

What's Critical about Critical Illness Products

By Sunil Sharma & Lawrence Tsui,

1. Introduction

1.1. Critical Illness Cover

Today's Critical Illness (CI) products are the successors to cancer benefits originally sold as riders to life insurance policies in the USA and Japan. The costs and lifestyle changes associated with cancer diagnosis have long been understood in these countries and cancer benefits have been seen as valuable addition to basic life contracts.

Since its introduction in South Africa in 1983, CI cover has come a long way. It's not just that the name of the product that has evolved from the original fear-inducing "dreaded disease" to more consumer-friendly product names such as critical illness, crisis cover, trauma and living assurance, but also the number, variety and scope of the conditions covered under CI products have greatly expanded over the years.

In its most simple form, a CI contract provides a fixed lump sum payment upon diagnosis of any of a number of specified diseases. At the heart of almost all products available around the world would be some or all of the following "core" conditions:

- cancer,
- heart attack,
- coronary artery disease requiring bypass surgery,
- stroke, and
- Kidney (renal) failure.

Other common conditions covered around the world include Alzheimer's disease, aorta surgery, benign brain tumour, blindness, coma, deafness, end-stage liver failure, end-stage lung failure, heart valve surgery, HIV due to blood transfusion, loss of speech, major burns, major head trauma, major organ transplant, motor neurone disease, multiple sclerosis, paralysis, Parkinson's disease, terminal illness, and total and permanent disability (TPD).

Depending on the characteristics of individual insurance markets, the regulators, the insurance market players (and the support of their reinsurers), the number of conditions covered under CI products varies considerably around the world, ranging from single-disease cancer products to some covering more than 50 conditions at various different levels of sum assured.

1.2. Critical Illness Cover in India

CI cover is not new to India. Life Insurance Corporation of India (LIC) had been selling products like "Asha deep", "Jeevan Asha" and "Jeevan Bharti" (female CI) with inbuilt dread disease cover for a number of years, with the maximum sum assured prudently set at the relatively low level of around Rs. 3 lacs.

At present, CI cover in India is typically being sold as a rider benefit to basic whole life or endowment policies, both as an accelerated and as an additional benefit (see Section 4.1). Although there are no published figures relating to premiums generated from CI products in India, anecdotal evidence suggests that sales of CI cover are increasing rapidly. It appears that all life offices in India now sell CI covers, with most CI business generated to date through individual policies. Group CI benefits have made very little impact in the Indian market to date.

For actuaries working for insurance companies in India, one of the major pricing issues for CI business is that there is currently no published CI morbidity experience. As a result, most insurance companies in India rely heavily on reinsurers when pricing their CI benefits. Fortunately however, CI products in India have remained relatively simple to date and insurance companies have resisted the temptation to greatly extend the number of CI conditions to be covered, thereby limiting the uncertainty risks associated with CI pricing. Given that the insurance industry has only been denationalised for a relatively short period of time with as yet little experience of health riders, it would seem that restricting CI products mainly to the “core” conditions is a prudent approach, at least until insurance companies have developed a reasonable amount of CI experience as well as a reasonable number of qualified and experienced underwriters and claims assessors.

When considering the development of CI benefits, a number of important issues need to be considered. This paper will consider some of the marketing (Section 2), distribution (Section 3), product design (Section 4), risk management (Section 5) and pricing (Section 6) issues associated with CI business, with a particular emphasis on the actuarial pricing aspects in a developing market such as India.

2. Marketing

2.1. Marketing Messages for Critical Illness Products

When the product was first conceived, the marketing of CI products was sometimes rather insensitive and tended to prey on people’s fears, emphasising the “dreaded” nature of many of the conditions covered. This may have been one of the reasons why some UK insurers were initially reluctant to enter the CI market. However, the experience in many developed countries is that a change in the emphasis of marketing material, highlighting the more positive aspects of CI insurance and the specific needs that it meets, has helped to overcome some of the initial negative perceptions.

Since CI benefits are paid in respect of people who survive with a serious illness, CI cover is often characterised as a “Living Benefit”, designed to protect people in case they survive a serious illness, rather than in case of they die of the illness. The main objective is to provide financial support at a time when a number of different financial pressures are likely to strike at the same time, such as:

- expensive bills associated with long and complex medical treatment,
- loss of income due to the inability of the life assured to work,
- the need for home and workplace modifications to adapt to the life assured’s impairment, and
- the cost of rehabilitation, nursing care or help around the home while recovering from a serious illness.

