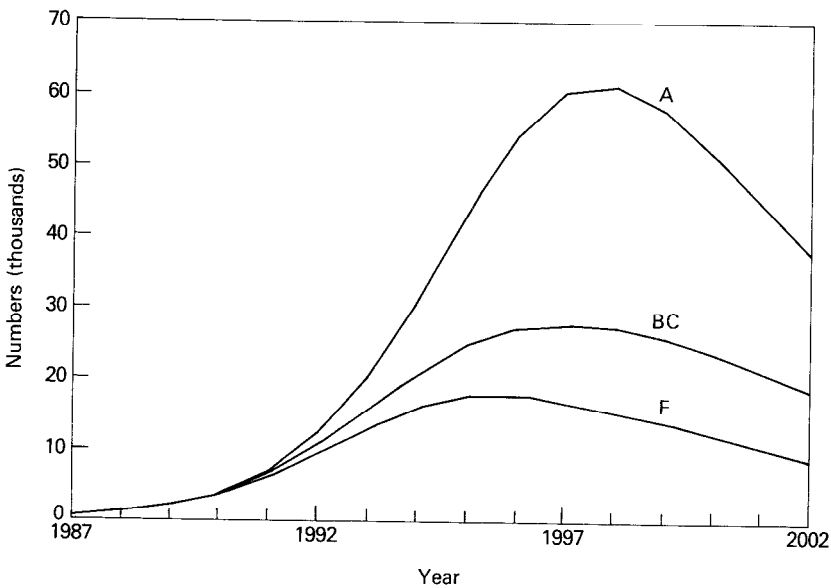

Figure 10. Projected numbers of new cases of AIDS.

6.9 It is impossible to attach probabilities to these projections. In theory, even Projection A, which could be regarded as highly pessimistic, cannot be taken as an upper bound to the possibilities, since the underlying population at risk might in fact be higher than has been assumed. At the other extreme, Projection F cannot be assumed to be at the bottom of the range of possibilities, since the core population at risk may be smaller than has been assumed, the slow-down in the spread of infection may be faster than we have assumed and may have started earlier, and the reaction to the publicity about AIDS may produce an even greater reduction in the size of the group remaining at risk of infection than has been assumed.

6.10 Furthermore, it must be underlined that all the projections have been constructed on the basis that infection remains within the groups currently showing the highest incidence of infection. The possibility must be faced that infection might spread to a significant extent amongst heterosexuals, in the same way as other sexually transmitted diseases and in the same way that it appears to be doing in the U.S.A. In this context Projection A may not be particularly pessimistic, and the ultimate size of the epidemic could be substantially greater in the long-term. The general shape of a heterosexual epidemic in the U.K., if one occurs, would be a very slow build-up of cases, with any peak deferred well into the twenty-first century.

7. THE IMPACT OF AIDS ON MORTALITY RATES

7.1 The additional deaths from AIDS can be translated into mortality rates at each age for each future year. Tables 11 & 12 and Figures 11 & 12 show the ratio of total projected mortality, including deaths from AIDS, to normal population mortality at 5-yearly intervals of age and calendar year for Projections A and F. The peak ages for proportional extra mortality are 35 to 40 and the peak years are in the late 1990s. The peak ratio rises from nearly twice population mortality in Projection F to nearly five times in Projection A. Since the mortality of assured lives is considerably lighter than the assumed population mortality, it can be seen that, if AIDS affects the insured population to the same extent as the uninsured population, the extra mortality ratios for insured lives will be higher than those shown in Tables 11 & 12.

7.2 Figure 13 shows how the additional mortality from AIDS at the level of Projection BC would affect the mortality rates for selected five-year age-groups over the next few years. Mortality rates could rise to the levels of some 30 years ago. Figure 14 shows the impact of additional AIDS mortality on each of Projections A, BC and F on the mortality which might be experienced by the cohort of males aged 30 in 1987.

7.3 Table 13 shows a selection of figures to illustrate the incidence of the additional mortality from AIDS as compared with assured lives mortality. The additional mortality is clearly highly dependent not only on age and AIDS

Table 11. *Ratio of total mortality in Projection A to normal mortality (1983 male population mortality)*

	1988	1993	1998	2003	2008	2013
20	1·005	1·002	1·002	1·002	1·002	1·002
25	1·036	1·038	1·008	1·008	1·008	1·008
30	1·036	1·550	1·418	1·103	1·103	1·103
35	1·027	1·679	4·630	3·008	2·056	2·056
40	1·017	1·427	3·603	3·141	1·934	1·985
45	1·010	1·247	2·503	2·074	1·448	1·185
50	1·005	1·139	1·847	1·605	1·206	1·075
55	1·003	1·077	1·480	1·343	1·117	1·035
60	1·001	1·026	1·244	1·197	1·068	1·020
65	1·000	1·005	1·072	1·120	1·041	1·012
70	1·000	1·001	1·008	1·055	1·030	1·008
75	1·000	1·000	1·000	1·004	1·019	1·006
80	1·000	1·000	1·000	1·000	1·001	1·004

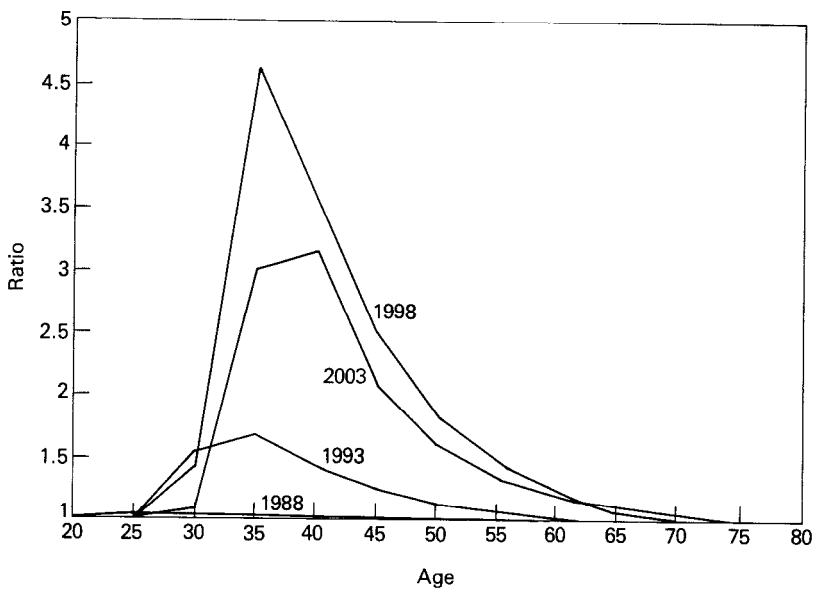

Figure 11. Ratio of total mortality in Projection A to normal mortality without AIDS.

Table 12. *Ratio of total mortality in Projection F to normal mortality (1983 male population mortality)*

	1988	1993	1998	2003	2008	2013
20	1·005	1·001	1·001	1·001	1·001	1·001
25	1·033	1·026	1·002	1·002	1·002	1·002
30	1·033	1·304	1·093	1·005	1·004	1·004
35	1·024	1·364	1·913	1·192	1·014	1·013
40	1·015	1·229	1·718	1·544	1·149	1·029
45	1·009	1·132	1·414	1·320	1·163	1·053
50	1·005	1·075	1·233	1·180	1·084	1·036
55	1·003	1·042	1·132	1·102	1·048	1·018
60	1·001	1·016	1·071	1·058	1·028	1·010
65	1·000	1·004	1·024	1·032	1·016	1·006
70	1·000	1·001	1·004	1·012	1·009	1·004
75	1·000	1·000	1·000	1·002	1·004	1·002
80	1·000	1·000	1·000	1·000	1·000	1·001

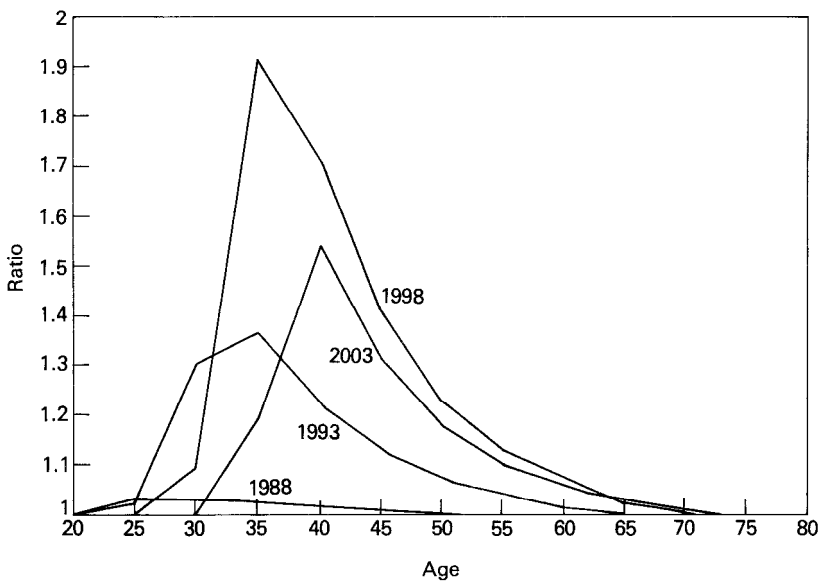

Figure 12. Ratio of total mortality in Projection F to normal mortality without AIDS.

Table 13. *Extra mortality per 1,000 males*

Attained age	AIDS projection*		Extra mortality per 1,000 males in year (% of assured lives mortality)** 1993	1998	2003
30	High	(A)	·62 (112)	·46 (83)	·12 (21)
	Moderate	(BC)	·52 (93)	·12 (22)	·01 (2)
	Low	(F)	·32 (58)	·09 (16)	—
35	High	(A)	1·01 (146)	4·38 (632)	2·34 (337)
	Moderate	(BC)	·86 (123)	1·86 (268)	·37 (53)
	Low	(F)	·51 (74)	1·06 (152)	·23 (33)
40	High	(A)	1·01 (88)	4·78 (418)	3·50 (306)
	Moderate	(BC)	·86 (75)	2·38 (208)	1·73 (151)
	Low	(F)	·51 (45)	1·28 (112)	·92 (81)

* See Table 5.

** The *extra* mortality is shown in brackets as a percentage of normal assured lives mortality.

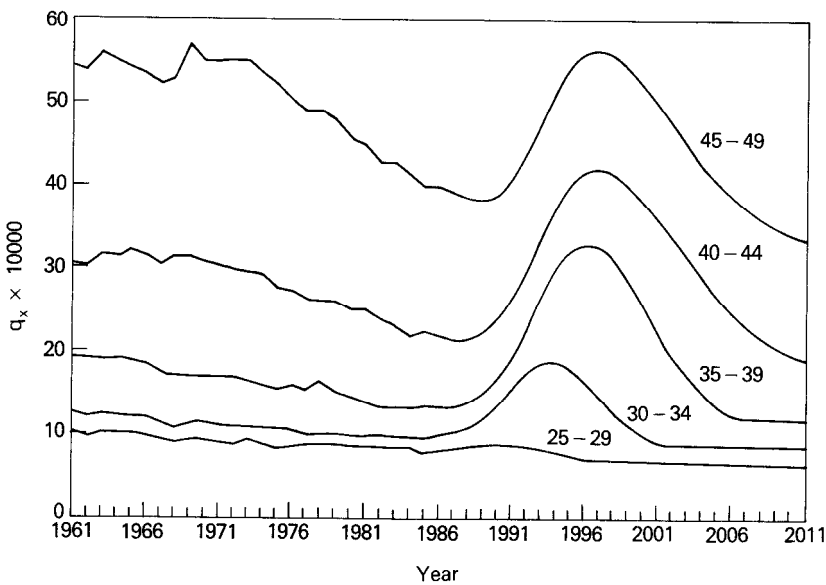

Figure 13. Mortality rates for ages 25–49 from 1961–2011. AIDS Projection BC.

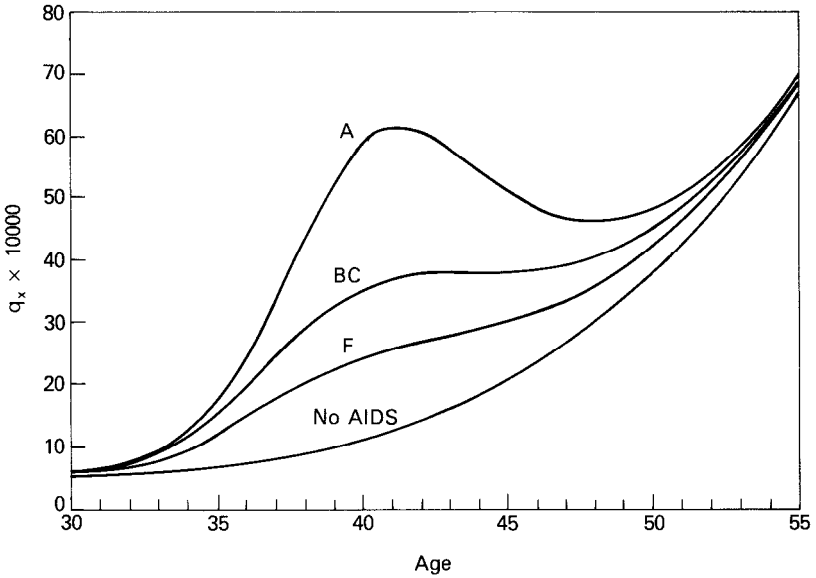

Figure 14. Mortality rates with and without AIDS; age 30 at the end of 1987.

projection basis but also on calendar year. Further details of the excess mortality rates from AIDS on Projections A, BC and F are given in Appendix 1.

8. AIDS AND LIFE INSURANCE

8.1 *The existing portfolio—Reserving*

8.1.1 Much of the existing portfolio of most insurance companies was written at a time before there was any general awareness of the existence of HIV infection, or of the problems associated with it. It may be expected, therefore, that current portfolios contain a significant number of policies on lives which have either acquired or are likely to acquire the virus and who may ultimately die of AIDS. One needs first to ask whether the incidence of cases of HIV infection is likely to be the same amongst insured persons as amongst the population at large.

8.1.2 Various factors may affect this. On the one hand it seems possible that, prior to the AIDS scare, single males would be less inclined to apply for life insurance than their married counterparts. On the other hand, those in the 'at risk' groups are not necessarily single; 10% of AIDS cases reported so far in the U.K. have been amongst married males and this figure could become higher in the future. Furthermore, there was a period when those most at risk of acquiring HIV infection were aware of the fact, whilst insurance companies were slow to

take any action to change their underwriting procedures. It is possible, therefore, that, amongst policies of a relatively recent duration, there may be a higher proportion in the at risk categories, or with HIV infection, than in the population at large.

8.1.3 A further consideration may be the geographical distribution of the business. About three-quarters of all AIDS cases so far have been reported in the Thames Regions of the National Health Service, i.e. in London and the immediately surrounding area. Whilst it can be expected that there will be some evening out of the distribution of cases as the epidemic spreads, it is likely that the groups most at risk will remain unevenly distributed about the country, with a more than proportionate incidence in the major cities. This may also be the pattern of coverage of many insurance portfolios, whereas others may be less dominated by city populations and, in particular, by London and the south east.

8.1.4 Concentrations of infection may also occur within particular social groups or even within particular employments and firms, if only because people who work together may also have social contact in their leisure time.

8.1.5 Whilst it is for individual insurance companies to take a view on how their portfolios may compare with the population at large, we assumed, for the purposes of illustration, that existing portfolios would mirror the wider population in relation to the proportions in the at risk group, with HIV infection and with AIDS. It would not appear to be prudent to make a more optimistic assumption than this when considering valuation reserve levels.

8.1.6 The projections of the incidence of HIV infection and AIDS show that the additional mortality and morbidity are related not only to age but also to calendar year. It is not, therefore, a simple matter to adjust existing valuation factors to allow for the impact of AIDS. It would be possible in principle to sort policies by calendar year of birth and value each tranche separately using different mortality rates. For future business, valuation might also have to be carried out separately for different years of entry.

8.1.7 It seems likely that a more practicable approach for most companies in the short-term will be to investigate the impact of AIDS using a model and to apply the results of such an exercise to the whole portfolio. Many offices may be able to obtain an approximate idea of the impact of AIDS on the reserves for their existing portfolio by grouping the business appropriately and applying factors. In order to facilitate such a procedure we prepared tables on the three main projection bases to show the impact of AIDS on reserving levels for a few straight-forward contracts at a selection of entry ages, durations and attained ages.

8.1.8 In the light of what is now known about AIDS, premium rates for non-profit policies written in the last few years should have been, in some cases, substantially higher than have been charged. A net premium valuation on a mortality basis which allows for the impact of AIDS would use a net premium calculated on the 'new' mortality basis, whereas an existing policy has been written with a gross premium calculated on the 'old' mortality basis. The results

shown in Appendices 2 to 7 are on a 'deficiency reserve' approach, calculating net premium reserves on the old mortality basis and then calculating reserves using factors on the new mortality basis, but with the old net premium. In the case of with-profits business, a realistic rate of interest and an explicit bonus loading have been assumed, to avoid setting up excessive reserves on a 'with-profits' basis.

8.1.9 Reserves on this basis are shown in Appendices 2 to 4 for level temporary assurance on the high, moderate and low AIDS projections respectively and in Appendices 5 to 7 for with-profits endowment assurance (including whole life). Results are shown for years of entry 1973, 1978, 1983, 1988. Entry is assumed to take place on 1 January of the respective years. The rate of interest is 6% a year throughout and the rate of bonus, both past and future, is taken as being fixed at 3·5% a year. The old mortality basis is based on the C.M.I. male assured lives experience for 1979–82, durations 2 and over (*C.M.I.R.* 9, 1988), which approximates to 80% of A 1967–70. The tables assume that valuation takes place at the end of 1987. Thus the extra reserve for policies commencing in 1988 is in effect the AIDS mortality strain in respect of business being written at current premium rates. Negative reserves on the old basis, where they occur, have been taken as zero.

8.1.10 Figures 15 and 16 show the additional reserves required on this basis per 1,000 sum at risk for a level temporary assurance written in 1983 and valued 5

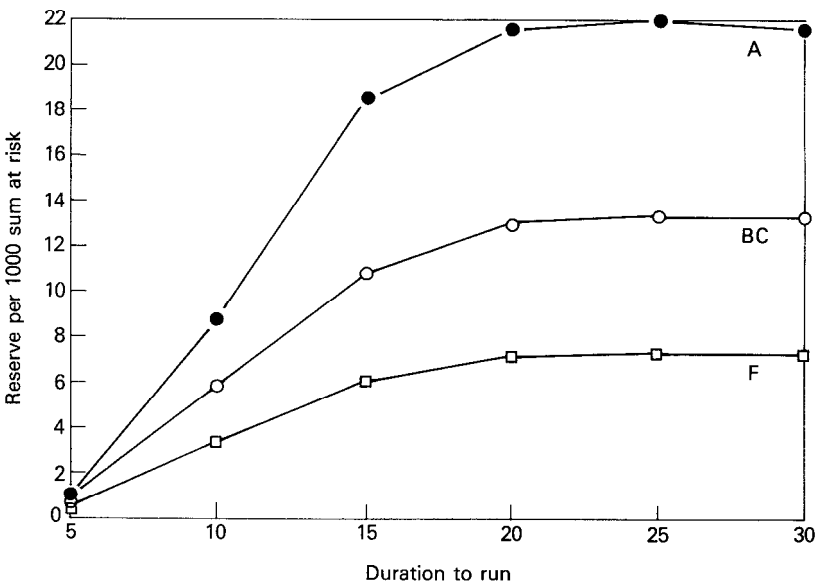

Figure 15. Additional reserve per 1,000 sum at risk—level temporary assurance, attained age 40 at end of 1987.

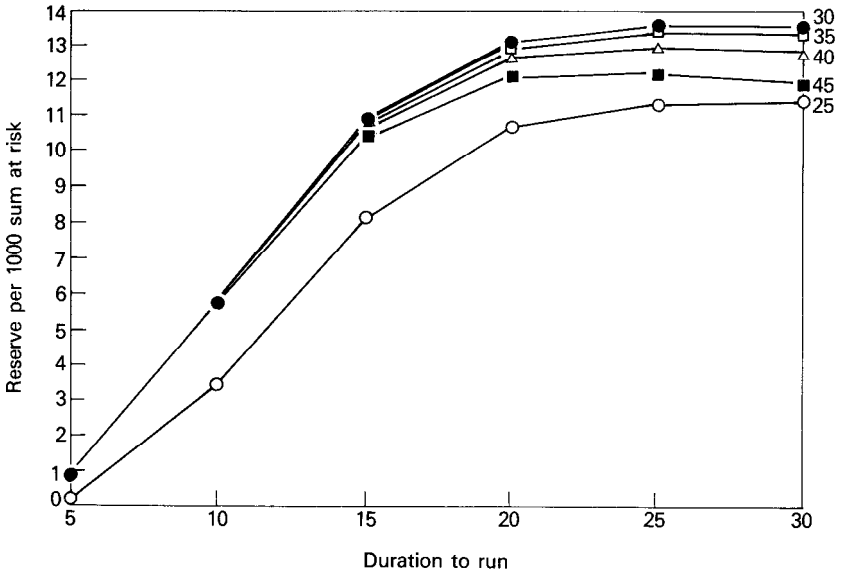

Figure 16. Additional reserve per 1,000 sum at risk level—temporary assurance, Projection BC, by attained age at end of 1987.

years later. Figure 15 shows the additional reserves at attained age 40 on the high, moderate and low projections and Figure 16 shows the variation by attained age on the moderate (BC) projection. Figures 17 and 18 show corresponding results for with-profits endowment assurance.

