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DREAD DISEASE COVER— AN ACTUARIAL PERSPECTIVE

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1. INTRODUCTION

A Dread Disease contract pays out a lump sum on the diagnosis of any of a number of specified diseases. Those most commonly covered are heart attack, coronary artery disease requiring surgery, cancer and stroke. The benefit can take either of two main forms—it may provide an acceleration of all or part of any death benefit or it may be an additional benefit. It can be sold in conjunction with many conventional products or as a stand-alone policy.

Dread Disease contracts were originally developed in South Africa in the early 1980's, although cancer riders had previously been sold in the U.S.A., Japan and Israel. To some extent the marketing of these contracts was insensitive and preyed on people's fears in a distasteful way. This may explain some initial reluctance amongst U.K. insurers to enter this market; however with marketing literature now emphasizing more positive aspects, this appears to have been overcome.

Unlike conventional life assurance and Permanent Health Insurance, Dread Disease covers do not meet any specific need or indemnify the claimant against any loss of earnings or any expenses incurred. Neither does the claimant have to fulfil any criteria for disability—Dread Disease covers pay out on *diagnosis* regardless of the extent of ill-health. Indeed the marketing literature for one product stresses that you can "receive your life assurance before you die" and others suggest that the claimant could return to work the following day with a much healthier bank balance! This promotional emphasis may hide the fact that in some cases Dread Disease cover can meet a genuine need—for example, to pay medical expenses, to allow prolonged convalescence or early retirement, to purchase special equipment or to modify one's home. However, it can be seen as incomplete in that the insured may suffer a severe and debilitating disease that is not covered by the contract.

The interest generated by Dread Disease products both in the U.K. and overseas has demonstrated a market for the benefit, particularly in the direct sales sector. It may be that it fills a gap that conventional life assurance cannot. For example a single person without dependants may have no need for life cover beyond a mortgage, but be worried about the financial hardship of a serious illness. In these circumstances the relative simplicity of a lump sum payment on diagnosis of a Dread Disease may be more attractive than Permanent Health Insurance.

Throughout its development, Dread Disease cover has been a marketing-led

concept. In this paper we give an actuarial perspective to the process of developing an innovative product. Inevitably this goes wider than the purely actuarial function and other disciplines such as marketing and underwriting are considered as part of the process.

We commence with a brief consideration of the diseases to be covered, followed by some thoughts on product design for both individual and group business. We then look at the data available and derive a suitable costing basis. Sample premium rates are shown and all the data used is set out in Appendix 3. Subsequent sections cover miscellaneous topics including underwriting, valuation and a look into what the future may hold for this product. Throughout the paper we are primarily concerned with the U.K., although many of the principles will be more widely applicable.

2. THE DISEASES TO BE COVERED

2.1 Any disease to be included in a Dread Disease contract should satisfy the following criteria, which reflect marketing, medical and actuarial considerations:

(*a*) It should be perceived by the public as a disease that could afflict them and one that could then leave them in need of a lump sum.
(*b*) It should be capable of clear and precise definition.
(*c*) There should be adequate data for costing.
(*d*) It should not allow antiselection by applicants.

As stated earlier, the four main diseases included in contracts are heart attack, coronary artery disease requiring surgery, cancer and stroke. Other diseases that may be considered suitable include kidney failure, paralysis and major organ transplantation.

One way of making the product more 'complete' is to incorporate a total and permanent disability benefit. Thus the policyholder will be able to claim in the event of severe disability even if this is not caused by one of the specified diseases.

2.2 It is imperative that the definitions used are sufficiently rigorous to exclude potential claims that have not been allowed for in the premium rates. It is interesting to note that the early claims in South Africa showed some evidence of non-disclosure, prompting a tightening-up of policy definitions. Specimen definitions of the above diseases are given below. Claims may be admitted even where the definition is not fully satisfied, but tight definitions are necessary to allow further investigation of dubious claims.

Heart Attack

"The death of a portion of heart muscle as a result of inadequate blood supply to the relevant area. The diagnosis must be based on all of:

(*a*) a history of typical chest pain;
(*b*) new electrocardiographic changes;
(*c*) elevation of cardiac enzymes."

Coronary Artery Disease Requiring Surgery

"The undergoing of surgery to correct narrowing or blockage of two or more coronary arteries with bypass grafts in persons with limiting anginal symptoms, but excluding non-surgical techniques such as balloon angioplasty or laser relief of an obstruction."

Cancer

"A malignant tumour characterized by the uncontrolled growth and spread of malignant cells and the invasion of tissue. This includes leukaemia (other than chronic lymphocytic leukaemia), but excludes non-invasive cancers *in situ*, tumours in the presence of any human immuno-deficiency virus and any skin cancer other than malignant melanoma."

Stroke

"Any cerebrovascular incident producing neurological sequelae lasting more than twenty-four hours and including infarction of brain tissue, haemorrhage and embolisation from an extra-cranial source. There must be evidence of permanent neurological deficit."

Kidney Failure

"End stage renal disease, due to whatever cause or causes, with the life assured undergoing regular peritoneal dialysis or haemodialysis or having had renal transplantation."

Paralysis

"Complete and permanent loss of use of two or more limbs (alternatively 'arms and legs') through paralysis."

Major Organ Transplantation

"The actual undergoing as a recipient of a transplant of a heart, heart and lung, liver, pancreas, kidney or bone marrow."

Total and Permanent Disability

"The insured has become permanently, totally and irreversibly disabled prior to his 65th birthday and is thereby totally incapable of being employed or engaged in any work or occupation whatsoever for remuneration or profit. Such disablement must have continued without interruption for twelve consecutive months or for such longer period as the company may reasonably require to establish that a claim falls within this definition."

2.3 Other diseases which have been considered for Dread Disease products are Multiple Sclerosis and Alzheimer's Disease. These afflictions differ from the diseases considered above in that they have a long stage of development whereas the usual Dread Diseases result from an *event* such as a heart attack or an organ transplant operation. Thus diagnosis of Multiple Sclerosis and Alzheimer's

Disease is difficult and the actual stage at which diagnosis is made may not match that assumed in the costing of a Dread Disease product.

These difficulties could leave an insurer with claims admittance problems unless the definitions are strict enough. This effectively means that the claim is paid only in the later stages of the disease, but then a Total and Permanent Disability claim may well be triggered instead. There may be no real advantage, therefore, in covering Multiple Sclerosis or Alzheimer's Disease as well as Total and Permanent Disability, other than for apparent product differentiation.

If such progressive diseases are to be included then the product literature should make clear that the benefit will be paid only at the end-stage of the disease, otherwise the office could be open to criticism for failing to meet policyholders' reasonable expectations.

3. PRODUCT DESIGN: INDIVIDUAL BUSINESS

The first question to be addressed when considering the introduction of a Dread Disease benefit is whether to issue a 'stand-alone' product or to attach the cover to an existing contract. In the latter case, one must also decide on which policy (or policies) and whether to offer the Dread Disease benefit in addition to or as an acceleration of the attaching life cover: these questions are not independent since some combinations of cover may have particular marketing appeal.

3.1 Before we look at specific product designs, let us first consider several general matters:

(*a*) *Acceleration or Addition*

The advantages of offering the Dread Disease benefit as an acceleration of the death benefit are as follows:

(i) The cost of the Dread Disease cover is substantially lower than for an additional benefit, increasing sales potential.

(ii) Any uncertainty in the premium rates charged may be reduced for an acceleration benefit where we are concerned only with the addition required to the mortality rate.

However, there are also advantages to offering an additional benefit:

(i) Dread Disease can be sold in conjunction with contracts that do not contain life cover.

(ii) After suffering a Dread Disease the policyholder may be uninsurable or subject to a high rating so that the continuation of all of the life cover (where applicable) would be extremely valuable to him.

(iii) Premium income is increased.

Two problems can arise with an additional benefit if death occurs soon after the incidence of a Dread Disease. First, if there is attaching life cover then the payment of both claims may result in unnecessarily large benefits,

since there will be insufficient time for the Dread Disease benefit to be used for any of the purposes suggested in the introduction. Second, there could be difficulties in verifying the validity of a Dread Disease claim—for example, although the death certificate could record 'heart attack' as the primary cause of death it may not be clear that this event satisfied the required definition of a Dread Disease.

Both of these problems can be overcome by making the Dread Disease benefit subject to the claimant surviving a deferred period of, say, 90 days. Where the contract includes life cover there is an alternative that may prove a more attractive marketing proposition; this is to pay the Dread Disease claim immediately on diagnosis as an acceleration of the corresponding amount of life cover but then to reinstate the full death benefit after the deferred period.

(*b*) *Benefit Limitation*

In order to limit the antiselection under Dread Disease contracts, it is generally considered advisable to limit the maximum benefit allowed under a contract. The policy should also allow for a reduced payment where the claimant has other policies (including group cover). A maximum benefit of £100,000 is commonly applied in the U.K., although some products do allow higher sums. Underwriting, both financial and medical, should be stricter if the sum assured exceeds the market norm.

(*c*) *Options*

It has become customary to offer the policyholder various opportunities to increase his life cover, although these have recently been restricted as a result of AIDS. These options can also apply to Dread Disease cover, although it may be necessary to adopt additional restrictions to limit antiselection.

Such options include increasing the sum insured by up to a fixed maximum percentage of the original cover on such events as marriage or childbirth. Following these increases the benefit limitation noted in (*b*) above should still be applied, so that offices may prefer to limit the initial sum insured to a lower level than that suggested to enable the options to still be exercised.

Another common option is to increase the sum insured each year in line with the increase in the general level of prices (perhaps subject to a fixed maximum increase). This option can be applied to Dread Disease cover, although it should be lost if missed in any year. Offices may be happy not to apply the benefit limitation each year on the basis that the maximum benefit can increase in line with inflation.

There is so far no evidence as to the scale of antiselection on Dread Disease policies relative to that for ordinary life cover, so that it is even more difficult to price any options offered. This problem also needs to be

considered where a contract offers renewability of Dread Disease cover. A particular example of this is if a Flexible Whole Life contract with Dread Disease acceleration is available on a 'maximum cover' basis. The units are expected to be exhausted at the first review date so the contract is then effectively renewable. Furthermore, it is likely that a high level of deficiency reserves will be required in such cases, to prevent problems of selective persistency if significant premium increases are required at the review date.

(*d*) *Qualifying status*

Where the main contract to which the Dread Disease benefit is to be attached is a life policy, its qualifying status must be considered. Since the removal of Life Assurance Premium Relief (LAPR) in 1984, there is little advantage in restricting the design of protection-type policies in order to satisfy the necessary conditions. However, for higher-rate taxpayers, qualifying status is still desirable for savings-orientated contracts.