By easing the financial burden of these and other costs, the lump sum payable under CI benefits provides peace of mind and acts to ease the stress of a difficult situation.

It is notable that the marketing emphasis for CI products does vary from one country to another. In the UK for example, where there is near-universal access to affordable medical treatment via the National Health Service (NHS), there is less emphasis on the cost of medical treatment and more emphasis on lifestyle changes in the sales message for CI products. In particular, a very large proportion of CI covers are sold in conjunction with mortgage protection business in the UK under the premise that diagnosis with a CI condition could severely curtail the life assured’s ability to service his or her mortgage.

In contrast, in most Asian markets, where government-funded healthcare is either very limited or non-existent, there is a much stronger emphasis on the financial burden of very large medical bills. CI in these markets is often viewed as a form of catastrophic medical

cover, purchased as a (rather limited) substitute for or as a supplement to private medical expenses insurance.

2.2. Sales Success compared to Other Health Insurance Products

CI has had considerable sales success in many markets, particularly compared to other insurance products that look to meet an overlapping need, such as private medical expenses insurance and disability income (DI) insurance (also known as permanent health insurance (PHI) or income protection (IP) insurance).

Although mostly speculative, we believe that some of the main reasons for CI's success relative to other health insurance products are as follows:

- A simple fixed lump sum benefit payment, where the life assured has the option to spend the money however he/she wishes generally holds more appeal to consumers than a more complex reimbursement of medical expenses incurred or an income benefit paid over a number of years.
- Because of the relatively limited coverage provided under CI policies, they are usually substantially cheaper in rate per mille terms than private medical or disability income products, both of which cover a wider range of impairments.
- Potential customers are normally able to identify more easily, a person suffering from a specific and well-known CI condition (eg cancer, heart attack, stroke, etc) rather than the more abstract concept of "inability to perform an occupation" under disability income products.

2.3. Target Markets

One of the major strengths of CI from a marketing perspective is that it potentially has a wider target audience than most other life and health insurance products. In fact, targeted sales messages can be tailored to appeal to different market segments such as:

- those with dependents;
- those without dependents;
- those who are employed;
- those who are self employed;
- those who are employed in the home as housewives or homemakers;
- those with loans and mortgages;
- companies wishing to protect against the loss key employees;
- etc

In contrast to basic life protection, CI cover tends to hold a much greater appeal to singles and lone householders. While the financial impact of death for such people should be less than for those with dependents, should one of these people suffer a CI condition requiring expensive medical treatment and follow up nursing care, the financial burden could be just as significant as for those supporting a family. Clearly lone householders, no matter how independent they may be before illness strikes, will have significant financial needs if they suffer a heart attack, stroke or cancer.

Those who are self-employed running a small family business may have much more particular needs for CI cover than other groups. Unlike an employee who might be able to return to a previous job after a prolonged period of serious illness, the owner of a small family business may find that there is nothing to return to. Other family members may have little idea about and/or little interest in running the business and years of hard work spent building up the business may be lost in the period that the owner is absent through

illness. Clearly, there is need for readily available cash to continue to meet business expenses and loan repayments during the period that the owner is unable to work. CI cover would be one way to fulfil this need.

CI also tends to hold greater appeal for females than other types of life insurance protection, reflected in the fact that females often make up more than 50% of CI sales in developed CI markets, while providing substantially less than 50% of the customer base for normal life insurance products. While social conventions and cultural norms would often give less consideration to the adverse financial impact of the death of a female housewife than the death of the male breadwinner, the financial impact of a CI condition striking the female housewife is often as great as that of a CI condition striking the male breadwinner. The medical bills would be just as burdensome for a female as for a male and costly alternative arrangements might need to be made for taking care of children and household duties.

In similar ways, suitable scenarios can be constructed to help make CI appeal to other different market segments.

One particular market segment that has seen relatively little CI penetration thus far is the employer-employee group insurance market. In those companies where CI benefits are offered, they are usually perceived as a high value benefit by employees and may even reduce staff turnover. However, in practice many employers are concerned about the cost of the additional insurance cover and are usually reluctant to provide comparatively expensive CI cover to their employees in addition to cost of other traditional benefits like Basic Death or Accidental Death and Dismemberment (ADD). Where CI cover is provided under group schemes, the sums assured are typically much smaller than for Basic Death and ADD covers.

3. Distribution and Sales

3.1. Distribution Channels

The sales success of CI benefits, like any other insurance product, is largely determined by the suitability and efficiency of the distribution channels employed.