8.1.11 We are satisfied that the assumptions underlying Projection F are sufficiently conservative for it to be essential for insurance companies to have regard to the possibility of an incidence of HIV infection of at least this level. There is no reason in this context for any reliance to be placed on the presence of a solvency margin, which is needed to provide some protection against more adverse scenarios or other contingencies.

8.1.12 We do not envisage, on the other hand, that companies need establish technical reserves for the time being to enable them to cope with a situation such as that described by Projection A, neither is it sensible, nor commercially viable, to establish non-profit premium rates 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 meet future liabilities. Any potential strain on new business written on deficient premium rates should be considered and the possible impact of selective persistency should be investigated.

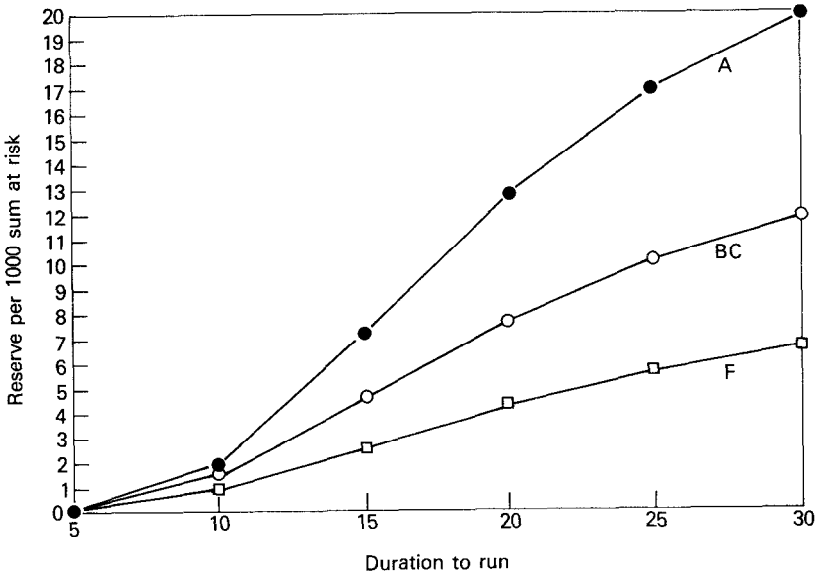

Figure 17. Additional reserve per 1,000 sum at risk—with profits endowment assurance, attained age 40 at end of 1987.

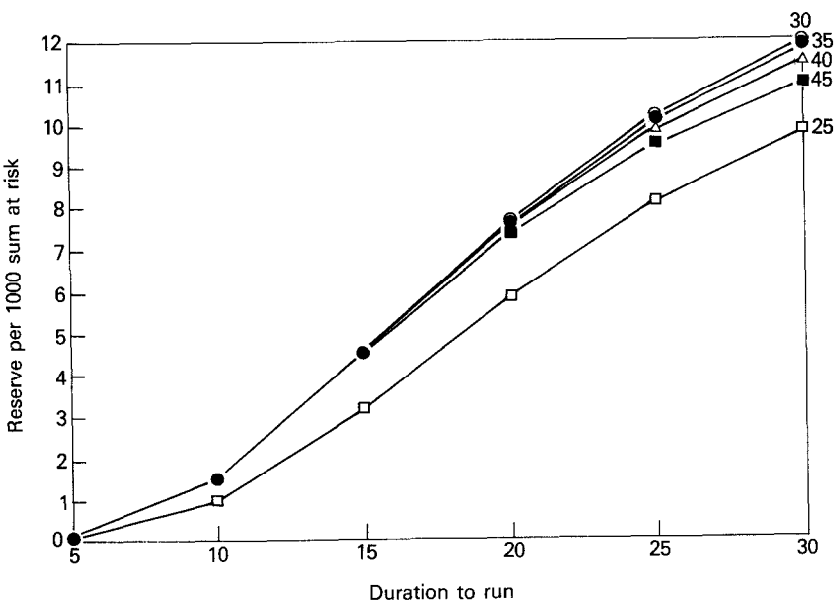

Figure 18. Additional reserve per 1,000 sum at risk—with profits endowment assurance, Projection BC, by attained age at end of 1987.

8.1.13 It was suggested in Bulletin No. 2 that companies should develop a strategy for strengthening their reserves over the next few years to the level implied by the moderate projection (BC), subject to adjustment as time goes on and estimates of the impact of AIDS become firmer. It can be seen from the figures illustrated in the Appendices that substantial increases in reserves could be required for certain types of policy, even on the basis of Projection F, and even more so on the basis of Projection BC. The extent to which additional reserves may be necessary will depend upon margins in the existing reserves. With a net premium valuation basis, companies may take credit for the higher net premium on the mortality basis allowing for the impact of AIDS, although they must ensure that sufficient margin remains between the office premiums to be received and the net premiums for which credit is taken to cover expenses adequately.

8.1.14 Offices writing mainly with-profits business may feel that they have adequate reserves to cover most eventualities within their valuation margins, investment reserves, surplus carried forward, etc. We nevertheless suggested that explicit provisions should be established by such offices to cover mortality in respect of AIDS. It is important also for consideration to be given to the problem of equity between the existing policyholders of different generations and prospective new policyholders, whether or not the underwriting basis is to be changed. This requires thought to be given to the problem of who should pay, through lower bonuses or reduced profits, for the extra AIDS mortality. The problems may be more significant in the case of some low cost endowment assurances, although the uncertainty arising from AIDS is not likely to be as great as the uncertainty about future returns on investments.

8.1.15 Unit-linked offices with mortality deductions that can be altered at the office's discretion may be able to increase their mortality deductions in order to offset the impact of higher mortality from AIDS. However, consideration should be given to any guarantee periods and to the commercial pressures or administration system restraints which might inhibit the company from increasing such deductions. We suggested that actuaries should nevertheless reserve for additional mortality in these cases until such time as the deductions had been increased. With maximum sum assured plans, little or no fund is built up, so that the scope for recovering additional mortality costs through higher fund charges will be extremely limited.

8.1.16 It should be noted that the mortality deduction appropriate for existing policyholders may be different from that appropriate for new policyholders, the latter depending upon the underwriting strategy adopted. Considerations of equity may point towards differing mortality deductions for different tranches of policies. Unit-linked offices without discretion to alter deductions to allow for the impact of higher mortality need to reserve for the effect of AIDS in the usual way.

8.1.17 Special attention should be given to setting up adequate reserves for options, e.g. options to renew or to increase the sum assured without medical evidence, as it is likely that such options will increasingly be selectively exercised by those who are HIV-positive or in the at risk groups.

8.1.18 Events appear to have moved relatively fast since the publication of

Bulletin No. 2 in December 1987. The meeting at Staple Inn Hall on 1 February 1988 provided an opportunity for some discussion within the profession on reserving issues. Subsequently, the published reports and accounts of many insurance companies have made reference to additional AIDS provisions.

8.2 *The rationale for underwriting*

8.2.1 The sharing of risks is fundamental to the insurance process. However, for an effective market to flourish, risks insured for a particular premium must have an effectively equal probability of incurring a claim. A risk which, *a priori*, has a higher probability of incurring a claim can only be insured at the same rate as other risks if a deliberate decision is taken to provide a cross-subsidy, and if there is no possibility of any advantage being taken of the situation by the insured with a higher risk of claim. In a commercial market, insurers seek to classify risks into largely homogeneous groups where the criteria of equal susceptibility to risk can be met. Applicants for insurance who exhibit particularly high risk characteristics will not be offered insurance at standard rates, but may still be capable of being included in a group of sufficient size with similar risks for which a higher premium can be charged.

8.2.2 In life insurance (or P.H.I.), the purpose of underwriting is to identify which applicants exhibit sufficiently normal characteristics to be included in the group of those insurable at normal rates, and, on the other hand, to identify those whose state of health, occupation or habits are such that they are subject to an abnormal risk of death (or disability). Applicants in this latter category may still be insurable at an increased rate of premium, in some cases at a substantially increased rate. However, those for whom death is clearly imminent could not reasonably be accepted for life insurance on this basis, other than in return for a premium which, by the time it has been loaded for expenses, might be as much as, or little short of, the full sum assured.

8.3 *Modelling the selection process*

8.3.1 In order to explore the consequences of different underwriting strategies, it is necessary to take into account the effect of selection. To do this we developed the multistate model, which was used for making projections of the incidence of HIV infection and AIDS. The aim was to keep track of those who started in each particular status and to identify the proportions of each such group which have progressed to other statuses at subsequent times. It is then possible to form 'survival tables' for each of the starting statuses. Details are given in Appendix 8 of a number of illustrative survival tables for individuals of different ages in 1987 and in different initial statuses. Selected mortality rates are shown in Appendix 9. The pattern of survival for 30-year-old males in each of the initial statuses is shown in Figure 19.

8.3.2 Appendix 8.2 shows that, on the moderate (BC) assumptions, the expectation of life for a 30-year-old male in the clear category is 46·6 years. For a 30-year-old male in the at risk category the expectation of life is 26·7 years, and

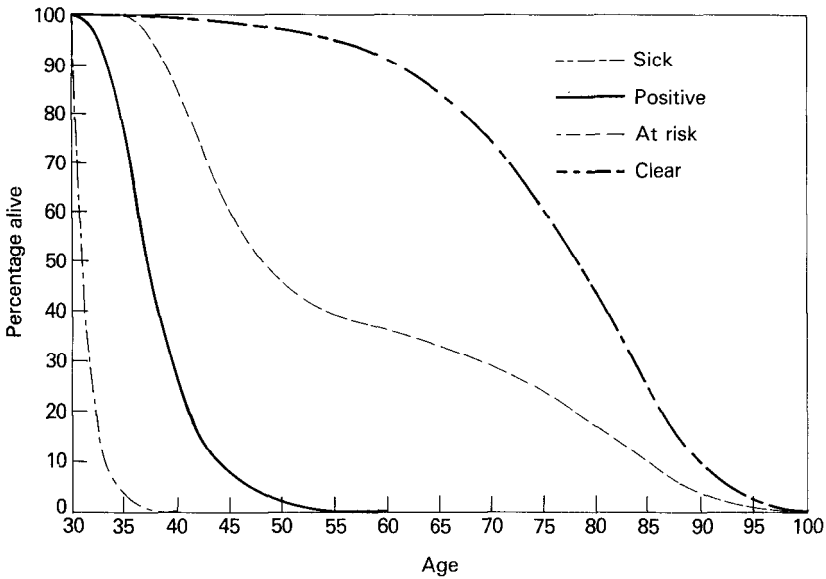

Figure 19. Survival pattern for clears, at risk, positive and sick from age 30.

for someone who is already HIV-positive it is 8·2 years. These correspond to the expectation of life at ages 51 and 77 respectively for a male in the clear category. The expectation of life for a 30-year-old with AIDS is only 1·5 years.

8.3.3 Appendix 9.2 shows that, on the moderate (BC) assumptions, a 30-year-old male with AIDS is over 900 times as likely to die in the next year from AIDS as an average 30-year-old in the clear category. A 30-year-old male who has just become HIV-positive is 10 times as likely to die in the next year as someone who is clear. Whereas only 2·8% of clear 30-year-olds would be expected to die before they reached the age of 50, 54·3% of those in the at risk category will die before 50 on the basis of the moderate assumptions. 97·8% of those who are HIV-positive at 30, and 100% of those who are sick with AIDS, will die before age 50.

8.3.4 The next stage is to make an assumption about the efficacy of selection. It is assumed that the population is divided into four live statuses: clear, at risk, positive and sick from AIDS. The insurance company is assumed to select new policyholders from a mix of these groups, according to the criteria adopted for underwriting. Thus, an office that applies no underwriting selection at all (and is not selected against) would accept 100% of each category and hence its new policyholders would correspond to a cross-section of the population in terms of the incidence of the at risk category, positives and those sick with AIDS.

8.3.5 At the other extreme, a hypothetical insurance company with clairvoyant underwriters might be able to operate such an efficient underwriting selection procedure as to admit only those in the clear category. In this case the new policyholders would consist of 100% of the clears and 0% of the other groups. This corresponds to a population without AIDS and gives a useful standard for comparison. Intermediate positions may be chosen, by specifying that the office excludes a proportion of those sick with AIDS, a proportion of those HIV-positive and a proportion of those at risk, the proportions varying in each case between 0% and 100%. Antiselection by those who know they are at risk can be allowed for by taking a higher proportion in that category, even to the extent of assuming more than 100%.

8.3.6 For a given selection basis, a given age and for selection in a given calendar year, a life table can be calculated by weighting the proportions surviving from each starting status at that time. This can be used to calculate actuarial values in the usual way. Appendix 10 shows the cumulative deaths for insured persons who entered at age 30 at the end of 1987, on a number of different selection bases, based on the moderate AIDS projection assumptions. The selection bases are described in more detail in §8.4.1. Appendix 11 shows the corresponding mortality rates at selected ages. These are also illustrated in Figure 20. It can be seen that simply excluding those who are sick with AIDS has very little effect on the overall mortality experience at this stage, since the number

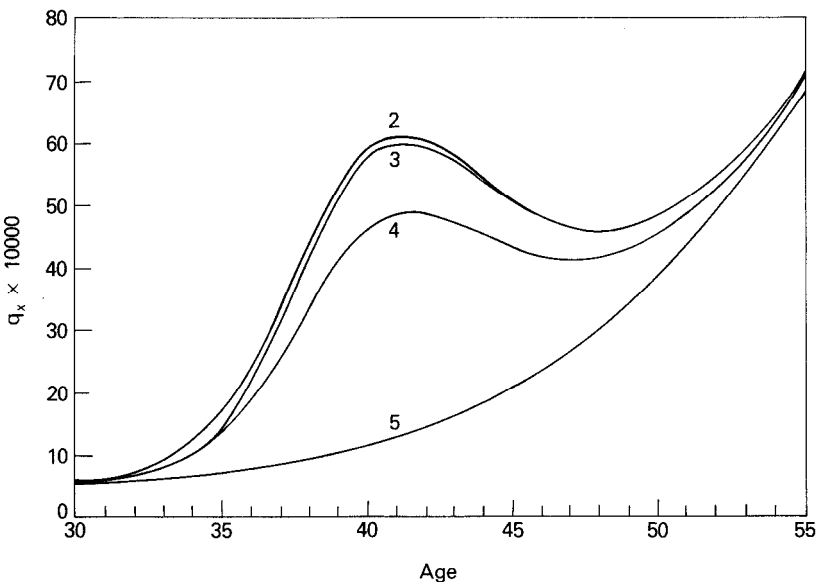

Figure 20. Mortality rates for different selection bases; age 30 at the end of 1987 (see §8.4.1 for description of bases 2 to 5).

of people who have developed AIDS and are still alive is very small. Exclusion of 50% of those infected with the virus has some effect on mortality in the short term, but this apparent advantage could easily be lost if the remaining 50% who are not excluded by the underwriting process take higher levels of cover.

8.3.7 Full blood-testing of all applicants could permit the exclusion of a very much higher percentage of those infected with the virus. However, the results described in Ranki *et al.* (1987) suggest there may be a longer delay in some individuals than hitherto thought likely before antibodies to HIV are produced. This opens up the prospect that even widespread blood-testing may not be wholly effective.

8.3.8 The strictest level of underwriting which we illustrate (selection basis 4) assumes the exclusion of 50% of those infected with the virus but not already sick with AIDS and 25% of those in the at risk group who are not yet infected. It is not clear that the current underwriting standards in the U.K. will achieve this, especially on business such as mortgage-related endowment assurance where only a limited number of underwriting questions are asked. It can be seen from Appendices 10 and 11 that even this strict level of underwriting implies substantially higher mortality experience than would have been expected on the basis of normal insured persons' mortality prior to the advent of AIDS. Antiselection is likely to aggravate the position further, as will the spread of the virus to groups at risk in the heterosexual population, which will make it more difficult for underwriters to recognize those who are at risk of becoming infected.

8.3.9 These considerations suggest that it will only be possible for insurers to limit their exposure to the effects of HIV to a modest extent. Routine blood-testing of all applicants (male and female, married or single) for sums assured of any size is the first line of defence. Many companies in the U.S.A. are now testing at a level of $100,000.

8.3.10 In Bulletin No. 2 we recommended routine blood-testing as a standard part of the underwriting process for large policies. The percentage of the population with the virus will increase rapidly and blood-testing will become a more significant underwriting tool. It may be difficult for insurers to introduce such tests at a realistic level in the short term but we suggested a progressive lowering of the automatic limits to around £50,000 for term assurance covers. A higher limit may be appropriate for endowment-type assurance business. More attention should be given to seeking to identify multiple applications for small amounts of cover to a number of life offices over a period of time.

8.3.11 Beyond this, underwriters need to attempt to exclude those most at risk of HIV infection, i.e. those, both male and female, who have sexual relationships with other people who might be carrying the virus. To do this effectively might mean asking all applicants about numbers of sexual partners, frequency of partner change, etc. This will not be a very popular development, but as AIDS becomes more widespread, it may become more acceptable to ask such questions. Nevertheless, it has to be acknowledged that it will be difficult to get useful

answers and to identify correctly those whose behaviour puts them most at risk of becoming infected with HIV.

8.3.12 Another line of defence is financial underwriting. The insurer can endeavour to ensure that the proposed sum assured is in keeping with the proposer's needs. This may reduce antiselection but insurers must, nevertheless, expect a significant worsening of mortality experience over the next few years and will have to increase their premiums accordingly. The weaker the underwriting, the more premiums will need to increase.

8.3.13 In February 1988 the Association of British Insurers issued further guidance to member offices concerning underwriting for AIDS. It was recommended that all male proposers should be automatically required to take a blood test for HIV antibodies if they were applying for a sum assured of more than £150,000. All male applicants should be asked to complete a confidential lifestyle questionnaire if the proposed sum assured was £75,000 or more, to assist in the underwriting process.

8.3.14 It is not yet clear how many offices have followed this guidance. Some have adopted somewhat higher limits. Whilst there are some grounds for being encouraged by these developments, both the recommended level and the levels being adopted remain significantly higher than the level to which we recommended that it would be necessary to move if insurers were to be adequately protected against insuring those with HIV infection. They also continue to make the assumption that there is less potential risk to insurance companies from married males and females, which may not be so in the long run.

8.4 *Premium rating*

8.4.1 Having developed 'select' mortality rates, the next stage is to calculate net premium rates in order to illustrate the effect of different underwriting criteria. Results are shown in Appendices 12 to 14 for level term assurance, and in Appendices 15 to 17 for with-profits endowment assurance, on the following selection bases:

1. no selection
2. excluding those sick with AIDS
3. excluding those sick with AIDS and 50% of HIV-positives
4. excluding those sick with AIDS, 50% of HIV-positives and 25% of the at risk group.
5. including only clears.

8.4.2 Basis 3 corresponds to underwriting with automatic blood-testing only at a relatively high level of sum assured. Automatic blood testing at a lower level of sum assured might be represented by an assumption that a higher proportion of HIV-positives could be excluded.

8.4.3 Basis 4 corresponds to automatic blood-testing at a relatively high level, and in addition some form of lifestyle underwriting to exclude people in the at risk category. Because it is behaviour that puts someone at risk, it is unlikely that

Table 14. *Net premiums per 1,000 sum assured for level temporary assurance, Projection BC and year of entry 1988*

Age at entry 30

	Selection Basis				
Term	1	2	3	4	5
5	·75	·74	·66	·66	·56
10	1·40	1·39	1·26	1·15	·65
15	1·90	1·89	1·77	1·57	·83
20	2·17	2·17	2·06	1·85	1·08
25	2·45	2·45	2·35	2·15	1·43

lifestyle underwriting of this sort could ever eliminate a high percentage of those in the at risk category.

8.4.4 As in the section on reserving, results are shown for level term assurance and with profits endowment assurance, including whole-life. Because of the sensitivity of the results to year of entry, premiums are illustrated for entry in 1988 and 1993 (on 1 January). Results are shown for a variety of entry ages and terms. The mortality rates for clears (and for all those who do not die from AIDS) are based on the C.M.I. male assured lives experience for 1979–82, durations 2 and over (*C.M.I.R.* 9, 1988).

8.4.5 The premiums shown are net premium rates, with no allowance for expenses. The sum assured is payable at the end of the year of death. Premiums are payable annually in advance. Rates are calculated assuming 6% a year interest (net) and 3·5% a year compound bonus. Bonus is assumed to vest at the beginning of each year, so that the sum payable on death during the first year is $(1+b)$, during the second year $(1+b)^2$, etc.

8.4.6 Table 14 shows an illustrative set of figures which correspond to Appendix 13.1, with level term assurance on a 30-year-old male entering on 1 January 1988. Figure 21 shows the results graphically.

8.4.7 These figures do not specifically assume any antiselection against the life office, although they could be interpreted as representing a higher level of selection, with some degree of antiselection by those who are not screened out. Even at a relatively strict level of underwriting, corresponding to Basis 4, and on the moderate (BC) set of assumptions, net premium rates would be increased by 70% or more for terms of 10 to 20 years as a result of additional deaths from AIDS. By 1993, the net premium rates for a 30-year-old male for terms of 10 to 15 years will need to be about double the level based on normal mortality without AIDS.