Schedule 15 of the Income and Corporation Taxes Act 1988 states that:

"Subject to the following provisions of this Part of this Schedule, if a policy secures a capital sum which is payable only on death, *or one payable either on death or on earlier disability*, it is a qualifying policy if . . ."

It is our understanding that this is interpreted by the Revenue as permitting only a policy where the Dread Disease benefit is a 100% acceleration of the death benefit.

Where a non-qualifying policy is issued, the taxation position is as follows. Section 539 of the Income and Corporation Taxes Act 1988 states that maturity, surrender, part surrender or death give rise to a chargeable event, so that the payment of a lump sum on disability does not constitute a chargeable event. This appears to be a loophole in the legislation and one might, therefore, expect this to be amended in due course, so that diagnosis of a Dread Disease would be treated similarly to death.

3.2 In theory, a Dread Disease benefit could be attached to most life assurance products, or alternatively sold as a stand-alone product. However, some products have particular marketing potential and we shall consider these now. The premium rates are obviously a crucial factor in deciding on product design, so we shall attempt to illustrate the relative cost for certain policies. A unit-linked approach has been adopted in each case, details of this are set out in Appendix 1. Realistic charges for the four main Dread Diseases have been incorporated, their derivation is set out in Section 6. A contingency margin of 10% has been included in the charges.

(*a*) *Stand-alone policy*

Issuing a stand-alone Dread Disease product at the current time may represent a high-risk/high-reward strategy. The initial costs involved in

introducing a specific new product are likely to be higher than if an existing policy is extended to include this cover. Further, a stand-alone policy will have to bear its full share of development costs and acquisition expenses, so that a policy including other benefits may offer better value for money. However, if Dread Disease cover proves popular then the stand-alone product may be better positioned to achieve high sales, particularly to individuals with no further perceived need for life cover.

In the absence of reliable assured lives' experience it may not be appropriate to issue a stand-alone policy on a long-term guaranteed basis. Instead a five-year renewable contract or a unit-linked product with reviewable charges may be considered. The cost of the latter is illustrated below; this will be compared with the cost for term assurance covers in (*b*). It has been assumed that a deferred period of 90 days applies and that there is a death benefit equal to the value of units. Monthly premiums for a sum assured of £50,000 are as follows:

Male 30 next, term 10 years	£6.19
Male 30 next, term 25 years	£13.77
Male 50 next, term 10 years	£46.90

(*b*) *Term Assurance*

A term assurance plus Dread Disease package may prove attractive as a relatively low-priced protection policy. The Dread Disease benefit could be either an addition to or an acceleration of the life cover, and the relative advantages listed earlier must be considered.

The cost of including Dread Disease cover is illustrated below for various forms of benefit. Monthly premiums for a sum assured of £50,000 are as follows:

Benefit	*Male 30 next, Term 10 years*	*Male 30 next, Term 25 years*	*Male 50 next, Term 10 years*
Life cover only	£6.33	£11.69	£42.73
with 100% acceleration	£9.42	£18.58	£63.73
with 50% additional	£8.44	£17.14	£65.19

The cost of alternative proportions of Dread Disease cover can be obtained by interpolation. It can be seen that the acceleration of a low proportion (say 25%) of the death benefit adds little cost to the basic term assurance cover and this could, therefore, prove a useful marketing tool.

Where a contract is designed to be marketed specifically as a Dread Disease product, then the inclusion of life cover significantly increases the cost of the stand-alone product considered in (*a*). This comparison also needs to take into account the effect of AIDS, which has been omitted from the cost of life cover for simplicity. This clearly increases the relative attraction of the stand-alone product.

(*c*) *Flexible Whole Life contract*

It is customary for a Flexible Whole Life contract to include optional benefits such as Permanent Health Insurance, Waiver of Premium, Double Accident Benefit and Total and Permanent Disability benefit. Regular deductions are made from the unit fund to charge for mortality and the other benefits; these deductions are not guaranteed (other than any implicit guarantee for policies on the maximum sum assured).

It should not, therefore, prove administratively difficult to include the option of Dread Disease cover under the contract. Further, the lack of guarantees on the charges may make this route attractive to the actuary, at least until reliable assured lives' experience is available. The Dread Disease cover could be on either an additional or an acceleration basis.

However the inclusion of Dread Disease cover may have little impact on sales. Optional additional benefits have not generally sold well on such a contract since the agent or intermediary may not wish to complicate a sale by introducing a new concept at a late stage. There is an advantage in that this does allow some pre-underwriting by the agent; for example, if earlier enquiries elicit an adverse family history of heart disease, Dread Disease cover may not be mentioned.

The cost of including Dread Disease cover is illustrated below. Monthly premiums for a sum assured of £50,000 are as follows:

Benefit	*Male 30 next*	*Male 50 next*
Life cover only	£6.69	£42.87
with 100% acceleration	£10.06	£63.27
with 50% additional	£8.99	£65.16

(*d*) *Mortgage Endowment contracts*

Dread Disease cover could be added to either conventional low-cost endowment assurances or unit-linked mortgage plans. In the former case the charges for Dread Disease would presumably be guaranteed (as are the mortality charges), with any variation in the experience from that anticipated reflected in the surplus distribution. In the unit-linked plan the charges would not be guaranteed and the premium is reviewed periodically to ensure the required maturity value is achieved.

The obvious product design is to provide 100% acceleration of the guaranteed death benefit on diagnosis of a Dread Disease, thus enabling the mortgage to be paid off. Specimen monthly premiums for a £40,000 contract are as follows:

Benefit	*Male 30 next Term 25 years*	*Male 50 next Term 10 years*
Life cover only	£59.30	£268.20
with 100% acceleration	£62.41	£277.48

It can be seen that only a relatively small increase in the premium is

required. This is not surprising, of course, since the majority of the premium is required to fund the maturity value. We feel that such a product presents an attractive concept which may be particularly beneficial to offices seeking a marketing advantage through product differentiation.

(*e*) *Permanent Health Insurance*

The payment of a lump sum on diagnosis of a Dread Disease followed by a regular income whilst the insured remained unable to work may present an attractive marketing concept. It is possible that the removal of stress as a result of receiving a Dread Disease benefit may improve the PHI claims experience, however the opposite appears more likely due to the reduced incentive to return to work.

The product development actuary is thus caught in a dilemma. Can he devise a combination of these benefits that will meet the real needs of the policyholder and offer value for money yet at the same time not cause any significant deterioration in the PHI claims experience?

Firstly it seems advisable to maintain the financial incentive to return to work by restricting the lump sum Dread Disease benefit in relation to the PHI benefit that may also be received—perhaps to 12 or 24 months' PHI benefit. Secondly, paying the Dread Disease benefit in instalments may also have a positive effect on PHI experience. For example, half could be paid on admission and half at the end of the deferred period (or earlier return to work or death). Alternatively the nature of the PHI benefit could be complemented by paying the Dread Disease benefit as an income throughout the PHI deferred period followed by the remainder as a lump sum.

4. PRODUCT DESIGN: GROUP BUSINESS

The questions considered at the start of Section 3 also apply here. In group business, however, the fundamental decisions on product design may result more from the legal framework than from actuarial and marketing considerations. We shall, therefore, commence by setting out our interpretation of the relevant legislation in the U.K. We should stress that this represents a personal view and should not be regarded as definitive.

4.1 Under Section 20(1) of the Finance Act 1970, the Board of Inland Revenue have discretion as to the conditions a scheme must meet in order to obtain 'exempt approved' status. In particular, under Section 20(2), a scheme can provide a lump sum on death in service, whilst under Section 20(2)(d) it can provide benefits on incapacity prior to retirement. We would be very surprised, however, if the Revenue were to approve a scheme containing Dread Disease cover, primarily because of the possibility of the cover providing benefits when the claimant was not 'incapacitated' to the extent of needing to take early retirement.

As a result, the scope for Group Dread Disease cover in the U.K. would appear to be restricted to employers wishing to offer benefits outside the pension scheme. Acceleration products may only have appeal where there is little or no existing life cover; additional cover could be sold in conjunction with Permanent Health Insurance or Medical Expenses contracts or as a stand-alone product.

4.2 It is our understanding that the taxation position for a stand-alone contract would be as follows:

(*a*) The premium could be considered an allowable expense, if it is payable by the employer.
(*b*) The premium would then be taxable as a 'benefit in kind' in the hands of the employee.
(*c*) Lump sum Dread Disease benefits would be free of tax if paid direct to the individual. If the payment passed through the accounts of the employer then a tax charge would arise on the claim amount which might not be offset by relief on the payment to the individual.

This situation could be complicated if the Dread Disease cover was sold attached to another form of benefit.

4.3 The target market for Group Dread Disease is potentially large, for example it could be marketed to any group between the following extremes:

(*a*) Executives and other senior employees who have comprehensive final salary pension arrangements and ancillary benefits, or
(*b*) Companies without PHI or Medical Expenses cover, as a cheaper but less comprehensive alternative.

4.4 At the time of writing, no group arrangement has been issued in the U.K. so that the marketing appeal remains open to question. Contracts have been written elsewhere in the world including South Africa. We shall now consider various aspects of group business basing our comments on the contracts written in South Africa, and the limited experience that has emerged.

(*a*) *Free Cover.* Group Dread Disease appears to offer some scope for antiselection. For example groups of senior executives may opt for Dread Disease cover because they perceive their stressful jobs put them at risk from heart attack. The experience in South Africa appears to bear this out. Thus it seems advisable to restrict Dread Disease free cover to say half that offered for group life. Also, it would seem appropriate to require a higher scheme membership before free cover is offered than for group life.
(*b*) *Benefit Limitation.* For the same reasons it seems advisable to restrict Dread Disease benefit to say twice salary with an overriding maximum not more than that available in the Individual market.
(*c*) *Pre-Existing Conditions.* It is essential that a clause is included in the policy to exclude claims resulting from conditions diagnosed prior to entry. All

the South African contracts include such a clause, a suitable wording might be as follows:

> "No benefits shall be payable in respect of any claim arising within two years of entry into the scheme which, in the opinion of the company's Chief Medical Officer, results directly or indirectly from a condition for which the member had previously received treatment or of which he was aware at entry."

It must be considered whether to extend this clause to cover increases in benefit—generally those resulting solely from salary increases would be allowed.

(*d*) *Previous incidences.* It is imperative that the cover should preclude the possibility of paying a claim on other than the first incidence of Dread Disease, regardless of whether the earlier incidence occurred before the individual was covered or whether he was covered by this or another insurer.

5. THE COSTING OF A DREAD DISEASE PRODUCT: DATA

The introduction of any new concept such as Dread Disease Cover into the insurance market causes interesting problems for the actuary, not least because no insured experience is available on which to base premium rates. Further, the nature of a Dread Disease product requires data such as incidence rates of Dread Disease that are not even available for the U.K. population or only in limited form.

