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Risk *Insights*

Substandard Underwriting

Contents

An endless array of insurance products is offered throughout the world, and the underwriting philosophy for these covers varies company by company. One universal concern is how to handle higher risk cases. As a global reinsurer, GeneralCologne Re has gained an excellent perspective on the topic of substandard underwriting, which is the focus of this issue of *Risk Insights*. Articles discuss calculation and administration of substandard premiums, substandard underwriting in the context of long term care insurance and hazardous occupations, innovative products for individuals considered "uninsurable" by traditional criteria, and practical suggestions for how to place a substandard risk. The final paper discusses one of the most common underwriting problems worldwide, chronic hepatitis B infection.

Substandard Risk Premiums: Calculation and Administration

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The influence of medical impairments on the morbidity and mortality of the applicant is assessed by the underwriter's review of information such as application forms, medical tests and reports, EKGs, etc. Substandard underwriting assessments, which are found in underwriting manuals,[1] include multiple extra loadings, flat extra loadings, and postponing or declining of applications. In addition to these underwriting assessments, liens and increases of the age at entry have often been used in the past, and can still be found in many countries.

This paper is divided into two sections. In the first section, there is a discussion about how multiple extra loadings and flat extra loadings influence the insurance premium that the policyholder must pay. It will also touch briefly on an option that can be used to make extra premiums look more attractive to applicants. The second

section addresses the transformation of multiple extra loadings and flat extra loadings into liens, an age at entry assessment, and other assessments.

Lifting the Mystery of Substandard Risk Premium Calculation

The indices used in this section have the following meanings:

- x = age of the policyholder at policy commencement
- k = premium payment duration
- n = insurance duration
- std = these values refer to the insurance of standard lives
- sub = these values refer to the insurance of substandard lives
- extra = refers to a difference between substandard lives and standard lives

Net premium calculation

The general formula for calculating *net extra premiums* payable by substandard policyholders in excess of the standard insurance premium is: $NP^{extra} = NP^{sub}_{x,n} - NP^{std}_{x,n}$, where $NP^{std}_{x,n}$ represents the net premium payable by standard lives and $NP^{sub}_{x,n}$ represents the net premium payable by substandard lives.

In the case of traditional life insurance products such as term insurance and endowment, only the mortality risk has to be considered for calculating premiums. Net premiums are calculated with a standard mortality rate q_x and a substandard mortality rate q^{sub}_x, respectively, and the difference in net premiums gives the *net extra premium payable*. The increased mortality rate q^{sub}_x can be calculated using the underwriter's rating or by applying an exponential smoothing method to the assessed mortality.[2] Table 1 gives an example of the calculation of substandard premiums for an endowment policy.

In the case of more non-traditional insurance products such as disability income and dread disease insurance, the morbidity risk also has to be assessed and taken into consideration. The pricing of dread disease products is based on the incidence rate of dread disease diagnosis (i_x), the mortality rate of persons who have been diagnosed with a dread disease (qd_x) and the overall mortality rate (q_x). The risk premium for accelerated dread disease products is $i_x - qd_x + q_x$. The underwriter will make separate assessments for the death risk and the dread disease morbidity risk. These ratings will be applied to the overall mortality rate and the dread disease incidence rate of the applicant. Regarding the mortality rate qd_x, little is known about the relationship between a rating for an impairment and the mortality rate of lives who have been diagnosed with a dread disease (unless the impairment is a dread disease itself). However, it is safe to assume that the mortality of lives with such an impairment is not lower than the overall mortality rate q_x. The mortality rate qd_x is therefore not adjusted for the calculation of extra premiums. Extra premiums for products such as health and disability income insurance are calculated using the same methodology with suitable adjustments in the basic rates of mortality and morbidity.

A "return of the extra premium" on survival could be offered to applicants as an option to make the extra premium more appealing. If the applicant is still alive at the end of m ($m \le k$) policy years and the policy is still in force at that time, the insurance company will return the accumulated extra premiums. In the case of policy surrenders or death, however, the extra premium would not be refunded.[3] As applicants have an incentive to keep their policies in force during the "return of extra premium" period, it is also expected that the persistency of the substandard business increases. The premium for this option is based on the extra premium without the premium return feature, but is loaded by a premium return factor (PRF).[4]

$$NP^{extra}_{x,n}(PRF) = PRF * NP^{extra}_{x,n}$$

where the factor PRF is defined by

$$PRF = \frac{1}{1-m*\frac{D_{x+m}}{N_x-N_{x+m}}}$$

Table 1 gives an example of the calculation of net premiums for the "return of extra premium" option for an endowment policy.

Table 1. Substandard risk premiums for a 20-year endowment policy of a male applicant with an extra mortality of +50%[5]

Age at entry	Net substandard premium (per mille)	Net standard premium (per mille)	Net extra premium (per mille)	Net premium for "return of premium" option (per mille)
25	40.68	40.42	0.26	0.76
30	40.91	40.57	0.33	0.96
35	41.40	40.90	0.50	1.37
40	42.25	41.47	0.78	2.03
45	43.66	42.40	1.26	3.00

Gross premium calculation

Two broad classes of expenses should be distinguished when calculating gross premiums: investment expenses and insurance expenses. In the following, we assume that there are no significant differences between the asset management of standard and substandard lives. We will hence focus on the allocation of insurance expenses between standard and substandard business.

Basically speaking, there are two diametrically opposed opinions. The first opinion takes the view that a life insurance company manages risks and that such risks vary by plan, age, amount, as well as by impairment. The decision whether a case is substandard or not cannot be made until all the relevant information has been submitted and analyzed, and the extra expenses produced by substandard business are allocated over all policies. The second opinion takes the view that substandard business is a separate line of business and should therefore bear the extra expenses caused by the underwriting process.

Most companies apply a method lying between these two opposing views. The following points should be taken into consideration when deciding on an expense allocation structure:

- Acquisition expenses of substandard business are usually higher because more underwriting information (medical examinations, tests, reports) has to be collected, paid for, and analyzed.
- Typically, substandard business has a higher rejection rate since, in general, substandard applicants are reluctant to pay extra premiums and may shop around.
- Direct provision could be made for expenses such as agents' commission.
- Maintenance expenses (e.g., administration expenses) for substandard business are usually in the same order as those for standard policies.
- Substandard business usually has a higher lapse experience than standard business. The greatest difference between substandard and standard lapse rates occurs during the first few years.

Due to the small number of substandard lives involved, a loading for a higher level of fluctuation between actual and expected claims may also be appropriate. Reinsurance is one way of managing the fluctuation risk associated with writing substandard lives.

Reserves and surrender values

Typically, legislators do not specify a particular basis for the valuation of substandard lives policies, but rather leave it to the judgment of the company's valuation actuary to define such a reserving standard. Appropriate approximations for reserves of substandard lives may also be acceptable.

Certain factors should be considered by the actuary when establishing the valuation method so that it:

- does not overstate the reserves (e.g., for tax purposes),
- does not understate the reserves,
- is practicable and reasonable, and takes into account the size (typically small) of the substandard portfolio and the administration involved, and
- complies with minimum legal standards.

Some actuarial results[6] may provide some guidance and may assist in developing a suitable reserving method for substandard lives. The calculation of surrender values typically follows the reserving methodology applied by the company.

Further pricing considerations

In this section, we base the calculation of extra premiums on factors such as interest, morbidity and mortality. The question is: what is the meaning of a 50% loading assessed by underwriters? Does it mean 50% of smoker rates, 50% of non-smoker rates, or 50% of aggregate mortality rates? Using 50% of the smoker rates for smokers and 50% of the non-smoker rates for non-smokers appears illogical if an impairment is independent of the smoking habit. Using only 50% of the non-smoker rates may not be sufficient to cover the risk since the non-smoker rates include an implicit "health-discount."

Extra premiums for substandard lives can be calculated using either of two methodologies:

- Since substandard risk loading factors have usually been derived from aggregate population data, it would appear to be in line with the risk to use aggregate mortality data for calculating extra premiums. For certain diseases such as epilepsy, smoking status would not have much bearing and an extra loading for smoking would be inappropriate. If the underwriter feels that a disease warrants an adjustment to the loading, smoking status could be taken into consideration by increasing the substandard loading.
- For numerous conditions such as potential cardiovascular problems or diabetes, which are two of the main reasons for imposing a medical loading, the extra loading should be higher for smokers than for non-smokers. As there are not many conditions that would not be compounded to some extent by smoking, the multiple should apply to the non-smoker or smoker rates, and not to aggregate rates. For conditions in which the extra dollar loadings should be the same for smokers and non-smokers, such as occupational or hazardous pursuits, the flat extra loadings could be used instead of multiple extras.

The latter approach results in substantial discounts of the aggregate extra premium for substandard non-smokers. In view of the increasing percentage of non-smokers in the overall insured population, special attention should be given to the pricing of substandard non-smoker policies.

Administering Substandard Lives Ratings with a Standard Administration System

In some markets it is common to use alternatives to the multiple extra loading rating and the flat extra loading rating. Reasons for using alternative methods can be summarized as follows:

- alternative rating methods are historically preferred,
- policyholders are occasionally not willing to pay an additional premium for insurance coverage, though they are prepared to accept a reduction in the amount payable in case of death during the first policy years, and
- the company's administration system may not be able to handle flat extra loadings.

The most common alternatives to the multiple extra loading and the flat extra loading ratings are liens and an adjustment to the age at entry of the applicant. Conversion of a flat extra loading to an equivalent multiple extra loading is also often requested, especially if a company's administration system cannot handle flat extra loading ratings.

Age at entry adjustment

In the case of an adjustment to the age at entry, the entry age of the applicant is adjusted in such a way that the standard premium at the adjusted age is equivalent to the substandard premium at the actual age. Tables that adjust the entry age can be developed for the most common tariffs and age groups.

The substandard premium rate can be found by solving the following problem:

"minimise $| NP^{sub}_{x,n} - NP^{std}_{y,n} |$"

where the minimum is taken over all valid entry ages of the plan greater than the actual age at entry x.

Table 2 gives an example of a 20-year policy with an extra mortality loading of 50%.

Table 2. Age adjustment factors for a male policyholder and an extra mortality of +50%[5], 20-year policy duration

Age at entry	Term life (years)	Endowment (years)
25	+6	+8
30	+5	+6
35	+5	+5
40	+5	+5
45	+5	+5

Lien (debt)

In the case of liens, the insurance protection of the first policy years is reduced, resulting in a lower substandard insurance premium. The substandard insurance premium can, in many cases, be equivalent to the premium on standard lives. The reduction of the insurance protection can be arranged as a level lien for a given period or as a lien which reduces by a fixed amount each year. The latter method is used more frequently and it is on this method which we will now focus.

A lien of (m-1)*D reducing by D each year can be calculated by the normal method of equating the present values of premiums and benefits.[7]

$$\begin{cases} NP^{std}_{x,n} * \ddot{a}_{x,n} = \text{PV(future benefits)} - D* \dfrac{m*M_x - R_x+R_{x+m}}{D_x} \\ NP^{sub}_{x,n} * \ddot{a}_{x,n} = \text{PV(future benefits)} \end{cases}$$

$$\Rightarrow (NP^{sub}_{x,n} - NP^{std}_{x,n}) * \ddot{a}_{x,n} = D* \frac{m*M_x - R_x+R_{x+m}}{D_x} \quad \text{(Formula [1])}$$

The commutation values and annuities are calculated on the basis of the total substandard mortality and the pricing interest rate. It should be noted that a lien is not always sufficient to offset the substandard extra premium entirely; in such cases, a reduced extra premium would still be payable in addition to the lien.

Table 3 gives an example of a lien pattern for a 35-year-old policyholder with an extra mortality of +50%. As can be seen from the table, the lien can, in the case of an endowment policy, fully compensate for the extra mortality; in the case of a term policy, the lien cannot fully offset the substandard mortality rate and can only reduce the extra premium which has to be paid.

Table 3. Lien pattern of a 5-year lien and net premiums for a 35-year-old male policyholder with an extra mortality of +50%[5], 10-year policy duration

	Term life	Endowment
Lien pattern of a 5-year lien		
Policy year 1	80%	70%
Policy year 2	60%	52%
Policy year 3	40%	35%
Policy year 4	20%	17%
Policy year 5	0%	0%
Net extra premium for a substandard life	0.76 per mille	0.31 per mille
Net extra premium for a substandard life with the lien	0.39 per mille	0.0 per mille

An approximate formula for a lien can be developed using the recursive reserve calculation formula: The following relationship can be developed (where L_t is the lien imposed for the $(t+1)^{th}$ year)[8]:

$$NP*(1+i)=q_{x+t}*(DB_t-V_{x,t+1}-SB_t)+[V_{x,t+1}-V_{x,t}*(1+i)+SB_t]$$

$$NP*(1+i)=q^{sub}_{x+t}*(DB_t-L_t-V^{sub}_{x,t+1}-SB_t)+[V^{sub}_{x,t+1}-V^{sub}_{x,t}*(1+i)+SB_t]$$

Assuming that the substandard lives reserve is equivalent to the standard lives reserve and that the lien fully offsets the extra mortality risk, the above formula results in:

$$L_t * q^{sub}_{x+t} = (q^{sub}_{x+t} - q_{x+t}) * (DB_t - V_{x,t+1} - SB_t) \quad \text{(Formula [2])}$$

$$\Rightarrow \qquad L_t = \frac{(q^{sub}_{x+t} - q_{x+t})}{q^{sub}_{x+t}} * (DB_t - V_{x,t+1} - SB_t)$$

For an endowment policy, it is often assumed that the sum at risk reduces in a straight line from 1 to 0 at maturity. This assumption leads to the frequently used approximation:

$$L_t = \frac{k}{1+k} * \left(1 - \frac{t}{n}\right) \qquad \text{(Formula [3])}$$

with k being the extra mortality loading (i.e., $q^{sub}_x = (1+k) * q_x$). The lien therefore reduces by a level amount on each policy anniversary over (n-1) years, where n is the term of the policy.