8.4.8 It would be wrong to conclude from this that underwriting has little effect. It is essential in order to guard against antiselection. The effect of a small number of claims, each with a high sum assured, could threaten the emergence of profit. In some cases a run of such claims could impair an office's solvency. If no

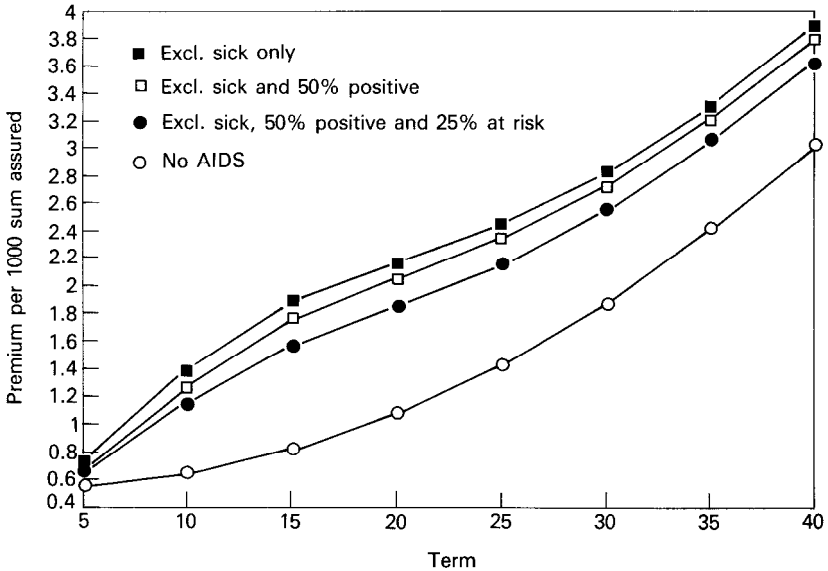

Figure 21. Net premiums per 1,000 sum assured for level temporary assurance, Projection BC and year of entry 1988.

underwriting is carried out, or if it is weak, those who are HIV-positive or in the at risk category are likely to be far more than proportionately represented amongst the population of new assureds, either numerically or in terms of amounts assured, or both.

8.4.9 Some measure of antiselection can be allowed for in the model by increasing the weighting applied to the HIV-positive and at risk categories. For example, if the underwriting strategy is designed along the lines of Basis 4 (to exclude those sick from AIDS, 50% of those HIV-positive and 25% of those at risk), one might assume that the remaining 50% of HIV-positives who are accepted have a weighting equivalent to twice the average, thus bringing their weighting up to 100%. Table 15 shows the resulting premiums on two selection bases, Basis 2 and Basis 4, with accepted HIV-positives having a weighting of twice the average and accepted people in the at risk group having a weighting of half as much again as the average. Figure 22 shows the figures on this basis over a wider range of terms.

8.4.10 It is clear that, even with reasonably stringent underwriting, premiums will have to rise significantly for some ages and terms if the cost of AIDS claims is to be covered. Table 15 gives an illustration of the sort of increases that might be necessary in 1988 for a particular age at entry. The increases in premiums

Table 15. *Net premiums per 1,000 sum assured for level temporary assurance, Projection BC, and year of entry 1988*

Age at entry 30

Term	No AIDS	High level of selection (Basis 4)	Low level of selection (Basis 2)
5	·56	·74	·90
10	·65	1·44	1·87
15	·83	1·99	2·53
20	1·08	2·28	2·81
25	1·43	2·55	3·05

Notes: Allowance is made for some anti-selection—those HIV positive take out twice as much cover as average and those at risk take out half as much again as the average.

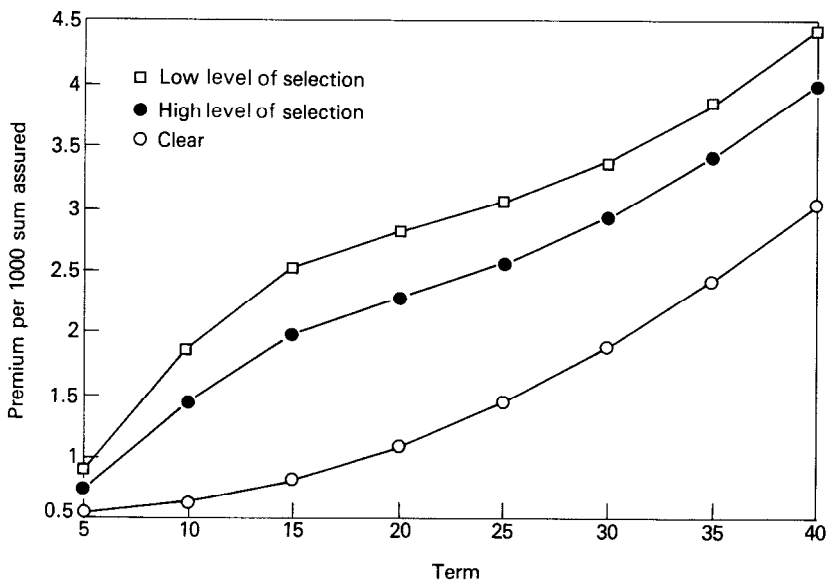

Figure 22. Net premiums per 1,000 sum assured for level temporary assurance allowing for antiselection, Projection BC, and year of entry 1988.

required for business written over the next 5 years will be still larger at certain ages and terms.

8.4.11 April 1988 saw the beginning of a number of announcements of premium increases on term assurance covers, because of the potential cost of AIDS-related claims. Different offices have responded in different ways, some relying more on the efficacy of their underwriting procedures than others, but there does appear to have been a general trend towards higher rates. Some of the premium increases have been very substantial, amounting to 150% or more for 15 year term assurance on a male aged 30. This is compatible with an underlying assumption of AIDS mortality close to that arising from our moderate projection (BC). A few offices have chosen to increase their premium rates rather less and to introduce further underwriting restrictions, such as a maximum sum assured available on term covers to single males. Others have made it clear that premium rates on certain types of policy will no longer be guaranteed but will be reviewed at future dates. Several offices have introduced higher scales of mortality deductions on flexible contracts.

8.5 *Product Design*

8.5.1 The difficulties involved in setting premium rates to reflect both the efficacy of the underwriting process and the considerable uncertainty about the spread of the disease, may have implications for product design. In particular insurers may be reluctant to quote for term assurance covers on guaranteed premiums for lives below age 50 and for terms that will cover the period of years when deaths from AIDS are accelerating. Insurers may seek to develop products which will leave them more scope to pass on the cost of AIDS claims to policyholders, by increasing premiums and mortality deductions or reducing sums assured. Alternatively, they might consider writing term business on a with-profits basis; one insurer has already introduced such a policy. Similarly, insurers may wish to avoid issuing options to extend, renew or convert policies, since the scope for antiselection on these covers and other guaranteed insurability options could be considerable.

8.5.2 AIDS exclusions have found little support as a means of tackling the problem, although at least two companies have now introduced a life policy with such an exclusion. AIDS often does not appear as a contributory factor on the death certificate. Without such specific reference, the evidence to support a denial may be, in legal terms, no more than circumstantial. Nevertheless, the very existence of an AIDS exclusion may be a valuable dissuasive factor in preventing antiselection.

9. AIDS AND GROUP LIFE INSURANCE

9.1 Despite the considerable problems, the selection process inherent in the acceptance of individual business holds out some hope that the worst risks can be identified and declined. By contrast, the concept of selection-free cover as applied

to group business denies the same opportunity and will mean that increasing numbers of AIDS claims are bound to emerge. There will normally, however, be less room for anti-selection in this type of business, since membership of group schemes is not a matter of individual choice, nor is the level of cover.

9.2 There will be a limited number of schemes associated with certain occupations which can be recognized as being particularly exposed to the risk of HIV infection. Underwriting of other schemes will need to pay much more attention to the composition of the group, particularly where there is a high proportion of young single males, and to the availability of free life cover and continuation options. There is a real danger of a progressive worsening of group experience which may manifest itself in the scheme results, or possibly in the results of individual contracts effected under continuation options.

9.3 Group life premium scales are guaranteed for a limited period, generally for not more than 5 years and often for just 2 years. The move towards 2 year guarantees was originally prompted by savings in stamp duty, but is a trend which is likely to accelerate in the face of the AIDS threat. Indeed it is now unlikely that underwriters would wish to offer a 5 year guarantee, other than with a substantial loading.

9.4 The leading companies in the group life market derive their premium charges from a rating process which takes account of a number of elements. A basic premium scale is adjusted for occupational and locational factors and may be further adjusted in the light of previous experience. If it is accepted that experience will worsen, a decision has to be made about the way in which the changes will be reflected in the various elements of the rating process.

9.5 The simplest approach is to adjust the basic age-related premium scale in line with overall experience, and to continue to apply the same occupational and locational factors. However, as mentioned above, the incidence of AIDS has not been uniform throughout the country. Cases and deaths have been concentrated very much amongst urban populations, and particularly in the London region. It seems illogical to offer different group life terms in different regions without recognizing this important fact, but, whilst existing locational adjustments are made by a fixed percentage reduction or loading, a regional loading for AIDS would not be so straightforward. As we have seen, the effect of AIDS upon mortality is not constant through the age range, but changes the shape of the mortality curve. Thus, any adjustment needs to take account of the age distribution of the membership and cannot be expressed in terms of a fixed percentage loading. Care will need to be taken to monitor any adjustments made, since the geographical incidence of AIDS may change over time.

9.6 In making changes to the occupational ratings, companies will be on yet more difficult ground. No data is available on the occupational distribution of HIV infection.

9.7 Experience rating, by its very nature, gives a measure of weight to past events. The degree of credibility attached to past experience will depend upon the size of the risk group and the period of observation. This is a legitimate approach

in a period of stable or improving mortality, but undermines attempts to anticipate a worsening experience. This problem can perhaps be overcome by calculating the experience-rated cost using the original expected cost and applying the percentage reduction (or increase) to the projected cost on the new premium scales.

9.8 A further aspect of group life insurance which warrants attention is the continuation option. The experience of policies effected under the continuation option is not normally included in companies' group life experience. This technical inaccuracy has not been of serious importance in the past, given the infrequency with which these options have been taken up. With the tightening of the selection process for individual business, it is likely that the continuation option will be seen as a valuable option to those who have HIV infection or perceive themselves to be at risk of acquiring it. If this proves to be the case, the extent to which group life experience is understated could become significant, and this could mask the true underlying trend of the experience. It is possible to envisage that the exercise of continuation options could significantly increase the overall quantum of group life claims arising from AIDS.

10. AIDS AND PERMANENT HEALTH INSURANCE

10.1 *The impact of HIV and AIDS on P.H.I.*

10.1.1 The basic benefit under a Permanent Health Insurance (P.H.I.) contract is an income to replace a loss of earnings resulting from the policyholder becoming disabled. The criterion for deciding if benefit is payable is not the degree of impairment, nor the severity of the sickness or the accident suffered by the policyholder, but whether he or she is unable to work because of sickness or an accident and whether there is a resulting loss of earnings.

10.1.2 It is not necessary for the incapacity to be permanent (i.e. for there to be no likelihood of recovery), and it can be of a very minor or temporary nature, provided that the policyholder is genuinely unable to continue in employment. The income from the policy may start immediately on disability, or the commencement may be deferred for a specified number of weeks of sickness, known as the deferred period. Income payments continue until the policyholder dies, recovers, or until the agreed termination date is reached. Definitions of disablement in P.H.I. policies differ; some are based on the inability to carry on *any* occupation, or any occupation appropriate to one's skills and training, whereas others relate to the ability to carry on one's normal occupation.

10.1.3 Until relatively recently, individual P.H.I. contracts were written on a level annual premium basis and the insurer had no right or ability to adjust premium rates on existing contracts. Over the last two or three years, however, several offices have introduced flexible unit-linked P.H.I. policies, under which the morbidity risk premium can be varied. The majority of P.H.I. business in the U.K., however, is written on a group basis using single premium costing. Rate

guarantees do not normally extend beyond five years and the deferred period for group business is usually 26 weeks.

10.1.4 Group P.H.I. cover is often regarded by the employer as a convenient way of providing for employees who experience long-term sickness, either instead of, or complementary to, ill-health retirement provisions under a pension scheme. Once a person has developed AIDS, he or she is unlikely to be able to continue his or her normal occupation for very long and is likely to become a claimant for P.H.I. benefit. It is possible that zidovudine (AZT) and other such drugs might be able to control the development of symptoms sufficiently to enable patients to carry on a fairly normal life for a while, with intermittent periods of more serious illness.

10.1.5 Prior to developing AIDS, however, a person infected with HIV may suffer from a variety of conditions which could give rise to absence from work and the start of a P.H.I. claim, e.g. somebody developing HIV disease, in the shape of progressive dementia, might become unemployable well before full AIDS develops. Some employers might not want to keep someone in employment simply because he or she was known to be HIV-positive, and there may be considerable pressure on insurers to admit as P.H.I. claims persons infected with the virus who have not yet developed AIDS.

10.1.6 There is no real justification for employers taking this line, since there is little risk of infection being spread in the normal workplace. There is only a remote risk where injuries might occur in which blood from an infected person could intermingle with the blood of an uninfected individual. There is no evidence that HIV infection can be spread by airborne transmission, by non-sterilized eating or drinking utensils, through toilets or washrooms or by normal personal contact. Nevertheless, there could be situations where the relative vulnerability of those with HIV infection to catching, and possibly passing on, other infectious diseases could be a problem.

10.1.7 A major difficulty, therefore, in estimating the impact of HIV infection and AIDS on P.H.I. business is to know at what stage a P.H.I. claim will be presented to an insurer. This will only become clear as there are a greater number of claims and experience is gained in handling them.

10.1.8 For the purposes of illustration, we can take two extreme cases. In the first it is assumed that a claim is only admitted when full AIDS develops. In the case of 26 weeks deferred P.H.I. business this means that no benefit is payable until 26 weeks after AIDS has developed. The second basis, which is shown for illustrative purposes only, makes the extreme assumption that claims are admitted on the basis of HIV-positivity alone, without requiring evidence of symptoms of AIDS-related complex or AIDS.

10.1.9 Some technical problems arise because of the complex structure of P.H.I. business. Prospective sickness experience cannot be encapsulated in a simple age-related table, as is usually possible for mortality. Sickness experience varies not only by age but also by duration of sickness, deferred period, duration

from the inception of the policy and, in the case of sickness from AIDS, calendar year.

10.1.10 The traditional approach to valuing P.H.I. business in the U.K. has been to use tables of factors such as those developed for the Manchester Unity Friendly Society at the end of the nineteenth century. The Manchester Unity 1893–97 tables have in fact been used, albeit with substantial percentage adjustments, right up to the present time, particularly for valuation purposes. Although they have served their purpose well, they have significant shortcomings for pricing P.H.I. business in current conditions, and indeed for reserving. These shortcomings have been discussed in a paper in Report No. 7 of the Continuous Mortality Investigation (*C.M.I.R.* 7, 1984).

10.1.11 Suffice it to say that the sickness rates (amount of sickness per anum) derived from past experience for longer durations of sickness are always likely substantially to understate the true position, since, with the growing volume of business, the longer durations are inadequately represented in the exposed to risk. Nevertheless, since no other suitable reference point is available, we have made use of Manchester Unity style factors derived from the C.M.I. experience in the years 1975–78, as reported in *C.M.I.R.* 7, as a standard for comparison.

10.2 *Comparison of sickness rates with C.M.I. 1975–78*

10.2.1 Appendix 18 shows the sickness rates resulting from AIDS-related sickness, as compared to the C.M.I. 1975–78 experience, for deferred periods 1 week and 26 weeks. In the case of the former, comparison is made in effect with AIDS-related sickness having no deferred period, but the resulting error is not significant in the context of the many uncertainties involved. As mentioned above, the comparison is made on two separate bases:

(a) sick with AIDS only
(b) HIV-positive (including sick with AIDS).

10.2.2 Figures have been shown on the basis of Projections A, BC and F for all sickness periods combined at 5-yearly age intervals for different cohorts of men. For cohorts aged 30 or over at the start of 1988, the rates depend more on the year in question than on the age attained. Rates for cohorts aged 40 and 45 at the start of 1988 can be obtained by advancing the age 35 cohort rates 5 and 10 years respectively. The sickness rates for males aged 30 at the beginning of 1988 are illustrated in Figures 23 to 26. It is assumed that the portfolio contains an average cross-section of the population in terms of people with AIDS, those HIV positive and those at risk of becoming infected. No allowance has been made for the effect of selective underwriting or for the possible impact of antiselection.

10.2.3 For males aged 30 at the beginning of 1988, with a 26 weeks deferred period and claims payable only on development of AIDS, the sickness rates relating to AIDS, on the basis of Projection BC, rise from about 12% of the C.M.I. experience rates in 1988 to over 220% of the C.M.I. experience rates in 1996. The peak level of sickness rates is about half as high again for Projection F

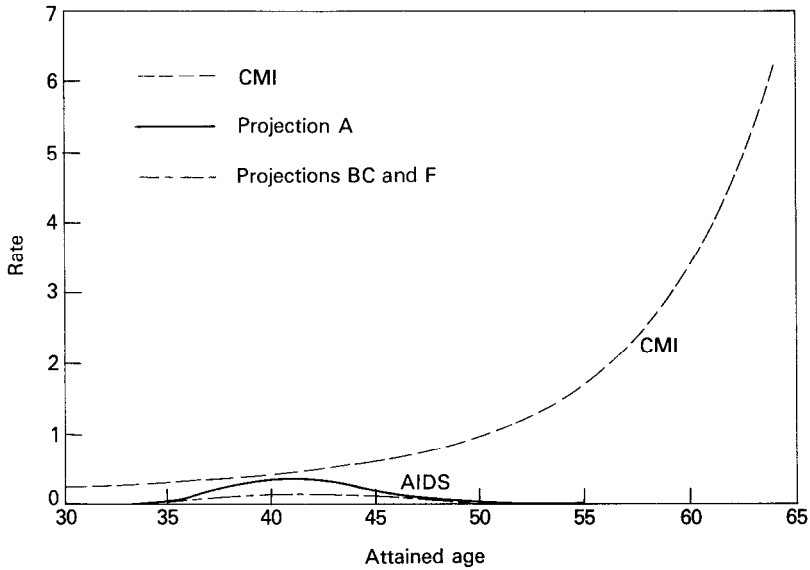

Figure 23. Sickness rates for 0/all weeks cover-benefit payable only to those with AIDS, attained age 30 at the end of 1987.

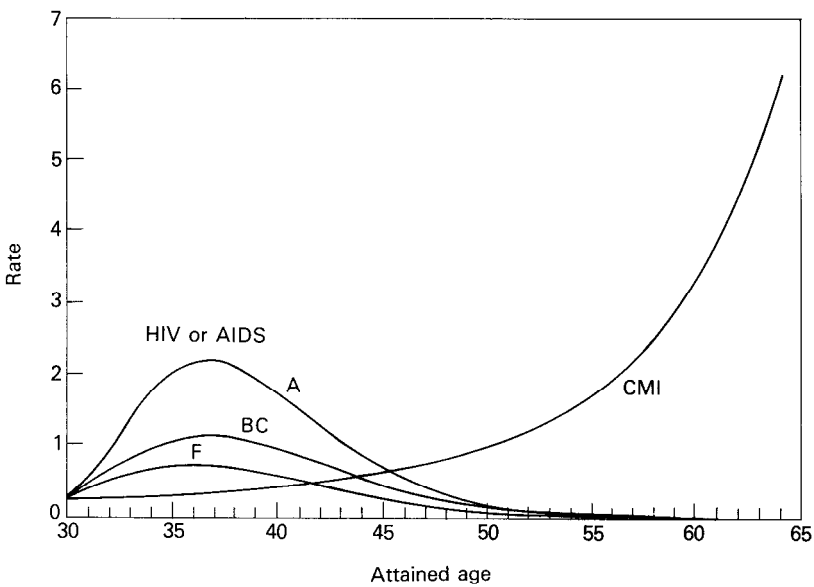

Figure 24. Sickness rates for 0/all weeks cover-benefit payable to those infected with HIV, attained age 30 at the end of 1987.

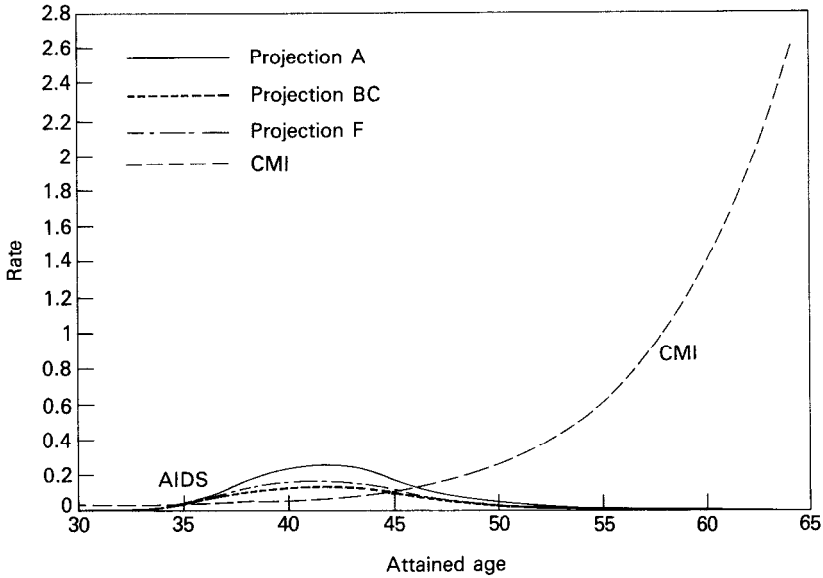

Figure 25. Sickness rates for 26/all weeks cover-benefit payable only to those with AIDS, attained age 30 at the end of 1987.