The actuary is then forced to design a costing model making the best use of available statistics. Assumptions will have to be made on several parameters as well as the application of population statistics to insured lives, perhaps with little evidence to justify them. The model should be constructed and tested so that the final premium rates are not overly sensitive to the impact of these assumptions.

In the following section we outline a number of possible methods for calculating premium rates for Dread Disease cover. They vary in terms of which of the available statistics are used and the assumptions made in order to complete the model. It may be useful to outline first some of the data available to the actuary for this purpose. We will consider only the most significant Dread Diseases—Heart Attack, Cancer and Stroke—at this stage. The data is set out in Appendix 3.

5.1 *Incidence Rates*

It is obvious that we will need a measure of the probability of being diagnosed as having a Dread Disease in the year of age x to $x+1$.

The Office of Population Censuses and Surveys (OPCS) publishes morbidity data from hospitals and General Practices. For cancer the very detailed publication 'Cancer Registrations'[1] gives first-time diagnosis rates in five-year age bands separately for males and females and for each type of cancer. This allows us to pick out the data relevant to a Dread Disease product; our suggested definition in chapter 2 covers malignant neoplasms except of the skin. Diseases are classified according to 'International Classification of Disease' (ICD) numbers and the relevant numbers and data are shown in Table 1 of Appendix 3. Note that these are 'first-time' incidence rates which are appropriate since a Dread Disease product pays out only when a disease is diagnosed for the first time.

Such detailed data is not available for the other Dread Diseases. However, another OPCS publication 'Morbidity Statistics from General Practice'[2] does give 'Episodes (type 2 and 4) incidence rates per 1,000 persons at risk' split by sex but in broad age bands for a variety of diseases. The precise definition of these rates is important. 'Episodes' are defined as face-to-face contact between doctor and patient including contact in hospital. 'Types 2 and 4' means these rates identify the first time ever the condition occurred. (So, for example, a patient rushed to hospital with a first heart attack would be accounted for, as would an immediate death following a first stroke or a first heart attack, whether that occurred at home or in hospital.) Thus these rates do correspond with the cover in a Dread Disease product. Again the necessary figures are in Table 1. (Appendix 3).

It might be thought that the Hospital In-Patient Enquiry (HIPE) would be a good source of data for incidence rates, particularly since the data is not in such broad age-brands as the General Practitioners survey. However, to be included in the relevant HIPE measure (the 'discharge rate') a patient must undergo a full hospital admission procedure, so that immediate deaths would not be counted. Further, first time incidences cannot be separated out and double counting due to multiple admittance of the same person in one year could be significant. We have, therefore, used figures from the General Practitioners survey, as their definition matches more precisely what is required for the costing of a Dread Disease product.

5.2 *Mortality after a Dread Disease*

For an additional or stand-alone benefit we are interested only in the incidence of Dread Disease, but for an acceleration benefit we need further data. The intuitively obvious way of costing an acceleration product is to construct a multiple decrement table with decrements being diagnosis of a covered disease, deaths of those who have suffered a Dread Disease, and deaths of healthy lives. Thus, we need the mortality experience of Dread Disease sufferers.

The OPCS publication, 'Cancer Survival 1981'[3] gives detailed survival rates for cancer sufferers by site. It is, therefore, possible to adjust the 'All sites' rate to remove skin cancer, in line with the policy conditions suggested in Section 2.

Crude Survival Rates (per cent) for cases registered in 1981
All sites (excl. skin): ICD 140–172 and 174–208

	Males			*Females*		
Age	*1-year*	*3-year*	*5-year*	*1-year*	*3-year*	*5-year*
15–24	80·4	65·8	61·3	85·4	71·5	67·8
25–34	79·8	67·6	63·1	85·5	71·4	66·1
35–44	64·2	50·7	46·7	83·4	65·4	58·6
45–54	50·5	35·1	30·7	73·2	53·5	46·1
55–64	43·3	27·5	22·3	61·4	43·1	36·4
65–74	39·1	23·1	17·4	51·3	36·0	29·3
75–84	33·6	17·7	11·8	38·9	25·8	19·3

Crude survival rates represent the percentage of registrations alive at the end of each time span with a correction made for those registrations which are withdrawn.

As would be expected the mortality rates are highly dependent on duration since diagnosis of cancer, and data is not published for durations intermediate to those shown above. In particular, the mortality in the first year is likely to be highly non-linear. Although the data for cancer is not complete, even less detail is available for the other Dread Diseases. We have found studies of the mortality rates after heart attack and stroke, but all are imperfect for one or more of the following reasons:

(*a*) A specific group of lives has been studied so the results may not be appropriate for an insured portfolio.
(*b*) The classification of heart attack or stroke is not the same as in a Dread Disease policy.
(*c*) The results are presented in wide age bands.
(*d*) The results are not separated by duration since diagnosis.

The American publication 'Medical Risks' by Singer and Levinson[4] collates the results of a large number of studies into mortality after the onset of certain diseases, including those in which we are interested. However, the problems noted above apply to all of these.

Haberman[5] reports on a project that combined a number of studies into the mortality of those who had suffered a stroke. His results gave ratios of the mortality rates of those who suffered strokes (excluding the first year after onset) to those who had not. The following values are for the first attack and cover lives with no previous history of heart failure.

Age at onset	*All cerebrovascular disease*	*Cerebral infarction*	*Cerebral embolism*	*Cerebral haemorrhage*	*Subarachnoid haemorrhage*	*Transient ischaemic attacks*
40	425	955	1,100	365	225	280
50	315	583	880	280	175	215
60	220	360	540	205	125	150
70	175	220	335	130	100	100
80	105	140	205	100	100	100

These illustrate the importance of using data corresponding to the policy definitions since the probability of survival is much higher for transient ischaemic attacks than for the incidents covered.

The wide variance in the results and the problems with the data listed above suggest it would not be advisable to base premium rates directly on the statistics of the mortality of Dread Disease sufferers.

5.3 *Proportions of deaths due to Dread Disease*

Considering again the multiple decrement table, we need the mortality rates of those who have suffered a Dread Disease and of healthy lives. The OPCS publication 'Mortality Statistics by Cause'[6] gives numbers of deaths for each cause for each sex in five-year age bands. The most useful statistic for our purpose will be the proportions of deaths due to the Dread Diseases and the relevant figures are in Table 2 of Appendix 3.

The ICD numbers for 'heart attack' cover ischaemic heart disease as well as acute myocardial infarction. We have used this wider definition because the recording of cause of death on death certificates is thought to be inconsistent. Ischaemic heart disease may follow a heart attack but on death some doctors will record the first attack, others the subsequent episode.

The CMI bureau publishes similar statistics for assured lives and this is obviously pertinent for an insurance product. The most recent figures are in CMI Report No. 9.[7] The data is in broad age bands but we know the distribution of the assured lives studied within these age bands. We can, therefore, combine the population figures in the same age distribution and compare as follows:

Dread Disease deaths as a percentage of total deaths
(Male lives)

Age	*CMI (1)*	*Population (2)*	*100 × (1)/(2)*
Up to 44	49·9	42·2	118
45–59	74·9	75·7	99
60–74	75·0	76·1	99

CMI figures are medical and non-medical combined for causes of death Stroke, Heart and All Neoplasms. Durations 1+ are taken although the split in age groups for durations 1–4 is approximate.

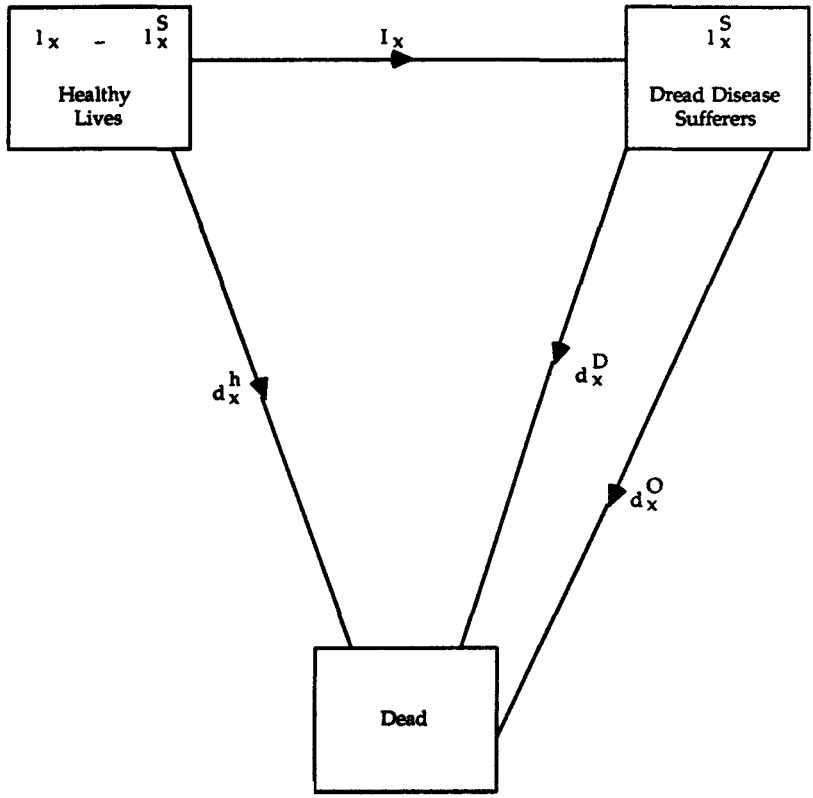
This suggests the population data is suitable to use unadjusted for assured lives in all but the youngest age group. We believe there to be a further complication for this group in that the accident rate is higher in the population because of occupations less frequently found in an assured portfolio. This effect accounts for about 13% of the 18% difference shown above which suggests we should increase the population cause of death proportions by 5% up to age 44 to apply to assured lives.

For females the CMI data is too sparse to draw any firm conclusions and we suggest the same 5% adjustment could be applied to the youngest age group.

6. THE COSTING OF A DREAD DISEASE PRODUCT: METHODS AND PREMIUMS

6.1 *Acceleration Benefit*

The intuitive approach for costing an acceleration benefit is to build up a multiple decrement table for a population of insured lives denoted by l_x:



The decrements are:

I_x = number of incidences of Dread Disease from the population of healthy lives.

d_x^h = number of deaths among healthy lives.

d_x^D, d_x^O = number of deaths from the population of Dread Disease sufferers due to Dread Disease and other causes respectively.

It can be seen that the total claims on a Dread Disease acceleration product per unit sum assured are simply:

$$I_x + d_x^h$$

Note that our definition of I_x includes 'sudden deaths' so for example a life who dies instantly from his first heart attack will be counted in both I_x and d_x^D. This means that all Dread Disease deaths are counted in d_x^D. We therefore know that:

$$d_x^D = k_x d_x$$

where $d_x = q_x l_x$ and q_x = mortality rate of insurance population l_x.
k_x = proportion of deaths due to Dread Disease in the population l_x.