Table 4 compares the different methods used to calculate liens for an endowment policy:

Table 4. Lien pattern of a 10-year lien for a 35-year-old male policyholder who bought an endowment policy with an extra mortality of +50%[5], 10-year policy duration

Policy year	According to Formula [1]	According to Formula [2]	According to Formula [3]
1	31%	30%	33%
2	28%	27%	30%
3	24%	24%	27%
4	21%	21%	23%
5	17%	18%	20%
6-10	etc.	etc.	etc.

Transforming a temporary flat extra loading into a multiple extra loading

Administration systems sometimes cannot handle the whole variety of possible risk assessments. We are therefore frequently requested to convert a temporary flat extra mortality loading (e.g., in case of applicants with a recent cancer diagnosis) into a multiple extra loading.

The calculation of actuarial equivalent multiple extra ratings is straightforward, though such converted ratings very often involve a significant anti-selection risk for the insurance company as shown by Chart 1.

Chart 1. Comparison of the cash flow pattern of a 35-year-old male policyholder who bought a 20-year endowment policy [5] and who was rated with +50% extra mortality plus 5 per mille flat extra for 5 years. An actuarial equivalent extra mortality loading is +169%.

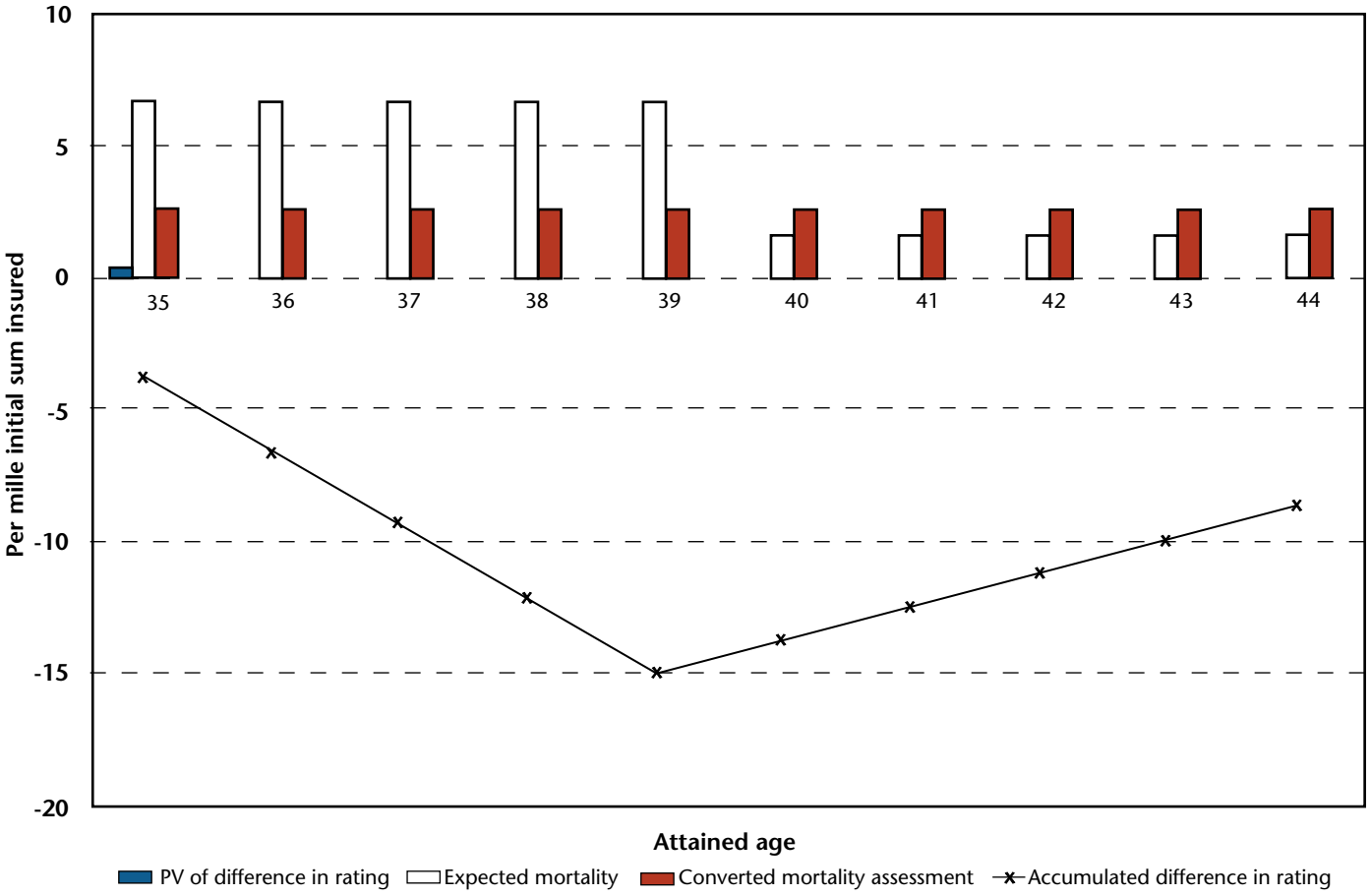


Chart 1 shows that the actuarial present values of both assessments are about the same, though the risk premium of the converted mortality assessment in the first few policy years is not enough to compensate the high risk. If the policyholder cancels his policy within the first policy years, as might be the case if he is able to obtain a more favourable rating from another insurance company after a few years, the insurance company is deprived of the opportunity to recoup the deficit in the risk premium.

This risk could be reduced if the surrender value were adjusted in such a way that the accumulated premium difference was recouped from the surrender value. Alternatives to the rating proposed in Chart 1 reduce the risk for the insurance company but often overcharge the applicant for his impairment, as can be seen from the example in Chart 2.

Chart 2. Comparison of the cash flow pattern of a 35-year-old male policyholder who bought a 20-year endowment policy [5] and who was rated with +50% extra mortality plus 5 per mille flat extra for 5 years. As a converted assessment, an extra mortality loading of +450% was considered.

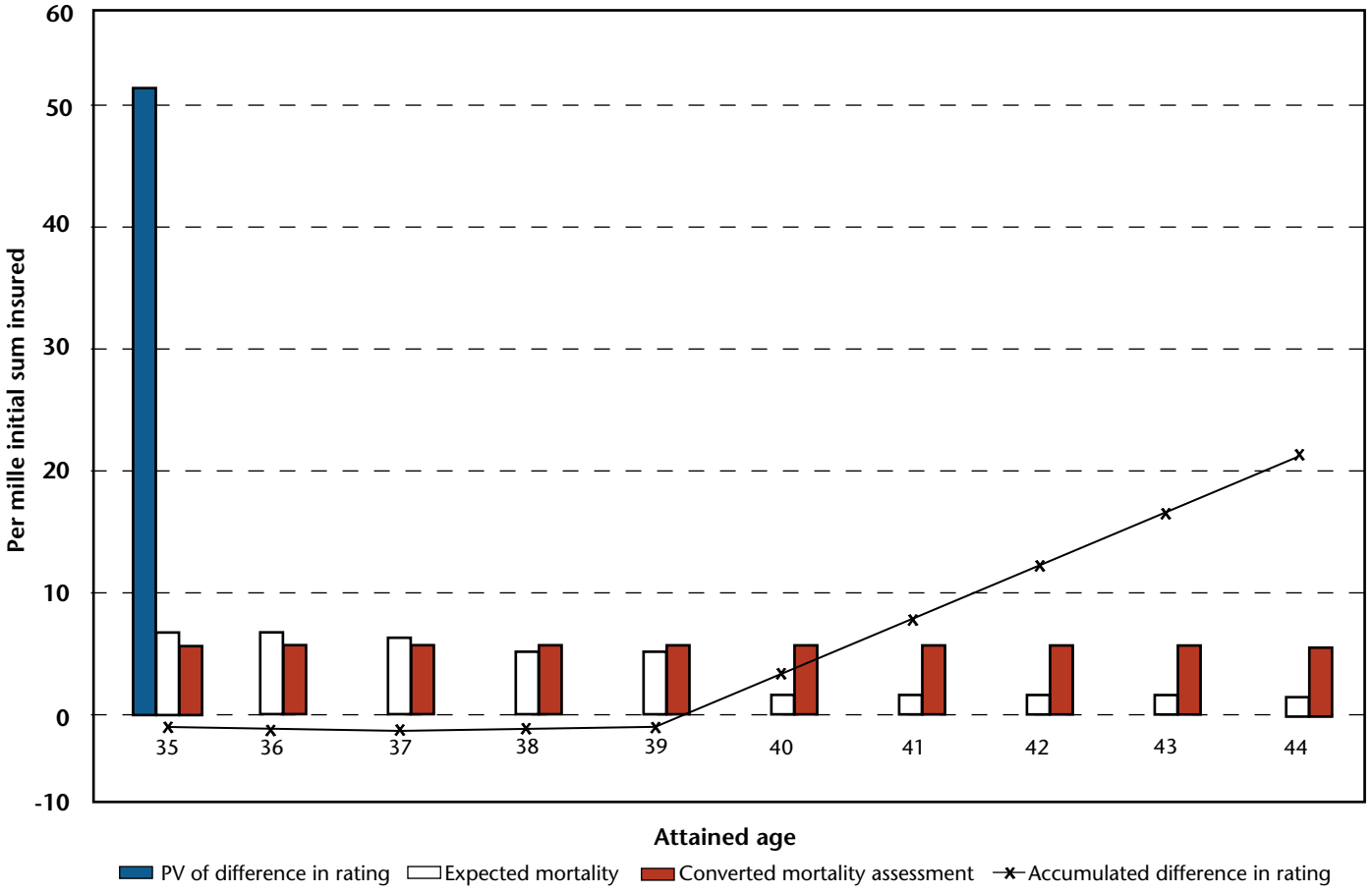
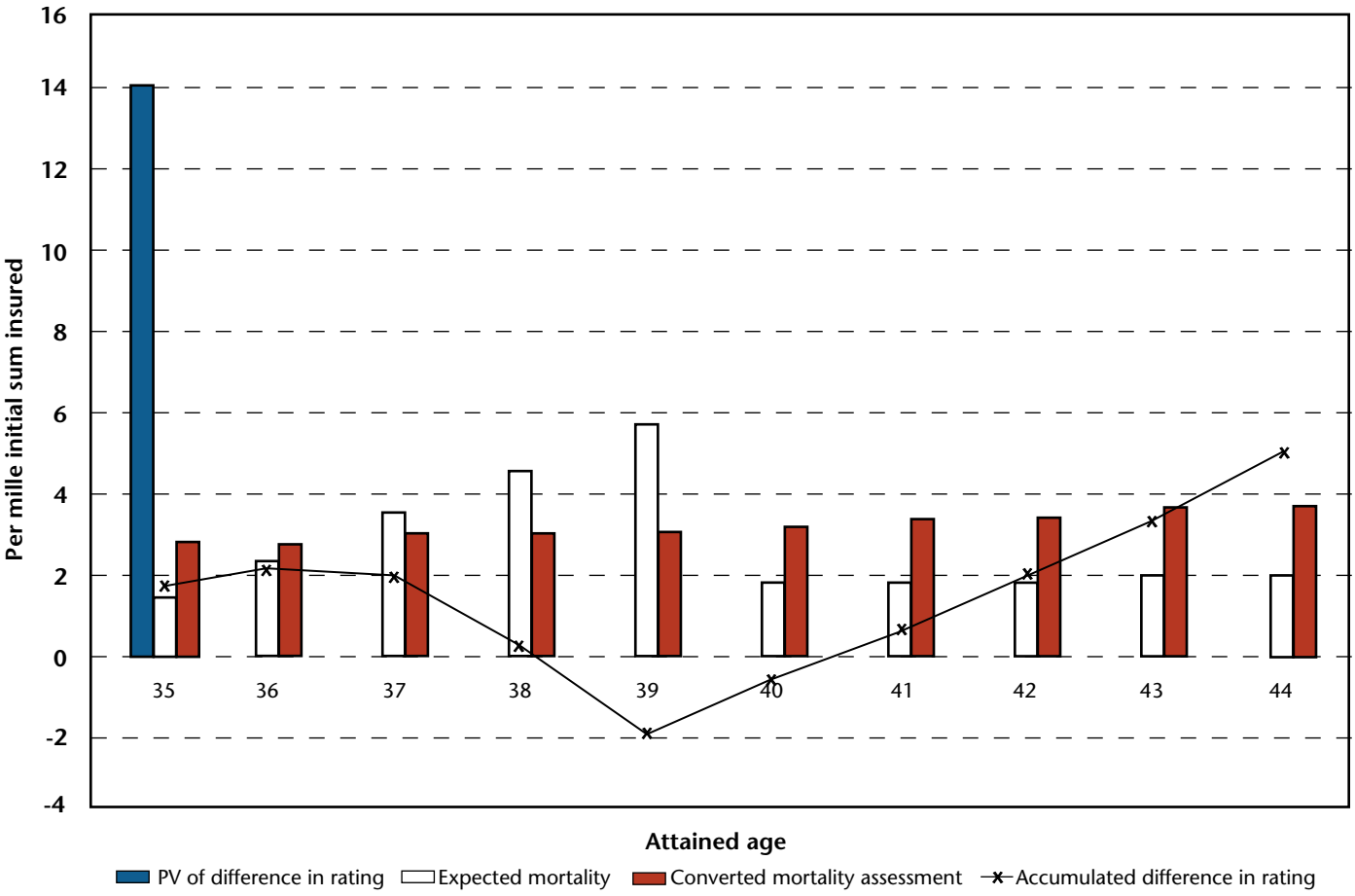


Chart 2 shows that the loss in risk premium to the company is significantly reduced for the converted mortality assessment. However, the actuarial present value shows that the policyholder would have to pay a much higher premium in the long run compared to the actual assessment. The likelihood of the policyholder finding an insurance company with a more attractive proposal is significantly higher than in the circumstance described in Chart 1, in particular if the health condition of the policyholder does not deteriorate further. Overall, it can be expected that mainly policyholders with deteriorating health conditions will continue their policies with the company, leading to cumulative anti-selection effects.