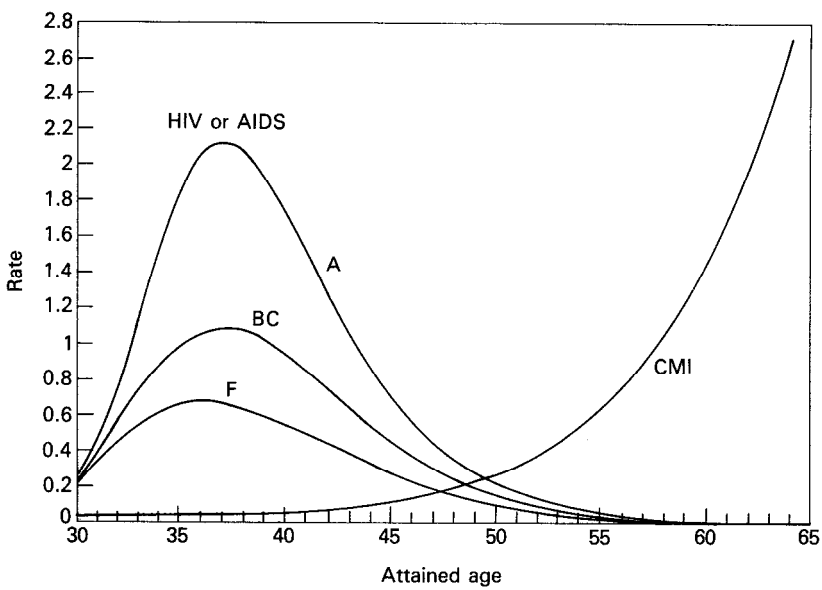

Figure 26. Sickness rates for 26/all weeks cover-benefit payable to those infected with HIV, attained age 30 at the end of 1987.

(because the higher expectation of life assumed for people with AIDS more than offsets the lower incidence of infection) and about twice as high for Projection A. Figures corresponding to the same initial population at risk as in Projections A and BC but with other assumptions as in Projection F would be roughly twice as high as those for Projection F. With a 1 week deferred period, the C.M.I. experience rates are considerably higher (of the order of 10 times higher at young ages), so the impact of AIDS is proportionately very much less. Even at the peak in 1997, sickness from AIDS would increase the C.M.I. experience rates by only about 40%.

10.2.4 It is worth emphasizing that the AIDS sickness rates are relatively high in relation to the C.M.I. rates at ages between 35 and 45 (particularly for 26 weeks deferred business) but that much of the normal cost of P.H.I. is accounted for by the rapidly increasing level of sickness at ages over 50, where the additional AIDS sickness is negligible. The relative impact of AIDS claims would clearly be much more serious if P.H.I. business were written on, say, a 10 or 15 year term basis, rather than, as is usually the case, up to a retirement age of 60 or 65.

10.2.5 Although it seems unlikely that insurers would generally need to admit a P.H.I. claim purely on the basis of an individual being HIV-positive, we illustrate the extreme position in which claims are paid on all HIV-positive individuals and not just on those who are sick with AIDS. For a 26 weeks deferred period, the peak additional morbidity would occur in 1994, when the sickness rate due to sero-positivity would be more than *26* times the C.M.I. experience rates. Even for business with a 1 week deferred period, the rates in respect of sero-positivity rise to more than 3 times the C.M.I. experience factors for all periods of sickness and to 36 times the C.M.I. experience rates for periods of sickness of 2 years and over.

10.2.6 It is clear that it would be very expensive for insurers to pay claims in respect of every individual who tests positive for HIV antibodies. Claims need to be restricted to genuine sickness resulting in disability within the terms of the policy, such as may be expected to arise when the patient develops AIDS, or possibly intermittently prior to that.

10.2.7 The existing portfolio of an insurer may be expected to approximate to the average cross-section of the population considered here. Underwriting in past years would not in general have included assessing proposers for the risk of HIV infection and, although people with AIDS would not have been insurable, their exclusion at the inception of the policy would not have a significant effect on the results. There is also no reason to suppose that the groups in which HIV is currently most prevalent (e.g. single males) will be less than proportionately represented amongst P.H.I. policyholders.

10.3 *Inception rates*

10.3.1 Although sickness rates in the form of Manchester Unity factors are still commonly used for reserving purposes, they are not suitable for rating. No other standard table exists in the U.K. to help in this process, although some

insurers use North American experience to derive suitable factors. The approach which is usually adopted is to look at sickness inception rates and to value sickness annuities, taking into account terminations as a result of death, rehabilitation or attainment of the upper age limit under the policy. The P.H.I. Sub-committee of the Continuous Mortality Investigation has been developing methodology along these lines but has not yet completed its work, although they have published some tentative data on inception rates in *C.M.I.R.* 7.

10.3.2 Inception rates for sickness from AIDS are shown by attained age and by age at the start of 1988 in Appendix 19. For cohorts aged 30 or over at the start of 1988 the rates depend more on the year in question than on the attained age. Rates for cohorts aged 40 and 45 at the start of 1988 can be obtained by advancing the age 35 cohort rates 5 and 10 years respectively. Comparison is made with the graduated inception rates in Appendix H of *C.M.I.R.* 7, based on the experience in the years 1975–78. Separate rates are given for deferred periods 1 and 26 weeks and on the assumption of claims being admitted only on the development of AIDS or on the basis of HIV sero-positivity.

10.4 *Terminations*

10.4.1 Since people with AIDS are assumed in the projections to experience a constant mortality decrement as a result of death from AIDS and since, in relation to this, mortality from other causes can be ignored as *de minimis*, the value of a continuous annuity payable from the onset of AIDS until subsequent death is $1/[\cdot 7 + \delta]$ where δ is the force of interest to be assumed. For Projection F the figure of ·7 falls to ·35 by 1 January 1992. The value of annuities payable from the start of sero-positivity cannot be expressed so simply. However, values of appropriate annuities are given in Appendix 20 on a rate of interest of 6% a year. The results are identical for Projections A and BC and vary little by age over quite a wide range. Only the results for Projection F depend on the time period in question but even these are constant from the beginning of 1992.

10.5 *Value of additional sickness*

10.5.1 Another way of describing the additional sickness resulting from AIDS, which may be helpful both in pricing and reserving, is the discounted present value of additional sickness payments up to the limiting age under the policy. This is the single premium required to pay for all the additional future sickness arising out of AIDS or, alternatively, the additional reserve necessary for 1 per week benefit in force. Appendix 21 shows figures for different ages at the start of 1988 for the cost of a payment of 1 per week to age 60, if AIDS cases only are admitted, and if HIV-positive cases are also admitted as claims. Appendix 22 shows similar figures where the benefit is payable to age 65. The C.M.I. figures shown for comparison are based on a discounted aggregation of the 1975–78 experience sickness rates, allowance being made for normal insured persons mortality (i.e. without adjustment for mortality from AIDS). Interest is allowed for at 6% a year. Additional mortality from AIDS can be shown to have a

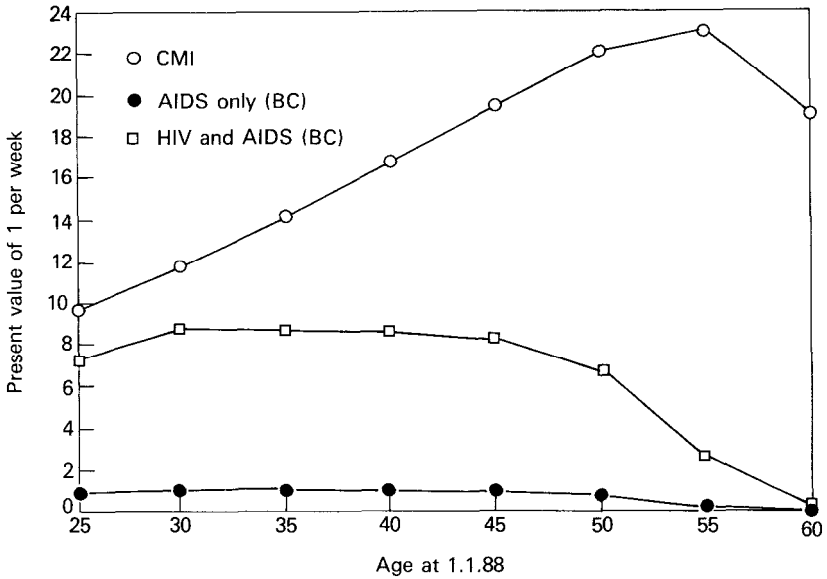

Figure 27. Present value of benefit to age 65—1 week deferred sickness benefit.

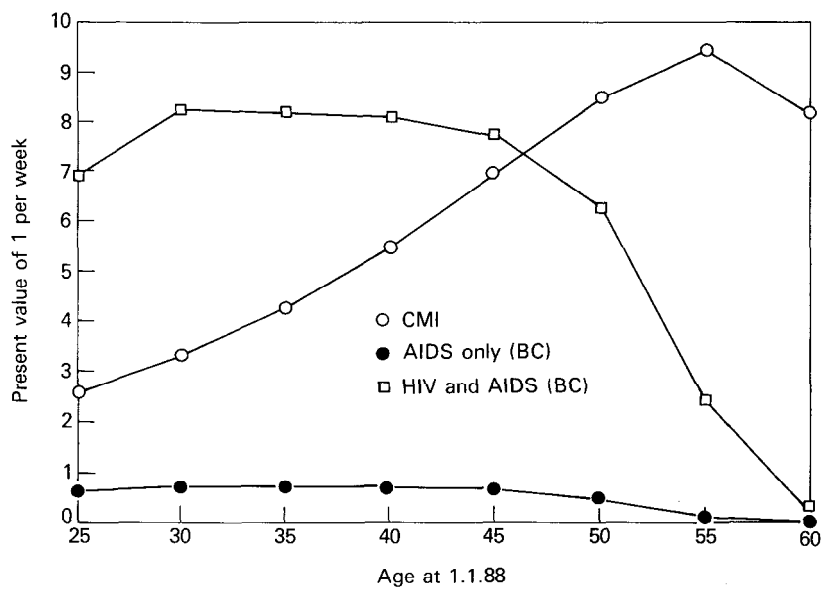

Figure 28. Present value of benefit to age 65—26 weeks deferred sickness benefit.

negligible impact on annuity factors for valuing future premiums and so can reasonably be ignored in that context.

10.5.2 Figures 27 and 28 show the present values of additional sickness benefits to age 65 relating to HIV infection and AIDS on Projection BC. These are on the extreme assumptions mentioned above, i.e. benefit payable throughout HIV infection or only on developing AIDS. They are compared with benefits payable during all sickness (in the absence of HIV infection and AIDS) using the C.M.I. 1975–78 experience, for a 1 week and a 26 weeks deferred period respectively and different ages at the start of 1988. It is clear from these graphs, particularly in regard to 1 week deferred business, that the additional cost of AIDS claims is not too great relative to other sickness if claims can be restricted to full AIDS. If, however, claims were to become payable on the grounds that an individual is HIV-positive, the cost of the additional sickness benefits would, at younger ages, equal or even exceed the cost of benefits payable during all other sickness. This is most notably so in the case of 26 weeks deferred business, where the cost of HIV claims could be 4 times the cost of all other sickness claims for a new entrant under 35.

10.5.3 In reality, some claims are likely to arise before full AIDS develops, but probably not at an early stage after acquiring the infection. Rough estimates can be made on any particular assumption regarding the duration of sickness before AIDS is diagnosed. The AIDS-only sickness costs allow for an annuity of approximately 1·3 (2·4 on Projection F for cases of AIDS developing after 1992) in the case of 1 week deferred and ·8 (1·9) in the case of 26 weeks deferred. An additional year's sickness prior to diagnosis of AIDS can, therefore, be costed approximately by taking 75% of the AIDS sickness costs for 1 week deferred business and 125% for 26 weeks deferred business.

10.5.4 The present value of benefits during sickness with AIDS or whilst HIV-positive is roughly halved by moving from Projection A to Projection BC. These two projections have the same assumed initial population at risk, but Projection BC assumes a substantial level of transfer out of the at risk population and a halving in the intensity of infection of those in the at risk category. A projection which made the same assumptions as Projection BC but took an initial population at risk at half that level would give rise to results at approximately half the level shown for Projection BC.

10.5.5 Projection F assumes this lower initial population at risk, but also takes into account a lengthening of the expectation of life of people with AIDS, as a result of treatment with zidovudine and possible successor drugs. This substantially increases the cost of paying P.H.I. benefits to people with AIDS, more than offsetting the effect of the lower initial population at risk than in Projection BC. The proportionate impact of the greater life expectancy of people with AIDS is less in the case of P.H.I. benefits payable on the grounds of HIV-positivity, and the resulting values on Projection F are about two-thirds of those on Projection BC. Approximate results with the greater life expectancy of people with AIDS in

Projection F and the higher initial population of risk of Projection BC may be obtained by doubling the Projection F results.

10.6 *Exclusions for AIDS-related P.H.I. claims*

10.6.1 Most P.H.I. insurers have now effected an exclusion clause for sickness related to AIDS and HIV infection. As is the case with medical expenses insurance, it is more practicable to operate an exclusion clause with P.H.I. business than it is with ordinary life cover. The fact that the individual will normally be alive at the time the claim is made will make it possible, at least in principle, to determine whether or not the case relates to HIV infection or AIDS, if necessary by arranging for a blood test to be carried out.

10.6.2 Various forms of exclusion clause have been introduced. One approach is to exclude AIDS, HIV disease and other conditions related to or arising from HIV infection. A second form of exclusion is to lay down that no benefit is payable if the claimant is found to be infected with HIV. An intermediate form excludes the payment of benefit to a claimant found to be infected with HIV, except for accidental injuries that are not self-inflicted.

10.6.3 There are problems for the insurer with each of these approaches. The first could give rise to difficulties of interpretation and disputes over whether a condition is related to or arises from HIV infection. The second definition is unequivocal but might seem unduly harsh if a claim arises which has nothing to do with a claimant's sero-positivity. The intermediate form of exclusion attempts to meet this criticism but opens up the way to further uncertainty over whether an accident was or was not self-inflicted.

10.6.4 Attitudes may differ according to whether it is group P.H.I. business or individual business. In the case of the former, it is the employer who is being insured, not the individual claimant, so the operation of a strict HIV exclusion clause simply transfers to the employer the risk of paying sickness benefits to sero-positive individuals. Since the alternative is likely to be much higher premiums, or no P.H.I. cover at all, employers may be prepared to acquiesce in this arrangement.

10.6.5 Apart from being in the insurer's interest, such a strict exclusion may have advantages from a wider perspective. It removes the incentive for the employer to make use of the P.H.I. policy as a way of refusing to face up to the need for rational personnel policies for dealing with HIV infection in the workplace.

10.6.6 For group P.H.I., therefore, an HIV exclusion or cancellation clause seems practicable and meets the insurer's objectives effectively. In practice, even with the strictest form of exclusion clause, insurers may not wish to test all claimants for HIV infection. It is more likely that claims will be paid in the usual way unless there is *prima facie* evidence to suppose that a claim is related to HIV infection. It is always open to the insurer to pay the claim on an *ex gratia* basis if it has nothing to do with the claimant being HIV-positive.

10.6.7 In the case of individual business, there is a further dilemma. Refusal to pay a claim if the claimant is HIV-positive would mean that all sero-positive individuals would in effect be uninsured. Anyone finding themselves in this position could reasonably expect to have his or her premiums returned, at least from the date of acquiring the infection, if that can be established. This suggests that there may still be a need for underwriting, even if an exclusion clause is operated, since insurers may be seen as having a moral responsibility to select out infected or high risk applicants who may have little hope of deriving any benefit from the policy. With exclusions and return of premium there is in effect a one-way option for policyholders who are HIV positive or at risk. They either get away with any claims they might make, or they get their premiums refunded. This also points to the need for careful underwriting.

10.6.8 The uncertainties about when P.H.I. claims might arise for people with HIV infection, and the very high potential cost if claims arise to a significant extent whilst people are simply HIV-positive, would have presented considerable difficulties for pricing P.H.I. business if exclusion clauses had not been introduced. These problems would have been more acute for individual business than for group business, where rates can be changed more easily in the light of developing experience and where antiselection is less of a potential problem.

10.6.9 The HIV cancellation clause for individual P.H.I. can come in various forms. It might say, for example, that if, at any time during the currency of the policy, the insured is found to be HIV-positive, the cover will lapse with immediate effect. An alternative would be to express the cancellation clause in the form that it would apply if, in the event of any claim, the claimant is found to be HIV-positive. The first places the responsibility squarely on the insured to inform the insurer that he or she is infected or to adopt the simpler course of allowing the policy to lapse. The practical effect of the alternative wording is much the same, but less starkly expressed. In either alternative, there is a case for refunding premiums, at least as far back as the point when HIV infection was diagnosed.

11. MEDICAL EXPENSES INSURANCE

11.1 In a survey of American studies on the medical care costs associated with treating AIDS patients, Bloom & Carliner (1988) estimate that AIDS patients require on average between 50 and 70 days of in-patient care during their illness. Some studies have shown much higher figures, but this may reflect a high incidence of patients who were intravenous drug users. Apart from being variable between individual patients, this figure is also likely to be highly dependent upon the systems of health care, in particular the balance between in-patient and out-patient care, and the role of specialized clinics, general practitioners and hospices, as opposed to normal hospital care.

11.2 Figures also vary widely for the cost of treating AIDS patients. The figures quoted by Bloom & Carliner suggest an average cost of $800 to $900 per day. This is very different from the daily cost estimated by Johnson *et al.* (1986) in

one of the few published British studies. They estimated a mean length of stay for AIDS in-patients of 50 days and an average cost per in-patient day of £218. Others have estimated both the mean length of stay and the cost per day as being somewhat higher than this, even in the U.K. context, and the total cost of treating an average AIDS patient has been given at around £30,000 a year. Further detailed studies are required on these aspects before proper estimates can be made of the implications of HIV infection and AIDS for medical expenses insurance and for public health services.

11.3 Much of the debate about blood-testing for HIV infection in the U.S.A. has been generated by public policy concerns over access to health care. In a system relying heavily on private medical insurance, the inability of individuals to obtain cover as a result of having acquired the virus can result in a significant load being placed on local hospital resources, with many of the cases not qualifying for reimbursement under the fallback means-tested Medicaid programme. This has had a strong influence on the whole debate, and medical expenses insurers are in many respects in the front line for the insurance industry as far as the political considerations are concerned.

11.4 The situation is very different in the U.K. Private medical insurance accounts for only a very small part of total expenditure on medical care. Orros & Webber (1988) estimated that only some 10% of the population is covered by medical expenses insurance; the cover is intended mainly to provide for the costs of treating acute medical conditions. With this background, the leading private medical insurers have reacted to the spread of HIV infection by excluding cover for AIDS and AIDS-related illnesses for all new policyholders or members, at least for a period of 5 years until the situation becomes clearer. This approach appears to have met with general acceptance by the public as a reasonable means of protecting the level of premiums for insured persons, in the light of uncertainty about the impact of AIDS and its possible heavy financial consequences in terms of medical treatment. Significant costs may still fall to be met by medical expenses insurers in respect of existing policyholders who are infected with HIV or may become so.

12. AIDS AND GENERAL INSURANCE

12.1 Apart from medical expenses insurance, there are a number of classes of general insurance business which could be affected by claims relating to AIDS. Some of the issues have been discussed by Cassidy (1988). Under personal accident policies, for example, people who become infected with HIV may claim that their infection was the result of an accident coming under the terms of the policy, e.g. as a result of blood transfusion. Even the emotional trauma associated with learning that a person is infected with HIV, or that their spouse or partner is, might be regarded by the courts as a form of bodily injury. General insurance companies and Lloyd's syndicates may well react by inserting an AIDS exclusion clause in the policy conditions for personal accident business.

12.2 Travel insurance could be affected in a similar way in regard to the personal accident component, with there being a significant risk of becoming infected with HIV in certain parts of the world as a result of a blood transfusion or an injection with an infected needle or syringe. Insurers may face an increased level of claims for repatriation for medical treatment in order to avoid such risks as may be associated with hospital treatment elsewhere in the world.

12.3 A more unusual side to AIDS claims may arise in classes such as householders' comprehensive. Cases are arising in the U.S.A. of infected persons suing their spouse or partner for failing to inform them that they were infected with HIV and seeking to collect damages under the defendants' householders' policies. In the U.K. a claim has been admitted for the replacement of a bed and bedclothes which had to be destroyed after an intruder who was possibly infected with HIV had taken a nap in the policyholder's bedroom.

12.4 Even under motor insurance such claims could arise, such as the case in Scotland where a car was stolen. The car was then involved in an accident and the thief, who was infected with HIV, suffered extensive bleeding. As a result the car was burned and compressed by the police and a claim was submitted to the insurers for replacing the car.

12.5 Such cases are likely to remain somewhat exceptional. However, serious claims could arise under medical malpractice covers, e.g. for breach of confidentiality or failure to obtain consent for an HIV antibody test, or alleging liability for treatment with infected blood products. Claims in relation to infected blood products could also be made against the blood transfusion services and damages may be sought, for example by haemophiliacs, from the manufacturers of blood products.

12.6 A further problem area could be in employers' liability insurance, where claims could arise in a number of ways, whether from infected people claiming discrimination or unfairness, or from uninfected people concerned about the continued employment of infected people.

12.7 As is often the case in general insurance, estimating the financial impact of a particular factor such as AIDS will be difficult. Much will depend upon the attitudes taken by the courts, particularly in the U.S.A., where liability settlements could be very substantial if claimants are successful. However, AIDS is only one more factor in the already very complex business of liability insurance. In other classes, such as personal accident and travel, it may be possible to reduce the possible impact of AIDS-related claims by careful wording of policies.

13. SOME DEVELOPMENTS OVERSEAS

13.1 *United States of America*

13.1.1 By far the largest number of cases of AIDS so far has been reported in the U.S.A., with a total at the end of August 1988 of 71,171. Estimates have been made (CDC, 1987) that 1 million to $1\frac{1}{2}$ million Americans might be infected with

HIV. Prevalence varies considerably by location and is particularly high in some major cities. A considerable amount of information on prevalence is becoming available as a result of routine testing of applicants for military service, blood donors and patients at so-called sentinel hospitals, of which a number have been designated in different parts of the U.S.A.