Further, considering the deaths due to causes other than Dread Disease:

$$d_x^h + d_x^O = (1-k_x)d_x$$

Hence the total claims cost can be re-expressed as

$$I_x + d_x^h = I_x + (1-k_x)d_x - d_x^O$$

As noted earlier, we have reliable data for I_x and k_x. Further, d_x follows from the assumption of insured lives mortality used in costing the basic life cover. To complete our costing we need values for d_x^O for which we do not have any data which can be used directly. Thus we have to deduce acceptable values for d_x^O and this is the point at which the existing methods of costing Dread Disease have varied. We now consider three different approaches and the merits of each.

(*a*) *Mortality of Dread Disease sufferers*

Here we make use of the data that is available on the mortality experience of those who have suffered a Dread Disease. This gives us figures for the sum of the mortality rates:

$$\frac{d_x^D}{l_x^S} + \frac{d_x^O}{l_x^S}$$

Now since

$$d_x^h = d_x - d_x^D - d_x^O$$

we have all the elements required to build a multiple decrement table from which we can extract the required rates directly.

The difficulty with this approach is that the data is insufficient to have confidence in the rates as discussed in Section 5.2. (This method may be practical in other territories, if reliable data is available.) Because of this difficulty we shall consider alternative methods that do not directly use the mortality after a Dread Disease.

(*b*) *Proportions of Deaths*

Suppose we define a factor f_x as the proportion of deaths among Dread Disease sufferers attributable to Dread Diseases in the year of age x to $x+1$.

$$f_x = \frac{d_x^D}{d_x^O + d_x^D} = \frac{k_x d_x}{d_x^O + k_x d_x}$$

Thus d_x^O is found if we can arrive at suitable values for f_x. It has been suggested elsewhere that f is relatively constant between ·80 and ·85 for many ages. Unfortunately we have been unable to locate any data to validate this. However, extending the method explained in the following section suggests that f is almost unity. This highlights the danger in relying on assumptions to which the premium rates will be sensitive since the higher value for f results in significantly higher premiums.

(c) *Extra Mortality*

A different approach is to compare the mortality of Dread Disease sufferers from causes other than Dread Disease with the mortality of healthy lives. Suppose the former exceeds healthy lives' mortality by an extra mortality of m:

$$\frac{d_x^O}{l_x^S} = \frac{d_x^h}{l_x - l_x^S}(1-m)$$

We also have

$$d_x^h + d_x^O = (1-k_x)\, d_x$$

and eliminating d_x^O from these equations gives

$$\frac{d_x^h}{l_x - l_x^S}(l_x + m l_x^S) = (1-k_x)\, d_x$$

Thus if we know m and l_x^S then we know d_x^h and the first equation gives d_x^O completing the values needed. If we continue the algebra then we can find the net premium rate for a Dread Disease acceleration benefit:

$$\frac{I_x + d_x^h}{l_x - l_x^S}$$

$$= \frac{I_x}{l_x - l_x^S} + \frac{(1-k_x)q_x l_x}{l_x + m l_x^S}$$

$$= i_x + \frac{(1-k_x)q_x}{1 + m l_x^S l_x}$$

where i_x is the incidence *rate* of Dread Disease.

If $m = 0$ then the rate can be expressed simply as:

$$i_x + (1-k_x)q_x$$

so that the extra premium over the mortality rate is:

$$i_x - k_x q_x$$

As we will show later, the values of l_x^S/l_x are small so the assumption for m is not critical. However, it would appear likely that $m>0$, since Dread Disease sufferers could be more prone to accidents than healthy lives. Taking $m=0$ simplifies the algebra and incorporates a margin since the premium rates will be slightly higher than if we take $m>0$.

We believe that this method is the most robust of those considered and we shall now proceed to produce premium rates on this basis.

We first need to graduate the population incidence rates and adjust them for use on insured lives. This process is fully described in Appendix 2 for those who are interested in the details.

We shall use the following assumptions in calculating the premium rates:

1. q_x—take 80% A67/70(2) Ult for male lives and 95% FA75/78 Ult for female lives.
2. k_x—take population figures in Table 2 increased by 5% at ages 44 and under.
3. i_x—take population figures in Table 4 and multiply by the ratio of the Dread Disease mortality rate for insured lives to that of the population. (q_x for the population taken as ELT No. 14). Rates increased by 5% to allow for this approximation. (See Appendix 2.)

The value of $i_x-k_xq_x$ can be calculated for each impairment—Cancer, Heart Attack Stroke—then the three rates totalled to give an overall rate for the cover. We find that at ages over 70, our data gives negative figures for heart attack i.e.

$$i_x < k_xq_x \text{ for } x > 70$$

Dread Disease deaths at a certain age can exceed incidences at that age because of deaths arising from incidences at younger ages. This is not unreasonable on a population basis but is clearly inappropriate for lives entering insurance at older ages. In practice, the negative figures can be set at zero before totalling the rates, since the maximum entry age for Dread Disease products would be restricted to say 55 or 60.

The additions to the mortality rates for a Dread Disease benefit with 100% acceleration of the life cover using the formula $i_x-k_xq_x$ are shown below. These are also shown as a percentage of the mortality rate for interest.

	Males		*Females*	
Age	*Dread Disease rate per mille*	*% of* q_x	*Dread Disease rate per mille*	*% of* q_x
25	·23	41	·33	100
30	·32	61	·61	135
35	·57	83	·78	117
40	1·25	108	1·12	110
45	2·38	113	1·68	105
50	3·40	89	2·39	93
55	3·98	59	3·24	78
60	5·02	43	4·17	62
65	6·30	33	5·17	48
70	7·60	24	6·87	39

To investigate the sensitivity of these rates to the value of m, consider the following values of ${}^{m}I_x/l_x$ for male lives. These have been obtained by constructing the multiple decrement table suggested at the start of this section.

Age	m=*0*	m=*1*	m=*5*
25	·0013	·0013	·0013
30	·0027	·0027	·0027
35	·0046	·0046	·0046
40	·0086	·0086	·0085
45	·0171	·0170	·0168
50	·0317	·0316	·0310
55	·0503	·0500	·0487
60	·0739	·0730	·0701
65	·1068	·1046	·0984
70	·1512	·1459	·1321

These low values demonstrate that the method is not overly sensitive to the value of m chosen except perhaps at the older ages. We propose that $i_x - k_x q_x$ is a suitable formula by which to cost the extra premium for this benefit. Taking $m=0$ in this way incorporates a small margin which should be borne in mind when loading the rates for contingencies and profit. Although we have started from adequate base data and have proved that our final premium rates are insensitive to the assumptions made, given the lack of experience in this product the actuary is likely to use a higher contingency margin than for life or PHI products where the costing methods are more established and insured experience is available. The level of contingency margin will depend on the extent of any guarantees on the rates.

6.2 *Stand-alone or Additional Benefits*

The cost of a benefit which pays out on diagnosis of a Dread Disease in addition to any attaching life cover is simply the incidence rate of the diseases covered. We have previously derived appropriate incidence rates so this benefit is very easily costed.

A minor complication arises from the use of a deferred period after diagnosis. The incidence rate must be reduced by the mortality rate in the deferred period. However as explained earlier, insufficient data is available on mortality after a Dread Disease. In practice an arbitrary 10% reduction from the incidence rates seems reasonable for a deferred period of 90 days.

On this basis and using the assumptions set out on the previous page, the rates for a stand-alone benefit are as follows. These rates are again shown also as a percentage of the mortality rate.

	Males		*Females*	
Age	*Dread Disease rate per mille*	*% of* q_x	*Dread Disease rate per mille*	*% of* q_x
25	·30	54	·40	122
30	·40	76	·74	163
35	·76	111	1·05	158
40	1·70	147	1·62	159
45	3·38	160	2·51	157
50	5·60	146	3·81	149
55	8·25	122	5·65	137
60	12·59	109	8·20	123
65	18·86	98	11·78	108
70	26·50	85	17·58	99

7. THE COSTING OF A DREAD DISEASE PRODUCT: FURTHER REFINEMENTS

7.1 *Other Impairments*

Impairments other than cancer, heart attack and stroke which have so far been included in Dread Disease policies generally have a very low incidence rate. The additional charge may then be taken as zero, i.e. the cost of any claims under the additional impairments is deemed to be met from margins elsewhere. Examples of low-cost impairments are:

Kidney Failure—by far the most common cause of kidney failure is nephritis which has an all ages incidence rate of ·10‰.

Major Organ Transplants—The numbers of transplant operations undertaken in NHS hospitals are as follows:

	1986	*1987*
Heart	176	243
Heart & Lung	51	72
Liver	127	172
Pancreas	6	8
Kidney	1,493	1,485
Bone Marrow	450 (England only)	

which gives a total population incidence rate in the order of ·04‰.

Paralysis—an all ages incidence rate of less than ·05‰.

Coronary bypass surgery is considered to be already costed into the basic Dread Disease premium since it is at present in the U.K. generally undertaken only on patients who have suffered a heart attack or with advanced ischaemic heart disease. This may not be true in other countries—for example in the U.S.A. it is almost a status symbol to have had bypass surgery and it is performed at a much earlier stage of illness.

Total and Permanent Disability cover (TPD) is often included in Dread Disease products because it answers the criticism that Dread Disease products are incomplete. The inclusion of both of these benefits implies that we can reduce

the normal TPD rate because of 'double-counting'. The appropriate reduction can be estimated from CMI Report No. 8.[8] This gives figures for inceptions on individual PHI policies by cause, hence we can consider the inceptions due to Dread Diseases as a percentage of the total. We can use this as an approximation to the percentage of TPD claims that would also be Dread Disease claims and the normal TPD rate can be reduced by these factors.

This suggests the following (conservative) reductions:

Age	*Factor %*
Up to 35	10
40	15
45	20
50+	30

7.2 *Female Lives*

The Dread Disease rates for females were shown earlier, and we can see that the shape of the rates is very different from the male rates. Expressing the additional charge for Dread Disease as a percentage of the mortality rate shows that the female charge is generally higher with the peak at younger ages. Indeed the absolute values of female rates are higher at ages up to 35 for both an acceleration product and an additional product. This is due to a higher incidence of cancer.

This suggests that the use of a fixed age differential will lead to inappropriate Dread Disease premiums for females and separate rate tables should be used if at all possible. This should not be too much of a problem for computerized mortality deduction systems in the case of unit-linked policies.

7.3 *Selection*

The Dread Disease rates have been calculated on an 'all durations' basis and it may not be immediately obvious how to arrive at the appropriate select and ultimate rates.