CI business fits quite well with the main business of most agents. For those agents with a sizeable existing customer base, it represents a very natural and logical up-sell product. For relatively new agents, an offer of conventional life insurance products packaged with CI benefits may be used as a useful differentiator. In some countries in Asia, among some agency forces, CI benefits are attached to more than 50% of new policies.

Bancassurers have had varying degrees of success with sales of CI business. For many Asian bancassurance players, where the focus has been on easy and quick to sell single-premium investment products with a strong resistance to complex underwriting, CI has often formed only a minor part of the product offering. However, in some developed markets such as the UK, bancassurers have been able to capitalise on the strong market for mortgage protection, packaging CI together with conventional term assurance policies in what has become an almost automatic sale.

Direct marketing campaigns for CI business have had varying degrees of success. In general, the more complex nature of CI business, with potentially long lists of conditions and very technical and wordy definitions, is not very well suited to direct marketing, where simplicity is often the most important determinant of sales success. Because of the much greater scope for anti-selection (see Section 5.1), CI business is also generally less suited to simplified underwriting, another key success factor for direct marketing. However, despite the challenges, some insurers have managed to put together successful CI direct

marketing campaigns, either by up-selling to existing customers or by designing very simple products in conjunction with simplified application forms.

3.2. Sales Training

While sales training is largely outside the scope of this paper, it is difficult to do justice to CI without mentioning the importance of training for sales people. Without adequate training and preparations, sales people are unlikely, regardless of their underlying talents and abilities, to realise their full potential. Although this message applies across all products, it is particularly relevant when it comes to CI products, which have very specific training needs.

There are two areas in particular that have often caused problems for life offices selling CI policies:

- Firstly, there is the difficulty of explaining in everyday language exactly what CI conditions are covered and what the individual definitions mean. Sales people and their clients are often deterred by use of any medical terms that they do not fully understand. For example, difficulties may arise in distinguishing between the different types of invasive/malignant and pre-invasive/pre-malignant/benign tumours, or between angina pectoris and a myocardial infarction - as far as a lay person is concerned they may both be "heart attacks".
- A second problem is the need for the salesperson to understand his or her role as the initial underwriter, largely because the risk assessment process for CI benefits is more stringent than for death only cover (see Section 5.1 for more details). An applicant who has a personal history of any of the medical conditions included in the scope of cover is unlikely to be accepted. Likewise, many of the conditions covered under CI policies have a strong genetic component, significantly elevating the importance of family history in the underwriting process. Sales people need to understand that certain impairments that may be of little or no relevance to a normal life insurance application may attract a loading or decline rating for CI.

A trained salesperson should be able to detect the existence of any adverse underwriting features during early stage of sales meeting and adapt the sales presentation accordingly. On the other hand, the unprepared sales person might persist with a potential CI sale and may later have to go back to applicants with an unfavourable underwriting decision.

4. Product Design

4.1. Product Types

From an actuarial perspective, CI benefits are usually classified into two main varieties: (1) Accelerated or Advance Payment benefits and (2) Additional or Stand Alone benefits.

4.1.1. Accelerated or Advance Payment Benefit

Accelerated or Advance Payment CI benefits are provided as an advance or acceleration of the death sum assured. The critical feature of these benefits is that the payment of the CI benefit reduces the underlying death benefit by the amount of the CI claim payment.

Acceleration CI benefits can be designed to accelerate 100% or a smaller proportion of the death sum assured. For example, if a term assurance policy provides INR 500 000 upon death with 50% acceleration CI benefit, then a sum of INR 250 000 will be paid upon diagnosis of any of the CI conditions specified in the product, with the balance of INR 250,000 payable upon death during the term of the policy, subsequent to the CI payment.

CI benefits can be structured as an acceleration of a basic whole life, endowment or term assurance sum assured, or they may be structured as a term assurance rider where the

CI benefit accelerates only the term rider sum assured, not the basic sum assured. The latter generally provides a simpler modular structure as it can be attached to many different basic plans, while an acceleration of the basic sum assured will generally need to be designed specifically for a particular underlying basic plan.

4.1.2. Additional or Stand Alone Benefits

Additional CI benefits are riders to basic policies where the CI benefit is independent of any other benefits. They differ from Stand Alone CI policies only in the sense that Additional CI benefits are sold as riders to an underlying Death benefit, while Stand Alone CI policies usually refer to those that are completely separate basic policies with no death benefit.

It is usual for the CI benefit to be paid as a lump sum, but it is also possible to structure the benefit to pay in instalments, either as a waiver of premium, or as an income benefit.