13.1.2 Burke *et al.* (1987) reported an overall prevalence of HIV infection amongst applicants for military service of 1·5 per 1,000, with a ratio of infected males to infected females of 2·6: 1. Prevalence amongst males rose sharply with increasing age from ·3 per 1,000 at age 18 to a peak of 5·7 per 1,000 at age 27. The state with the highest prevalence was the District of Colombia with 10·1 per 1,000. New York (4·2), Maryland (3·7), New Jersey (3·5), Nevada (3·5), Delaware (2·3) and California (2·1) were the other states with a prevalence of over 2 per 1,000. Very high prevalence (of more than 1%) was reported in 4 counties in the New York–Newark metropolitan area, in San Francisco County, California and in Washington, D.C. In these areas the ratio of male prevalence to female prevalence was 1·2 (2·7 for the U.S.A. as a whole).

13.1.3 Redfield (1987) reported that the prevalence of HIV infection in the existing members of the U.S.A. military had been found to be 1·9 per 1,000 amongst males and ·8 per 1,000 amongst females. Some 46% of the infected individuals were married.

13.1.4 AIDS is likely to be an issue of major proportions for the insurance industry in the U.S.A., although up to now the public discussion has focused more on the rights of those who are infected than on the possible impact on everyone else if the full impact of AIDS claims is felt by the insurance companies. Indeed, a few State Insurance Commissioners seem to have been primarily concerned to inhibit insurance companies from discriminatory underwriting and even, in some cases, from testing for HIV antibodies. There has not, as yet, been any general pressure on companies to charge higher premiums, to underwrite selectively or to set up reserves for AIDS mortality, although many companies have taken action on the underwriting front and some consideration is now being given to reserving.

13.1.5 A recent New York Supreme Court decision has upheld the right of insurers to underwrite and to make use of reliable tests for this purpose and has accepted that AIDS should not be treated as different from any other serious disease in terms of the ability of insurance companies to make a proper assessment of risk. It is hoped that this decision, which is still subject to appeal, could have helpful repercussions across the U.S.A. However, there are a good many legal battles ahead. In California the insurers are still fighting for the right to make use of the standard antibody testing protocol (double ELISA with confirmatory Western Blot) as opposed to the unreliable T4 cell test, which is all that is permitted at the moment. In Massachusetts, legislation severely limiting the use of blood-testing for underwriting was proposed by the Commissioner. After a legal battle, the Courts upheld the Commissioner's power to interfere with the underwriting process and the restrictive legislation came into force.

13.1.6 Firm opposition remains to the idea of making use of knowledge of a proposer's sexual orientation in the underwriting process. In certain States, this is banned by legislation, but a similar policy is laid down in N.A.I.C. (National Association of Insurance Commissioners) guidelines and industry speakers emphasize the importance of adhering strictly to the guidelines, in order not to undermine the stance of insurers on other aspects.

13.1.7 The Society of Actuaries in the U.S.A. established a Task Force to study the impact of AIDS. At an early stage in their deliberations, a special report by Cowell & Hoskins (1987) was circulated to members of the Society. This included projections of the spread of AIDS in the U.S.A., estimates of AIDS claims and their financial effect on the industry, and comments on underwriting and pricing.

13.1.8 The Report of the AIDS Task Force (1988) was available in time for the May 1988 Symposium of the Society of Actuaries in Chicago. Awareness is increasing among American actuaries about the problems likely to be faced in relation to HIV infection and AIDS, but it may be some while before any major changes take place. Automatic testing limits appear to have come down markedly, although not all companies are applying lower limits. Underwriting based on more detailed lifestyle questionnaires would appear to be out of the question in the U.S.A. It should be noted, in this context, that company retentions for individual life assurance are far higher in the U.S.A. than in the U.K. Although the Task Force has now been disbanded, working groups have been set up by the Society of Actuaries to give further consideration to modelling the AIDS epidemic and to the implications for reserving.

13.2 *Canada*

13.2.1 The AIDS epidemic is somewhat less well developed in Canada than in the U.S.A., but the overall pattern is not dissimilar. The regulatory environment, however, is very different. New guidelines have been issued for the Canadian life insurance industry. One principle taken up is that of 'informed consent', whereby, before a sample of blood is drawn, the proposed insured's written consent to a test for HIV antibodies must be obtained. On the proposal form, no question should be directed towards determining, directly or indirectly, the proposer's sexual orientation. A life insurance company, when authorizing test for HIV exposure from a proposer, must follow a standard protocol. The result will only be considered positive if an ELISA test is reactive, and a second ELISA test is also reactive (or two out of three ELISA tests are reactive), and a Western Blot test is positive. The life companies do have the right to decline an application if the proposer fails to comply with a request to have his or her blood tested.

13.2.2 The decision to accept, decline, or rate an application should be based on all available data but no adverse decision should be based on the proposer's sexual orientation, or on an unconfirmed positive result on an ELISA test.

13.2.3 Currently the threshold for blood testing is C$200,000 to C$250,000; it is expected that this level will be lowered shortly.

13.2.4 It is understood that at least one Canadian company has introduced a policy with an AIDS exclusion clause. There are unlikely to be serious obstacles to moves by the actuarial profession to set up AIDS reserves and to influence premium rating. Working parties on AIDS have been set up by the Canadian Institute of Actuaries. Some companies, and branches of overseas companies operating in Canada, established AIDS reserves at the end of 1987.

13.3 *Australia*

13.3.1 In Australia there has been a considerable amount of activity and the Life Insurance Federation of Australia has reached agreement with the government on a Code of Practice on underwriting in relation to AIDS. This defends the right of an insurance company to underwrite in relation to AIDS but lays down aspects of good practice. No adverse underwriting decision should be based solely on the known or suspected sexual orientation of the proposer, or on the basis of previous consultation about HIV infection, or testing for it with a negative or unknown result. Matters on which it is reasonable to ask questions of a proposer are set out and it is recommended that these should be grouped and covered by a single declaration. A model declaration is included which contains a number of pertinent statements that the proposer is asked to declare to be true, including a statement that all his or her sexual partners since 1980 would be able to make the same declaration in relation to all the other statements.

13.3.2 The Institute of Actuaries of Australia has established a Working Party to consider the impact of AIDS on life insurance in Australia. A report by Mann *et al.* (1987) was discussed at the Perth Convention in October 1987 and the Working Party has now published its first three bulletins (1988, 1988a and 1988b).

13.4 *Japan*

13.4.1 The first reported case of AIDS in Japan was in March 1985, whereas AIDS had manifested itself in Europe and America as early as 1981. So far there are only about 80 reported cases in Japan, mainly among haemophiliacs, which indicates a very different pattern of experience to that in the West.

13.5 *South Africa*

13.5.1 South Africa is experiencing two distinct epidemics of HIV infection. Amongst the black population, there is a growing prevalence of heterosexually-acquired HIV infection. Amongst the white population, the spread is occurring in the first instance amongst male homosexuals and intravenous drug users.

13.6 *Europe*

13.6.1 In most European countries, insurers have been taking action to strengthen underwriting procedures in order to reduce the impact of future AIDS-related claims on their portfolios. In Belgium, Germany and Switzerland, for example, insurance associations have recommended the incorporation of

questions on AIDS in proposal forms, the inclusion of questions about AIDS in medical examiners' reports, the incorporation in proposal forms of a question about applications to or policies with other companies, and the introduction of HIV antibody tests for sums assured above a certain level.

13.6.2 Elsewhere, such as in the Netherlands, recommendations have been made by insurance associations on some of these aspects or, as in Ireland, Finland and Sweden, companies in the market have agreed similar measures. The current recommended, suggested or *de facto* mandatory testing limits for life cover in European countries (and the approximate sterling equivalents) are understood to be as follows:

Belgium	BF 5,000,000	(£75,000)
Denmark	DKr 2,000,000	(£170,000)
Finland	FM 300,000	(£40,000)
France	FF 1,000,000	(£95,000)
Germany	DM 250,000	(£80,000)
Ireland	I£150,000	(£130,000)
Netherlands	DFl 200,000	(£60,000)
Norway	NKr 1,200,000	(£105,000)
Sweden	SKr 2,000,000	(£185,000)
Switzerland	SF 200,000	(£80,000)
United Kingdom	£150,000	(£150,000)

13.6.3 The situation in the market is rather variable, with some companies operating lower testing limits than those generally recommended and others operating higher limits. In many cases, reinsurers are requiring tests at lower levels in respect of ceded facultative business. Testing levels for disability income (P.H.I.) business are usually in the range of 5 to 10% of the above figures for the annual annuity.

13.6.4 There do not seem to have been any premium rate increases or changes to reserving levels in continental Europe. Because mortality on the Continent is often assessed on a population, rather than on an assured lives, basis, it is felt at the moment that offices can withstand a deterioration in mortality experience perhaps better than in the U.K. thus deferring the need for detailed study of the situation. A more active interest in the potential problems of AIDS is being shown by the reinsurers.

13.6.5 Some research has been undertaken in Germany on the possible spread of AIDS and its effect on life insurance. Weyer *et al.* (1988, 1988a) have described a cascade model for exploring the possible spread of AIDS in 8 different risk groups. Holzwarth & Weyer (1987) and Weyer & Holzwarth (1988) have examined some of the implications of AIDS for life insurance.

13.6.6 In Denmark, Kolbye (1987) has developed a model similar to that used by the Institute Working Party and has illustrated the impact of AIDS mortality on premiums and the possible effect of antiselection.

14. CONCLUSION

14.1 The spread of HIV infection raises some difficult issues for society as a whole and for the insurance industry in particular. It is too early to be able to predict the ultimate size of the epidemic in the U.K. but it seems likely that the number of reported cases of AIDS will go on growing for at least the next decade and that deaths from AIDS will become the major cause of death amongst young males.

14.2 For insurance companies, this is certain to mean a worsening mortality experience on existing portfolios of business and problems of managing their resources to ensure that the liabilities can be met. There will also be challenges to ensure that the cost is borne in an equitable way by shareholders and by different generations of policyholders.

14.3 In the light of what is now known about AIDS, the opportunity exists to take action to avoid future policyholders being faced with greatly increased premiums. Such opportunities include the possibility of AIDS exclusion clauses (particularly for P.H.I. and medical expenses insurance), careful underwriting and policy design. Even so, premium increases are likely to be necessary on non-profit business, increased mortality deductions will be needed on unit-linked business and bonus rates on with profits business may eventually be affected.

14.4 The seriousness of HIV infection and AIDS for individuals who are affected will make the handling of this a very delicate issue for insurers. Aspects such as confidentiality, test accuracy, discrimination and grounds for uninsurability will inevitably have a high profile. Actuaries need to be sensitive to these problems and yet clear in the advice on the financial consequences of whatever policy companies adopt. In Bulletins Nos. 1–3, we have sought to analyse the technical issues and to provide some tools for actuaries giving advice in this area.

14.5 The projections of the spread of HIV infection are no more than that—projections of the impact of chosen sets of parameters on a particular mathematical model of the dynamics of the epidemic. They are not forecasts or predictions. Time alone will tell the precise shape and size of the epidemic in the U.K. Better projections may be possible as more becomes known about HIV infection and AIDS, about the current prevalence of the virus in the population at large and about people's sexual behaviour.

14.6 In the meantime our projections provide a basis for more informed discussion of the issues and for a considered, not over-reactive, response from the actuarial profession.

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APPENDICES

Appendix 1.1. *Excess mortality rates* (q_x) *from AIDS 1988–2015—Projection A*

Age	Normal mortality	Calendar year 1988	1989	1990	1991	1992	1993	1994	1995
20	·00079	—	—	—	—	—	—	—	—
25	·00061	·00004	·00005	·00006	·00006	·00005	·00003	·00001	·00001
30	·00056	·00004	·00008	·00016	·00027	·00043	·00062	·00074	·00081
35	·00069	·00004	·00008	·00016	·00031	·00057	·00101	·00167	·00249
40	·00114	·00004	·00008	·00016	·00031	·00057	·00101	·00167	·00254
45	·00209	·00004	·00008	·00016	·00031	·00057	·00101	·00167	·00254
50	·00382	·00004	·00008	·00016	·00031	·00057	·00101	·00167	·00254
55	·00680	·00004	·00008	·00015	·00029	·00055	·00098	·00163	·00250
60	·01175	·00003	·00005	·00008	·00015	·00029	·00054	·00100	·00168
65	·01982	·00002	·00002	·00004	·00006	·00010	·00016	·00028	·00047
70	·03275	·00001	·00001	·00002	·00002	·00003	·00004	·00006	·00009
75	·05321	—	—	—	—	·00001	·00001	·00001	·00001
80	·08512	—	—	—	—	—	—	—	—

Age	Normal mortality	Calendar year 1996	1997	1998	1999	2000	2005	2010	2015
20	·00079	—	—	—	—	—	—	—	—
25	·00061	·00001	·00001	·00001	·00001	·00001	·00001	·00001	·00001
30	·00056	·00079	·00046	·00012	·00012	·00012	·00012	·00012	·00012
35	·00069	·00329	·00394	·00438	·00417	·00380	·00137	·00137	·00137
40	·00114	·00349	·00430	·00478	·00486	·00463	·00238	·00164	·00164
45	·00209	·00349	·00429	·00477	·00486	·00461	·00202	·00079	·00063
50	·00382	·00348	·00429	·00476	·00485	·00460	·00199	·00062	·00023
55	·00680	·00344	·00426	·00474	·00483	·00458	·00199	·00061	·00018
60	·01175	·00256	·00347	·00416	·00446	·00438	·00197	·00061	·00018
65	·01982	·00081	·00134	·00211	·00299	·00355	·00204	·00061	·00018
70	·03275	·00014	·00022	·00035	·00056	·00089	·00236	·00068	·00018
75	·05321	·00002	·00002	·00003	·00004	·00006	·00056	·00092	·00020
80	·08512	—	—	—	—	—	·00019	·00017	·00027

Appendix 1.2. *Excess mortality rates* (q_x) *from AIDS 1988–2015—Projection BC*

Age	Normal mortality	Calendar year 1988	1989	1990	1991	1992	1993	1994	1995
20	·00079	—	—	—	—	—	—	—	—
25	·00061	·00004	·00005	·00006	·00006	·00005	·00003	·00001	·00001
30	·00056	·00004	·00008	·00016	·00026	·00039	·00052	·00053	·00047
35	·00069	·00004	·00008	·00016	·00030	·00053	·00086	·00126	·00164
40	·00114	·00004	·00008	·00016	·00030	·00053	·00086	·00126	·00168
45	·00209	·00004	·00008	·00016	·00030	·00053	·00085	·00126	·00167
50	·00382	·00004	·00008	·00016	·00030	·00053	·00085	·00126	·00167
55	·00680	·00004	·00008	·00015	·00029	·00051	·00083	·00124	·00165
60	·01175	·00003	·00005	·00008	·00015	·00027	·00048	·00079	·00116
65	·01982	·00002	·00002	·00004	·00006	·00010	·00015	·00024	·00035
70	·03275	·00001	·00001	·00002	·00002	·00003	·00004	·00006	·00008
75	·05321	—	—	—	—	·00001	·00001	·00001	·00001
80	·08512	—	—	—	—	—	—	—	—

Age	Normal mortality	Calendar year 1996	1997	1998	1999	2000	2005	2010	2015
20	·00079	—	—	—	—	—	—	—	—
25	·00061	—	—	—	—	—	—	—	—
30	·00056	·00037	·00024	·00012	·00002	·00002	·00001	·00001	·00001
35	·00069	·00187	·00193	·00186	·00154	·00122	·00007	·00004	·00004
40	·00114	·00203	·00226	·00238	·00239	·00229	·00111	·00019	·00013
45	·00209	·00202	·00226	·00238	·00239	·00230	·00126	·00051	·00020
50	·00382	·00202	·00226	·00237	·00238	·00230	·00125	·00046	·00018
55	·00680	·00200	·00224	·00236	·00237	·00229	·00124	·00045	·00014
60	·01175	·00152	·00182	·00202	·00211	·00209	·00121	·00045	·00014
65	·01982	·00051	·00072	·00096	·00123	·00140	·00110	·00044	·00014
70	·03275	·00010	·00014	·00019	·00026	·00035	·00081	·00042	·00014
75	·05321	·00001	·00002	·00002	·00003	·00004	·00016	·00030	·00013
80	·08512	—	—	—	—	—	·00001	·00005	·00009

Appendix 1.3. *Excess mortality rates* (q_x) *from AIDS 1988–2015—Projection F*

Age	Normal mortality	1988	1989	1990	1991	1992	1993	1994	1995
20	·00079	—	—	—	—	—	—	—	—
25	·00061	·00003	·00004	·00005	·00004	·00004	·00002	·00001	—
30	·00056	·00004	·00007	·00011	·00017	·00024	·00032	·00034	·00031
35	·00069	·00004	·00007	·00012	·00019	·00032	·00051	·00074	·00094
40	·00114	·00004	·00007	·00012	·00019	·00032	·00051	·00074	·00096
45	·00209	·00004	·00007	·00012	·00019	·00032	·00051	·00074	·00095
50	·00382	·00004	·00007	·00012	·00019	·00032	·00051	·00074	·00095
55	·00680	·00003	·00006	·00011	·00018	·00031	·00050	·00073	·00094
60	·01175	·00002	·00004	·00006	·00010	·00018	·00031	·00051	·00073
65	·01982	·00001	·00002	·00003	·00004	·00007	·00011	·00017	·00026
70	·03275	·00001	·00001	·00001	·00002	·00002	·00003	·00004	·00006
75	·05321	—	—	—	—	—	·00001	·00001	·00001
80	·08512	—	—	—	—	—	—	—	—

Age	Normal mortality	1996	1997	1998	1999	2000	2005	2010	2015
20	·00079	—	—	—	—	—	—	—	—
25	·00061	—	—	—	—	—	—	—	—
30	·00056	·00025	·00017	·00009	·00002	·00001	—	—	—
35	·00069	·00106	·00109	·00106	·00088	·00070	·00003	·00002	·00002
40	·00114	·00113	·00124	·00128	·00128	·00122	·00059	·00008	·00005
45	·00209	·00113	·00124	·00128	·00127	·00122	·00070	·00029	·00010
50	·00382	·00113	·00124	·00128	·00127	·00122	·00070	·00029	·00011
55	·00680	·00112	·00123	·00128	·00127	·00122	·00069	·00028	·00010
60	·01175	·00093	·00108	·00116	·00119	·00116	·00068	·00028	·00010
65	·01982	·00038	·00051	·00066	·00081	·00089	·00064	·00028	·00010
70	·03275	·00009	·00012	·00017	·00023	·00029	·00053	·00026	·00009
75	·05321	·00002	·00002	·00003	·00004	·00005	·00016	·00022	·00008
80	·08512	—	—	—	—	·00001	·00002	·00006	·00008

Appendix 2.1. *Policy values per 1,000 sum assured—level temporary assurance, years of entry 1988 and 1983*

PROJECTION A

		Entry in 1988			Entry in 1983		
Entry age	Term	Old Basis	New Basis	Extra per 1,000 sum at risk	Old Basis	New Basis	Extra per 1,000 sum at risk
20	5	0	·07	·07	—	—	—
	10	0	·41	·41	0	·25	·25
	15	0	3·17	3·17	0	5·99	5·99
	20	0	6·95	6·95	0	16·55	16·55
	25	0	8·29	8·29	·18	21·16	20·98
25	5	0	·59	·59	—	—	—
	10	0	6·42	6·42	·02	·95	·92
	15	0	16·81	16·81	·36	9·09	8·73
	20	0	20·98	20·98	1·06	19·84	18·80
	25	0	21·91	21·91	2·14	24·33	22·23
30	5	0	·92	·92	—	—	—
	10	0	8·73	8·73	·59	1·51	·92
	15	0	18.79	18.79	1·62	10·31	8·71
	20	0	22·21	22·21	3·15	21·78	18·69
	25	0	22·87	22·87	5·22	27·10	22·00
40	5	0	·92	·92	—	—	—
	10	0	8·63	8·63	2·92	3·84	·92
	15	0	18·39	18·39	6·76	15·26	8·55
	20	0	21·47	21·47	11·61	29·40	18·00
	25	0	21·80	21·80	17·47	37·88	20·78
50	5	0	·90	·90	—	—	—
	10	0	7·62	7·62	8·77	9·39	·62
	15	0	15·81	15·81	19·42	23·18	3·84

Appendix 2.2. *Policy values per 1,000 sum assured—level temporary assurance, years of entry 1978 and 1973*

PROJECTION A

		Entry in 1978			Entry in 1973		
Entry age	Term	Old Basis	New Basis	Extra per 1,000 sum at risk	Old Basis	New Basis	Extra per 1,000 sum at risk
20	15	0	·70	·70	—	—	—
	20	·16	8·89	8·73	·68	1·60	·92
	25	1·21	19·99	18·81	2·54	11·23	8·71
25	15	·80	1·72	·92	—	—	—
	20	2·42	11·11	8·71	2·88	3·80	0·92
	25	4·96	23·58	18·71	7·37	15·99	8·68
30	15	2·42	3·34	·92	—	—	—
	20	6·00	14·62	8·67	6·36	7·28	·92
	25	10·86	29·18	18·52	14·99	23·47	8·61
40	15	9·07	9·97	·91	—	—	—
	20	20·51	28·09	7·74	20·59	21·21	·63
	25	34·34	49·93	16·15	45·47	49·21	3·91
50	15	25·66	25·93	·27	—	—	—

Appendix 3.1. *Policy values per 1,000 sum assured—level temporary assurance, years of entry 1988 and 1983*