One solution could be to combine an extra mortality rating with a lien as shown in Chart 3.

Chart 3. Comparison of the cash flow pattern of a 35-year-old male policyholder who bought a 20-year endowment policy [5] and who was rated with +50% extra mortality plus 5 per mille flat extra for 5 years. As a converted assessment, an extra mortality loading of +175% plus a 5-year lien was considered.



The premium of the converted assessment is still higher than the premium of the actual assessment, though the difference is significantly reduced compared to the parameters used for Chart 2. The anti-selection risk for the insurance company is much lower as well.

Concluding Remark

There is no simple solution to the problem of converting an underwriting assessment into an assessment that uses different criteria. Both the risk which an insurance company has to face by possible anti-selection by substandard lives and the adequacy and equity of the insurance premium charged to policyholders must be considered.

1 For example, GeneralCologne Re's electronic underwriting guidelines, CLUE. The next update will be launched in the 4th quarter 2000.

2 In the case where the underwriter's rating is directly applied, the substandard mortality is calculated according to the following formula: $\overline{q}_x=(1+d) * q_x$ where we assume that the underwriter's extra mortality loading is d. The smoothing method assumes $\overline{q}_x=1 - (1- q_x)^{1+d}$. The advantage of the latter method is that the overall mortality rate can never exceed 1000 per mille.

3 As no cash value is offered for the "return of the extra premium" benefit, the interest rate which is used for calculating this benefit is usually higher than that used for pricing the substandard risk premium. The higher interest rate is intended to compensate for the lost surrender value which this benefit involves. In Germany, for example, the interest rate for the "return of extra premium" benefit is typically 1.5% higher than that used for calculating the substandard risk premium.

4 The commutation values are calculated on the basis of the total substandard mortality.

5 Based on the 1996 Japanese experience table and an interest rate of 2.1%.

6 For example, Bowers et al. Actuarial Mathematics.

7 The formula applies to different lien patterns such as liens used in Japan mutatis mutandis.

8 DB_t stands for the Death Benefit in year (t+1); SB_t stands for a survival benefit in year (t+1).

Substandard Long Term Care Insurance: Are You Crazy?

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While long term care insurance (LTC) is still only a teenager in the product life-cycle of the U.S. market, a surprising number of carriers are evolving toward underwriting class structures that are characteristic of more mature products. A recent A.M. Best survey of LTC insurers, representing two-thirds of the U.S. LTC market, revealed that 33% have one underwriting class, 25% have 2 classes, 20% have 3 classes, and the remainder have 4 or more classes. Therefore, about 4 out of 10 companies surveyed have 3 or more classes, including one that could implicitly be labeled "substandard." Defining and pricing the highest risk class of a multi-class underwriting structure is challenging for immature products such as LTC. One could even argue that attempting to do so is crazy, but nonetheless, "substandard" LTC is now a market reality. What does "substandard" mean? What motivates the market to offer it? Is there a sane (or less insane) approach? What are the implications for marketing, pricing, and the future of LTC insurance?

Market Driven

In today's U.S. LTC market, insurers compete not only on product design, commissions, and pricing, but also on the risks each is willing to accept. The issue is really risk bandwidth. Once the insurer determines which risk elements constitute absolute unacceptable risk, the focus shifts to the acceptable segments. What constitutes preferred, standard and substandard risk strata, and what are the boundaries of each stratum?

To further understand the underwriting challenge, it is important to view LTC insurance accurately. It is not medical insurance. The required care delivery is generally sub-acute, as Medicare (U.S. Government health care program for the elderly) and employee benefits generally provide coverage for acute care conditions. In this sense, it is not really health insurance. Perhaps a better paradigm is the "ability to live independently" insurance. Many insureds trigger LTC benefits simply because they become old and feeble. Further, LTC services are provided over a continuum of locations and intensities of delivery: at home, in the community, and in various levels of care facilities generally known as "nursing homes." As such, the underwriting process goes beyond considering current health conditions, health history, or family health.

The marketing dilemma is most clearly portrayed when a husband and wife each apply for coverage. One spouse may be completely acceptable, but the other spouse has chronic conditions that may be nearly unacceptable. If the insurer declines the spouse, it most likely will not be successful in retaining the healthy applicant. A family unit does not react favorably to the experience of one member's rejection. Many couple sales are thus lost, the agent's time has been wasted, and the insurer has invested significant costs in the underwriting process. The marketing dilemma is further heightened by the fact that most LTC insurance in the U.S. is sold by agents that are not captive to one insurer. This type of agent, in couple sale settings, or in any context where the applicant appears to be near the cutoff of acceptable risk, will often eliminate insurers who do not accept substandard risks.

At one level, this could be considered an excellent outcome since the insurer always writes acceptable risk at standard rates. However, substandard risk is not invariably unprofitable, and the loss of that premium volume may not be consistent with the insurer's market share and profit objectives. So how can the LTC insurer address the acceptance of substandard risks?

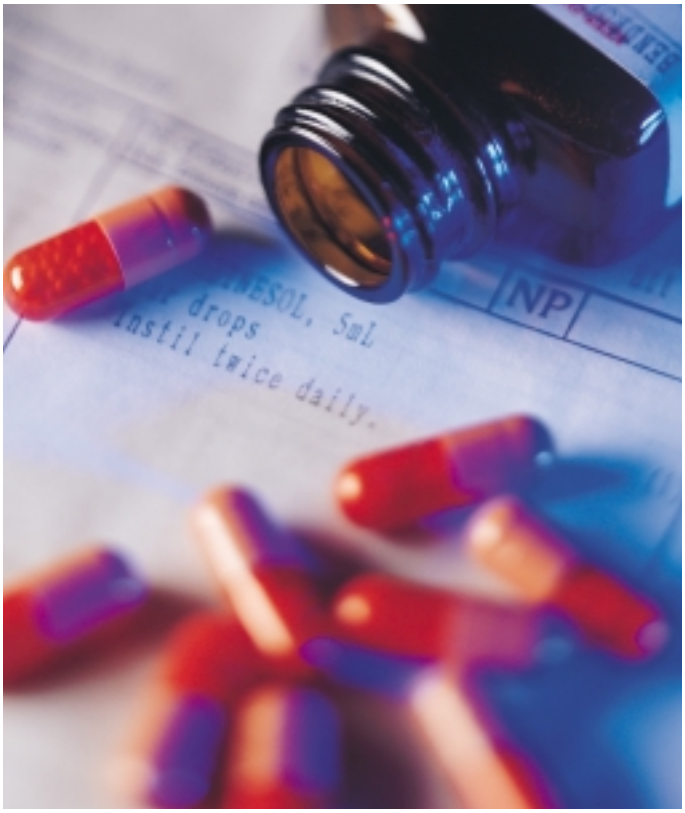
Theoretical Basics

In theory, the insurer is paid for reducing the insured's risk-of-loss. One way to slice risk is into *statistical* and *parametric* components. *Statistical* risk is the component that is reduced by the *Law of Large Numbers.* The insurer decreases *statistical* risk by pooling and thereby gains an advantage over individual retention of risk. *Parametric* risk is the risk element that is *not* reduced by the *Law of Large Numbers. Parametric* risk concerns the adequacy of pricing assumptions and premium rates, assuming a large volume of business.

Underwriting is the process whereby an insurer seeks to minimize *parametric* risk by classifying applicants according to the correct premium rate. In open competition, market forces tend to drive underwriting toward greater refinement, including a greater number of rate classes (up to a point). For newer forms of risk such as LTC, initially little is known about how morbidity pricing assumptions (the *parameters*) should vary by underwriting criteria. Therefore, insurers typically start with one broad rate class that is expected to be adequate "on average" for the accepted risks. "On average" is both key and a point of vulnerability. With just one broad rate class, accepted risks are certainly not identical and not necessarily even similar. Some will have diabetes, some not. Some will be smokers and some non-smokers. Some will have coronary heart disease and some not. Initially, there was no commonly accepted definition of a standard LTC risk. And that is still true to some extent relative to a mature product like life insurance, which has more universally accepted criteria for assigning various rating tables.

As more experience is gained, insurers tend to seek greater profitability and competitive advantage by refining their risk classifications. The first carriers who take this step may lose some market share, but they attract healthier lives and price-discourage less healthy lives from applying. Carriers

that are slow to adopt multiple rate classes will find that, over time, more applicants who meet their broad acceptance criteria will also be less healthy, thereby eroding profitability. In short, healthy lives are attracted to the lower premiums available from multiple rate classes, and less healthy lives are attracted to the subsidy received under one broad rate class. The point is that, sooner or later, all LTC insurers will be forced to consider adopting multiple rate classes and the challenge of defining the "substandard" risk. An insurer may opt for, or against, writing what it considers to be "substandard" risk. However, because rating classifications are shades of gray, rather than black and white, defining and pricing the highest risk class of a multi-class approach is an unavoidable challenge.



Practical Tools

The application

In the individual LTC market, application forms generally are quite detailed as to the health questions that are queried. These questions are often grouped by level of underwriting impact. Conditions such as Alzheimer's disease which automatically disqualify the applicant are often asked first, with conditions requiring more interpretation, such as diabetes, coming later. While only the application establishes any basis for later recession or denial of claim for failure to disclose, there are profound constraints on its use by the underwriter. Applications provide no third-party validation beyond the statement of the applicant and whatever is observable by the agent.

Post-application telephonic questionnaire

Telephonic interviews afford the insurer the ability to speak directly with the applicant and re-ask questions of interest on the application, as well as to ask for further detail on questionable answers. Unlike the answers on the application, any verbal answers provide only a limited basis for later recessions or denial of claim. It does, however, afford the insurer the ability to directly re-validate responses in the application. If the answers are consistent with those given on the application itself, a strengthened basis exists for later recession for untruthful application answers.

Telephonic cognitive assessment

In addition to the validation issues of the post-telephonic interview, insurers will often administer telephonic cognitive assessments using their own medical staff or a third-party assessment network. The telephonic cognitive assessment will typically focus on such elements as delayed word recall and orientation (e.g., who was the prior President of the United States, what day is today, where do you live, etc.). The weakness of even the most sophisticated telephonic examinations is the inability to validate that you are in fact speaking with the applicant, that the applicant is not being prompted, and that key elements requiring later recall are not being written down by the applicant for later reference.

Face-to-face assessment by a registered nurse

The insurer has at last accessed a far higher degree of risk validation at the point where it sends a registered nurse (RN) into the home setting to meet with the applicant. The face-to-face (FTF) Assessment includes a review of current medications, medical conditions, and medical history; observation of the applicant's ability to perform activities of daily living (ADLs) and instrumental activities of daily living (IADLs); direct measurement of sitting and standing blood pressure, pulse, respiration, and body weight; observation of skin tone and appearance of health, as well as the safety and orderliness of the home environment; and most important, the direct administration of cognitive assessments which measure short-term memory and orientation, as well as the ability to draw complex figures, do basic arithmetic, and demonstrate reasoning skills.

FTF assessments are a powerful tool to thwart application fraud by validating the functional status and the home setting of the applicant. In effect, these assessments provide a current clinical "snapshot" of the applicant and indicate how well he/she practices independent living. The snapshot can be invaluable. For example, if there is a history of hypertension but the applicant has not consulted his/her attending physician in the last 16 months, current blood pressure levels can be obtained during the FTF assessment.

These assessments are relatively expensive, and are therefore more useful for older applicants, e.g., those past normal retirement age. Many insurers require a FTF after age 70 or 75. FTF assessments are less valuable at younger ages where

cognitive dysfunction and ADL failure are less common. For younger ages, attending physician statements and medical records generally have greater protective value.

Attending physician's statement and medical records

An attending physician's statement (APS) is a specific query to the applicant's family or specialist physician. More generally, an APS refers to the acquisition of the applicant's entire medical records, including blood tests and the results of other clinical testing. Some insurers require medical records on most applicants regardless of age, except for actively-at-work employees in large employer groups. Others do not require an APS below a certain issue age for clean applications. One important value of the APS is discovery of conditions not disclosed on the application nor subsequently identified in the course of telephonic or FTF underwriting events. Another benefit arises in cases where emerging or long-standing chronic conditions pose significant risk for the underwriter to evaluate. However, APSs add significant costs to the underwriting budget and can require several weeks to obtain. There are third-party organizations that specialize in obtaining these medical records at a negotiated cost.

Certain impairments are often omitted from medical records due to social mores. For example, neither patients nor their doctors enjoy open discussion of conditions such as dementia. We have found FTF cognitive testing to yield significant information, even when an APS is obtained and no record of that condition exists. In pre-dementia, the emergence of cognitive decline is often not clinically observable to the physician, particularly in the absence of complete cognitive testing.