A key feature of Additional or Stand Alone CI policies is the survival period, a period that the life assured must survive from the time of diagnosis or surgical procedure until the CI benefit becomes payable (see Section 5.3.4).

4.1.3. Other Critical Illness Riders and Options

Other benefits options based around Critical Illness include:

4.1.3.1. Premium Waiver

Under a CI premium waiver benefit, future premiums for the basic policy (and possibly other non-CI riders) are waived upon the diagnosis of any of the covered CI conditions. CI premium waivers can be either additional CI benefits (when premiums are only waived upon CI diagnosis) or accelerated CI benefits (when premiums are waived upon death or CI diagnosis in a third-party premium payor).

4.1.3.2. Buy-Back Options

This is a common option in Australia, purchased at the time the policy is sold. This option, which is packaged with an accelerated CI benefit, allows the policyholder to reinstate fixed percentages of their death cover (that was reduced upon the payment of the CI claim) at fixed intervals after the CI claim. Options range from those allowing the policyholder to repurchase one-third of his/her death benefit at 1-year intervals (ie one-third each at 1 year, 2 years and 3 years) after his/her CI claim, to those allowing 100% repurchase of death cover 1 year after the CI claim.

It should be noted that from an actuarial pricing perspective, if one assumes 100% exercise of the Buy-Back Option, the cost of a Death + Accelerated CI + Buy-Back Option is actually identical to a Death + Additional CI plan where the survival period is equal to the buy-back repurchase period (a more complete explanation of this is provided in [7]).

4.1.3.3. Reinstatement of CI Cover

These options have been marketed in South Africa and in the UK, again purchased at the time that the policy is sold, but allowing the policyholder to reinstate his/her CI cover (excluding the condition already claimed for, as well as related conditions) after the first CI claim. For example, if the insured has a heart attack, his CI cover can be reinstated for conditions not directly linked to a heart attack such as cancer or kidney failure, but not for a second heart attack nor for coronary artery bypass surgery. In general however, this option has been rather expensive and has not proved to be very popular.

4.1.3.4. Female and other Specialty CI Products

Some companies, particularly in East Asia, market CI products aimed at specific groups such as females. Female CI products generally cover a number of additional or enhanced benefits related to female diseases and conditions as well as some conditions related to

pregnancy, although at much smaller sums assured than for normal CI policies, reflecting the much lower severity of the conditions covered. Common conditions covered under these products include carcinoma-in-situ (CIS) of the cervix and breast, systemic lupus erythematosus (SLE), pregnancy-related complications such as ectopic pregnancy and disseminated intravascular coagulation, as well as congenital anomalies in newborn children conditions such as down's syndrome, spina bifida and tetralogy of Fallot.

Some companies have also tried to market Male CI products (covering conditions such as prostate and testicular cancer) as well as Juvenile CI products (covering juvenile conditions such as insulin-dependent diabetes, juvenile rheumatoid arthritis and severe asthma), but usually with less success than with Female CI products.

4.2. Critical Illness Conditions

As noted in Section 1.1, CI policies in many countries have extended way beyond the core 3 to 5 conditions seen in the earliest versions of the product that still account for over 90% of claims in most markets. Very early on in the development of CI products, marketing men realised that they could significantly increase the number of conditions covered under CI policies without a significant increase in the price of the product.

At first, it seemed that this type of innovation could genuinely extend the scope of cover and improve the products offered to consumers by filling in some of the "gaps" in the early CI products. Extensions of cover to include very severely disabling, but rather rarer conditions and surgical procedures, such as heart valve surgery, multiple sclerosis and motor neurone disease, would fall into this category.

However, later additions to the list of conditions covered under CI products would appear rather more cynical, designed only to increase the number of conditions covered without any genuine attempt to extend the scope of cover provided. Such moves could only serve to encourage sales people to remain ignorant and compare CI products solely according to the number of conditions, without any genuine attempt to understand the actual conditions covered. Examples of these moves include the splitting of paralysis into multiple conditions (paraplegia, quadriplegia, tetraplegia, diplegia, hemiplegia), the addition of coverage for high profile, yet exceptionally rare conditions like Creutzfeld-Jakob disease, as well as the addition of extremely rare conditions with names that sound like common conditions, such as fulminant viral *hepatitis* and primary pulmonary arterial *hypertension*. Ultimately, competition of this type could only serve to confuse customers and ruin the reputation of CI products and the life industry.