PROJECTION BC

		Entry in 1988			Entry in 1983		
Entry age	Term	Old Basis	New Basis	Extra per 1,000 sum at risk	Old Basis	New Basis	Extra per 1,000 sum at risk
20	5	0	·06	·06	—	—	—
	10	0	·24	·24	0	·22	·22
	15	0	·71	·71	0	3·44	3·44
	20	0	1·48	1·48	0	8·11	8·11
	25	0	2·01	2·01	·18	10·87	10·69
25	5	0	·56	·56	—	—	—
	10	0	3·87	3·87	·02	·90	·88
	15	0	8·37	8·37	·36	6·15	5·79
	20	0	10·69	10·69	1·06	11·98	10·93
	25	0	11·36	11·36	2·14	15·18	13·07
30	5	0	·88	·88	—	—	—
	10	0	5·79	5·79	·59	1·47	·88
	15	0	10·93	10·93	1·62	7·38	5·77
	20	0	13·06	13·06	3·15	13·98	10·87
	25	0	13·57	13·57	5·22	18·09	12·93
40	5	0	·88	·88	—	—	—
	10	0	5·73	5·73	2·92	3·79	·87
	15	0	10·70	10·70	6·76	12·40	5·68
	20	0	12·62	12·62	11·61	21·94	10·45
	25	0	12·93	12·93	17·47	29·37	12·11
50	5	0	·86	·86	—	—	—
	10	0	5·16	5·16	8·77	9·37	·61
	15	0	8·95	8·95	19·42	22·11	2·74

Appendix 3.2. *Policy values per 1,000 sum assured—level temporary assurance, years of entry 1978 and 1973*

PROJECTION BC

Entry age	Term	Entry in 1978 Old Basis	New Basis	Extra per 1,000 sum at risk	Entry in 1973 Old Basis	New Basis	Extra per 1,000 sum at risk
20	15	0	·66	·66	—	—	—
	20	·16	5·95	5·79	·68	1·56	·88
	25	1·21	12·13	10·94	2·54	8·30	5·78
25	15	·80	1·67	·88	—	—	—
	20	2·42	8·18	5·78	2·88	3·75	·88
	25	4·96	15·79	10·88	7·37	13·09	5·76
30	15	2·42	3·29	·88	—	—	—
	20	6·00	11·71	5·75	6·36	7·23	·88
	25	10·86	21·52	10·77	14·99	20·62	5·71
40	15	9·07	9·93	·87	—	—	—
	20	20·51	25·65	5·24	20·59	21·19	·61
	25	34·34	43·15	9·13	45·47	48·13	2·79
50	15	25·66	25·93	·27	—	—	—

Appendix 4.1. *Policy values per 1,000 sum assured—level temporary assurance, years of entry 1988 and 1983*

PROJECTION F

		Entry in 1988			Entry in 1983		
Entry age	Term	Old Basis	New Basis	Extra per 1,000 sum at risk	Old Basis	New Basis	Extra per 1,000 sum at risk
20	5	0	·05	·05	—	—	—
	10	0	·18	·18	0	·05	·05
	15	0	·50	·50	0	1·95	1·95
	20	0	·95	·95	0	4·59	4·59
	25	0	1·23	1·23	·18	6·30	6·12
25	5	0	·38	·38	—	—	—
	10	0	2·38	2·38	·02	·60	·58
	15	0	4·85	4·85	·36	3·73	3·37
	20	0	6·12	6·12	1·06	7·18	6·13
	25	0	6·52	6·52	2·14	9·45	7·33
30	5	0	·58	·58	—	—	—
	10	0	3·37	3·37	·59	1·17	·58
	15	0	6·13	6·13	1·62	4·97	3·36
	20	0	7·32	7·32	3·15	9·23	6·10
	25	0	7·65	7·65	5·22	12·44	7·26
40	5	0	·58	·58	—	—	—
	10	0	3·33	3·33	2·92	3·49	·58
	15	0	6·01	6·01	6·76	10·05	3·31
	20	0	7·09	7·09	11·61	17·43	5·89
	25	0	7·30	7·30	17·47	24·20	6·85
50	5	0	·57	·57	—	—	—
	10	0	3·09	3·09	8·77	9·19	·42
	15	0	5·29	5·29	19·42	21·24	1·85

Appendix 4.2. *Policy values per 1,000 sum assured—level temporary assurance, years of entry 1978 and 1973*

PROJECTION F

		Entry in 1978			Entry in 1973		
Entry age	Term	Old Basis	New Basis	Extra per 1,000 sum at risk	Old Basis	New Basis	Extra per 1,000 sum at risk
20	15	0	·36	·36	—	—	—
	20	·16	3·53	3·37	·68	1·26	·58
	25	1·21	7·34	6·13	2·54	5·89	3·36
25	15	·80	1·37	·58	—	—	—
	20	2·42	5·77	3·36	2·88	3·45	·58
	25	4·96	11·03	6·11	7·37	10·70	3·35
30	15	2·42	2·99	·58	—	—	—
	20	6·00	9·33	3·35	6·36	6·93	·58
	25	10·86	16·84	6·05	14·99	18·27	3·33
40	15	9·07	9·64	·57	—	—	—
	20	20·51	23·59	3·14	20·59	21·01	·42
	25	34·34	39·54	5·39	45·47	47·27	1·89
50	15	25·66	25·86	0·20	—	—	—

Appendix 5.1. *Policy values per 1,000 original sum assured—with-profits endowment assurance, years of entry 1988 and 1983*

PROJECTION A

		Entry in 1988			Entry in 1983*		
Entry age	Term	Old Basis	New Basis	Extra per 1,000 sum at risk	Old Basis	New Basis	Extra per 1,000 sum at risk
20	10	0	·10	·09	602·30	602·38	·13
	15	0	·64	·62	404·52	405·62	1·33
	25	0	4·70	4·54	241·82	253·01	11·33
	WL	0	11·60	11·21	92·37	122·44	26·45
25	10	0	1·38	1·33	602·55	602·67	·18
	15	0	5·95	5·75	404·97	406·61	1·98
	25	0	16·02	15·48	242·89	255·56	12·84
	WL	0	26·93	26·02	106·10	135·67	26·33
30	10	0	2·06	1·99	602·67	602·79	·18
	15	0	7·43	7·18	405·37	407·00	1·98
	25	0	17·44	16·85	244·32	256·89	12·76
	WL	0	26·81	25·90	121·77	149·42	24·97
35	10	0	2·06	1·99	602·58	602·70	·18
	15	0	7·40	7·15	405·67	407·30	1·97
	25	0	17·27	16·68	246·32	258·72	12·62
	WL	0	25·39	24·54	139·58	165·03	23·35
40	10	0	2·05	1·98	602·16	602·27	·18
	15	0	7·35	7·10	405·83	407·45	1·96
	25	0	16·97	16·40	249·23	261·31	12·33
	WL	0	23·73	22·93	159·69	182·58	21·41
50	10	0	1·92	1·85	599·41	599·50	·14
	15	0	6·52	6·29	405·40	406·26	1·04
	25	0	14·74	14·25	260·00	265·80	5·98
	WL	0	18·58	17·95	207·23	217·18	9·73

* Sum assured as at end 1987 = 1,000 $(1{\cdot}035)^5$.

Appendix 5.2. *Policy values per 1,000 original sum assured—with-profits endowment assurance, years of entry 1978 and 1973*

PROJECTION A

		Entry in 1978*			Entry in 1973**		
Entry age	Term	Old Basis	New Basis	Extra per 1,000 sum at risk	Old Basis	New Basis	Extra per 1,000 sum at risk
20	15	947·46	947·55	·18	—	—	—
	25	566·46	572·96	7·28	1,001·32	1,002·76	1·97
	WL	216·48	249·68	26·70	382·17	416·85	25·65
25	15	947·81	947·90	·18	—	—	—
	25	568·15	574·62	7·25	1,002·88	1,004·31	1·96
	WL	247·74	278·46	25·34	435·36	466·58	24·04
30	15	947·96	948·06	·18	—	—	—
	25	570·33	576·74	7·20	1,004·71	1,006·13	1·95
	WL	282·99	310·92	23·73	494·42	521·79	22·08
35	15	947·81	947·90	·18	—	—	—
	25	573·29	579·58	7·10	1,006·98	1,008·31	1·83
	WL	322·42	347·18	21·77	559·26	581·50	18·93
40	15	947·16	947·25	·18	—	—	—
	25	577·47	583·10	6·38	1,009·95	1,010·69	1·03
	WL	366·11	386·50	18·64	629·51	640·66	10·10
50	15	943·11	943·15	·08	—	—	—
	25	592·74	593·40	·76	1,020·25	1,020·32	·10
	WL	465·59	467·02	1·44	782·50	782·70	·21

* Sum assured as at end 1987 = 1,000 $(1{\cdot}035)^{10}$.
** Sum assured as at end 1987 = 1,000 $(1{\cdot}035)^{15}$.

Appendix 6.1. *Policy values per 1,000 original sum assured—with-profits endowment assurance, years of entry 1988 and 1983*

PROJECTION BC

		Entry in 1988			Entry in 1983*		
Entry age	Term	Old Basis	New Basis	Extra per 1,000 sum at risk	Old Basis	New Basis	Extra per 1,000 sum at risk
20	10	0	·08	·08	602·30	602·38	·13
	15	0	·23	·22	404·52	405·35	1·00
	25	0	1·07	1·03	241·82	247·61	5·86
	WL	0	3·05	2·95	92·37	108·05	13·79
25	10	0	1·04	1·00	602·55	602·67	·18
	15	0	3·31	3·19	404·97	406·26	1·56
	25	0	8·26	7·98	242·89	250·48	7·70
	WL	0	14·04	13·57	106·10	123·65	15·63
30	10	0	1·62	1·57	602·67	602·79	·18
	15	0	4·70	4·54	405·37	406·65	1·56
	25	0	10·36	10·01	244·32	251·85	7·65
	WL	0	15·91	15·38	121·77	138·18	14·82
35	10	0	1·62	1·57	602·58	602·69	·18
	15	0	4·69	4·53	405·67	406·95	1·55
	25	0	10·26	9·92	246·32	253·76	7·57
	WL	0	15·08	14·57	139·58	154·67	13·85
40	10	0	1·62	1·56	602·16	602·27	·18
	15	0	4·66	4·50	405·83	407·11	1·55
	25	0	10·09	9·75	249·23	256·45	7·37
	WL	0	14·08	13·60	159·69	173·13	12·57
50	10	0	1·54	1·49	599·41	599·50	·14
	15	0	4·15	4·01	405·40	406·13	·88
	25	0	8·35	8·07	260·00	263·15	3·24
	WL	0	10·31	9·96	207·23	211·95	4·62

* Sum assured as at end 1987 = 1,000 $(1{\cdot}035)^5$.

Appendix 6.2. *Policy values per 1,000 original sum assured—with-profits endowment assurance, years of entry 1978 and 1973*

PROJECTION BC

		Entry in 1978			Entry in 1973*		
Entry age	Term	Old Basis	New Basis	Extra per 1,000 sum at risk	Old Basis	New Basis	Extra per 1,000 sum at risk
20	15	947·46	947·55	·18	—	—	—
	25	566·46	570·56	4·59	1,001·32	1,002·45	1·55
	WL	216·48	236·18	15·84	382·17	402·75	15·22
25	15	947·81	947·90	·18	—	—	—
	25	568·15	572·23	4·58	1,002·88	1,004·01	1·54
	WL	247·74	265·97	15·04	435·36	453·86	14·25
30	15	947·96	948·05	·18	—	—	—
	25	570·33	574·38	4·55	1,004·71	1,005·83	1·53
	WL	282·99	299·54	14·07	494·42	510·47	12·95
35	15	947·81	947·90	·18	—	—	—
	25	573·29	577·27	4·49	1,006·98	1,008·04	1·47
	WL	322·42	336·95	12·77	559·26	571·55	10·46
40	15	947·16	947·25	·17	—	—	—
	25	577·47	581·05	4·05	1,009·95	1,010·58	·87
	WL	366·11	377·39	10·31	629·51	634·77	4·76
50	15	943·11	943·15	·07	—	—	—
	25	592·74	593·26	·60	1,020·25	1,020·32	·10
	WL	465·59	466·55	·97	782·50	782·68	·19

* Sum assured as at end 1987 = 1,000 $(1{\cdot}035)^{10}$.
** Sum assured as at end 1987 = 1,000 $(1{\cdot}035)^{15}$.

Appendix 7.1. *Policy values per 1,000 original sum assured—with-profits endowment assurance, years of entry 1988 and 1983*

PROJECTION F

		Entry in 1988			Entry in 1983*		
Entry age	Term	Old Basis	New Basis	Extra per 1,000 sum at risk	Old Basis	New Basis	Extra per 1,000 sum at risk
20	10	0	·06	·06	602·30	602·36	·10
	15	0	·17	·17	404·52	405·06	·65
	25	0	·69	·67	241·82	245·20	3·42
	WL	0	1·84	1·78	92·37	101·39	7·93
25	10	0	·67	·65	602·55	602·64	·14
	15	0	1·99	1·93	404·97	405·76	·96
	25	0	4·77	4·61	242·89	247·18	4·36
	WL	0	8·07	7·80	106·10	116·01	8·83
30	10	0	1·00	·96	602·67	602·76	·14
	15	0	2·72	2·62	405·37	406·16	·96
	25	0	5·84	5·64	244·32	248·58	4·33
	WL	0	8·99	8·69	121·77	131·04	8·37
35	10	0	1·00	·96	602·58	602·67	·13
	15	0	2·71	2·61	405·67	406·46	·95
	25	0	5·79	5·59	246·32	250·53	4·28
	WL	0	8·52	8·23	139·58	148·11	7·83
40	10	0	·99	·96	602·16	602·24	·13
	15	0	2·69	2·60	405·83	406·61	·95
	25	0	5·69	5·50	249·23	253·34	4·19
	WL	0	7·96	7·69	159·69	167·34	7·15
50	10	0	·96	·93	599·41	599·48	·11
	15	0	2·49	2·40	405·40	405·90	·60
	25	0	4·96	4·79	260·00	262·17	2·23
	WL	0	6·13	5·92	207·23	210·54	3·23

* Sum assured as at end 1987 = 1000 $(1{\cdot}035)^5$.

Appendix 7.2. *Policy values per 1,000 original sum assured—with profits endowment assurance, years of entry 1978 and 1973*

PROJECTION F

		Entry in 1978*			Entry in 1973**		
Entry age	Term	Old Basis	New Basis	Extra per 1,000 sum at risk	Old Basis	New Basis	Extra per 1,000 sum at risk
20	15	947·46	947·52	·13	—	—	
	25	566·46	568·83	2·65	1,001·32	1,002·01	·95
	WL	216·48	227·61	8·95	382·17	393·80	8·60
25	15	947·81	947·88	·13	—	—	—
	25	568·15	570·51	2·64	1,002·88	1,003·57	·95
	WL	247·74	258·04	8·49	435·36	445·81	8·05
30	15	947·96	948·03	·13	—	—	—
	25	570·33	572·67	2·63	1,004·71	1,005·40	·94
	WL	282·99	292·34	7·95	494·42	503·55	7·37
35	15	947·81	947·88	·13	—	—	—
	25	573·29	575·59	2·59	1,006·98	1,007·64	·91
	WL	322·42	330·68	7·27	559·26	566·57	6·22
40	15	947·16	947·23	·13	—	—	—
	25	577·47	579·62	2·43	1,009·95	1,010·38	·59
	WL	366·11	372·82	6·13	629·51	633·19	3·33
50	15	943·11	943·14	·06	—	—	—
	25	592·74	593·15	·47	1,020·25	1,020·31	·08
	WL	465·59	466·39	·81	782·50	782·66	·17

* Sum assured as at end 1987 = 1,000 $(1{\cdot}035)^{10}$.
** Sum assured as at end 1987 = 1,000 $(1{\cdot}035)^{15}$.

Appendix 8.1. *Survival tables* (l_x) *for different initial statuses—Projection A*

Age 20 in 1987					Age 30 in 1987				
Age	Initially clear	Initially at risk	Initially positive	Initially sick	Age	Initially clear	Initially at risk	Initially positive	Initially sick
20	100,000	100,000	100,000	100,000	30	100,000	100,000	100,000	100,000
25	99,644	99,626	64,729	2,982	35	99,704	99,331	78,230	2,984
30	99,356	97,342	21,324	89	40	99,285	75,651	26,814	89
35	99,062	72,586	6,174	3	45	98,556	30,300	7,757	3
40	98,645	29,331	1,763		50	97,231	9,159	2,196	
45	97,921	8,940	501		55	94,878	2,587	614	
50	96,605	2,554	142		60	90,875	711	168	
55	94,267	715	40		65	84,400	189	45	
60	90,289	196	11		70	74,550	48	11	
65	83,857	52	3		75	60,719	11	3	
70	74,069	13	1		80	43,412	2	1	
75	60,328	3			85	25,191			
80	43,132	1			90	10,472			
85	25,029				95	2,555			
90	10,404				100	266			
95	2,539								
100	265								
$\mathring{e}_{20}$	56·3	18·1	7·2	1·5	$\mathring{e}_{30}$	46·6	13·4	8·3	1·5

Appendix 8.2. *Survival tables* (l_x) *for different initial statuses—Projection BC*

Age 20 in 1987					Age 30 in 1987				
Age	Initially clear	Initially at risk	Initially positive	Initially sick	Age	Initially clear	Initially at risk	Initially positive	Initially sick
20	100,000	100,000	100,000	100,000	30	100,000	100,000	100,000	100,000
25	99,644	99,630	64,280	2,982	35	99,704	99,413	77,769	2,984
30	99,356	98,465	21,116	89	40	99,285	85,100	26,576	89
35	99,062	93,769	6,112	3	45	98,556	60,370	7,686	3
40	98,645	83,697	1,746		50	97,231	45,653	2,175	
45	97,921	74,314	496		55	94,878	39,428	608	
50	96,605	69,207	140		60	90,875	36,208	167	
55	94,267	66,136	39		65	84,400	33,199	44	
60	90,289	62,934	11		70	74,550	29,214	11	
65	83,857	58,338	3		75	60,719	23,768	3	
70	74,069	51,500	1		80	43,412	16,988	1	
75	60,328	41,939			85	25,191	9,857		
80	43,132	29,983			90	10,472	4,097		
85	25,029	17,398			95	2,555	1,000		
90	10,404	7,232			100	266	104		
95	2,539	1,765							
100	265	184							
$\mathring{e}_{20}$	56·3	45·3	7·2	1·5	$\mathring{e}_{30}$	46·6	26·7	8·2	1·5

Appendix 8.3. *Survival tables* (l_x) *for different initial statuses—Projection F*

Age 20 in 1987					Age 30 in 1987				
Age	Initially clear	Initially at risk	Initially positive	Initially sick	Age	Initially clear	Initially at risk	Initially positive	Initially sick
20	100,000	100,000	100,000	100,000	30	100,000	100,000	100,000	100,000
25	99,644	99,627	72,656	9,841	35	99,704	99,410	83,836	9,847
30	99,356	98,164	31,542	1,703	40	99,285	84,732	38,196	1,702
35	99,062	92,002	10,874	295	45	98,556	58,717	13,320	293
40	98,645	80,505	3,424	51	50	97,231	42,067	4,185	50
45	97,921	70,506	1,029	9	55	94,878	34,431	1,241	8
50	96,605	64,833	300	2	60	90,875	30,720	352	1
55	94,267	61,464	86		65	84,400	27,852	96	
60	90,289	58,284	24		70	74,550	24,417	24	
65	83,857	53,959	6		75	60,719	19,842	6	
70	74,069	47,614	2		80	43,412	14,177	1	
75	60,328	38,770			85	25,191	8,225		
80	43,132	27,716			90	10,472	3,419		
85	25,029	16,083			95	2,555	834		
90	10,404	6,685			100	266	87		
95	2,539	1,631							
100	265	170							
$\mathring{e}_{20}$	56·3	43·4	8·5	2·1	$\mathring{e}_{30}$	46·6	24·9	9·5	2·1

Appendix 9.1. *Mortality rates* (q_x) *for different initial statuses—initial age 20*

Age	Initially clear	Initially at risk	Initially positive	Initially sick
	Age 20 in 1987—Projection A			
20	·00079	·00079	·022	·505
25	·00061	·00110	·173	·505
30	·00056	·0193	·217	·505
35	·00069	·128	·221	·519
40	·00114	·203	·222	
45	·00209	·220	·223	
50	·00382	·224	·224	
55	·00680	·227	·227	
60	·01175	·230	·229	
	Age 20 in 1987—Projection BC			
20	·00079	·00079	·023	·505
25	·00061	·00098	·174	·505
30	·00056	·00548	·217	·505
35	·00069	·0177	·221	·519
40	·00114	·0261	·222	
45	·00209	·0178	·223	
50	·00382	·0100	·224	
55	·00680	·0088	·227	
60	·01175	·0123	·224	
	Age 20 in 1987—Projection F			
20	·00079	·00079	·020	·450
25	·00061	·00106	·124	·296
30	·00056	·00742	·183	·296
35	·00069	·0221	·202	·296
40	·00114	·0290	·211	·296
45	·00209	·0205	·217	·295
50	·00382	·0120	·221	·267
55	·00680	·0097	·225	
60	·01175	·0127	·228	

Appendix 9.2. *Mortality rates* (q_x) *for different initial statuses—initial age 30*