CMI Report No. 9[7] gives actual over expected deaths for the Dread Disease causes split by duration.

A/E for duration as a percentage of A/E for duration 5+
Medical and Non-medical, Male Lives, All ages

	Duration			
	0	*1–2*	*3–4*	*5+*
Cancer	48	87	100	100
Stroke	51	65	82	100
Acute Myocardial Infarction	65	74	76	100
Ischaemic Heart Disease	65	81	78	100
All Dread Diseases	57	80	87	100

Compare these with the selection discounts on A67/70(5) select.

Select Mortality Rate as a percentage of Ultimate Mortality Rate

	Duration					
Age	*0*	*1*	*2*	*3*	*4*	*5+*
20	67	79	87	86	86	100
30	63	82	91	92	93	100
40	69	82	94	93	92	100
50	59	71	83	81	80	100
60	46	59	70	69	67	100

This suggests the same selection discounts as mortality could be assumed for the cause of death proportions k_x. If we assume the same discount could also be applied to incidence rates then we can calculate $i_{[x]} - k_{[x]}\, q_{[x]}$ and express this select Dread Disease rate as a percentage of the ultimate rate as follows:

	Duration					
Age	*0*	*1*	*2*	*3*	*4*	*5+*
20	77	86	91	91	90	100
30	72	87	94	95	95	100
40	78	88	96	96	95	100
50	74	85	94	94	94	100
60	76	90	98	98	99	100

This table shows that selection has a much less marked effect on the Dread Disease rate than on mortality; and selection discounts of around half the mortality discounts seem appropriate for an acceleration benefit. Offering no selection discount involves a small cross-subsidy from short-duration policies to long-duration policies.

7.4 *Smoking*

Following the model outlined in the previous chapter yields premium rates for an insured portfolio with the same proportion of smokers as standard life policies. Although there is little evidence as yet to support such a theory, it seems reasonable to suppose that smokers perceive themselves more at risk from the Dread Diseases than non-smokers, so a portfolio of Dread Disease policies may have a higher proportion of smokers than usual. Further, the product may be most attractive to the heaviest smokers. This means that the aggregate premium rates from the model will be inadequate and either the rates should be adjusted to allow for the different mix of smokers, or heavy smokers should be rated.

However it is likely that premium rates will follow the almost standard practice of differentiating between smokers and non-smokers so we must investigate how smoking habits affect Dread Disease experience. The Report of the Surgeon General on Smoking and Health[9] gives the following mortality ratios for smokers relative to non-smokers for the U.S.A.:

Cancers (ICD 140–205)	2·21
Coronary Heart Disease (420)	1·74
All Cardiovascular Diseases (330–334, 400–468)	1·75
All Causes	1·84

Combining the Dread Diseases ratios gives a figure close to the All Causes figure suggesting that:

$$\frac{k'_x q'_x}{k_x q_x} = \frac{q'_x}{q_x}$$

where the dashed functions refer to smokers and the undashed functions to non-smokers.

This implies that $k'_x = k_x$, i.e. that the percentage of deaths due to Dread Disease is the same in both the smoker and non-smoker populations. This may not be intuitively obvious but it simply means that the extra mortality rate experienced by smokers is due to the same percentage extra mortality for the non-Dread Disease causes as for the Dread Diseases. The main non-Dread Disease cause of death is accidents and there is evidence to suggest that the different lifestyle of smokers leads them to experience a higher accident death rate than non-smokers of the same order as the all causes extra mortality.

Then the ratio of smoker Dread Disease rate to non-smoker Dread Disease rate for an acceleration benefit is as follows, where w_x is defined in Appendix 2.

$$\frac{i'_x - k'_x q'_x}{i_x - k_x q_x} = \frac{k'_x q'_x (w'_x - 1)}{k_x q_x (w_x - 1)}$$

$$= \frac{q'_x (w'_x - 1)}{q_x (w_x - 1)}$$

Now if we assume $w' = w$, i.e. the mortality after a Dread Disease is the same for non-smokers and smokers, then the smoker/non-smoker differential for Dread Disease rates is the same as for the basic mortality rate. It seems likely however that the mortality of a smoker after a Dread Disease is higher than a non-smoker (i.e. $w' < w$) which suggests the smoker/non-smoker differential for Dread Disease rates should be less than for the mortality rate. The same conclusion can be reached for an additional benefit although the above formula will be different.

The simplest solution may be to adopt the same differential as for the basic life plan which the above suggests provides a small cross-subsidy from smokers to non-smokers.

The theory that more heavy smokers than normal may be found in a Dread Disease portfolio is most easily incorporated into a product by rating heavy smokers. The Report of the Surgeon General gives mortality ratios by degree of cigarette consumption:

Number of cigarettes per day	*Mortality ratio*
All Smokers	2·00
1–9	1·25
10–20	2·00
21–39	2·50
40+	3·00

Any rating guidelines must be consistent with the above. The following is currently used by some offices:

Aggregate rates:	
1–9 cigarettes per day	Standard rates
10–20 cigarettes per day	+50
21+ cigarettes per day	+50 to +100
Smoker/Non-smoker rates:	
1–20 cigarettes per day	Standard rates
21+ cigarettes per day	+0 to +50

7.5 *Dread Disease Overseas*

Clearly, to write Dread Disease in other territories involves finding data for the particular experience in that country. Where sufficient data is not available, then the required incidence rates can be estimated using our assumption of proportionality between Dread Disease incidence rates and Dread Disease mortality rates (see Appendix 2). The minimum data needed is then insured mortality rates and population cause of death proportions. The latter are available for some countries from the World Health Organization and graphs of cause of death proportions for various countries are shown in Appendix 4. The comparative figures in Appendix 5 may also be of interest. These show that the prevalence of Dread Diseases can vary quite markedly between different countries, but the U.K. has one of the highest incidences. Perhaps this means the fear of such diseases is not as strong in other territories—and this may even affect the marketing success of such a product.

8. UNDERWRITING FOR IMPAIRED LIVES

8.1 The innovation of Dread Disease products has meant that underwriters must learn new methodology as the approach to Dread Disease underwriting is different from that for both life and PHI. Since the benefit is payable on diagnosis of a disease, it may be thought that the approach is most similar to PHI—but there are still important differences in that a Dread Disease policy does not indemnify the claimant against loss of earnings and he may still be fairly healthy yet entitled to a large lump sum benefit.

When Dread Disease products first came on the market a conservative stance was taken and any substandard lives declined. However, the actuary has an important rôle to play here since, given suitable data on the Dread Disease experience of various impairments, it is possible to devise rating guidelines for these impairments.

8.2 For a Dread Disease acceleration product, the premium can be notionally split into the usual premium covering death only and the additional premium covering early payment of the death benefit on diagnosis of a Dread Disease. The 'death only' portion of the premium can be rated using established methods while the Dread Disease portion needs to be looked at separately.

A similar approach can be taken for a Dread Disease product providing an

additional benefit on diagnosis, but the additional premium is of course higher than for the acceleration policy.

To rate the Dread Disease portion of the premium means, in both cases, that we need to look at the effect an impairment has on the incidence of Dread Disease. If an impairment has no effect at all on Dread Disease experience then there is no need to load the extra Dread Disease premium even if the impairment increases the mortality rate so that the death only premium is loaded. Conversely, if an impairment increases the chance of having a Dread Disease but has little effect on the subsequent mortality, then only the Dread Disease portion of the premium should be rated.

8.3 To derive rating guidelines then, the actuary needs data on the effect impairments have on the incidence of the Dread Diseases. From our costing model we can use the assumption that Dread Disease incidence rates are proportional to Dread Disease mortality rates.

i.e. $$i_x = w_x k_x q_x$$

Data on the mortality experience by cause of death for various impairments is available from the 1983 Medical Impairment Study.[10] For each impairment it gives mortality ratios (actual against expected deaths relative to unimpaired lives) for various causes of death. For Dread Disease purposes we combine the causes: malignancy, cerebrovascular accident and heart/circulatory. This gives the extra Dread Disease mortality rate for each impairment. If we were to assume proportionality with Dread Disease incidence rates, then the rating can also be applied to the additional premium for Dread Disease cover.

Now direct proportionality cannot be assumed but any adjustment can be found by considering the difference in w_x between impaired lives and healthy lives. If an impairment is such that the mortality after a Dread Disease is higher than for healthy lives, then w_x is lower for impaired lives which means the rating is lower than the analysis using mortality ratios suggests. On the other hand if an impairment gives rise to a lower mortality after Dread Disease than for healthy lives, the rating from the analysis should be increased. It is vital, therefore, that Chief Medical Officers and underwriters should be able to adjust the figures from the actuarial investigation using their knowledge of the various impairments.

8.4 Examples of the results from such an analysis are shown below. The following mortality ratios and implied ratings are from the 1983 Medical Impairment Study.[10]

Mortality Ratios

Impairment	*Dread Diseases*	*All causes*	*Dread Disease rating*	*Life rating*
Family History of Cerebrovascular disease	2·03	1·89	+103	+89
Family History of Cancer	1·41	1·34	+41	+34
Asthma	1·54	2·11	+54	+111
Emphysema	2·14	3·23	+114	+223
Epilepsy (grandmal)	2·98	2·29	+198	+129

Family history is not normally rated for life policies. However, the above suggests it may need to be taken into account for Dread Disease. In practice, a loading may be applied to the Dread Disease premium if any parent or sibling has heart disease or if both parents had cancer before age 60. The opposite appears to be the case for asthma, where a small rating would probably be applied for a life policy but the condition could be ignored for Dread Disease.

For emphysema, the effect on Dread Disease appears to be significantly less than on mortality. Half the normal life rating seems appropriate. In contrast, epilepsy has a greater effect on Dread Disease than on mortality so that twice the normal life rating may be applied to the Dread Disease premium.

9. VALUATION AND RELATED TOPICS

9.1 *Classification of Dread Disease business*

The definitions of the various classes of Long Term business are set out in Schedule 1 of the Insurance Companies Act 1981. Dread Disease cover is classified as Class IV, or Permanent Health business, provided that:

(*a*) the contract is effected for a period of at least five years or until normal retirement age or without limit of time, and
(*b*) the contract is not terminable by the insurer.

If either of these conditions is not met then the contract would be classified under Class 2 of General Business. This does not preclude its inclusion as an additional benefit to a long-term contract, since this is permitted under Section 1(3) of the Act.

However whilst the Dread Disease benefit is itself deemed to be Class IV business the underlying contract will generally be classified differently. Even a unit-linked stand-alone contract is likely to be considered Class III business if it has a death benefit and a surrender value.

9.2 *Solvency Margin*

As Class IV business the required margin of solvency for a U.K. company for Dread Disease cover is 4% of the mathematical reserves gross of reinsurance ceded, reduced by not more than 15% for total Class IV liabilities reinsured (or 50% for pure reinsurers).