Realising the problems with (as well as the costs of) continuously adding meaningless conditions to CI policies to keep up with the competition, regulators or industry bodies in some countries (such as Taiwan, Singapore and Malaysia) have imposed restrictions on either the number or the exact conditions that can be covered under CI policies.

One other way to avoid the need to introduce large numbers of mostly irrelevant minor CI conditions is through the use of "catch-all" conditions. These conditions, such as total and permanent disablement (TPD) or loss of independent existence (LoIE), are designed to protect the life assured against a large number of rare, yet severe conditions, not all of which might be covered in a normal CI package.

In general, to ensure good value to consumers and to maintain the integrity of the product, any new conditions that are included in a CI product should fulfill a number of basic criteria:

- The condition should be life threatening or sufficiently serious to incur very large treatment expenditures or justify significant and costly lifestyle changes;

- The condition should affect the covered population to a non-negligible extent, representing a genuine increase in the cover offered by the policy;
- The condition should offer minimal scope for an assured life to select against the insurer by virtue of privileged knowledge about his/her state of health (eg conditions where cheap and easily available screening tests are available or those with direct hereditary patterns) and it should not be possible for the life assured to self-induce the proposed CI condition without endangering life;
- The conditions should be capable of clear and unambiguous definition; and
- There should be sufficient reliable and relevant data to price for the condition appropriately.
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4.3. Critical Illness Definitions

The importance of appropriate definitions to the management of CI products can be demonstrated by the way in which CI definitions have evolved over the period that CI benefits have been sold.

With each claim that companies have unintentionally been forced to pay because of a flaw in a CI definition, the need for small improvements has been highlighted. For example, early definitions of major organ transplant failed to specify that the life assured would need to be the recipient of the transplant. This modification was only made after one life assured successfully claimed as the donor in an organ transplant.

More subtly, numerous changes have also been made to the diagnostic criteria specified for each CI definition. For example, some early CI definitions essentially relied on a doctor to make an assessment of whether or not the life assured had suffered the relevant CI condition. The disputes that arose from some of the claims submitted with very questionable medical diagnoses have prompted, amongst other things, the requirement in cancer definitions for histological confirmation and the need for CT or MRI imaging in the diagnosis of strokes.

At the same time, changes in the way that the medical profession views certain conditions have also prompted changes in CI definitions. A classic example is the changes in the way that heart attack is defined. In early generations of CI products, heart attack definitions were based on typical chest pain, ECG changes and elevation of certain cardiac enzymes like CK-MB. With the medical profession shifting to Troponins as the new "gold standard" for whether someone has suffered a heart attack, insurance company definitions of heart attack have been forced to specifically acknowledge Troponins or else risk having definitions rendered irrelevant, obsolete and unenforceable.

We would therefore emphasise the need for up-to-date definitions that take into account the accumulated claims experience of insurance companies around the world, the very latest consensus views of the medical profession, as well as the very latest diagnostic techniques and tools.

Another trend around the world with respect to definitions has been the drive for standardisation. With the need to incorporate complex medical terminology in CI definitions in order to properly limit the scope for claims, CI definitions have become incomprehensible to most lay purchasers of CI benefits. This has resulted in potentially misleading behaviour on the part of some marketing and sales staff who attempt to highlight the advantages of one company's CI definitions versus another company's CI definitions, without the requisite medical knowledge to do so.

The confusion arising from the various different definitions that may exist for a single CI condition has driven many countries towards standardisation of CI definitions. Major CI markets such as the UK, Taiwan, Singapore and Malaysia have all created a set of

standard CI definitions used by all companies selling CI in that market. In some markets, such as the UK, the standardisation process has been driven by sales staff (mostly independent financial advisers) who need a way to ensure that the CI products they are selling are competitive in terms of the CI definitions used. In other markets such as Taiwan, the regulator has played an important role in the standardisation process. In other countries still, such as Singapore and Malaysia, the life insurance industry itself has taken the lead in standardising CI definitions to reduce destructive and misinformed competition by sales staff using CI definitions.

5. Risk Management

While this paper focuses mainly on issues of interest to actuaries when considering CI products, it is worth noting a few points in relation to the risk management aspect of CI business.

5.1. Underwriting

As a "Living Benefit" paid to people who are still alive upon the diagnosis of a serious life-threatening illness, the antiselection risks associated with CI benefits are generally higher than those for death cover since there is no need to die in order to claim. Because CI diagnosis tends to happen much sooner than death, the extra morbidity loadings for CI also tend to be higher than the extra mortality loadings for a corresponding death cover.