Blood and/or urine analysis

While blood and/or urine analysis is a common tool for life insurance underwriting, few LTC insurers have found the cost/benefit ratio of these tests to be high enough to warrant their routine use. This becomes clearer when you consider that LTC insurance is "ability to live independently" insurance.

Key body systems

While this article's mission is not to provide an LTC underwriting manual, it is important to consider the key systemic areas of human decline. The underwriting of LTC insurance on any basis involves understanding the key body systems and the emergence of system failure, ultimately leading to death. Between emergence and death, certain system failures can lead to protracted utilization of LTC services for one or more periods of time. The greatest LTC financial underwriting risk is dementia, a condition that has a number of etiologies in addition to Alzheimer's disease. Nervous disorders, cardiovascular and cerebrovascular risks, systemic endocrine conditions (e.g., diabetes), skeletal weakening, certain viral and bacterial infections, and co-morbid chronic conditions are brightest on the palette of medical conditions to be scrutinized by the underwriter. Surprising as it may seem, cancer is less likely to cause lengthy periods of long term care. Many dreaded conditions that create high mortality risk do not evolve to lengthy sub-acute or LTC utilization.

Underwriting Challenge

So what is the real underwriting challenge? Once you eliminate the applicants who present you with unacceptable health conditions or history, you then identify those individuals whose risks meet or exceed standards in the underwriting manual. The remaining risks are substandard.

The challenge in substandard underwriting is to consider the risk potential for lengthy LTC benefit utilization, when it will most likely commence, and how much time the insurer may have to pre-fund that risk through premium income. Then the underwriter must deploy one or more of the following remedies to develop an assumption of risk that will be acceptable to the LTC insurer:

- The first remedy is to establish a premium rate that will permit the insurer to pre-fund the risk through premium income.
- The second remedy is to determine which available constraints on coverage amount, duration, or onset date of utilization will be necessary given the profile of the applicant. It is not generally possible, either from a regulatory perspective or from a practical perspective, to eliminate specific causes of LTC utilization from coverage. At older ages, loss of independence seldom arises from a single medical condition. As a result, coverage parameters can only be adjusted as to the dollar amount of risk assumed on a daily or lifetime basis, and/or by applying higher elimination periods before coverage payments can begin.
- The third remedy is to constrain the scope of the covered care continuum. Some regulatory environments permit a form of LTC insurance for "Facility Only" care. Removal of home-based care coverage creates "Facility Only" coverage that is attractive to buyers whose principal concern is costs that might be incurred in a nursing home facility.

The decision to issue substandard LTC is ultimately driven by the underwriter's understanding of the severity of relevant chronic conditions and confidence in understanding each of the three "C's": control (degree of control for each relevant chronic condition), compliance (degree of compliance with the attending physician's treatment plan), and complications (the absence of significant complications).

Pricing Challenge

The actual claims experience of LTC insurers in the U.S., *in the aggregate*, appears to be tracking anticipated claims, according to the National Association of Insurance Commissioners (NAIC) Long-Term Care Experience Reporting. (This statement assumes the adequacy of the claim reserves reflected in the actual claim data, and thus remains somewhat uncertain.) Actual-to-anticipated claims experience, by company and policy form, varies considerably. Unfortunately, there is no industry study that reveals experience by underwriting class, and the lack of uniform class definitions remains a major obstacle to comparing LTC premium rates and emerging experience. Therefore, actuaries currently have little sound data or experience to price multiple rate classes.

Initial attempts to price multiple rate classes involve first starting with the desired number of classes, defining the criteria for each class, developing the expected distribution of issues by class (based on judgment or analysis of prior cases viewed under the new criteria), and then choosing rate factors that (when applied to the aforementioned distribution) result in at least the total premium that would have been produced by one broad rate class. There are an infinite number of rate factors that can be selected during this process. Usually some comfort is taken in the idea that the new class structure encourages more healthy lives to apply. But underpricing the lower risk classes would blunt that advantage, and it's suspected that the tendency has been to overprice better risks and underprice higher risks. If the new underwriting class structure accepts risks that would have been declined under the former structure, then typically the criteria that are loosened involve conditions that are not causes of the largest LTC claims and/or involve shorter look-backs and recovery periods for acute care episodes. Rate factors are currently mostly a matter of judgment, and therefore it is imperative for the insurer to monitor experience **by class**. The rate factors for multiple classes typically fall in the range of 0.65 to 2.5.

Future

The future will both mirror the past and hold new surprises, and LTC strategies will reflect all combinations of leader/follower and savvy/dumb. Copycat behavior in the market will continue and history will repeat itself. There is no substitute for experience, and there is no more valuable experience than a company's own. Companies that achieve and maintain success in the LTC market will be the ones that continuously analyze their underwriting results and make the necessary changes. They will actively manage the *parametric* risk by seeking to improve the match between rate class definition and pricing. Capturing underwriting data and claims experience in a computerized, data-mining environment will give the savvy carrier a competitive advantage over insurers that are not able to convert data to information and that have a "silo" mentality with respect to underwriting and claims operations. For companies that choose to write higher risk classes of LTC, the fundamentals of managing the business will be critical to success. A key goal of the savvy insurer will be to determine which conditions pose truly high risk for LTC, versus those that are assumed to be so because they present an increased risk for life and/or medical insurance.

As for new surprises, diagnostic and genetic technologies continue to evolve rapidly. Urine tests have been developed that indicate the likelihood of Alzheimer's disease. Other tests will become available that identify adverse conditions in their earliest stages. In some cases the public will be able to use information for self-selection before insurers are legally able to use it. A rancorous public debate can be anticipated concerning whether genetic information should be allowed for the purpose of underwriting, and the outcome of that debate may influence the future role of private health insurance in the U.S. A pleasant surprise could be the development of effective prevention and/or therapy for Alzheimer's disease, stroke, and some of the other causes of large LTC claims. For example, a promising preventive (and possibly therapeutic) treatment for Alzheimer's disease (beta-amyloid injection) has recently been shown to be safe in humans and extensive trials are about to begin. Paperless medical records will lead to standardization and faster access that could speed up the underwriting process and allow for more detailed experience analysis. Application of artificial intelligence and pattern recognition technology to underwriting may lead to insights regarding co-morbidity and other areas of underwriting that currently remain more art than science. However, underwriting will surely remain the insurance function that requires the most human judgment and experience.

Insuring the Uninsurable?

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GeneralCologne Re, Hong Kong

In the process of underwriting an applicant for life insurance cover, the underwriter reviews submitted medical and financial information to determine if the individual is "insurable" and, if so, on what terms. Is he/she acceptable at standard rates, at an increased premium, or with a "lien"? Inevitably, some will be considered "uninsurable." There are many reasons why an applicant is declined or is deemed to be uninsurable:

- the risk of claim is too high for the company to assume,
- it is not feasible for the company to administer such a policy, or
- the client will not accept the policy at the assessed rate.

This does not mean that the applicant's need for insurance cover is any less. On the contrary, it is often when confronted with one's own mortality that the need to provide for dependents becomes real and immediate. In many markets, highly substandard lives do have recourse to very limited sums of guaranteed-issue insurance. Such cover is often offered through banks or credit card companies using mailshots (mass mail marketing). Unfortunately, these mailshot offers may not be available when they are most needed, and the amounts available for purchase are often insufficient to replace future income.

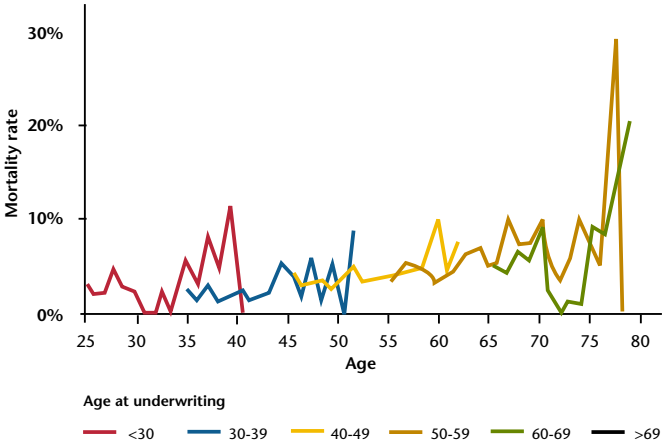
One product, the Modified Death Benefit (MDB), is specifically designed for sale to individuals rejected for traditional coverage. This coverage has been popular for some time in South Africa. It differs from a typical mass-marketed product which usually hopes to attract a certain percentage of standard or minimally substandard business. MDB requires few underwriting requirements. Applicants must answer two questions that relate to HIV-AIDS and sexually transmitted diseases, and they must be tested for HIV. No medical examination is required, and thus this product may also interest people who wish to avoid these examinations (e.g., older applicants).

There are policy restrictions associated with the MDB plan which allow these minimal underwriting requirements. Such restrictions include:

- any death claims received in the first three years are limited to the return of premiums paid, unless death occurs as a direct result of an accident,
- in cases where the full face value would be payable, the maximum amount insured is limited to R400,000 (US$60,000) per life, which in South Africa is enough to buy a small house, and
- normal exclusions for suicide and accidental death apply in the early years.

As evidenced by the application questions, AIDS is a concern for this product because it can result in early mortality experience after the initial years, and therefore the limit placed on death claims in the first three policy years will not provide adequate protection against anti-selection by HIV carriers.

Figure. Mortality rates in South African lives insured under an MDB product (legend refers to age at underwriting)



In Hong Kong, GeneralCologne Re has worked with a local insurance company to launch a similar product, with certain modifications to make it better suited to the local conditions. Other than differences in the benefit payment pattern, one notable modification is removal of the questions related to HIV-AIDS and sexually transmitted diseases. This makes it a truly guaranteed-issue product. It is an acceptable risk in this environment because the prevalence of HIV infection is low and protection for the insurance company is provided by excluding any death claims resulting from HIV infection. In addition, the maximum benefit amount was set at HK$1,000,000 (US$130,000), which in Hong Kong will cover the cost of a modest flat in an extremely out-of-the-way location.

Insurers interested in MDB products should price the cover with a percentage increase in the "standard" mortality rates to allow for the overall higher incidence of death. The initial anti-selection risk in the first few years is handled via a set of flat extra loadings per mille (per thousand). When establishing these assumptions it is also important to consider the likely client base for the product. Input from local underwriters and agents, as well as regional statistics on causes of death, are important factors for assessing conditions frequently encountered in the "uninsurable" market.

Experience from South Africa provides a good illustration of the importance of considering the likely clientele when pricing for MDB products. During the 1970s, a clan of farmers was considered to be uninsurable due to an extraordinarily high incidence of ischaemic heart disease.

These individuals had a significant family history of heart disease and early death was common. Yet insurance cover for inheritance tax purposes was in demand amongst this group. Thus was born the MDB. GeneralCologne Re continues to monitor the claims experience of this group and, over the last couple of decades, has tracked the following pattern of mortality rates (Figure, excluding rates calculated on an exposure of less than ten lives). As expected with an impairment such as ischaemic heart disease that does not improve with time, mortality rates increase with duration of coverage and are not higher in early policy years.

In Hong Kong ischaemic heart disease is far less prevalent, although cardiovascular conditions do comprise a significant proportion of substandard and declined lives. Instead, the majority of deaths result from cancer. For this impairment, excess mortality is highest soon after diagnosis, gradually declining thereafter until lives that have suffered from cancer become insurable at standard rates about the tenth year after treatment. For the MDB in Hong Kong, one might expect to see higher mortality rates in the initial years. This is similar to the experience of "funeral covers" in the U.K. that are sold in the older-age market and are based only on a declaration of health.

For an insurance company, the obvious advantage to adding MDB to its portfolio is that this product can be sold to anyone without the need for individual underwriting (which would be necessary for substandard cases with traditional life covers). But there are disadvantages, including the fact that it is more expensive, and the limited protection usually does not meet the broad needs addressed by full insurance cover. There is also the real possibility for "misselling," especially if the restricted coverage is not properly explained to potential clients. This could be a major factor in the high lapse rates experienced in South Africa. Similar products have also been marketed in the U.S. and Europe, but with limited success.

Ultimately, the most crucial determinant for success is the distribution channel(s) used by the insurer. For companies selling through a sales force, a guaranteed issue product completes their product line and means that agents truly have something to offer everyone!

GeneralCologne Re Hosts Symposia On Genetic Research

Marianne Kutzner
GeneralCologne Re, Germany

At one time, genetic testing belonged more to the realm of science fiction than to the business of insurance. But it is closer to an underwriting reality than some believe. GeneralCologne Re recently hosted the Third Symposium on Genetics in Germany which addressed many of the major genetics issues that face the life insurance industry.

The conference updated the underwriting community on the status of the Human Genome Project, and provided the latest scientific information on the genetics of neurologic and psychiatric disorders. It also delivered easy-to-understand information about the genetics of disease, the implications of new tests, the probability of developing certain genetic diseases after a positive test result, and the potential of mass genetic screening. Ethical, legal and social issues were addressed, including discussion of the position of European life insurers that they should have access to the results of genetic tests done prior to the application. Our experts presented scenarios where special offers might be made to applicants with a history of cancer but with other favourable genetic factors. These special offers would provide life insurance protection to individuals with a severe disease and also enhance the standing of companies that sell such cover.