9.3 *Taxation*

The taxation position for Dread Disease cover is similar to that for Permanent Health Insurance. The treatment of a contract will therefore depend on whether it is written in the life fund or the PHI fund.

9.4 *Valuation*

Standard methods can be adopted to value a policy incorporating Dread Disease cover with the mortality rates replaced by the appropriate Dread Disease

charges. Until reliable experience becomes available, the actuary may consider it appropriate to include a larger margin in the Dread Disease charges than is normally incorporated in the mortality basis.

There is a potential difficulty in respect of acceleration contracts, in that separate reserves may be required in the statutory returns for the life benefit and the Dread Disease benefit. The overall reserve can be calculated using the formula $i_x+(1-k_x)\,q_x$ instead of the usual mortality rate. The cost of the Dread Disease is the incidence rate (as for an additional benefit) but the cost of mortality is lower than normal due to the 'select' group of lives being considered.

There is a further possible problem with policies which do not terminate after payment of a Dread Disease claim. At outset we will have a group of lives, none of whom has suffered a Dread Disease. We will subsequently have two distinct groups—those who have already claimed on their Dread Disease benefit and who may be expected to exhibit heavier than normal mortality, and the 'select' lives who have not incurred a Dread Disease. It is likely that lapses will occur only in the second of these groups, so that it may no longer be appropriate to use an aggregate mortality table for valuing the overall portfolio. In this case we would require two separate mortality tables and the valuation would become much more complicated.

This problem in fact arises with all life contracts—the only difference here is that the valuation actuary will have details of which lives have suffered a Dread Disease. If he is happy to use aggregate mortality normally, then we feel that, for simplicity, he would probably also be prepared to use aggregate mortality here. The extent of the problem will need to be monitored to ensure the divergence from aggregate mortality is not significant.

10. FUTURE DEVELOPMENTS

Looking into the future, it is interesting to speculate on the experience of Dread Disease cover compared to that assumed in the premium basis. We consider below the effects that changes in medical practice have on the impairments covered. We then look at the possible impact of AIDS and discuss the causes of trends in Dread Disease experience. Finally, we consider an alternative to the type of Dread Disease products that we have been considering.

10.1 *'New' Impairments*

Of particular concern is that the definitions of Dread Disease impairments used in policies written now could be construed as covering different impairments in the future. For example surgical techniques could improve so that bypass surgeries or transplants are performed much more often than assumed in the premium basis. This can be partially prevented by ensuring the definitions only cover surgery performed at a late stage of illness. It has been suggested elsewhere that a Dread Disease contract should have a clause allowing the insurer to change policy wordings while the policy is in force. This could be difficult from a

marketing point of view (it is rather like moving the goalposts!) and such a policy may be considered to be general business. Guarantees are perhaps better restricted on the premium rates rather than on the benefit definitions.

10.2 *AIDS and Dread Disease*

One criticism of current Dread Disease products has been that they do not cover the most dreaded and topical disease—AIDS. The problems of covering AIDS include the risk of antiselection and the lack of reliable data for costing.

Not covering AIDS does not mean we can ignore it completely. There is evidence to suggest that HIV or AIDS can increase the risk of a heart attack or stroke and that Kaposi's Sarcoma may satisfy some of the definitions of cancer used in current Dread Disease policies. So should Dread Disease products incorporate an HIV exclusion or should the problem be countered by stricter definitions of diseases covered? Further, are rate increases necessary?

It is thought that over 50% of AIDS sufferers develop Kaposi's Sarcoma at some stage; the median time of survival for these sufferers is around 21 months, although this is reduced to 7 months if Pneumocystis Pneumonia is also present.[11] This suggests that the AIDS-related extra Dread Disease premium can be calculated by charging 50% of the AIDS extra mortality premium 21 months earlier. However, the prevalence of Kaposi's Sarcoma is probably significant enough to warrant its exclusion from the definition of cancer as a Dread Disease. This can be done by excluding tumours in the presence of the HIV virus. Our suggested cancer definition in Section 2 incorporates this point.

On acceleration policies where there is no AIDS exclusion on life cover, it seems illogical to impose an AIDS exclusion on the Dread Disease cover unless the survival time is significant. For AIDS-related lymphomas, heart attacks and strokes, it is thought that the survival time is short enough that such an exclusion is not warranted. The introduction of drugs that prolong survival of HIV/AIDS sufferers could impact on future Dread Disease experience so that monitoring is important.

For stand-alone policies there is a stronger argument to take the accepted PHI market approach and adopt an HIV exclusion or cancellation clause.

If the above suggestions are followed, it would appear that no specific loading in Dread Disease rates for AIDS experience is required at the moment, provided that there are no long-term guarantees. It is essential of course to monitor future claims experience, particularly at the young ages where we could find an AIDS-related increase in Dread Disease claims experience.

10.3 *Future Experience*

Prior to the advent of AIDS, we have been accustomed to steadily improving mortality over a long period. For Dread Disease cover the long-term trend is not so obvious since the cost depends on the underlying incidence of the diseases, the stage at which they are detected and the mortality after suffering a Dread Disease.

In so far as the general improvement in mortality results from improvements in the treatment of Dread Diseases, then the addition to the mortality rate for an acceleration product will tend to increase. This could be offset by some improvement in the incidence rates.

In Section 5.2 we gave figures for crude five-year survival rates for cancer sufferers registered in 1981. These are shown again below, compared with the corresponding figures for those registered in 1977:

	Males		*Females*	
Age	*1977*	*1981*	*1977*	*1981*
15–24	57·2	61·3	66·0	67·8
25–34	57·4	63·1	62·7	66·1
35–44	41·2	46·7	54·9	58·6
45–54	27·1	30·7	45·4	46·1
55–64	20·4	22·3	34·3	36·4
65–74	15·0	17·4	28·0	29·3

Even over such a short period the survival rates show a significant improvement, particularly for male lives. This improvement could reflect earlier diagnosis or improved mortality after diagnosis. However, the corresponding incidence rates set out below show no particular pattern:

Cancer incidence rates per mille

	Males		*Females*	
Age	*1977*	*1981*	*1977*	*1981*
15–19	·155	·149	·115	·102
20–24	·217	·198	·187	·165
25–29	·328	·280	·388	·388
30–34	·374	·404	·698	·672
35–39	·586	·632	1·178	1·144
40–44	·982	·968	1·941	1·967
45–59	1·829	1·660	3·130	2·902
50–54	3·594	3·202	4·351	4·010
55–59	5·683	5·803	5·347	5·570
60–64	9·745	9·118	6·971	6·914
65–69	14·397	13·682	8·530	8·557
70–74	19·590	18·851	10·085	10·213

This illustrates the more complex nature of trends in Dread Disease experience and reinforces the need for short-term rate guarantees. It also emphasises the importance of analysing trends in incidence rates independently of those in mortality, as discussed at the end of Appendix 2.

10.4 *Terminal Illness Benefits*

A different type of policy which pays out when a policyholder becomes terminally ill has recently been pioneered in Canada. A portion of the death benefit (of between 40% and 70%) is loaned to the sufferer, with the interest charges deducted on death from the residual sum assured. The charges are

calculated taking into account the life expectancy of the policyholder so that the company is in the same financial position as under the original contract. The payments made so far have been to sufferers of AIDS or a brain tumour, thought to have less than eighteen months to live.

This feature could be added to existing policies and is not a true rider benefit as are the Dread Disease products we have been considering. It shares one of the important marketing aspects of Dread Disease covers in that benefits are available before death, and it seems to have been welcomed by the Canadian public as a sympathetic idea. It could be a simple way for an office to offer a limited 'living benefit' if a full Dread Disease product is not yet part of its range.

10.5 *Conclusion*

It is likely that the traditional Dread Disease acceleration option will be attached to many more Flexible Whole Life and mortgage products soon as the public (and intermediaries and sales forces) become more aware of the idea. Different products on a Dread Disease theme are likely to be developed as the insurance industry responds to the growing market for ill-health benefits. Examples of such products may be medical expenses for specified diseases only, pre-funding packages for elderly lives and terminal illness benefits. Dread Disease covers may be prominent in the minds of product development actuaries for some time to come.

11. ACKNOWLEDGEMENTS

Thanks must be extended to all our colleagues who have made valuable input to this paper. We would especially like to mention Eugene Hertzman who provided much appreciated technical assistance.

The views expressed in this paper are our own and any errors solely our responsibility.

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APPENDIX 1:

ILLUSTRATING THE COST OF VARIOUS PRODUCT DESIGNS

The method adopted to illustrate the costs of the various product designs was as follows. A unit-linked product was considered in each case, and the value of the units was projected using the assumptions shown below.

For the stand-alone product and the term assurance, the premium was set in order to produce a zero unit fund at the end of the term. For the Flexible Whole Life contract a zero unit fund was also achieved, although here we assumed no growth in unit values and the projection was limited to ten years. For the mortgage plan the premium was set to produce a unit fund at maturity equal to the sum assured.

The Nil Allocation Periods were chosen with regard to policies currently available in the U.K. It has been assumed that no adjustment is required when Dread Disease is included, i.e. that the Dread Disease charges contain an adequate margin to cover any additional expenses. For the stand-alone product we have used the same Nil Allocation Periods as for the term assurance. The values used are as follows:

Term assurance	15 months for term 10
and stand-alone product	21 months for term 25
Flexible Whole Life	20 months for age 30
	13 months for age 50
Mortgage plan	4 months for term 10
	10 months for term 25

The remainder of the assumptions used are as follows:

Policy Fee	£1 p.m. (escalating at 7·5% p.a.)
Unit Allocation	100% after the Nil Allocation Period
Bid Offer Spread	5%
Fund Management Charge	·75% p.a.
Unit Growth Rate	0% p.a. for the Flexible Whole Life
(net of tax and charges)	7·5% p.a. otherwise
Mortality deductions	100% of A67/70(2) ultimate

The policy fee, fund management charge, mortality deduction and Dread Disease deduction are all levied by unit cancellation. The initial debt is carried forward on a non-interest bearing basis.

APPENDIX 2:

DERIVATION OF INCIDENCE RATES FOR INSURED LIVES

We have already noted that 'sudden deaths' are included in the incidences. We can split the Dread Disease mortality rate q_x^D into two components relating to 'sudden deaths' and those occurring after an initial period, say 6 months, following diagnosis of a Dread Disease:

$$q_x^D = q_x^{D1} + q_x^{D2}$$

Then the total number of deaths due to Dread Disease is:

$$k_x l_x q_x = (l_x - l_x^S)\, i_x\, q_x^{D1} + l_x^S q_x^{D2}$$

It will be noted that we have used l_x^S rather than the more correct $l_x^S - (l_x - l_x^S)\, i_x/2$ as the population to which the death rate following the initial period applies. Thus we are using dependent rather than independent decrements, but it is assumed that this loses very little accuracy.