Further underwriting risks related to CI are also evident in the strong hereditary or familial links of many CI conditions, including cancer and heart disease. This has prompted the collection of better family history information at the time of application for CI business.

The offering of cover for some less common CI conditions may also necessitate a few additional underwriting questions to properly underwrite the risk. For example, Parkinson's disease is a condition that develops very slowly over time, ultimately leading to death in perhaps up to 10-15 years, usually at older ages beyond the retirement age of many people. From the perspective of underwriting death covers therefore, indicators of Parkinson's disease, while still a concern to underwriters, is probably less important than other conditions leading to death within say 5 years. However, if Parkinson's disease is covered under a CI policy, with a payment trigger upon diagnosis of Parkinson's disease (although in reality, most CI definitions delay payment for Parkinson's disease until the condition has become very severe) it becomes significantly more important to underwrite specifically for the risk of developing Parkinson's disease.

In general therefore, underwriters need to be somewhat more vigilant and flexible in their thinking, to consider the risks of CI diagnoses that may not necessarily lead to death within a short period of time, as well as those which will result in a relatively speedy death.

5.2. Claims Assessment

While underwriting for CI benefits is not significantly more advanced than underwriting for death benefits, the same cannot be said of the claims assessment function.

Those who assess death claims can generally follow a fairly simple process in collecting a death certificate and in ensuring that no material facts were misstated or withheld at the time of policy application.

However, the assessment of CI claims requires significantly more advanced levels of knowledge and expertise. Compared to claim assessors for death benefits, those for CI business require much more detailed medical knowledge in order to perform their job properly. In particular, CI claim assessors must be sufficiently knowledgeable (or must have sufficient access to the relevant knowledge) to determine whether the complex medical criteria specified in a CI definition have been satisfied. In addition, with the greater

scope for antiselection and non-disclosure, claim assessors may also need to lift their game with the tracking of past medical histories and the detection of non-disclosure.

Another trend of note is the increasing attention given by insurance companies to independent verification of CI claims. Many companies in their policy wording now reserve the right to seek an independent evaluation of the medical evidence by an acknowledged expert in order to substantiate a claim and some may even retain the right to perform additional tests before admitting a claim. Such practices have largely evolved out of experience with more accommodating doctors, whose opinions have sometimes been subject to challenge by life insurers.

In short, the amount of additional training and knowledge required for CI claim assessors compared to those who assess death claims should not be underestimated.

5.3. Product Design Features

5.3.1. Issue Limit

It important to keep a reasonable upper limit on the amount of CI cover to be offered to any one life to avoid overinsurance. Maximum CI sums assured should be evaluated not only against the applicant's income and existing life insurance cover, but also against the likely costs associated with medical treatment, ongoing care and rehabilitation. Offering sums assured that greatly exceed the likely financial impact of a CI condition can only encourage anti-selection and fraudulent claims.

5.3.2. Issue and Expiry Age Limits

At older ages, underwriting CI benefits becomes increasingly difficult due to the higher prevalence of impairments and the greater opportunities for antiselection. It is therefore sensible to set an upper limit on age of entry, typically no more than 55 in most countries.

With respect to expiry ages, it is typical in most countries to limit the expiry age for CI benefits to normal retirement age, although whole life benefits do exist in some markets. The main difficulty associated with whole life benefits is the uncertainty of pricing CI benefits at extreme ages.

5.3.3. Waiting Period

Depending on the extent to which non-disclosure can be tracked in a particular market, there may be a need for an initial waiting period, such that CI conditions showing first symptoms or diagnosed during the waiting period will not be payable. In countries such as the UK where patient medical histories are easily tracked through a single family doctor, it may be possible to operate without a waiting period. However, in countries where a person may seek opinions from multiple doctors and might seek treatment in multiple regions or even countries, some form of initial waiting period, typically around 90 days, will usually be required to manage antiselection risks.

5.3.4. Survival Period

As noted in Section 4.1.2, a survival period is a normal feature of Additional or Stand Alone CI benefits. The survival period is a necessary feature both to ensure that there is sufficient time to confirm the CI diagnosis (potentially very difficult after the death of the life assured) and to prevent overinsurance in cases where the life assured dies only shortly after diagnosis of a CI condition (in such cases, it is argued that the life assured does not need *both* a CI and a death benefit). A typical survival period for many additional or stand alone CI products around the world is 30 days. For conditions such as heart attack and stroke, where death shortly after suffering the CI condition is relatively common, the existence of a survival period has a fairly significant impact on pricing.