Debate continues on whether or not life insurers will be allowed to use genetic tests to evaluate risk. The German government is considering a ban on the use of these tests by private life and health insurers. The position of the German Insurance Association and similar groups in other European markets is that insurers should have access to genetic test results. However, the public is concerned that applicants with unfavourable results may be forced to pay much higher premiums or even lose the opportunity to get cover. On the other hand, the public is less aware of the possibility that a favourable genetic test result may prompt some applicants to disclose this information to insurers in order to qualify for cheaper cover.

Sponsorship of this meeting continues GeneralCologne Re's active involvement with this issue via a broad range of sponsored talks, publications, and symposia. The goal is to deliver innovative underwriting support to our clients worldwide and help the life insurance industry find acceptable solutions to dilemmas posed by genetic advances.

How to Place a Substandard Risk

Thomas Coleman
GeneralCologne Re, United States

The agent is on the telephone with the status clerk at the insurance company and she has just been told that one of her biggest clients will be offered coverage on a substandard basis. She thanks the home office underwriter for his help and then asks her assistant to run another proposal based on the new table rating (loading), instead of the standard quote she originally gave the client. The premium has increased from US$5,000 to US$10,000. She takes a deep breath and considers how to explain this development to a valued client. There's a lot riding on this case: the client also happens to be the controller of a company that recently approached her to do estate planning for the partners and the board of directors.

She has no idea what to tell the proposed insured since the status clerk did not provide the precise reason for the rating, and the client did not reveal any significant medical history on the application. He had always been offered standard insurance in the past; what has changed? She could send the new proposal to the client and encourage him to accept the rating "before he loses this generous offer." Eventually she decides it would be a logical first step to seek the assistance of the home office underwriter who handled the case and made the risk determination. Hopefully, she can call upon the good relationship they have established over the years to resolve this dilemma.

Agent-Underwriter Relationships

When confronted with a substandard offer, an agent is concerned about the health of the client, as well as whether the offer will jeopardize the trust and business relationship that have been established over the years. Will it be possible to discuss this situation with the kind of sensitivity and professionalism that is required? Is the rating based on a minor problem or a misunderstanding, and discussion of the situation would unnecessarily upset the client? Or is there a real problem that should be brought to the client's attention? Should the attending physician be informed of the company's findings?

It is at times like these that all parties benefit from the relationship between the agent and the underwriter in order to arrive at a solution that is in the client's best interests. The underwriter's training and experience is essential to guide the producer through the areas of risk assessment that led to the rating. They must then find a way to approach the client, allay his concerns, and explain the rationale of the offer.

Identifying the Problem

Informing a proposed insured that he is being offered a contract at a higher premium because of medical reasons is difficult under any circumstance. It becomes increasingly complex given the rules of confidentiality that are so important to our industry. The client, although completely candid about his history at the time of application, may not be aware of any serious medical condition, much less know of any change in a pre-existing condition. The underwriter walks a fine line when attempting to explain the reason for any premium increase. He must be as straightforward as the details of the ailment allow, while protecting the interests of the company, the client, and the doctor or medical facility that supplied the information. A condition admitted on the application is usually easier for the underwriter to explain, especially if more recent tests indicate a quantifiable deterioration.

Given the nature of underwriting requirements such as blood and urine tests, ECGs, and treadmill stress tests at older ages and/or for large cases, it is relatively common for the insurer to detect new problems. There isn't an agent in the business that hasn't been surprised by lab findings in an otherwise healthy client. On the other hand, in reviewing an attending physician's statement (APS), the underwriter might discover a sign, symptom, or risk factor that the physician plans to evaluate at a later date. Whereas the doctor has the luxury of following his patient over time, the underwriter must make a decision on the data presented. Each of the above scenarios could result in the application being postponed, rated, or declined.

A first step in these cases is for the underwriter to obtain the insured's written permission to write to the attending physician or to the physician that supplied the information. This doctor is in the best position to respond to the insurer's concerns, evaluate the test results, decide if further testing is needed, determine if there are extenuating circumstances, or if there has been an error in recording or interpretation.

Placing the Case

John J. Doolan, MBA, RFC, and Principal of the Northeast Brokerage Agency, a recognized impaired risk specialist and the creator of a course entitled "The Art of Impaired Risk," emphasizes the importance of getting the proposed insured to contact his physician. It is the first step in returning the client to the proper frame of mind. The client's questions and concerns need to be addressed. At this juncture it is often necessary for the underwriter to educate both the client and the physician on the differences between clinical and insurance medicine, thereby providing a common ground from which to proceed.

Karen Jackson, Senior Underwriter at Companion Life Insurance Company of New York, believes that substandard ratings can put the home office underwriter and the agent in a seemingly adversarial position. The agent clearly runs a

greater risk of losing the business if the underwriter doesn't explain why a substandard offer is necessary. The abnormality that lead to the rating may or may not be indicative of a serious medical problem. But without prior history and clinical evaluation, a new finding presents an insurance risk that cannot be ignored. Both Mr. Doolan and Ms. Jackson agree that including the attending physician at this juncture is crucial. Underwriters may even take the initiative to contact the doctor directly in order to get a better understanding of the applicant's pertinent history. If the underwriter, the agent and the doctor work together from the outset, they improve the chances of placing the coverage.

The idea of reconsideration of the rating at some time in the future is a welcome tool for any producer. If further testing or clinical evaluation indicates that the rated condition no longer exists, has been adequately treated, is the result of a benign problem, or occurred in the past and not recurred, the underwriter can adjust the rating accordingly. The client who understands that the company is willing to reconsider his medical condition and offer a premium reduction, even at some future date, is more likely to purchase the insurance from the outset.

Sales and Underwriting Solutions

Mr. Doolan cautions that an agent who concentrates on the difference in price between the original quote and the rated quote unwittingly does a disservice to the client. After all, the family protection issues haven't disappeared; if it was a keyman policy, the employers' interests still exist. In fact, if the reason for the adverse rating is a medical problem, the need for life insurance may actually increase. The agent needs to emphasize these points.

Selling a client on the idea of purchasing a policy at an increased premium is not an easy task. The agent has numerous tools to help guide or redirect the sale. If price is driving the sale, lowering the face amount or introducing a new product may be the only way to go. If the original premise for the sale is still valid, then maintaining the original face amount, even at the higher premium outlay, is usually the best advice. Showing a client the various options available to him is recommended. Most insurers are staffed with underwriters who have the expertise to assist the field force in providing alternatives. In these cases, agents need look no farther than their own underwriting departments for help in placing impaired risk cases.

Another possible solution is for the field underwriter to develop a relationship with an impaired risk specialist for his/her surplus business. These specialists exist to provide the fastest service possible and to keep the lines of communication open between the agent and the client. Many of these operations have entire units dedicated to assisting the agent with any number of problems that may arise. They often have full-time underwriters on staff, and these "in-house" underwriters generally have long-standing relationships with the underwriting departments of multiple insurance companies. Since they work almost exclusively with hard-to-place cases, they have the expertise to facilitate the proper approach to the various substandard scenarios they see each day. For example, they are used to gathering the appropriate information and dealing with doctors and medical facilities to get to the root of a problem and move the case forward. The impaired risk specialist will often work directly with the client and thereby reinforce the perception that everything possible is being done to secure the needed coverage.

Major problems can develop when the agent hesitates to act quickly on a tough case. This places time constraints on the underwriting process and valuable time is lost. There is often a small window of opportunity to work with any client before the producer is faced with the need to literally re-sell the cover. Both home office underwriters and impaired risk specialists believe that all of the above solutions are viable, but other actions may be in vain if answers are not given to the client in a timely fashion.

One option that is often overlooked in substandard insurance is preliminary underwriting or an informal "inquiry." In some cases, the agent should have the client's history reviewed by an underwriter before formally submitting the application to the insurer. Medical questionnaires and a review of the APS can provide a clearer picture of the client's health and forestall surprises later on. Clearly no one can be prepared for unexpected findings that arise from the company's underwriting requirements. But if sufficient information about a pre-existing condition is provided before the application is submitted, the underwriter is able to reach a more informed decision, make suggestions, or ask for specific requirements or pertinent records. All of these steps should be taken from the very beginning. Thus, preliminary underwriting can be a valuable tool for understanding the risk as well as preserving the business relationship with the proposed insured.

Conclusion

Having a proper strategy to deal with substandard offers will increase the chances that the case can be placed. The agent must:

- focus on the needs of the client,
- keep the client informed,
- make him feel that he is part of the team and the solution,
- reinforce the purpose of the coverage,
- gather all pertinent medical information necessary for evaluation,
- work with the attending physician to help answer the client's concerns, and
- impress upon the prospective client that meeting his interests is everyone's goal.

When faced with an impaired risk case, the best way to achieve the desired result is to work together as a team. Satisfying the client, while maintaining the business for the company and the agent, will result in a happy ending for everyone.

Occupational Underwriting — A New Perspective?

John Turner
GeneralCologne Re, Germany

Occupational underwriting remains the poor cousin of the more glamorous medical and financial underwriting. Rigorously imposed safety regulations in most industrialized nations have caused fatal accident rates in the workplace to fall. This factor, combined with the ever increasing pressure to reduce the number of questions asked on insurance application forms, has made occupation a side issue in the underwriting process. Occupation does, however, present a real threat to the mortality assumptions made when pricing a product, and it must remain a major consideration during underwriting. For this reason it is important to examine the actual causes of occupational mortality.

The ILO (International Labor Organization) has estimated the annual figure for work related deaths to be 1.1 million globally,[1] of which only 335,000 are accidents. The immediate concern caused by such figures is that insurance rates for occupational extra premiums have primarily been based on accident rates, but accidents represent only 30% of total occupational mortality. This remains an estimate, because proving that a death due to illness was actually the result of occupational factors can be extremely difficult. Often, occupational diseases are simply diseases that are also found in the general population, but are noted to have a higher incidence amongst certain industries. Even when recognized as an "occupational disease," there is significant underreporting, which greatly influences the statistics. In Latin America, for example, it is estimated that only 1-4% of all occupational diseases are ever reported.

It would be easy for the industrialized countries to attribute much of this illness and injury to developing countries, where safety standards may not be as strictly enforced. Yet the ILO estimates total direct and indirect costs in the U.S. in 1992 to be US$171 billion, a financial impact greater than that of HIV-AIDS and similar to the costs associated with heart disease and cancer. The UK also does not escape inspection, with the HSC (Health and Safety Commission) estimating the costs of work related accidents and illness to the British economy in 1995 to be as high as £18 billion.[2] The HSC also estimated that, during 1995, approximately 2 million people suffered from ill health caused by their current or previous occupation, with over 25,000 people per annum being forced to give up work as a result of work related accidents and ill health.

Occupational Accidents

Risk of accident has often been discussed, possibly because it is easy to measure and the cause of fatal accidents is remarkably easy to record. To fully examine the impact of occupation on insurance, it is necessary to briefly consider fatal accidents, despite the above analysis which suggests that accidents are less important than disease as a cause of occupational mortality.

The Census of Fatal Occupational Injuries (CFOI) reports that, throughout the 90's, over 6,000 workers died annually due to occupational accidents in the U.S.[3] Leigh et al. confirm an annual rate of 6,500 fatalities due to work related injuries, with approximately 13.2 million non-fatal injuries.[4] From such a large working population, an annual fatal accident rate of 6000-6,500 should not be of major concern to life insurers; however, the accident rate is not level across all occupations.

Total fatalities, defined by type of industry, have little meaning since this figure does not take into account the numbers exposed to each risk. One method used to estimate occupational risk is the risk of fatal accidents relative to an industry average (Table). The high relative risks for occupations such as pilots, timber cutters and commercial fishermen are obviously of concern to the life underwriter, and especially so for the underwriter of accident insurance products, because the relative accident mortality risk for these occupations is about 20 times higher than the average of all occupations combined. As standard premium rates are usually based on national averages, it would be simple if these 3 occupations paid 20 times that part of the premium which covers fatal occupational injury. In practice, however, few underwriters are aware of the proportion of the risk premium which meets this need or have the system capability to rate only this part of the premium. Ratings are therefore based on the sum assured, with a small flat extra per thousand being appropriate for most life cover contracts.

Table. Occupations with largest relative risk of fatal accident, U.S., 1995[5]

Occupation	Fatality count	Employment (1,000's)	Index of relative risk	Leading fatal event
All occupations	6,210	126,248	1	—
Fishermen	48	45	21.3	Drowning (81%)
Timber cutters	98	97	20.6	Struck by object (81%)
Airplane pilots	111	114	19.9	Airplane crashes (98%)
Structural metal workers	38	59	13.1	Falls (66%)
Taxicab drivers	99	213	9.5	Homicide (70%)
Construction laborer	309	780	8.1	Vehicular (28%), falls (27%)
Roofers	60	205	5.9	Falls (75%)
Electrical power installers	35	126	5.7	Electrocutions (60%)
Truck drivers	749	2,861	5.3	Highway crashes (68%)
Farm occupations	579	2,282	5.1	Vehicular (50%)

Occupational Disease

Occupational disease has long been recognized as a major cause of mortality with one of the earliest examples coming from the 18th century when a remarkably high incidence of scrotal cancer was noted amongst chimney sweeps. Education on thorough cleansing of this part of the body was enough to significantly reduce the future incidence of such cancers for this group of workers, but perhaps not enough for society as a whole to learn the dangers of occupational exposure to carcinogenic agents. Later extreme examples include skin cancer in arsenic workers in 1822, and liver cancer in polyvinyl chloride (PVC) manufacturers in 1939. Despite best efforts, occupational disease persists and seems likely to continue to contribute to mortality and morbidity in the current workforce and in those with a history of prior exposure.