We can re-express the above equation as:

$$i_x = w_x k_x q_x$$

where

$$w_x = \frac{1}{q_x^{D1}} \quad \frac{1 - \dfrac{l_x^s}{l_x} \quad \dfrac{q_x^{D2}}{k_x\, q_x}}{1 - \dfrac{l_x^s}{l_x}}$$

w_x is inversely related to the mortality after a Dread Disease. It is likely that w_x varies slowly by age. We can express our population incidence rates i_x as a percentage of $k_x\, q_x$ (again using population values $-k_x$ from Table 2, q_x from ELT No. 14). This will give a smooth function which we can then graduate to provide values of i_x for each age from the broad age bands of the data.

Further adjustments are necessary so the incidence rates are in the form necessary for the costing model. The crude rates specifically cover first time incidence of a disease, but we are concerned with a group of lives none of whom have ever had any of the Dread Diseases *and* would pass the underwriting standards of a Dread Disease policy. For an approximation of the required adjustment we can look at the numbers who have consulted their General Practitioner about any of the Dread Diseases. The GP survey[2] gives consultation rates C_x (shown in Table 3) and the crude incidence rates can be grossed up by the factor $1 - C_x$.

A further adjustment is required to convert the incidence rates from central to initial form. Table 4 gives graduated incidence rates for the U.K. population for quinquennial ages, after the above adjustments have been made.

However, these are still population incidence rates and we need to investigate the necessary adjustment for insured lives. We have

$$i_x = w_x k_x q_x$$

and can express w_x as a function of the mortality after a Dread Disease. If we make the assumption that the mortality after a Dread Disease is the same for insured lives as for the population then $w_x^P = w_x^I$

Then
$$i_x^I = i_x^P \frac{k_x^I q_x^I}{k_x^P q_x^P} \quad (*)$$

The relationship of incidence rates for the population and insured lives deserves further attention. The differences in mortality experience between the two groups arise because of the different mix of socio-economic groups and the presence in the population of a group of impaired lives that would be rated or declined for life assurance.

The overall incidence rate for an insured portfolio is the weighted average of the incidence rates for each social class:

$$i^I = \Sigma\, r_j^I\, i_j$$

where r_j^I is the proportion of each class in the insured portolio and the summation is taken over all social classes. Similarly for the mortality rates due to Dread Diseases, we have:

$$kq^I = \Sigma\, r_j^I\, kq_j$$

We will therefore require some details as to the proportion of each social class within the insured portfolio. To quote CMI Report No. 9,[7] "The distribution of assured lives by social class may vary from office to office and the Bureau has no information about such distribution". For comparison purposes the Bureau uses two different assumptions for the distribution:

(*a*) Classes I, II and III (Non-Manual) in the same proportions as the population.
(*b*) Classes I, II III (Non-Manual) and III (Manual) in the same proportions as the population.

We shall use both these assumptions for the r_j^I below in order to compare the effect.

We are interested in the ratio of w_x for insured lives to w_x for the population, i.e:

$$\frac{w^I}{w^P} = \frac{i^I}{i^P} \Big/ \frac{kq^I}{kq^P}$$

$$= \frac{\Sigma\, r_j^I\, i_j / i^P}{\Sigma\, r_j^I\, kq_j / kq^P}$$

To evaluate this expression we can use data from the 1970–71 edition of the General Practitioners survey.[12] 'Standard Patients Consulting Ratios' (SPCR's) give the number of persons consulting their doctor for a particular condition standardized for different age structures within each social class, and we can use these as a proxy for the factors i_j/i^P above. Further we can use Standard Mortality Rates (SMR's) for the factors kq_j/kq^P. The necessary data is shown below:

	Social class					Male lives
	I	II	IIIN	IIIM	IV	V
Cancer (ICD 140–239)						
SPCR	94	80	107	105	105	110
SMR	76	80	92	113	116	131
Circulatory (ICD 390–458)						
SPCR	96	101	111	93	102	99
SMR	86	89	110	106	110	118
Proportion in each class	6%	21%	12%	38%	17%	6%

Thus we can look at:

$$\frac{w^I}{w^P} = \frac{\Sigma\, r_j^I\, \text{SPCR}\, j}{\Sigma\, r_j^I\, \text{SMR}\, j}$$

using our alternative assumptions as to the r_j^I factors. Note that this ignores the problem of rated or declined lives. In effect we are assuming that the improvement due to considering only unrated lives is the same for both SPCR's and SMR's.

On basis (*a*) we have $\dfrac{w^I}{w^P} = 1{\cdot}09$ for both cancer and circulatory causes

On basis (*b*) we have $\dfrac{w^I}{w^P} = 1{\cdot}00$ for cancer

$= {\cdot}98$ for circulatory

This analysis can only be regarded as approximate since:

1. It looks at consulting ratios rather than incidence rates.
2. The 'circulatory' group is wider than the Dread Disease definition.
3. The proportions in each social class for the insured portfolio are unknown.

Nevertheless it does suggest that w_x is slightly higher for insured lives than the population which accords with the intuitive expectation that insured mortality after a Dread Disease is lower. We suggest that for caution some adjustment needs to be made for this feature, perhaps by loading the insured incidence rates from equation (*) by a further 5%, although this factor may vary to reflect the particular portfolio of the office.

Another interesting feature arising from this analysis is that, in the derivation of insured lives incidence rates, it is important that the mortality rates used relate

to the same time period as the incidence rates. The population incidence rates come from studies of 1981–83, thus we have used population mortality from 1980–82 and the insured mortality rates are assumed to be relevant to the same period. However, in calculating the premium rates, incidence rates and mortality rates suitable for current experience should be used. This analysis highlights an important point should Dread Disease incidence rates and mortality rates not change over time at the same pace. It is possible that incidence remains fairly constant while mortality steadily improves. If it is assumed that incidence rates improve at the same pace as mortality in the calculation of premium rates then those premiums will be insufficient.

APPENDIX 3:

DATA FOR COSTING A DREAD DISEASE PRODUCT

Table 1. *Dread Disease incidence rates per mille for the U.K. population*

Cancer

Age	*Male*	*Female*
15–19	·156	·116
20–24	·205	·174
25–29	·276	·420
30–34	·380	·735
35–39	·541	1·150
40–44	·932	1·892
45–49	1·651	2·802
50–54	3·042	3·940
55–59	5·566	5·507
60–64	9·155	7·009
65–69	13·708	8·809
70–74	19·054	10·468
75–79	24·361	12·091
80–84	29·297	13·933
85+	30·204	16·312

Source: Cancer Statistics 1983,[1] Table 3.
All malignant neoplasma (ICD Numbers 140–208) excluding malignant neoplasm of skin (ICD Number 173).

Heart Attack

Age	*Male*	*Female*
15–24	—	—
25–44	·8	·2
45–64	7·4	2·5
65–74	12·8	6·8
75+	13·9	9·2

Source: Morbidity Statistics from General Practice 1981–82,[2] Table 8.
Acute myocardial infarction, subacute ischaemic heart disease, CC 181.

Stroke

Age	*Male*	*Female*
15–24	·1	·1
25–44	·2	—
45–64	2·0	1·5
65–74	9·1	7·5
75+	23·0	20·8

Source: Morbidity Statistics from General Practice 1981–82,[2] Table 8.
Other cerebrovascular disease, CC 196.

Table 2. *Percentages of deaths due to Dread Disease in U.K. Population*, k_x

Males

Age	*Cancer*	*Heart attack*	*Stroke*	*Total*
15–19	9·8	·1	·9	10·9
20–24	9·6	·5	1·3	11·4
25–29	13·2	2·3	3·2	18·8
30–34	17·8	6·8	3·2	27·7
35–39	22·6	17·4	4·8	44·8
40–44	24·3	29·1	4·7	58·2
45–49	26·6	38·0	5·1	69·7
50–54	30·0	40·9	5·3	76·1
55–59	32·9	40·0	5·2	78·2
60–64	32·9	38·7	6·0	77·6
65–69	31·6	36·6	7·5	75·8
70–74	28·6	34·3	9·6	72·5
75–79	24·8	30·7	11·8	67·3
80–84	20·8	27·7	12·9	61·4
85–89	16·4	24·4	13·5	54·3
90–94	11·9	21·9	13·3	47·0
95–99	7·7	18·9	13·2	39·8

Females

Age	*Cancer*	*Heart attack*	*Stroke*	*Total*
15–19	14·7	·2	2·4	17·3
20–24	19·0	·5	1·7	21·3
25–29	28·5	1·2	7·4	37·1
30–34	39·9	2·6	6·3	48·8
35–39	51·5	4·1	5·8	61·3
40–44	53·7	6·4	7·5	67·6
45–49	55·4	9·5	6·7	71·6
50–54	52·7	13·9	6·7	73·3
55–59	49·0	17·9	7·2	74·1
60–64	43·5	22·3	8·4	74·2
65–69	36·4	26·2	10·2	72·8
70–74	28·4	29·0	13·3	70·7
75–79	21·3	28·3	17·0	66·7
80–84	15·6	26·2	19·0	60·8
85–89	11·7	23·5	19·4	54·7
90–94	8·6	20·7	18·3	47·6
95–99	6·0	17·3	15·7	39·0

Source: Mortality Statistics by Cause 1985,[6] Table 2.
Cancer: Neoplasms ICD Numbers 140–239.
Heart Attack: Ischaemic Heart Disease ICD Numbers 410–414.
Stroke: Cerebrovascular Disease ICD Numbers 430–438.

Table 3. *Patients consulting—rates per 1,000 persons at risk*

Males

Age	*Cancer*	*Heart attack*	*Stroke*	*Total*
15–24	3·6	—	·1	3·7
25–44	5·7	1·6	·2	7·5
45–64	14·5	11·7	4·2	30·4
65–74	31·6	19·9	15·3	66·8
75+	41·0	22·4	39·6	103·0

Females

Age	*Cancer*	*Heart attack*	*Stroke*	*Total*
15–24	6·7	—	·1	6·8
25–44	15·7	·3	·1	16·1
45–64	21·7	3·8	2·6	28·1
65–74	26·5	11·1	12·5	50·1
75+	26·4	12·8	33·2	72·4

Source: Mortality Statistics from General Practice 1981–82,[2] Table 18.
Cancer: Neoplasms ICD 140–239 except malignant neoplasms of skin ICD 172,173.
Heart Attack: Acute myocardial infarction, subacute ischaemic heart disease ICD 410, 411.
Stroke: Other cerebrovascular disease, ICD 430–438 except 435.