Age	Initially clear	Initially at risk	Initially positive	Initially sick
	Age 30 in 1987—Projection A			
30	·00056	·00056	·005	·505
35	·00069	·0108	·158	·505
40	·00114	·130	·217	·505
45	·00209	·204	·222	·500
50	·00382	·221	·224	
55	·00680	·226	·227	
60	·01175	·230	·230	
	Age 30 in 1987—Projection BC			
30	·00056	·00056	·005	·505
35	·00069	·00839	·159	·505
40	·00114	·0601	·217	·505
45	·00209	·0647	·222	·500
50	·00382	·0375	·224	
55	·00680	·0193	·226	
60	·01175	·0156	·230	
	Age 30 in 1987—Projection F			
30	·00056	·00056	·005	·450
35	·00069	·00840	·109	·296
40	·00114	·0627	·179	·296
45	·00209	·0727	·202	·297
50	·00382	·0492	·213	·299
55	·00680	·0268	·220	·294
60	·01175	·0188	·227	·286

Appendix 10. *Cumulative deaths* (1_{30}-l_x) *for different selection bases—Projection BC—initial age 30 at end of 1987*

	Selection basis				
Age	No selection	Excluding sick from AIDS	Excluding sick and 50% positive	Excluding sick, 50% positive and 25% at risk	Clear
30	0	0	0	0	0
35	407	402	355	353	296
40	1,625	1,621	1,466	1,324	715
45	3,433	3,429	3,237	2,852	1,444
50	5,334	5,330	5,130	4,611	2,769
55	7,846	7,842	7,644	7,085	5,122
60	11,801	11,797	11,607	11,056	9,125
65	18,103	18,100	17,922	17,406	15,600
70	27,666	27,663	27,507	27,050	25,450
75	41,087	41,084	40,957	40,584	39,281
80	57,880	57,878	57,787	57,520	56,588
85	75,558	75,557	75,504	75,350	74,809
90	89,840	89,840	89,818	89,753	89,528
95	97,521	97,521	97,515	97,500	97,445
100	99,742	99,742	99,741	99,739	99,734

Appendix 11. *Mortality rates* (q_x) *for different selection bases—Projection BC—initial age 30 at end of 1987*

	Selection basis				
Age	No selection	Excluding sick from AIDS	Excluding sick and 50% positive	Excluding sick, 50% positive and 25% at risk	Clear
30	·00060	·00058	·00057	·00057	·00056
35	·00155	·00155	·00128	·00121	·00069
40	·00352	·00352	·00340	·00288	·00114
45	·00380	·00380	·00376	·00336	·00209
50	·00452	·00452	·00451	·00434	·00382
55	·00703	·00703	·00702	·00697	·00680
60	·01182	·01182	·01182	·01180	·01175
65	·01984	·01984	·01984	·01983	·01982
70	·03275	·03275	·03275	·03275	·03275

Appendix 12.1. *Net premiums per 1,000 sum assured—level temporary assurance, year of entry 1988*

PROJECTION A

Entry age	Term	Premium for clears	Additional premium on selection basis (% in brackets) Basis 2	Basis 3	Basis 4
20	5	·68	·01 (2)	·01 (1)	·01 (1)
	10	·62	·05 (8)	·04 (7)	·04 (6)
	15	·61	·31 (51)	·30 (50)	·23 (38)
	20	·63	·58 (91)	·57 (90)	·43 (68)
	25	·71	·62 (87)	·61 (86)	·56 (65)
25	5	·55	·12 (23)	·07 (13)	·07 (13)
	10	·55	·82 (149)	·74 (134)	·58 (105)
	15	·61	1·64 (271)	1·57 (258)	1·21 (199)
	20	·72	1·75 (242)	1·68 (233)	1·29 (179)
	25	·90	1·65 (182)	1·59 (176)	1·22 (135)
30	5	·56	·20 (36)	·11 (20)	·11 (19)
	10	·65	1·12 (171)	·98 (149)	·78 (119)
	15	·83	1·84 (223)	1·72 (208)	1·33 (161)
	20	1·08	1·86 (172)	1·75 (161)	1·35 (125)
	25	1·43	1·73 (121)	1·63 (114)	1·26 (88)
40	5	1·37	·20 (15)	·11 (8)	·11 (8)
	10	1·86	1·11 (60)	·97 (52)	·77 (42)
	15	2·50	1·82 (73)	1·69 (68)	1·31 (53)
	20	3·30	1·82 (55)	1·71 (52)	1·32 (40)
	25	4·28	1·68 (39)	1·58 (37)	1·22 (28)
50	5	4·54	·20 (4)	·11 (2)	·11 (2)
	10	5·99	·99 (17)	·86 (14)	·68 (11)
	15	7·74	1·60 (21)	1·48 (19)	1·15 (15)

Appendix 12.2. *Net premiums per 1,000 sum assured—level temporary assurance, year of entry 1993*

PROJECTION A

Entry age	Term	Premium for clears	Additional premium on selection basis (% in brackets) Basis 2	Basis 3	Basis 4
20	5	·68	—	—	—
	10	·62	·01 (2)	·01 (2)	·01 (1)
	15	·61	·11 (18)	·11 (18)	·08 (14)
	20	·63	·34 (54)	·34 (54)	·26 (40)
	25	·71	·42 (60)	·42 (59)	·32 (45)
25	5	·55	·10 (18)	·05 (10)	·05 (9)
	10	·55	·53 (96)	·47 (85)	·37 (67)
	15	·61	·90 (148)	·84 (139)	·65 (107)
	20	·72	·92 (127)	·86 (119)	·66 (92)
	25	·90	·85 (94)	·81 (89)	·62 (68)
30	5	·56	1·63 (294)	·85 (153)	·84 (152)
	10	·65	2·75 (420)	1·72 (263)	1·56 (239)
	15	·83	2·66 (322)	1·75 (212)	1·55 (188)
	20	1·08	2·37 (220)	1·58 (146)	1·39 (129)
	25	1·43	2·16 (151)	1·44 (101)	1·27 (89)
40	5	1·37	2·14 (157)	1·11 (81)	1·10 (81)
	10	1·86	2·99 (161)	1·74 (94)	1·63 (88)
	15	2·50	2·75 (110)	1·66 (67)	1·53 (61)
	20	3·30	2·42 (73)	1·48 (45)	1·35 (41)
	25	4·28	2·19 (51)	1·34 (31)	1·22 (29)
50	5	4·54	2·13 (47)	1·10 (24)	1·09 (24)
	10	5·99	2·94 (49)	1·71 (28)	1·60 (27)
	15	7·74	2·69 (35)	1·62 (21)	1·49 (19)

Appendix 13.1. *Net premiums per 1,000 sum assured—level temporary assurance, year of entry 1988*

PROJECTION BC

Entry age	Term	Premium for clears	Additional premium on selection basis (% in brackets) Basis 2	Basis 3	Basis 4
20	5	·68	·01 (2)	·01 (1)	·01 (1)
	10	·62	·03 (5)	·02 (4)	·02 (3)
	15	·61	·07 (11)	·06 (10)	·05 (8)
	20	·63	·12 (19)	·12 (18)	·09 (14)
	25	·71	·15 (21)	·14 (20)	·11 (15)
25	5	·55	·12 (21)	·07 (12)	·06 (11)
	10	·55	·49 (90)	·41 (75)	·33 (60)
	15	·61	·82 (134)	·74 (122)	·58 (96)
	20	·72	·89 (122)	·82 (114)	·64 (88)
	25	·90	·85 (94)	·79 (87)	·61 (68)
30	5	·56	·19 (34)	·10 (19)	·10 (18)
	10	·65	·74 (113)	·60 (92)	·49 (75)
	15	·83	1·07 (129)	·94 (114)	·75 (90)
	20	1·08	1·09 (100)	·98 (90)	·77 (71)
	25	1·43	1·02 (71)	·92 (64)	·72 (50)
40	5	1·37	·19 (14)	·10 (8)	·10 (7)
	10	1·86	·73 (40)	·60 (32)	·49 (26)
	15	2·50	1·05 (42)	·93 (37)	·74 (30)
	20	3·30	1·06 (32)	·96 (29)	·75 (23)
	25	4·28	·99 (23)	·89 (21)	·70 (16)
50	5	4·54	·19 (4)	·10 (2)	·10 (2)
	10	5·99	·67 (11)	·54 (9)	·44 (7)
	15	7·74	·90 (12)	·78 (10)	·62 (8)

Appendix 13.2. *Net premiums per 1,000 sum assured—level temporary assurance, year of entry 1993*

PROJECTION BC

Entry age	Term	Premium for clears	Additional premium on selection basis (% in brackets) Basis 2	Basis 3	Basis 4
20	5	·68	—	—	—
	10	·62	—	—	—
	15	·61	·01 (1)	·01 (1)	·01 (1)
	20	·63	·02 (3)	·02 (3)	·01 (2)
	25	·71	·03 (4)	·03 (4)	·02 (3)
25	5	·55	·04 (8)	·02 (4)	·02 (4)
	10	·55	·11 (19)	·08 (15)	·07 (12)
	15	·61	·18 (30)	·16 (26)	·13 (21)
	20	·72	·21 (29)	·19 (27)	·15 (21)
	25	·90	·21 (23)	·19 (21)	·15 (16)
30	5	·56	·89 (160)	·46 (82)	·45 (81)
	10	·65	1·29 (197)	·80 (122)	·73 (111)
	15	·83	1·29 (156)	·87 (105)	·76 (92)
	20	1·08	1·17 (108)	·80 (74)	·70 (65)
	25	1·43	1·07 (75)	·74 (52)	·64 (45)
40	5	1·37	1·29 (94)	·66 (48)	·66 (48)
	10	1·86	1·63 (88)	·95 (51)	·89 (48)
	15	2·50	1·53 (61)	·95 (38)	·86 (34)
	20	3·30	1·36 (41)	·86 (26)	·77 (23)
	25	4·28	1·24 (29)	·78 (18)	·70 (16)
50	5	4·54	1·28 (28)	·66 (14)	·65 (14)
	10	5·99	1·60 (27)	·92 (15)	·87 (14)
	15	7·74	1·48 (19)	·90 (12)	·83 (11)

Appendix 14.1. *Net premiums per 1,000 sum assured—level temporary assurance, year of entry 1988*

PROJECTION F

Entry age	Term	Premium for clears	Additional premium on selection basis (% in brackets) Basis 2	Basis 3	Basis 4
20	5	·68	·01 (1)	·01 (1)	·01 (1)
	10	·62	·02 (4)	·02 (3)	·01 (2)
	15	·61	·05 (8)	·04 (7)	·03 (6)
	20	·63	·08 (12)	·07 (11)	·06 (9)
	25	·71	·09 (13)	·09 (12)	·07 (9)
25	5	·55	·08 (14)	·04 (8)	·04 (8)
	10	·55	·30 (55)	·24 (43)	·19 (35)
	15	·61	·47 (77)	·41 (67)	·32 (53)
	20	·72	·50 (70)	·45 (62)	·35 (49)
	25	·90	·48 (53)	·43 (48)	·34 (37)
30	5	·56	·12 (22)	·07 (12)	·06 (11)
	10	·65	·43 (65)	·32 (49)	·27 (41)
	15	·83	·60 (72)	·49 (60)	·40 (48)
	20	1·08	·61 (56)	·51 (47)	·41 (38)
	25	1·43	·57 (40)	·49 (34)	·39 (27)
40	5	1·37	·12 (9)	·07 (5)	·06 (5)
	10	1·86	·43 (23)	·32 (17)	·27 (14)
	15	2·50	·59 (24)	·49 (20)	·39 (16)
	20	3·30	·59 (18)	·50 (15)	·40 (12)
	25	4·28	·55 (13)	·47 (11)	·38 (9)
50	5	4·54	·12 (3)	·06 (1)	·06 (1)
	10	5·99	·40 (7)	·30 (5)	·25 (4)
	15	7·74	·53 (7)	·43 (6)	·35 (5)

Appendix 14.2. *Net premiums per 1,000 sum assured—level temporary assurance, year of entry 1993*

PROJECTION F

Entry age	Term	Premium for clears	Additional premium on selection basis (% in brackets) Basis 2	Basis 3	Basis 4
20	5	·68	—	—	—
	10	·62	—	—	—
	15	·61	·01 (1)	—	—
	20	·63	·01 (2)	·01 (2)	·01 (1)
	25	·71	·02 (3)	·02 (3)	·01 (2)
25	5	·55	·03 (5)	·02 (3)	·02 (3)
	10	·55	·07 (13)	·05 (9)	·04 (8)
	15	·61	·11 (19)	·09 (15)	·08 (12)
	20	·72	·13 (18)	·11 (15)	·09 (12)
	25	·90	·12 (14)	·11 (12)	·09 (9)
30	5	·56	·48 (87)	·25 (44)	·24 (44)
	10	·65	·70 (107)	·39 (60)	·37 (57)
	15	·83	·70 (84)	·42 (51)	·39 (47)
	20	1·08	·64 (59)	·39 (36)	·36 (33)
	25	1·43	·58 (41)	·36 (25)	·33 (23)
40	5	1·37	·65 (48)	·33 (24)	·33 (24)
	10	1·86	·84 (45)	·46 (25)	·44 (24)
	15	2·50	·80 (32)	·45 (18)	·43 (17)
	20	3·30	·71 (22)	·41 (12)	·39 (12)
	25	4·28	·65 (15)	·38 (9)	·35 (8)
50	5	4·54	·65 (14)	·33 (7)	·33 (7)
	10	5·99	·83 (14)	·45 (7)	·43 (7)
	15	7·74	·77 (10)	·44 (6)	·41 (7)

Appendix 15.1. *Net premiums per 1,000 sum assured—with-profits endowment assurance, year of entry 1988*

PROJECTION A

Entry age	Term	Premium for clears	Additional premium on selection basis (% in brackets) Basis 2	Basis 3	Basis 4
20	10	101·33	·01 (—)	·01 (—)	·01 (—)
	15	68·30	·06 (·1)	·06 (·1)	·04 (·1)
	25	41·13	·35 (·9)	·35 (·8)	·26 (·6)
	WL	16·17	·70 (4·3)	·69 (4·3)	·52 (3·2)
25	10	101·27	·17 (·2)	·14 (·1)	·11 (·1)
	15	68·26	·58 (·8)	·53 (·8)	·42 (·6)
	25	41·18	1·20 (2·9)	1·15 (2·8)	·89 (2·2)
	WL	18·33	1·66 (9·1)	1·61 (8·8)	1·23 (6·7)
30	10	101·29	·26 (·3)	·20 (·2)	·17 (·2)
	15	68·33	·73 (1·1)	·65 (1·0)	·51 (·7)
	25	41·43	1·32 (3·2)	1·23 (3·0)	·95 (2·3)
	WL	20·96	1·69 (8·1)	1·60 (7·6)	1·23 (5·9)
35	10	101·44	·26 (·3)	·20 (·2)	·17 (·2)
	15	68·58	·73 (1·1)	·65 (·9)	·51 (·7)
	25	41·98	1·31 (3·1)	1·22 (2·9)	·95 (2·3)
	WL	24·17	1·65 (6·8)	1·55 (6·4)	1·20 (5·0)
40	10	101·80	·26 (·3)	·20 (·2)	·17 (·2)
	15	69·11	·72 (1·0)	·64 (·9)	·51 (·7)
	25	43·03	1·31 (3·0)	1·22 (2·8)	·94 (2·2)
	WL	28·12	1·60 (5·7)	1·50 (5·3)	1·16 (4·1)
50	10	103·75	·25 (·2)	·19 (·2)	·16 (·1)
	15	71·81	·66 (·9)	·58 (·8)	·46 (·6)
	25	47·87	1·20 (2·5)	1·11 (2·3)	·86 (1·8)
	WL	39·18	1·40 (3·6)	1·30 (3·3)	1·01 (2·6)

Appendix 15.2. *Net premiums per 1,000 sum assured—with-profits endowment assurance, year of entry 1993*

PROJECTION A

Entry age	Term	Premium for clears	Additional premium on selection basis (% in brackets) Basis 2	Basis 3	Basis 4
20	10	101·33	—	—	—
	15	68·30	·02 (—)	·02 (—)	·01 (—)
	25	41·13	·20 (·5)	·20 (·5)	·15 (·4)
	WL	16·17	·51 (3·2)	·51 (3·1)	·38 (2·4)
25	10	101·27	·12 (·1)	·09 (·1)	·08 (·1)
	15	68·26	·35 (·5)	·31 (·5)	·24 (·4)
	25	41·18	·64 (1·6)	·60 (1·5)	·46 (1·1)
	WL	18·33	·85 (4·6)	·81 (4·4)	·62 (3·4)
30	10	101·29	1·14 (1·1)	·65 (·6)	·62 (·6)
	15	68·33	1·59 (2·3)	·99 (1·4)	·90 (1·3)
	25	41·43	1·87 (4·5)	1·23 (3·0)	1·09 (2·6)
	WL	20·96	2·01 (9·6)	1·35 (6·4)	1·18 (5·6)
35	10	101·44	1·37 (1·4)	·75 (·7)	·72 (·7)
	15	68·58	1·75 (2·6)	1·01 (1·5)	·95 (1·4)
	25	41·98	1·96 (4·7)	1·18 (2·8)	1·08 (2·6)
	WL	24·17	2·04 (8·4)	1·25 (5·2)	1·14 (4·7)
40	10	101·80	1·37 (1·3)	·75 (·7)	·72 (·7)
	15	69·11	1·75 (2·5)	1·01 (1·5)	·95 (1·4)
	25	43·03	1·96 (4·6)	1·18 (2·7)	1·09 (2·5)
	WL	28·12	2·04 (7·2)	1·24 (4·4)	1·14 (4·0)
50	10	103·75	1·37 (1·3)	·74 (·7)	·72 (·7)
	15	71·81	1·76 (2·4)	1·01 (1·4)	·95 (1·3)
	25	47·87	1·97 (4·1)	1·18 (2·5)	1·09 (2·3)
	WL	39·18	2·03 (5·2)	1·23 (3·1)	1·13 (2·9)

Appendix 16.1. *Net premiums per 1,000 sum assured—with-profits endowment assurance, year of entry 1988*

PROJECTION BC

Entry age	Term	Premium for clears	Additional premium on selection basis (% in brackets) Basis 2	Basis 3	Basis 4
20	10	101·33	·01 (—)	·01 (—)	·01 (—)
	15	68·30	·02 (—)	·02 (—)	·01 (—)
	25	41·13	·08 (·2)	·07 (·2)	·06 (·1)
	WL	16·17	·18 (1·1)	·18 (1·1)	·14 (·8)
25	10	101·27	·13 (·1)	·09 (·1)	·08 (·1)
	15	68·26	·32 (·5)	·27 (·4)	·22 (·3)
	25	41·18	·62 (1·5)	·56 (1·4)	·44 (1·1)
	WL	18·33	·86 (4·7)	·80 (4·4)	·62 (3·4)
30	10	101·29	·20 (·2)	·15 (·1)	·13 (·1)
	15	68·33	·46 (·7)	·38 (·6)	·31 (·5)
	25	41·43	·78 (1·9)	·69 (1·7)	·54 (1·3)
	WL	20·96	·99 (4·7)	·90 (4·3)	·71 (3·4)
35	10	101·44	·20 (·2)	·15 (·1)	·13 (·1)
	15	68·58	·46 (·7)	·38 (·6)	·31 (·5)
	25	41·98	·77 (1·8)	·69 (1·6)	·54 (1·3)
	WL	24·17	·97 (4·0)	·88 (3·6)	·69 (2·8)
40	10	101·80	·20 (·2)	·15 (·1)	·13 (·1)
	15	69·11	·46 (·7)	·38 (·5)	·31 (·4)
	25	43·03	·77 (1·8)	·68 (1·6)	·54 (1·3)
	WL	28·12	·94 (3·3)	·85 (3·0)	·66 (2·4)
50	10	103·75	·20 (·2)	·14 (·1)	·12 (·1)
	15	71·81	·42 (·6)	·34 (·5)	·28 (·4)
	25	47·87	·67 (1·4)	·58 (1·2)	·46 (1·0)
	WL	39·18	·77 (2·0)	·68 (1·7)	·54 (1·4)

Appendix 16.2. *Net premiums per 1,000 sum assured—with-profits endowment assurance, year of entry 1993*

PROJECTION BC

Entry age	Term	Premium for clears	Additional premium on selection basis (% in brackets) Basis 2	Basis 3	Basis 4
20	10	101·33	—	—	—
	15	68·30	—	—	—
	25	41·13	·01 (—)	·01 (—)	·01 (—)
	WL	16·17	·05 (·3)	·05 (·3)	·04 (·2)
25	10	101·27	·03 (—)	·02 (—)	·02 (—)
	15	68·26	·07 (·1)	·06 (·1)	·05 (·1)
	25	41·18	·15 (·4)	·13 (·3)	·10 (·2)
	WL	18·33	·22 (1·2)	·20 (1·1)	·15 (·8)
30	10	101·29	·57 (·6)	·32 (·3)	·30 (·3)
	15	68·33	·76 (1·1)	·47 (·7)	·43 (·6)
	25	41·43	·91 (2·2)	·61 (1·5)	·54 (1·3)
	WL	20·96	1·00 (4·8)	·70 (3·3)	·60 (2·9)
35	10	101·44	·78 (·8)	·42 (·4)	·41 (·4)
	15	68·58	·97 (1·4)	·57 (·8)	·53 (·8)
	25	41·98	1·09 (2·6)	·68 (1·6)	·61 (1·5)
	WL	24·17	1·15 (4·8)	·73 (3·0)	·66 (2·7)
40	10	101·80	·78 (·8)	·42 (·4)	·41 (·4)
	15	69·11	·97 (1·4)	·57 (·8)	·53 (·8)
	25	43·03	1·10 (2·6)	·68 (1·6)	·61 (1·4)
	WL	28·12	1·15 (4·1)	·73 (2·6)	·65 (2·3)
50	10	103·75	·78 (·8)	·42 (·4)	·41 (·4)
	15	71·81	·97 (1·4)	·56 (·8)	·52 (·7)
	25	47·87	1·09 (2·3)	·66 (1·4)	·61 (1·3)
	WL	39·18	1·13 (2·9)	·70 (1·8)	·63 (1·6)