The ILO estimates there will be 160 million new cases of work related disease each year across the world, including respiratory and cardiovascular diseases, cancer, hearing loss, musculo-skeletal and reproductive disorders, as well as mental and neurological illnesses. Leigh et al.[4] estimate a similar figure, for the U.S. alone, of 862,000 new occupational diseases per annum, with 60,300 of these proving fatal. Looking only at the U.S. figures, it is apparent that we may be misguided if we concentrate solely on the accidental fatality rates, when occupational disease kills 10 times as many workers. It is of value to the underwriter to examine more closely the causes of occupational disease.

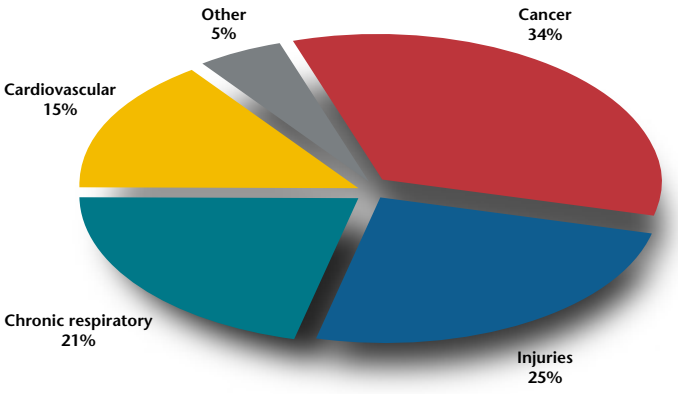
1. Biological agents, viruses, bacteria, parasites, fungi, moulds and organic dusts are all commonly encountered in the workplace. Healthcare workers are exposed to HIV, hepatitis B and C, and tuberculosis. Chronic parasitic diseases are common amongst forestry and agricultural workers, and asthma is frequently encountered by those exposed to organic dusts.
2. Physical factors, such as noise, vibration, ionizing and non-ionizing radiation, and microclimatic conditions can all have an effect on health. The World Health Organization (WHO) estimates that 10-30% of the workforce in developed countries, and up to 80% in developing countries, are exposed to such physical factors. Noise-induced hearing loss remains one of the most prevalent occupational health effects. Pilots appear particularly prone to this condition due to the long-term exposure to noise in the cockpit.
3. Occupational carcinogens are encountered in many occupations. In the European Union alone, approximately 16 million people are exposed to carcinogenic agents at work. Approximately 300-350 such agents have been identified, including benzene, chromium, nickel, and asbestos. Although estimates vary, these agents remain significant factors, with 4-9% of all cancers being thought to be occupational in origin, and 15% of male lung cancers attributable to occupational exposure.[6,7]
4. At least 100,000 different chemicals are currently used in the modern workplace and this number is still increasing. Chemicals are now used in almost all types of work, but high exposures are seen in the chemical processing and metal industries, amongst others. Health effects include metal and pesticide poisoning, damage to the central nervous system and liver, dermal and respiratory allergies, cancers, and reproductive disorders.
5. Allergenic agents are frequently encountered at work, with an estimated 3,000 different agents being present in the environment.
6. Psychological stress is now considered a major source of occupational illness. Sleep disturbances, burnout syndromes and depression are increasingly attributed to work related stress. Epidemiological evidence also shows stress to be a major risk factor for cardiovascular

disorders, with stress being implicated particularly in coronary heart disease and hypertension. Future advances in prevention of psychologically-induced disease may come in part through better understanding of the role of psychosocial factors in the workplace. A recent case-control study in Japan showed a striking relationship between increased mean working hours and the risk of acute myocardial infarction (MI).[8]

The Figure displays global work-related mortality by cause.

Estimated global work-related mortality

1.1 million per year (based on 1990-95 data)



Other diseases include pneumonconioses, nervous system and renal disorders
Source: ILO, 1999.

The Future of Occupational Underwriting

Medical research continues to provide links between particular occupations and certain diseases, often without any definite explanation. Pilots have recently been the subject of research. In a study of commercial jet pilots who had flown more than 5,000 hours, Gunestrup et al.[9] demonstrated a 5-fold increase in the incidence of acute myeloid leukemia, and a 3-fold greater incidence of non-melanotic skin cancers. Rafnsson et al.[10] observed a 25-fold increase in the incidence of malignant melanoma in airline pilots who flew over 5 time zones. Explanations for such figures vary, with lifestyle, cosmic radiation, and excessive sunbathing being implicated. The problem remains for the underwriter to decide what can be done with such information. Traditionally pilots have been prime candidates for insurance since they were thought to have more favourable mortality due to regular medical check-ups. For individual life covers, the answer is to continue to offer standard rates for airline pilots. Even if they are at greater relative risk for certain diseases, the absolute risk of getting these particular conditions is small, and this risk is offset by the generally improved all-cause mortality experience found in this and other occupations that are subject to strict medical selection criteria. For group covers, and in particular group dread disease contracts, an increase of 10-20% in the cancer portion of the risk premium may be justified.

Other information provided by the Health and Safety Executive (HSE) review reveals that the self-employed are twice as likely to be killed at work. It also showed that workers in small manufacturing firms were more than twice as likely to be killed than workers in larger firms in the same sector. Such statistics are perfectly valid but it is unlikely that insurers will start to offer different life tables for the self-employed, or indeed ask how many workers are employed in the company's factory. Such details, when compared to the total risk picture of a client, remain insignificant. It is worth remembering that we are all exposed to occupational disease in one form or another, so perhaps we should not get too carried away with one particular study. After all, even if occupation does contribute to, or even cause, up to 9% of all cancers, it should be remembered that diet alone causes at least twice this amount, and diet remains something over which the client has total control, but the underwriter has almost no chance of confirming. An attempt to review the vast number of medical papers covering the risks of working in an office setting would also confirm there are no longer any "safe" occupations.

As with accidental risks, emphasis should be on the extremes when assessing the impact of occupational illness. Applicants most exposed to occupational illness are already recognized by underwriters as being at higher risk and rated accordingly. Miners are an excellent example: few, if any, companies accept these risks at standard rates. Good underwriters would also recognize immediately the higher risk presented by applicants who work with asbestos. In effect underwriters have already moved towards partially reflecting the impact of occupational disease in their decisions, and perhaps the day will come when occupational ratings will be based more on total associated mortality and not just on past accidental fatality rates.

The problem remains, however, of what can be sold. Most salesmen would accept that a pilot should pay an extra premium because the risk of death due to crashing is greater than that of his ground based colleague. It would be more difficult for an agent to be persuaded, and indeed for the agent to persuade the client, that he should pay more because of the effects of cosmic radiation.

1 Takala J. Occupational Safety and Health Branch, International Labor Organization. Geneva, 1999.

2 Health and Safety Executive. Press Release. UK, June 2000.

3 U.S. Department of Labor, Bureau of Labor Statistics. Census of Fatal Occupational Injuries. 1999.

4 Leigh JP, et al. Arch Intern Med. July 1997.

5 U.S. Department of Labor, Bureau of Labor Statistics. Census of Fatal Occupational Injuries. 1995.

6 Doll et al. J Natl Cancer Inst. June 1981.

7 Canadian Cancer Incidence Atlas. Canada 1996.

8 Sokejima et al. BMJ. September 1998.

9 Gunestrup et al. Lancet. December 1999.

10 Rafnsson et al. Occup Environ Med. March 2000.

Hepatitis B Virus Infection in China

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This is the second of a three-part series that analyzes insured lives morbidity and mortality risk associated with chronic viral hepatitis. The previous article (September 2000) discussed hepatitis C infection in Western insurance applicants. The final installment will focus on hepatitis C infection in Japanese populations.

Worldwide there are approximately 350 million carriers of the hepatitis B virus (HBV). As many as one million of these people develop hepatocellular carcinoma (HCC) each year, and countless others develop end-stage liver disease. Prevalence of HBV is highest in China, Southeast Asia, Indonesia, and sub-Saharan Africa, where more than 8% of the population are chronic carriers, as defined by the presence of hepatitis B surface antigen (HBsAg). In these countries, HBV infection almost always occurs at birth or during early childhood, and sequelae of long-term chronic infection are uncommon until decades later.

The protracted course of HBV infection makes it difficult to estimate morbidity and mortality risk in an insured lives population that is chronically infected with HBV. Most studies on this topic have been based on older patients with advanced disease who were treated at tertiary centers which specialize in care of patients with liver disease. These reports bias risk estimates toward severe cases and are not appropriate indicators of what might be expected in an insurance context. In contrast, data for this analysis were obtained from long-term prospective studies of cohorts that were well characterized with respect to risk factors predictive of long-term prognosis.

This article is a shortened version of a longer, more detailed discussion. The unabridged version and the accompanying references may be obtained by contacting the author.

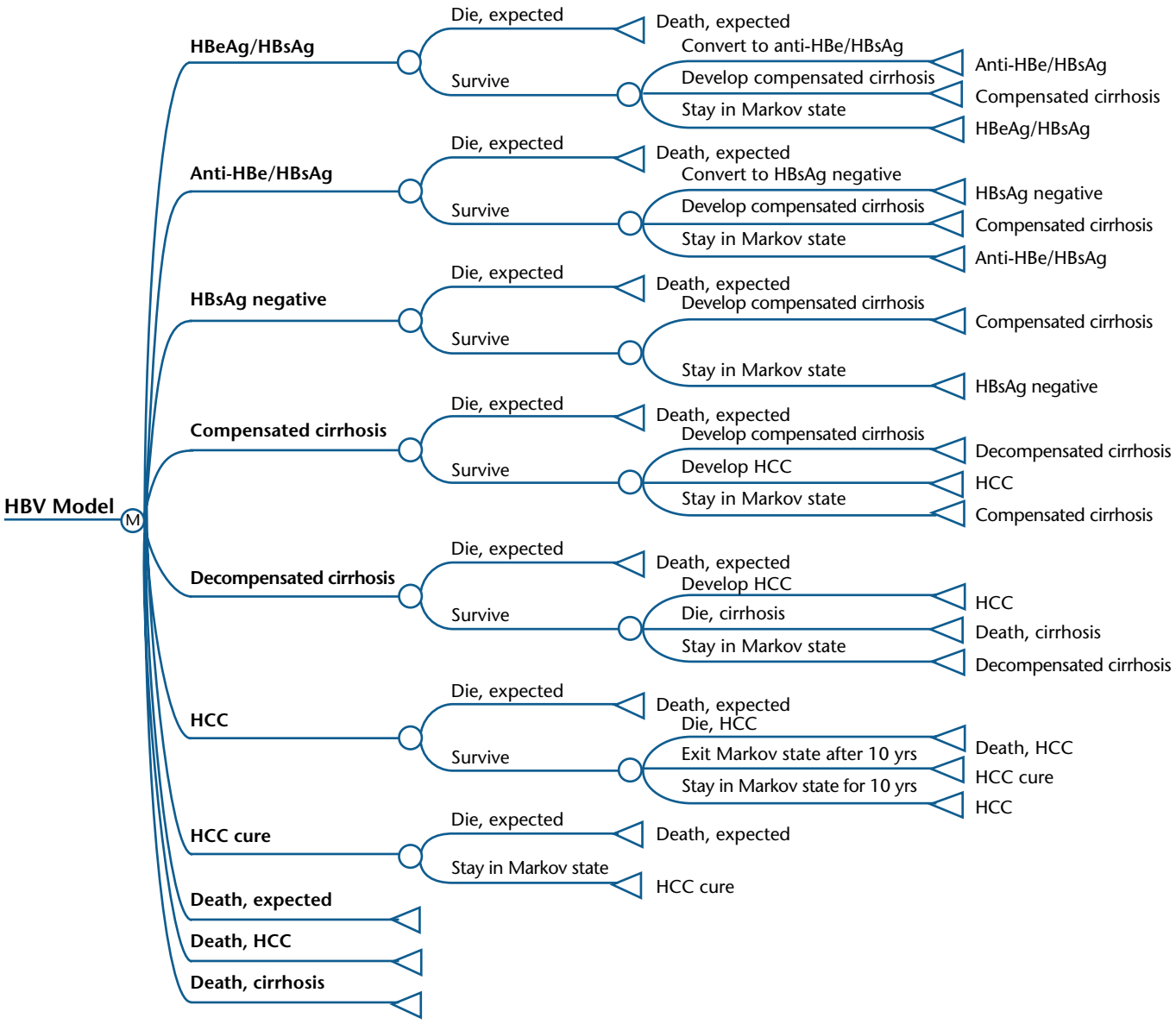
Description of Model

A cohort simulation Markov model was created to estimate long-term morbidity and mortality risk associated with chronic HBV infection in otherwise healthy insurance applicants who reside in China and were presumably infected at birth or during early childhood (Figure 1).* Subjects in the Markov state "HBeAg/HBsAg" test positive for HBeAg (hepatitis B "e" antigen) and HBsAg. Those in "Anti-HBe/HBsAg" have developed antibodies to HBe but remain HBsAg positive. Designations of other Markov states are self-explanatory. Subjects age 20 at the time of underwriting begin the model in "HBeAg/HBsAg" or "Anti-HBe/HBsAg"; those underwritten at ages 30, 40, and 50 begin the model in "HBeAg/HBsAg," "Anti-HBe/HBsAg," or "Compensated cirrhosis" (described in greater detail below).

For each of the ten Markov states, subjects are first exposed to age- and gender-specific risk of expected death per the chosen mortality table. Those who survive expected death remain at risk for other events in the Markov state. After each one-year cycle of the model, subjects gradually move into other (lower) Markov states, e.g., some become HBsAg negative, some develop compensated cirrhosis, decompensated cirrhosis (liver failure), or HCC, and some die.