Table 4. *Absolute values of incidence rates for the U.K. population, per 1,000 of population previously free from any Dread Disease*

Males

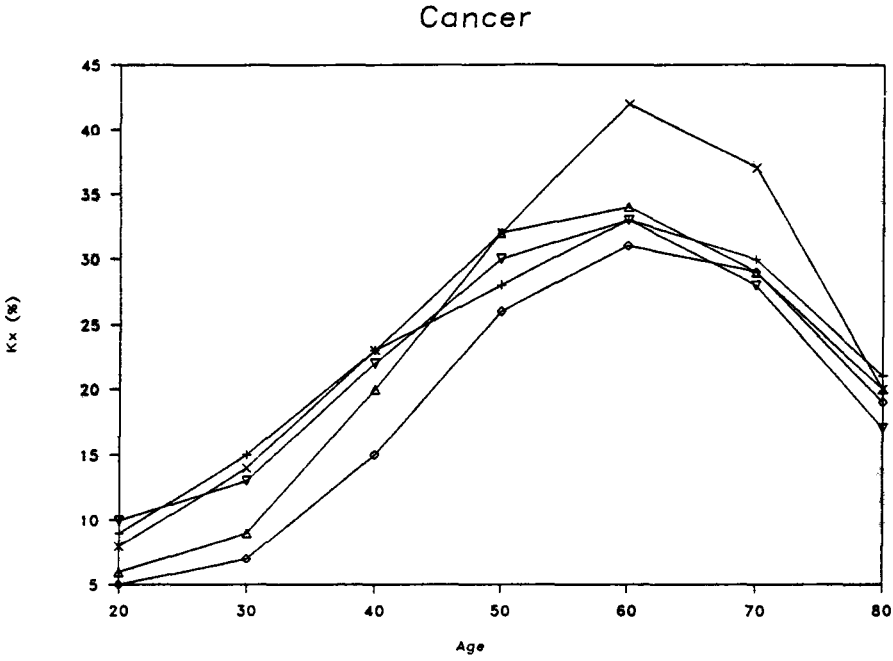
Age	*Cancer*	*Heart attack*	*Stroke*	*Total*
20	·19	—	·10	·29
25	·24	·03	·16	·43
30	·34	·18	·17	·69
35	·46	·58	·22	1·26
40	·76	1·64	·33	2·73
45	1·34	3·74	·54	5·62
50	2·46	6·03	·99	9·48
55	4·55	7·82	1·79	14·16
60	7·91	9·99	3·30	21·20
65	12·15	12·61	5·78	30·54
70	17·88	13·98	10·19	42·05
75	23·87	15·18	17·68	56·73
80	29·36	15·37	25·04	69·77
85	33·58	13·67	31·37	78·62
90	32·74	14·49	37·19	84·42

Females

Age	*Cancer*	*Heart attack*	*Stroke*	*Total*
20	·15	—	·06	·21
25	·30	·01	·16	·47
30	·60	·06	·18	·84
35	·99	·16	·10	1·25
40	1·58	·37	·09	2·04
45	2·47	·82	·35	3·64
50	3·55	1·61	·78	5·94
55	5·00	2·65	1·36	9·01
60	6·57	3·76	2·43	12·76
65	8·22	4·97	4·29	17·48
70	10·22	7·23	8·01	25·46
75	12·09	9·57	15·70	37·36
80	14·14	10·61	20·06	44·81
85	16·71	10·36	24·23	51·30
90	17·93	8·31	36·52	62·76

APPENDIX 4:

CAUSE OF DEATH PERCENTAGES FOR VARIOUS COUNTRIES



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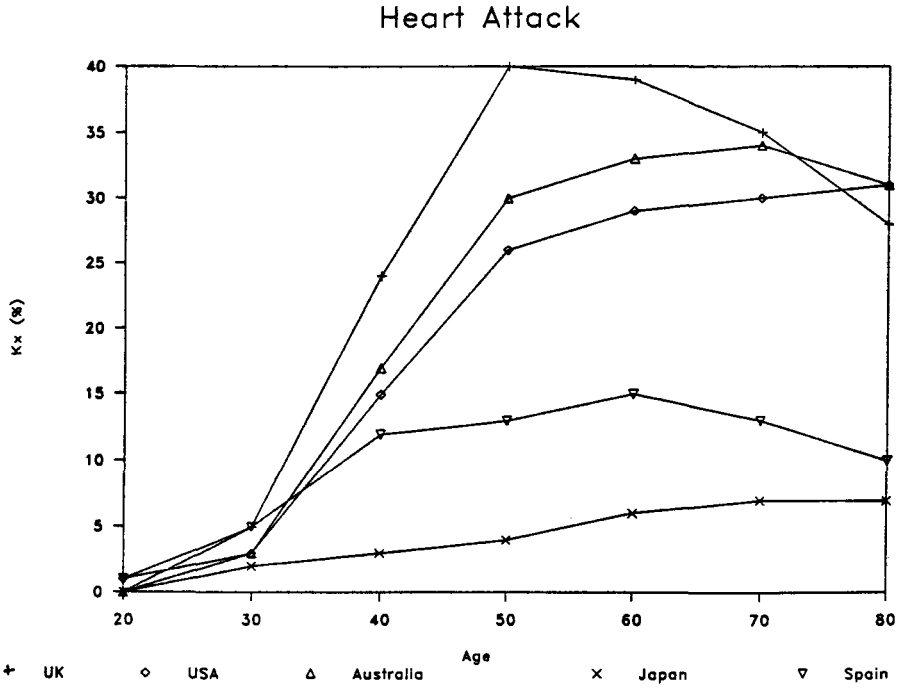

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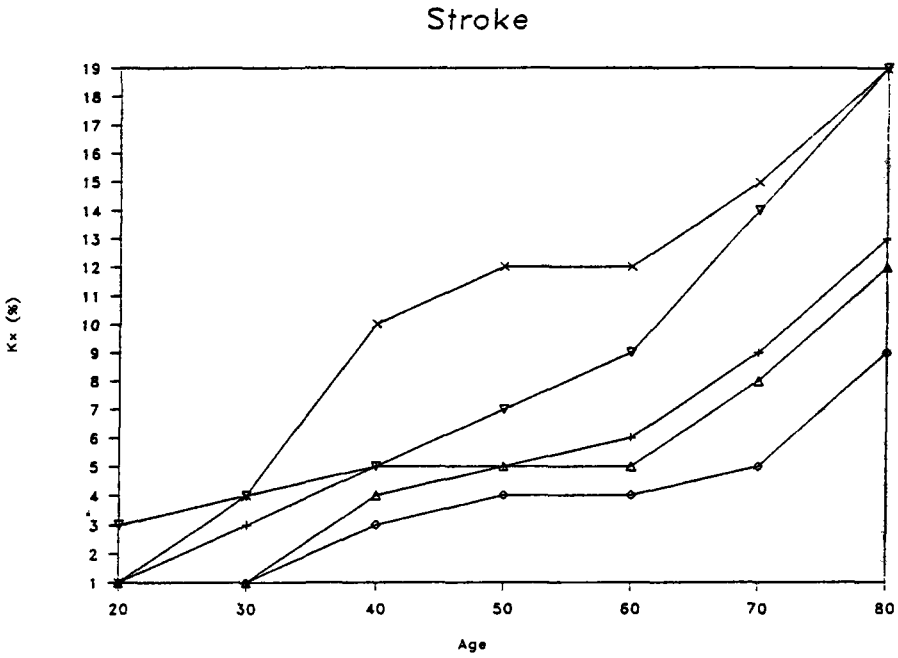
CAUSE OF DEATH PERCENTAGES FOR VARIOUS COUNTRIES



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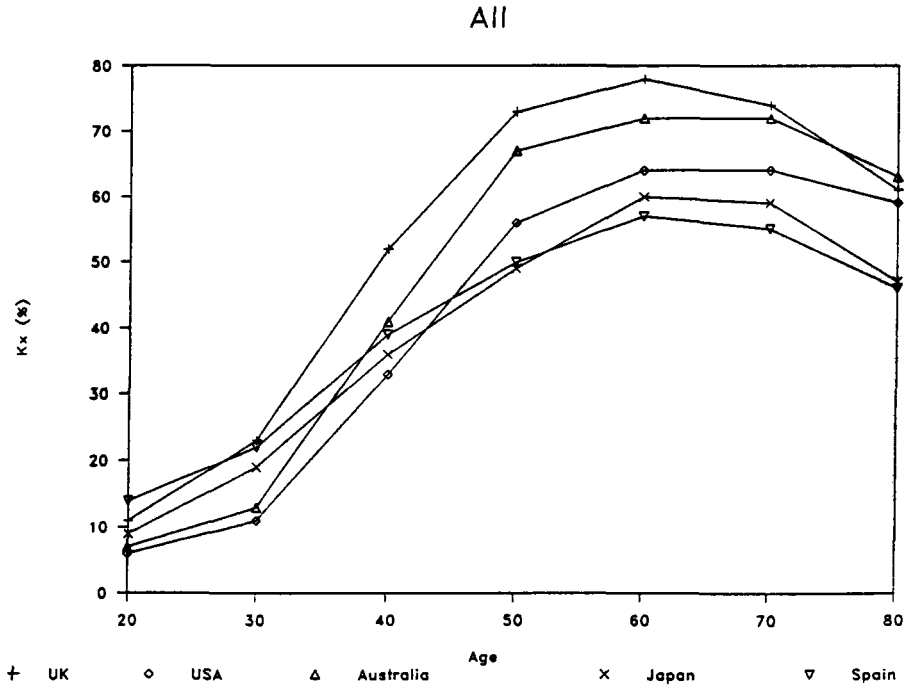
CAUSE OF DEATH PERCENTAGES FOR VARIOUS COUNTRIES



Source: 1987 World Health Statistics Annual.[13]

APPENDIX 5:

DEATHS DUE TO DREAD DISEASES IN VARIOUS COUNTRIES

Age-standardized mortality rates for 1986–87 due to Malignant Neoplasms, Ischaemic Heart Disease and Cerebrovascular Disease per 100,000 male population.

	Mortality rate	*Percentage of U.K. figure*
Ireland	772·0	107
Finland	756·7	105
U.K.	722·3	100
New Zealand	704·8	98
Denmark	689·7	95
Norway	631·7	87
West Germany	631·4	87
Australia	630·2	87
Austria	627·9	87
Netherlands	626·9	87
Sweden	615·9	85
Canada	594·9	82
U.S.A.	580·1	80
Italy	576·5	80
Belgium	568·4	79
Portugal	557·7	77
France	525·3	73
Israel	515·8	71
Switzerland	506·5	70
Spain	478·4	66
Greece	474·2	66
Japan	403·3	56

Source: World Health Organisation Weekly Epidemiological Record 7 April 1989.[14]