The survival period might however create some problems for Stand Alone CI products from a marketing perspective. If life assured dies within the survival period, no claim will be payable and the policy would expire. It could be very difficult for beneficiaries to understand this, particularly when the policyholder has paid premiums for many years and there is no death benefit in the policy, leading to bad publicity for the company. One way to overcome this would be to incorporate some form of death benefit into the policy.

6. Pricing

6.1. Pricing of Additional or Stand Alone Critical Illness Benefits

The pricing of Additional or Stand Alone CI benefits is relatively straightforward. The probability of a payment being made depends only on the incidence of the CI condition itself, with an allowance for the probability that the life assured lives beyond the survival period. Risk rates for additional CI benefits can be simply expressed as:

$$i_x (1 - iq_x) \tag{1}$$

where i_x represents the incidence of CI at age x ; and iq_x represents the probability that a life diagnosed with CI at age x dies within the survival period (typically 30-days).

6.2. Pricing of Accelerated or Advance Payment Critical Illness Benefits

The pricing of acceleration CI benefits is somewhat more complex. In theory, the extra cost of an accelerated CI benefit (over and above the cost of a death benefit) is the incidence of critical illness, less the present value of expected extra mortality (over and above standard mortality) for a life that has been diagnosed with a CI.

However, using some simplifying assumptions, Dash and Grimshaw [6] managed to derive a much simpler formula that is much easier to apply in practice. Because death and CI diagnosis are highly correlated, the combined probability that either death or CI occurs is significantly less than the sum of mortality and CI incidence. On the assumption that mortality due to non-CI causes is the same irrespective of whether a person has ever been diagnosed with a CI condition, the risk cost of a combined death and accelerated CI benefit, can be expressed as:

$$i_x + (1 - k_x) q_x \tag{2a}$$

$$q_x + i_x - k_x q_x \tag{2b}$$

where i_x represents the incidence of CI at age x ; and k_x represents the proportion of deaths at age x due to CI causes
 q_x represents standard mortality

Expression (2a) is generally more intuitive. Effectively, it suggests that a claim under a policy covering death and accelerated CI can be triggered under one of two circumstances:

- a person could be diagnosed with a CI condition; or
- a person could die of a non-CI cause.

However, expression (2b) is more closely aligned with the way in which risk rates and reinsurance rates for accelerated CI benefits are typically expressed. When pricing combined death and accelerated CI benefits, the mortality component (q_x) is usually

¹ A full derivation of this formula can be found in the Appendix following the derivation in Dash and Grimshaw [6].

treated in the same manner as normal stand alone death benefits. The acceleration CI benefit is then priced as a rider with $(i_x - k_x q_x)$ being used for the underlying risk rates.

6.3. Impact of Accelerated Critical Illness benefits on Mortality Experience

One of the implications of formulae (2a) and (2b) above is that, when investigating the experience of a portfolio of death benefits, the existence of acceleration CI benefits will have a significant impact on the experience.

Where there is a CI benefit that accelerates the entire death benefit, one should usually only observe mortality due to non-CI causes, equal to $(1 - k_x) q_x$, since anyone dying of a CI cause would have claimed for the CI benefit and been removed from the exposure prior to death. The exception would be those dying suddenly as a result of a CI condition, such as directly following a heart attack, where it is more likely the claim would be classified under death rather than CI.

6.4. Pricing of Critical Illness Benefits in Developed and Developing Markets

From the sections above, it is clear that the pricing of CI benefits requires the estimation of four main parameters q_x , i_x , k_x and $i q_x$.

6.4.1. Mortality Rates q_x

In developed countries, actuaries have long been involved in estimating mortality rates q_x , and the estimation of this parameter has generally proved to be a trivial task, with many years of insured life data to rely upon.

India is little different, with more than sufficient volumes of insured life mortality data available for use in pricing mortality and CI benefits.

6.4.2. Critical Illness Incidence Rates i_x

This is the most important parameter for pricing CI benefits and the area in which actuaries have expended the most effort.

The various adjustments required from raw incidence data to the insured life incidence rates for pricing of CI benefits are summarised in the table below. Each of the data types are described in Section 6.4.2.1 and the pricing adjustments shown in the table are explained in Section 6.4.2.2. Section 6.4.2.3 considers the pricing data available for the core CI conditions.