The Table lists annual transition probabilities which determine the rate at which subjects move from state-to-state. With one exception, transition probabilities were based exclusively on Chinese data.

Figure 1. Markov model used to estimate long-term morbidity and mortality in Chinese insurance applicants infected with the hepatitis B virus.



* Morbidity and mortality estimates provided by this model can be generalized to other populations and individuals where HBV infection occurs at birth or during early childhood. Some modifications of insurance risk (usually higher risk estimates) may be required in non-Asian markets where few HBV related deaths are included in insured lives mortality rates.

Validation

The model was validated by comparing the output to multiple "real life" population data sets: (1) HCC incidence rates in Taiwan, Hong Kong, Shanghai, Singapore, and Korea; (2) HCC mortality rates in Taiwan, Hong Kong, and Korea; and (3) cirrhosis mortality rates in Taiwan. Expected death rates for the validation phase of the model were based on the 1996 Taiwan Life Tables for the general population. Figures 2-7 indicate that the results of the model closely approximate "real life" population data.

- Figures 2 and 3 display, respectively, male and female HCC incidence rates calculated by the model compared to 70% of actual HCC incidence rates in Taiwan, Hong Kong, Shanghai, Singapore, and Korea. (Approximately 70% of primary liver cancers in China are due to HBV.)

Figure 2. Male HCC incidence rates calculated by Markov model vs. 70% of actual HCC incidence rates, by country (assume 15% HBV prevalence rate).

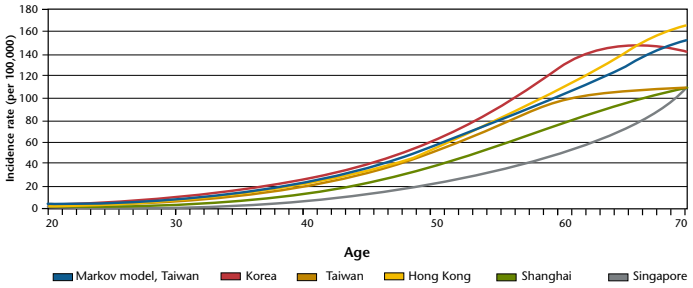
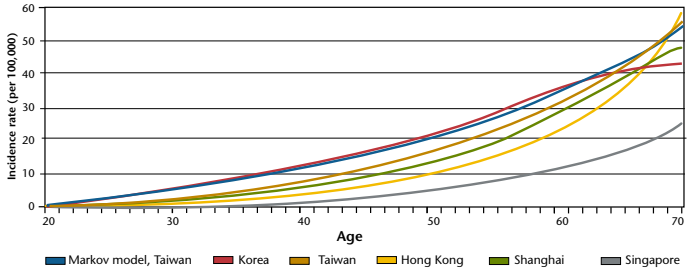


Figure 3. Female HCC incidence rates calculated by Markov model vs. 70% of actual HCC incidence rates, by country (assume 15% HBV prevalence rate).



- Figures 4 and 5 display, respectively, male and female HCC mortality rates calculated by the model compared to 70% of actual HCC mortality rates in Taiwan, Hong Kong, and Korea.
- Figures 6 and 7 display, respectively, male and female cirrhosis mortality rates calculated by the model compared to 50% of actual cirrhosis mortality rates in Taiwan. (The model assumes that 50% of cirrhosis deaths are attributable to HBV.)

Figure 4. Male HCC mortality rates calculated by Markov model vs. 70% of actual HCC mortality rates, by country (assume 15% prevalence rate).

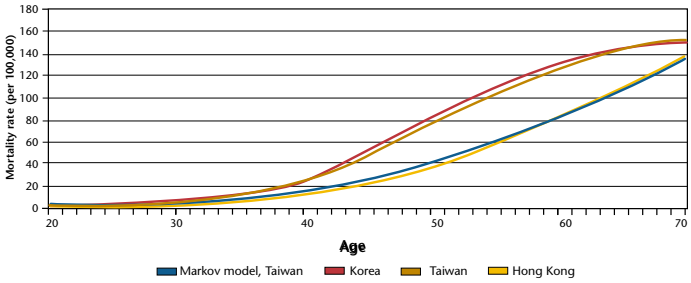
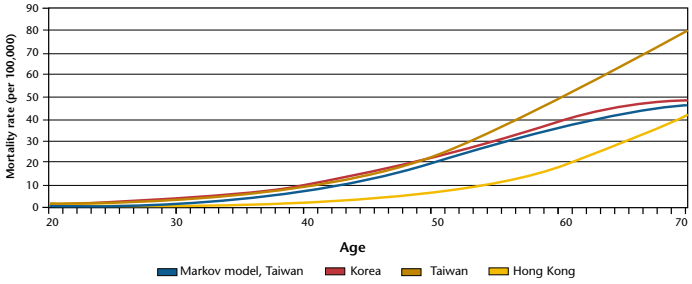


Figure 5. Female HCC mortality rates calculated by Markov model vs. 70% of actual HCC mortality rates, by country (assume 15% prevalence rate).



Mortality Results

Having demonstrated that the model approximates **population** HCC incidence rates, HCC mortality rates, and cirrhosis mortality rates in East and Southeastern Asia, the next step was to estimate **insured lives** morbidity and mortality experience. Expected death rates for this phase of the modeling process were based on 90% of the 1989 Taiwan Standard Ordinary (TSO89) insured lives table.

Age 20 at underwriting

Cirrhosis and HCC are rare at young ages. Accordingly, the model assumes that healthy 20-year-old applicants begin the model in either the "HBeAg/HBsAg" or the "Anti-HBe/HBsAg" Markov state.

Medical studies report a less favorable outcome in patients with HBeAg, principally because HBeAg is associated with more rapid development of cirrhosis, but the magnitude of this risk has not been quantified in an insured lives context. The question is "What is the mortality risk of a healthy 20-year-old HBV infected applicant (1) known to be HBeAg positive (HBeAg100%, Figures 8-9), (2) known to be anti-HBe positive (Anti-HBe100%), and (3) whose HBe status is unknown at the time of underwriting (HBeAg80%_anti-HBe20%, i.e., the usual HBeAg and anti-HBe distribution for a 20-year-old)?"

- Mortality ratios for males age 20 at underwriting (Figure 8) increase gradually for the first decade, plateau between ages 40 and 55, and taper gradually at older ages. Peak mortality ratios are as follows: HBeAg100%, 173%; HBeAg80%_anti-HBe20%, 168%; and Anti-HBe100%, 150%.

Figure 6. Male cirrhosis mortality rates calculated by Markov model vs. 50% of actual cirrhosis mortality rates, Taiwan (assume 15% HBV prevalence rate).

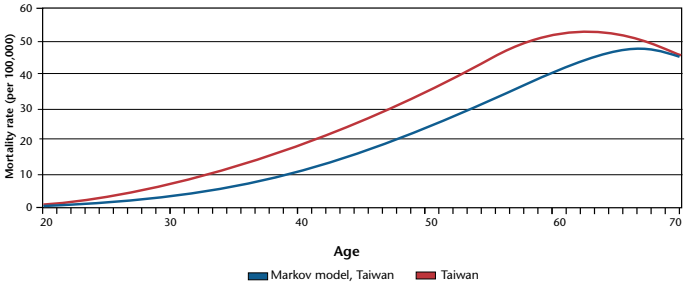


Figure 7. Female cirrhosis mortality rates calculated by Markov model vs. 50% of actual cirrhosis mortality rates, Taiwan (assume 15% HBV prevalence rate).

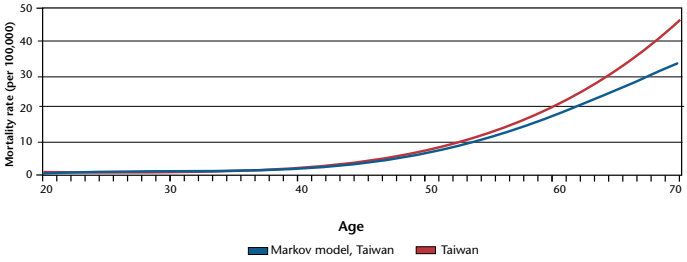


Figure 8. Estimated mortality ratios for HBV infected Chinese males age 20 at underwriting, by HBeAg and anti-HBe status.

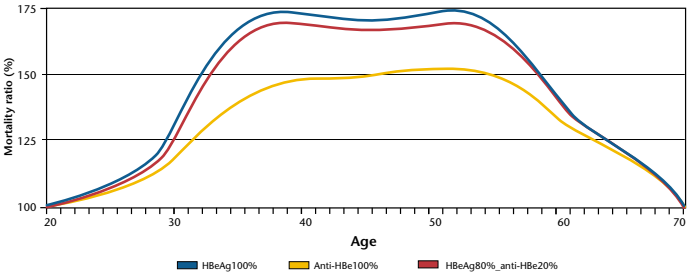
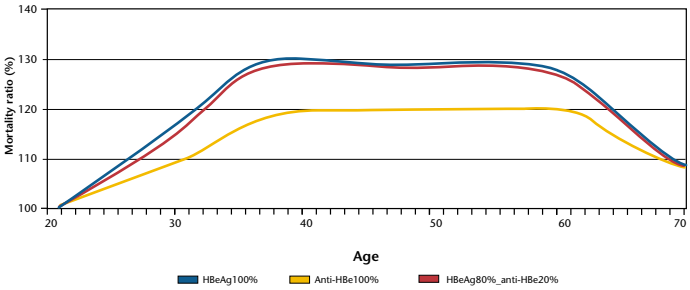


Figure 9. Estimated mortality ratios for HBV infected Chinese females age 20 at underwriting, by HBeAg and anti-HBe status.



- Mortality ratios for females age 20 at underwriting (Figure 9) demonstrate a similar pattern. Peak mortality ratios are as follows: HBeAg100%, 131%; HBeAg80%_anti-HBe20%, 129%; and Anti-HBe100%, 121%.
- Depending on HBeAg/anti-HBe status, mortality ratios for males are 30-40 percentage points higher than for females.

Age 30, 40, and 50 at underwriting

The incidence of complications increases with older age. However, applicants age 30, 40, or 50 would not be sold coverage if there was a history of severe HBV related disease (decompensated cirrhosis or HCC), i.e., at the time of underwriting, no subjects would begin the model in "Decompensated cirrhosis," "HCC," or "HCC cure." Thus, all subjects at underwriting ages 30, 40, and 50 would be in one of three Markov states: "HBeAg/HBsAg," "Anti-HBe/HBsAg," and "Compensated cirrhosis" (subjects with relatively mild cirrhosis not detected at the time of underwriting). Distribution among these three states at the beginning of the model was determined by the weighted probability of being located in these states per attained age, and the percentage of applicants with compensated cirrhosis that were detected and eliminated from the risk pool during the underwriting process, i.e., the effectiveness of the "selection" process.

Figures 10-15 display estimated mortality experience for HBV infected applicants, by age, gender, and theoretical percent cirrhosis detection rate (20%, 50%, and 80%) at the time of underwriting.

- Age 30. Mortality ratios for males (Figure 10) increase rapidly during the first decade, plateau between ages 40 and 55 at values that vary with percent cirrhosis detection, and taper gradually thereafter. Peak mortality ratios are: Detect 20%, 172%; and Detect 50%, 170%. The 80% detection rate is not shown because calculated values were identical to the 50% detection rate. For females (Figure 11), mortality ratios peak after the first decade, followed by a long plateau. Peak mortality ratios are: Detect 20%, 154%; and Detect 50%, 137% (80% detection rate not shown for reasons explained above).

Figure 10. Estimated mortality ratios for HBV infected Chinese males age 30 at underwriting, by percent detection of existing cirrhosis.

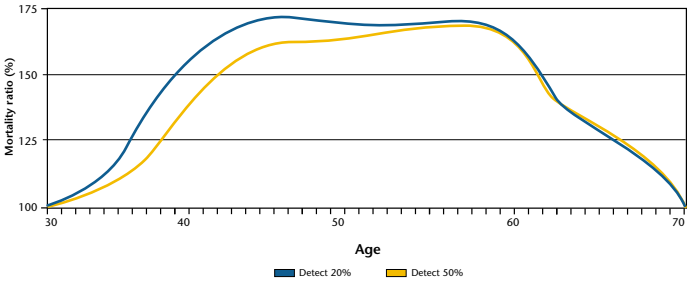
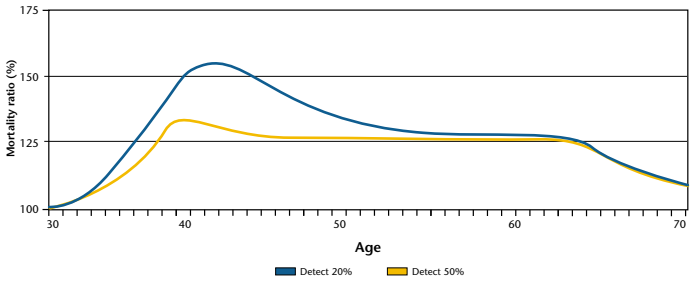


Figure 11. Estimated mortality ratios for HBV infected Chinese females age 30 at underwriting, by percent detection of existing cirrhosis.



- Age 40. Mortality ratios increase until approximately ages 45-50. For males (Figure 12), peak mortality ratios are: Detect 20%, 176%; Detect 50%, 170%; and Detect 80%, 165%. Female peak mortality ratios (Figure 13) are: Detect 20%, 156%; Detect 50%, 143%; and Detect 80%, 131%.
- Age 50. Mortality ratios increase until approximately ages 55-60. For males (Figure 14), peak mortality ratios are: Detect 20%, 160%; Detect 50%, 151%; and Detect 80%, 143%. Female peak mortality ratios (Figure 15) are: Detect 20%, 167%; Detect 50%, 149%; and Detect 80%, 131%.