Appendix 17.1. *Net premiums per 1,000 sum assured—with-profits endowment assurance, year of entry 1988*

PROJECTION F

Entry age	Term	Premium for clears	Additional premium on selection basis (% in brackets) Basis 2	Basis 3	Basis 4
20	10	101·33	·01 (—)	—	—
	15	68·30	·02 (—)	·01 (—)	·01 (—)
	25	41·13	·05 (·1)	·05 (·1)	·04 (·1)
	WL	16·17	·11 (·7)	·11 1·7)	·08 (·5)
25	10	101·27	·08 (·1)	·06 (·1)	·05 (·1)
	15	68·26	·19 (·3)	·16 (·2)	·13 (·2)
	25	41·18	·35 (·9)	·31 (·8)	·24 (·6)
	WL	18·33	·49 (2·7)	·44 (2·4)	·34 (1·9)
30	10	101·29	·12 (·1)	·08 (·1)	·07 (·1)
	15	68·33	·26 (·4)	·20 (·3)	·17 (·2)
	25	41·43	·43 (1·0)	·36 (·9)	·29 (·7)
	WL	20·96	·56 (2·7)	·48 (2·3)	·38 (1·8)
35	10	101·44	·12 (·1)	·08 (·1)	·07 (·1)
	15	68·58	·26 (·4)	·20 (·3)	·17 (·2)
	25	41·98	·43 (1·0)	·36 (·9)	·29 (·7)
	WL	24·17	·54 (2·2)	·47 (1·9)	·37 (1·5)
40	10	101·80	·12 (·1)	·08 (·1)	·07 (·1)
	15	69·11	·26 (·4)	·20 (·3)	·17 (·2)
	25	43·03	·43 (1·0)	·36 (·8)	·29 (·7)
	WL	28·12	·53 (1·9)	·45 (1·6)	·36 (1·3)
50	10	103·75	·12 (·1)	·08 (·1)	·07 (·1)
	15	71·81	·25 (·3)	·19 (·3)	·16 (·2)
	25	47·87	·40 (·8)	·32 (·7)	·26 (·5)
	WL	39·18	·45 (1·2)	·38 (1·0)	·30 (·8)

Appendix 17.2. *Net premiums per 1,000 sum assured—with-profits endowment assurance, year of entry 1993*

PROJECTION F

Entry age	Term	Premium for clears	Additional premium on selection basis (% in brackets) Basis 2	Basis 3	Basis 4
20	10	101·33	—	—	—
	15	68·30	—	—	—
	25	41·13	·01 (—)	·01 (—)	·01 (—)
	WL	16·17	·03 (·2)	·03 (·2)	·02 (·1)
25	10	101·27	·02 (—)	·01 (—)	·01 (—)
	15	68·26	·05 (·1)	·03 (·1)	·03 (—)
	25	41·18	·09 (·2)	·07 (·2)	·06 (·1)
	WL	18·33	·13 (·7)	·11 (·6)	·09 (·5)
30	10	101·29	·31 (·3)	·16 (·2)	·16 (·2)
	15	68·33	·41 (·6)	·23 (·3)	·22 (·3)
	25	41·43	·50 (1·2)	·30 (·7)	·27 (·7)
	WL	20·96	·55 (2·6)	·34 (1·6)	·31 (1·5)
35	10	101·44	·40 (·4)	·21 (·2)	·20 (·2)
	15	68·58	·50 (·7)	·27 (·4)	·26 (·4)
	25	41·98	·57 (1·4)	·32 (·8)	·31 (·7)
	WL	24·17	·61 (2·5)	·35 (1·5)	·33 (1·4)
40	10	101·80	·40 (·4)	·21 (·2)	·20 (·2)
	15	69·11	·50 (·7)	·27 (·4)	·26 (·4)
	25	43·03	·57 (1·3)	·32 (·7)	·31 (·7)
	WL	28·12	·60 (2·1)	·35 (1·2)	·33 (1·2)
50	10	103·75	·40 (·4)	·21 (·2)	·20 (·2)
	15	71·81	·50 (·7)	·27 (·4)	·26 (·4)
	25	47·87	·57 (1·2)	·32 (·7)	·30 (·6)
	WL	39·18	·59 (1·5)	·34 (·9)	·32 (·8)

Appendix 18.1. *Comparison of AIDS sickness rates with graduated rates from C.M.I. 1975–78, all sickness periods*

DEFERRED PERIOD: 1 week (0 weeks for AIDS)

Attained age	C.M.I. rates	Sickness rates for AIDS (by age at 1.1.1988) 25	30	35
Projection A				
25	·196	·003		
30	·258	·048	·003	
35	·342	·326	·077	·003
40	·455	·261	·355	·077
45	·639	·092	·225	·355
50	·993	·027	·075	·225
55	1·716	·008	·022	·075
60	3·351	·002	·006	·022
Projection BC				
25	·196	·003		
30	·258	·039	·003	
35	·342	·139	·064	·003
40	·455	·129	·177	·064
45	·639	·060	·128	·177
50	·993	·021	·053	·128
55	1·716	·006	·017	·053
60	3·351	·002	·005	·017
Projection F				
25	·196	·003		
30	·258	·049	·003	
35	·342	·157	·077	·003
40	·455	·137	·191	·077
45	·639	·069	·138	·191
50	·993	·027	·063	·138
55	1·716	·009	·023	·063
60	3·351	·003	·008	·023

Appendix 18.2. *Comparison of HIV infection rates with graduated sickness rates from C.M.I. 1975–78, all sickness periods*

DEFERRED PERIOD: 1 week (0 weeks for HIV)

Attained age	C.M.I. rates	Sickness rates for HIV (by age at 1.1.1988) 25	30	35
Projection A				
25	·196	·198		
30	·258	1·784	·333	
35	·342	1·936	2·026	·333
40	·455	·840	1·757	2·026
45	·639	·263	·697	1·757
50	·993	·077	·214	·697
55	1·716	·022	·062	·214
60	3·351	·006	·018	·062
Projection BC				
25	·196	·180		
30	·258	·799	·302	
35	·342	·914	1·062	·302
40	·455	·505	·957	1·062
45	·639	·190	·457	·957
50	·993	·061	·161	·457
55	1·716	·018	·050	·161
60	3·351	·005	·015	·050
Projection F				
25	·196	·167		
30	·258	·565	·269	
35	·342	·542	·694	·269
40	·455	·296	·557	·694
45	·639	·120	·274	·557
50	·993	·042	·105	·274
55	1·716	·013	·036	·105
60	3·351	·004	·011	·036

Appendix 18.3. *Comparison of AIDS sickness rates with graduated rates from C.M.I. 1975–78, all sickness periods*

DEFERRED PERIOD: 26 weeks

Attained age	C.M.I. rates	Sickness rates for AIDS (by age at 1.1.1988) 25	30	35
Projection A				
25	·026	·001		
30	·025	·025	·002	
35	·034	·211	·041	·002
40	·058	·200	·240	·041
45	·119	·073	·174	·240
50	·268	·022	·060	·174
55	·603	·006	·018	·060
60	1·386	·002	·005	·018
Projection BC				
25	·026	·001		
30	·025	·022	·002	
35	·034	·093	·036	·002
40	·058	·095	·122	·036
45	·119	·047	·096	·122
50	·268	·016	·041	·096
55	·603	·005	·014	·041
60	1·386	·001	·004	·014
Projection F				
25	·026	·002		
30	·025	·032	·002	
35	·034	·127	·052	·002
40	·058	·121	·159	·052
45	·119	·063	·123	·159
50	·268	·025	·058	·123
55	·603	·008	·021	·058
60	1·386	·003	·007	·021

Appendix 18.4. *Comparison of HIV infection rates with graduated sickness rates from C.M.I. 1975–78, all sickness periods*

DEFERRED PERIOD: 26 weeks

Attained age	C.M.I. rates	Sickness rates for HIV (by age at 1.1.1988) 25	30	35
Projection A				
25	·026	·144		
30	·025	1·590	·245	
35	·034	1·922	1·876	·245
40	·058	·839	1·749	1·876
45	·119	·263	·697	1·749
50	·268	·077	·214	·697
55	·603	·022	·062	·214
60	1·386	·006	·018	·062
Projection BC				
25	·026	·137		
30	·025	·732	·232	
35	·034	·892	·997	·232
40	·058	·501	·942	·997
45	·119	·190	·455	·942
50	·268	·060	·161	·455
55	·603	·018	·050	·161
60	1·386	·005	·015	·050
Projection F				
25	·026	·130		
30	·025	·534	·212	
35	·034	·535	·668	·212
40	·058	·295	·553	·668
45	·119	·120	·274	·553
50	·268	·042	·105	·274
55	·603	·013	·036	·105
60	1·386	·004	·011	·036

Appendix 19.1. *Comparison of inception rates for AIDS with graduated rates from C.M.I. 1975–78*

DEFERRED PERIOD: 1 week (0 weeks for AIDS)

Attained age	C.M.I. rates	Inception rates for AIDS (by age at 1.1.1988) 25	30	35
Projection A				
25	·1152	·0001		
30	·1223	·0011	·0001	
35	·1255	·0053	·0018	·0001
40	·1268	·0027	·0052	·0018
45	·1284	·0008	·0022	·0052
50	·1327	·0002	·0007	·0022
55	·1425	·0001	·0002	·0007
60	·1619	—	·0001	·0002
Projection BC				
25	·1152	·0001		
30	·1223	·0009	·0001	
35	·1255	·0021	·0014	·0001
40	·1268	·0015	·0025	·0014
45	·1284	·0006	·0014	·0025
50	·1327	·0002	·0005	·0014
55	·1425	·0001	·0002	·0005
60	·1619	—	—	·0002
Projection F				
25	·1152	·0001		
30	·1223	·0007	·0001	
35	·1255	·0012	·0011	·0001
40	·1268	·0007	·0013	·0011
45	·1284	·0002	·0006	·0013
50	·1327	·0001	·0002	·0006
55	·1245	—	·0001	·0002
60	·1619	—	—	·0001

Appendix 19.2. *Comparison of inception rates for HIV infection with graduated rates from C.M.I. 1975–78*

DEFERRED PERIOD: 1 week (0 weeks for HIV)

Attained age	C.M.I. rates	Inception rates for HIV (by age at 1.1.1988) 25	30	35
Projection A				
25	·1152	·0024		
30	·1223	·0071	·0038	
35	·1255	·0004	·0052	·0038
40	·1268	—	·0003	·0052
45	·1284	—	—	·0003
50	·1327	—	—	—
55	·1425	—	—	—
60	·1619	—	—	—
Projection BC				
25	·1152	·0018		
30	·1223	·0025	·0029	
35	·1255	·0008	·0024	·0029
40	·1268	·0001	·0005	·0024
45	·1284	—	·0001	·0005
50	·1327	—	—	·0001
55	·1425	—	—	—
60	·1619	—	—	—
Projection F				
25	·1152	·0016		
30	·1223	·0012	·0023	
35	·1255	·0002	·0009	·0023
40	·1268	—	·0002	·0009
45	·1284	—	—	·0002
50	·1327	—	—	—
55	·1425	—	—	—
60	·1619	—	—	—

Appendix 19.3. *Comparison of inception rates for AIDS with graduated rates from C.M.I. 1975–78*

DEFERRED PERIOD: 26 weeks

Attained age	C.M.I. rates	Inception rates for AIDS (by age at 1.1.1988) 25	30	35
Projection A				
25	·0005	—		
30	·0005	·0006	—	
35	·0006	·0036	·0010	—
40	·0009	·0021	·0037	·0010
45	·0013	·0006	·0017	·0037
50	·0023	·0002	·0005	·0017
55	·0041	·0001	·0002	·0005
60	·0078	—	—	·0002
Projection BC				
25	·0005	—		
30	·0005	·0005	—	
35	·0006	·0014	·0008	—
40	·0009	·0011	·0018	·0008
45	·0013	·0005	·0011	·0018
50	·0023	·0001	·0004	·0011
55	·0041	—	·0001	·0004
60	·0078	—	—	·0001
Projection F				
25	·0005	—		
30	·0005	·0005	—	
35	·0006	·0011	·0008	—
40	·0009	·0006	·0012	·0008
45	·0013	·0002	·0006	·0012
50	·0023	·0001	·0002	·0006
55	·0041	—	·0001	·0002
60	·0078	—	—	·0001

Appendix 19.4. *Comparison of inception rates for HIV infection with graduated rates from C.M.I. 1975–78*

DEFERRED PERIOD: 26 weeks

Attained age	C.M.I. rates	Inception rates for HIV (by age at 1.1.1988) 25	30	35
Projection A				
25	·0005	·0017		
30	·0005	·0079	·0029	
35	·0006	·0006	·0063	·0029
40	·0009	—	·0004	·0063
45	·0013	—	—	·0004
50	·0023	—	—	—
55	·0041	—	—	—
60	·0078	—	—	—
Projection BC				
25	·0005	·0015		
30	·0005	·0026	·0025	
35	·0006	·0009	·0026	·0025
40	·0009	·0001	·0006	·0026
45	·0013	—	·0001	·0006
50	·0023	—	—	·0001
55	·0041	—	—	—
60	·0078	—	—	—
Projection F				
25	·0005	·0013		
30	·0005	·0013	·0021	
35	·0006	·0003	·0011	·0021
40	·0009	—	·0002	·0011
45	·0013	—	—	·0002
50	·0023	—	—	—
55	·0041	—	—	—
60	·0078	—	—	—

Appendix 20. *Present values of annuity of 1 per year payable continuously from entry age shown to age 60 or 65 for a life that has just become HIV positive or is sick with AIDS (at any duration of sickness)*

INTEREST: 6% p.a. throughout

	Positive duration 0		Sick (any duration)	
Entry age	To 60	To 65	To 60	To 65
Projections A and BC (any date)				
25	6·97	6·97	1·32	1·32
30	6·96	6·96	1·32	1·32
35	6·94	6·95	1·32	1·32
40	6·89	6·92	1·32	1·32
45	6·74	6·85	1·31	1·31
50	6·19	6·67	1·31	1·31
55	4·10	6·10	1·28	1·31
60		4·05		1·27
Projection F (as at 1.1.88)				
25	7·67	7·67	1·76	1·76
30	7·67	7·67	1·76	1·76
35	7·64	7·65	1·76	1·76
40	7·56	7·60	1·76	1·76
45	7·32	7·50	1·75	1·75
50	6·50	7·22	1·72	1·74
55	4·11	6·40	1·56	1·71
60		4·06		1·55
Projection F (as at 1.1.92 or later)				
25	7·68	7·68	2·45	2·45
30	7·67	7·67	2·45	2·45
35	7·64	7·65	2·44	2·44
40	7·56	7·61	2·44	2·44
45	7·32	7·50	2·43	2·43
50	6·51	7·23	2·38	2·42
55	4·11	6·40	2·10	2·36
60		4·06		2·08

Appendix 21.1. *Present value of benefit of 1 per week during sickness with AIDS or whilst HIV positive compared with present value of 1 per week throughout all sickness on C.M.I. 1975–78. Benefit ceasing at age 60*

DEFERRED PERIOD: 1 week (0 weeks for AIDS)
INTEREST: 6% p.a.

Age at 1.1.88	Present value of benefit (C.M.I. sickness)	Benefit for AIDS only		Benefit whilst HIV positive	
		Present value	Ratio to C.M.I.	Present value	Ratio to C.M.I.
Projection A					
25	7·45	1·71	·23	14·38	1·93
30	8·73	1·79	·21	14·96	1·71
35	10·05	1·77	·18	14·86	1·48
40	11·28	1·68	·15	14·58	1·29
45	12·20	1·39	·11	13·60	1·11
50	12·14	·59	·05	9·61	·79
55	9·46	·05	·01	1·82	·19
Projection BC					
25	7·45	·89	·12	7·40	·99
30	8·73	1·06	·12	8·75	1·00
35	10·05	1·05	·10	8·68	·86
40	11·28	·99	·09	8·48	·75
45	12·20	·81	·07	7·75	·64
50	12·14	·40	·03	5·38	·44
55	9·46	·05	—	1·29	·14
Projection F					
25	7·45	1·02	·14	4·97	·67
30	8·73	1·19	·14	5·75	·66
35	10·05	1·17	·12	5·70	·57
40	11·28	1·10	·10	5·57	·49
45	12·20	·90	·07	5·15	·42
50	12·14	·47	·04	3·83	·32
55	9·46	·06	·01	1·12	·12

Appendix 21.2. *Present value of benefit of 1 per week during sickness with AIDS or whilst HIV positive compared with present value of 1 per week throughout all sickness on C.M.I. 1975–78. Benefit ceasing at age 60*

DEFERRED PERIOD: 26 weeks
INTEREST: 6% p.a.

Age at 1.1.88	Present value of benefit (C.M.I. sickness)	Benefit for AIDS only		Benefit whilst HIV positive	
		Present value	Ratio to C.M.I.	Present value	Ratio to C.M.I.
Projection A					
25	1·61	1·17	·73	13·43	8·36
30	2·01	1·22	·61	14·00	6·96
35	2·54	1·20	·47	13·91	5·48
40	3·17	1·14	·36	13·63	4·30
45	3·83	·92	·24	12·66	3·31
50	4·22	·35	·08	8·75	2·07
55	3·60	·03	·01	1·53	·43
Projection BC					
25	1·61	·61	·38	6·93	4·31
30	2·01	·73	·36	8·23	4·09
35	2·54	·71	·28	8·16	3·22
40	3·17	·67	·21	7·96	2·51
45	3·83	·53	·14	7·24	1·89
50	4·22	·25	·06	4·95	1·17
55	3·60	·03	·01	1·14	·32
Projection F					
25	1·61	·83	·52	4·70	2·93
30	2·01	·97	·48	5·46	2·72
35	2·54	·95	·37	5·42	2·14
40	3·17	·89	·28	5·28	1·67
45	3·83	·71	·19	4·87	1·27
50	4·22	·34	·08	3·59	·85
55	3·60	·04	·01	1·01	·28

Appendix 22.1. *Present value of benefit of 1 per week during sickness with AIDS or whilst HIV positive compared with present value of 1 per week throughout all sickness on C.M.I. 1975–78. Benefit ceasing at age 65*

DEFERRED PERIOD: 1 week (0 weeks for AIDS)
INTEREST: 6% p.a.

Age at 1.1.88	Present value of benefit (C.M.I. sickness)	Benefit for AIDS only		Benefit whilst HIV positive	
		Present value	Ratio to C.M.I.	Present value	Ratio to C.M.I.
Projection A					
25	9·70	1·71	·18	14·38	1·48
30	11·75	1·79	·15	14·96	1·27
35	14·10	1·78	·13	14·90	1·06
40	16·73	1·74	·10	14·75	·88
45	19·54	1·64	·08	14·35	·73
50	22·10	1·24	·06	12·56	·57
55	23·12	·30	·01	5·11	·22
60	19·08	·02	—	·44	·02
Projection BC					
25	9·70	·89	·09	7·40	·76
30	11·75	1·07	·09	8·76	·75
35	14·10	1·06	·07	8·71	·62
40	16·73	1·03	·06	8·60	·51
45	19·54	·96	·05	8·25	·42
50	22·10	·70	·03	6·77	·31
55	23·12	·21	·01	2·66	·11
60	19·08	·02	—	·35	·02
Projection F					
25	9·70	1·02	·11	4·97	·51
30	11·75	1·20	·10	5·75	·49
35	14·10	1·18	·08	5·72	·41
40	16·73	1·15	·07	5·66	·34
45	19·54	1·07	·05	5·46	·28
50	22·10	·82	·04	4·71	·21
55	23·12	·28	·01	2·22	·10
60	19·08	·03	—	·34	·02

Appendix 22.2. *Present value of benefit of 1 per week during sickness with AIDS or whilst HIV positive compared with present value of 1 per week throughout all sickness on C.M.I. 1975–78. Benefit ceasing at age 65*

DEFERRED PERIOD: 26 weeks
INTEREST: 6% p.a.

Age at 1.1.88	Present value of benefit (C.M.I. sickness)	Benefit for AIDS only		Benefit whilst HIV positive	
		Present value	Ratio to C.M.I.	Present value	Ratio to C.M.I.
Projection A					
25	2·57	1·17	·46	13·44	5·22
30	3·30	1·23	·37	14·01	4·24
35	4·27	1·21	·28	13·94	3·26
40	5·50	1·19	·22	13·80	2·51
45	6·97	1·11	·16	13·41	1·92
50	8·49	·82	·10	11·67	1·38
55	9·45	·18	·02	4·60	·49
60	8·18	·01	—	·39	·05
Projection BC					
25	2·57	·61	·24	6·93	2·70
30	3·30	·73	·22	8·23	2·49
35	4·27	·72	·17	8·19	1·92
40	5·50	·70	·13	8·08	1·47
45	6·97	·65	·09	7·74	1·11
50	8·49	·47	·05	6·33	·75
55	9·45	·13	·01	2·46	·26
60	8·18	·01	—	·32	·04
Projection F					
25	2·57	·83	·32	4·70	1·83
30	3·30	·97	·29	5·47	1·65
35	4·27	·96	·23	5·44	1·27
40	5·50	·94	·17	5·37	·98
45	6·97	·86	·12	5·18	·74
50	8·49	·65	·08	4·46	·53
55	9·45	·20	·02	2·07	·22
60	8·18	·02	—	·31	·04