Figure 12. Estimated mortality ratios for HBV infected Chinese males age 40 at underwriting, by percent detection of existing cirrhosis.

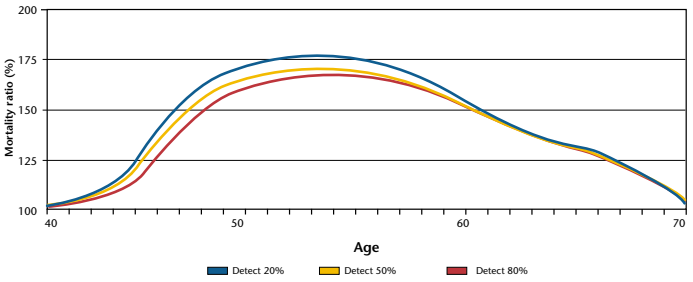


Figure 13. Estimated mortality ratios for HBV infected Chinese females age 40 at underwriting, by percent detection of existing cirrhosis.

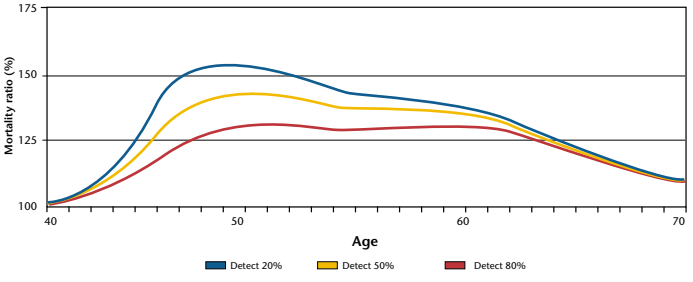


Figure 14. Estimated mortality ratios for HBV infected Chinese males age 50 at underwriting, by percent detection of existing cirrhosis.

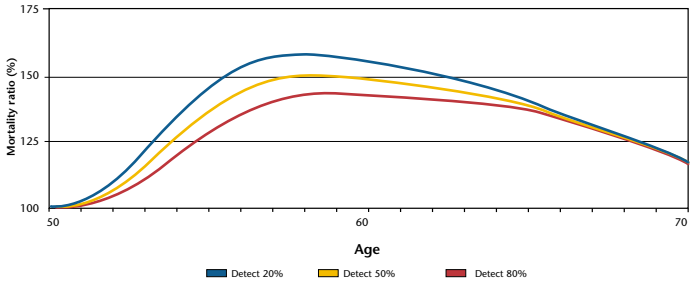
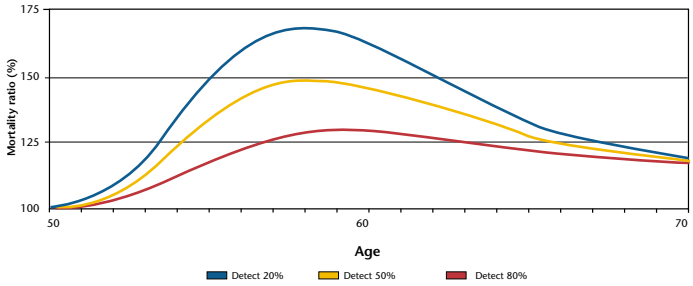


Figure 15. Estimated mortality ratios for HBV infected Chinese females age 50 at underwriting, by percent detection of existing cirrhosis.



Morbidity Results

An assumption was made that total and permanent disability (TPD) would occur upon diagnosis of HCC or decompensated cirrhosis. Figures 16-17 display estimated incidence rates of TPD for males and females, respectively, age 20 at underwriting, according to liver-related causes of disability. TPD incidence rates peak at age 70 at 13.7 per 1,000 for males, and 6.1 per 1,000 for females.

Figure 16. Estimated incidence of total and permanent disability in HBV infected Chinese males age 20 at underwriting, by cause of disability.

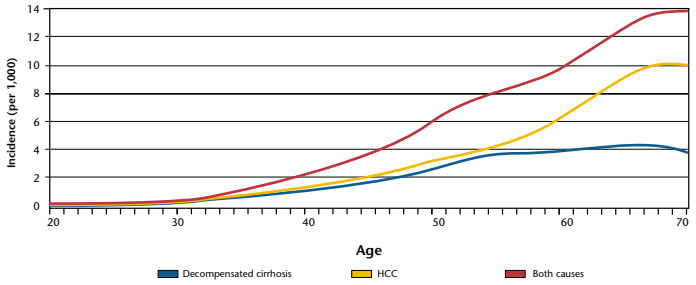
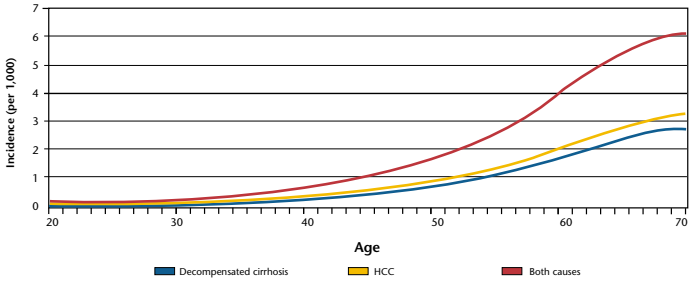


Figure 17. Estimated incidence of total and permanent disability in HBV infected Chinese females age 20 at underwriting, by cause of disability.



Figures 18-19 summarize estimated incidence rates for both liver-related causes of TPD in HBV infected males and females, respectively, for ages 20-50 at underwriting. Peak TPD incidence rates occur at age 70 for males (18.4 per 1,000) and females (7.8 per 1,000).

Figure 18. Estimated incidence of total and permanent disability due to both HCC and decompensated cirrhosis in HBV infected Chinese males by age at underwriting.

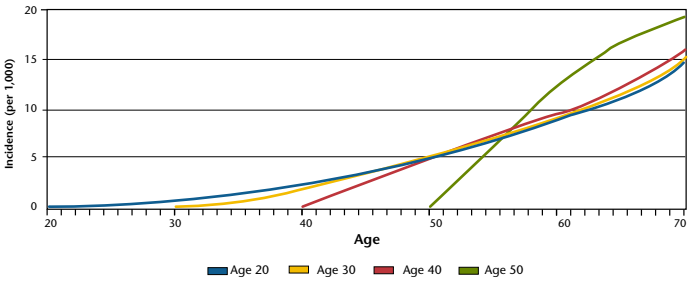
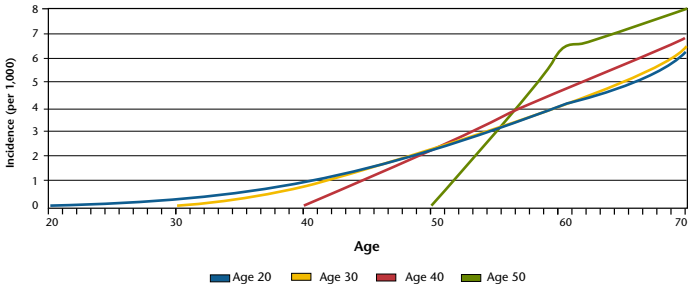


Figure 19. Estimated incidence of total and permanent disability due to both HCC and decompensated cirrhosis in HBV infected Chinese females, by age at underwriting.



Discussion

Insurability

The model indicates that morbidity and mortality experience would be within the insurable range for the majority of HBV infected persons. For males, mortality ratios are in the range of 150%-175% for underwriting ages 20, 30, and 40, and slightly lower for age 50. For females, mortality ratios are in the range of 125%-150%, and slightly higher for age 50. Higher mortality ratios in males are related to the four-fold higher HCC incidence rate in Chinese males.

Risk varies with extent of underwriting evaluation

Some HBV infected people have significant liver fibrosis or early cirrhosis when they apply for insurance, and they are "closer" to the date of HBV related complications. Cirrhosis detection rates in Figures 10-15 are theoretical illustrations of the inverse relationship between rate of detection and estimated insured lives experience for ages 30, 40, and 50. For example, a detection rate of 20% means that fewer high risk applicants (with compensated cirrhosis at the time of underwriting) would be detected, and mortality ratios would be higher; if the cirrhosis detection rate were 50%, more high risk applicants would be detected, with correspondingly lower mortality ratios.

What percentage of higher risk applicants would actually be detected during the underwriting process? There are no specific data that answer this question. In general the likelihood of identifying applicants at higher risk would depend on the extent of the underwriting evaluation:

- few or no laboratory tests vs. a full blood profile (e.g., a serum albumin level below the lower limit of normal indicates a poor prognosis) and alpha-fetoprotein (AFP) level,
- insurance examination to detect signs and symptoms of more advanced disease,
- a physician's statement (essential if a liver biopsy has been performed), and
- liver ultrasound to detect cirrhosis and early HCC (especially for large amount cases).

HBeAg/anti-HBe status not a major factor for differentiating risk

For subjects age 20 at underwriting, the difference between peak mortality ratios for HBeAg positive vs. anti-HBe positive is approximately 25 (males) and 10 (females) mortality percentage points (Figures 8 and 9, respectively). When averaged over 50-year follow-up (ages 20-70), estimated mortality ratios for HBeAg positive subjects are approximately 15 mortality percentage points higher for males and 5 mortality percentage points higher for females. These small mortality differences would be even lower when insurance ratings (loadings) were derived based on the present value of excess mortality associated with HBeAg. Thus, HBeAg/anti-HBe status is not a major factor for differentiating risk in an insurance context.

HBV mutations

HBV often mutates to a form in which active replication persists even though HBeAg is not detectable. These are known as "precore" and "core promoter" mutations. Studies involving these mutations were not incorporated in the model because the reported prevalence of the mutation varies a great deal from study-to-study, there are insufficient data regarding the long-term impact of the core mutation, and "real life" data sets could be approximated without further complicating the model.

ALT levels

Serum alanine aminotransferase (ALT) levels were not included as a variable in the Markov model because the literature indicated that the correlation between ALT levels and prognosis was weak. The natural history of HBV acquired at birth or during early childhood is such that ALT levels fluctuate during the course of HBV infection, increasing and decreasing depending on host and viral factors, and values at a single point in time are not strongly predictive of outcome. For example, an elevated ALT level at the time of underwriting might indicate seroconversion or attempted seroconversion from HBeAg to anti-HBe (a favorable development), while a normal ALT level could occur in an applicant with progressive fibrosis and/or cirrhosis (both unfavorable developments).

One situation where ALT levels might prove useful is with sustained ALT elevation. Some authors have observed more rapid progression to cirrhosis in patients with sustained elevation of serum ALT for 6 months or longer. These cases could be identified in an insurance setting only via a physician's statement that listed the results of prior enzyme tests.

Conclusions

Morbidity and mortality are within the insurable range for the majority of otherwise healthy HBV infected insurance applicants who reside in China, with higher male mortality ratios due to the four-fold higher HCC incidence rate in males. Risk varies with the extent of the underwriting evaluation and the percentage of applicants with significant liver fibrosis or early cirrhosis that are detected during the underwriting process. HBeAg/anti-HBe status is not a major factor for differentiating risk in an insurance context. ALT levels are generally not useful for estimating risk. Morbidity and mortality estimates provided by the model can be generalized to other populations and individuals where HBV infection occurs at birth or during early childhood, although some modifications of insurance risk (usually higher risk estimates) may be required in non-Asian markets.

Table. Annual transition probabilities, male and female unless otherwise stated

Transition	Transition rate (range)
Expected death	Per mortality table
HBeAg/HBsAg to anti-HBe/HBsAg	0.034 (0.031-0.034)
Anti-HBe/HBsAg to HBsAg negative	0.005 (0.001-0.01)
Cirrhosis data	—
Overall cirrhosis incidence rate (all ages combined)	—
Male	0.0074 (0.0074-0.021)
Female	0.25* male overall cirrhosis incidence rate
Age-adjusted cirrhosis incidence multiplier	Per derived table
HBeAg multiplier	1.73 (1.73-1.8)
Anti-HBe/HBsAg to compensated cirrhosis	Overall cirrhosis incidence rate* age-adjusted cirrhosis incidence multiplier
HBeAg/HBsAg to compensated cirrhosis	HBeAg multiplier* anti-HBe/HBsAg to compensated cirrhosis transition rate
HBsAg negative to compensated cirrhosis	0.01* anti-HBe/HBsAg to compensated cirrhosis transition rate
Compensated cirrhosis to decompensated cirrhosis	—
Males	—
Ages 20-54	0.023 (0.023-0.05)
Ages 55-70	0.7* age 20-54 transition rate
Females, all ages	0.023 (0.023-0.05)
Decompensated cirrhosis to cirrhosis death	0.19 (0.19-0.33)
Compensated/decompensated cirrhosis to HCC	—
Males	—
Ages 20-60	0.028 (0.0083-0.05)
Ages 61-70	Per derived values
Females, all ages	0.028 (0.0083-0.05)
HCC mortality rates	—
Year 1	0.458
Year 2	0.219
Year 3	0.213
Year 4	0.206
Year 5	0.199
Year 6	0.064
Year 7	0.064
Year 8	0.064
Year 9	0.064
Year 10	0.064

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Dread Disease/Critical Illness (February 1999)

Long Term Care (November 1998)

Financial Risk Management (September 1998)

Smoker/Nonsmoker Issues (August 1998)

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