Type of Raw Data	Pricing Adjustments Usually Required						Other
	Multiple Entry	Trend	Foreign to Local	Population to Insured	CI Overlap	IBNR	
Local Population Registry	x	✓	x	✓	✓	x	a,c a,b,c a,b,c
Hospitalisation Survey	✓	✓	x	✓	✓	x	
Foreign Population Registry	x	✓	✓	✓	✓	x	a,c a,b,c a,b,c
Hospitalisation Survey	✓	✓	✓	✓	✓	x	
Local Insured	x	✓	x	x	x	✓	x
Foreign Insured	x	✓	✓	x	x	✓	x

6.4.2.1. Types of Population Data

In developed countries, the starting point for developing CI incidence rates has usually been population data. Depending on the CI condition in question, there are three main sources for the population data used in CI pricing:

1. Registry Data

For many of the most serious and common conditions covered under CI policies, registries have been set up in various cities or regions to collate data relating that particular condition. For the purposes of extracting pricing information, disease registries can be divided into two types:

- Registries that are complete and reasonably self-contained for the region they cover (with relatively few patients referred into or outside the region) and which therefore allow the reliable estimation of incidence rates for that region; and
- Registries that cover a single hospital or a very localised area, designed primarily to monitor the characteristics of the patients who present with the disease. While these registries are unable to accurately estimate incidence rates for a particular region, the data from these registries can sometimes be useful in understanding disease patterns, particularly in relation to overlaps between CI conditions and the impact of definition changes.

2. Hospitalisation or Doctor Visitation Data

In most developed countries, comprehensive data is available on inpatient hospital admissions² and sometimes on visits to doctors (general practitioners) (such as the UK data in [11]).

² Examples of hospital data sets include:

Australia – Australian Hospital Statistics (AHS) - www.aihw.gov.au/hospitals/index.cfm

At the most detailed level, information is available on each and every hospital admission, together with details of the patient's age, sex, diagnosis codes (typically in a standard coding format such as ICD-9 or ICD-10), procedure or surgery codes (typically also in a standard coding format), length of stay, total hospital bill, etc.

However, the most detailed data format usually requires a specific extract and can sometimes be difficult (and costly) to obtain. This type of data can also be difficult for actuaries to work with as it requires some knowledge of database query tools as well as familiarity with the data format and coding systems used. Depending on the level of accuracy required, it may often be easier to work with summarised hospital data to derive CI incidence rates.

3. Survey Data

The most basic type of population CI incidence data comes from population surveys. These surveys may vary in their level of sophistication, ranging from basic surveys of prevalence at a single point in time, to more sophisticated surveys with a few years of follow-up which are able to arrive at an estimate of incidence rates.

Reliance on such surveys for pricing of CI benefits should generally be limited to less significant CI conditions which are less material to the overall incidence rate, although survey data can sometimes be used to calibrate CI incidence rates from a foreign country to local conditions. In particular, surveys that provide only a crude incidence rate or even an age-standardised incidence rate should be used with caution, as the incidence of CI conditions can vary substantially by age and sex. Crude rates and age-standardised rates are often weighted heavily towards the incidence at very old ages – this is less relevant to insurance pricing requiring a focus on ages from about 30 to 55.

6.4.2.2. Adjustments to Population Data

As outlined in the table in Section 6.4.2 above, a number of different adjustments may be required to move from raw incidence data to insured life incidence data, depending on the starting point of the raw data used. In general, the following adjustments may be made:

1. Multiple Entry

This adjustment is almost always required with hospitalisation data. The problem arises because, due to privacy concerns, hospital data sets usually do not allow the tracking of a single patient through multiple hospital episodes. For example, if a patient is transferred from one hospital to another, he/she will be counted twice in the hospital statistics. Similarly, if he/she is admitted to hospital, discharged and then admitted again, the same patient will be counted twice.

A further problem arises with conditions like heart attack or stroke, where a person can suffer from the same condition more than once. Hospital statistics will record a heart attack in the same way, irrespective of whether it is the patient's first, second or tenth heart attack. As CI policies only cover the first episode of a disease, any repeat hospitalisations need to be eliminated before calculation of incidence rates for pricing purposes.

2. Trends

The incidence of most CI conditions is not static, but changing from one year to the next.

For example, in most developed countries, the incidence of cancer has changed over the last few decades as diagnostic methods have improved and screening programmes have

become more common (eg better screening has reduced the incidence of cervical cancers while it has significantly increased the incidence of prostate cancers). Some lifestyle changes have also given rise to increasing underlying incidence of some cancers (eg increasing breast cancer rates are associated with delayed motherhood and decreasing fertility rates).

The incidence of coronary artery bypass surgery has also undergone huge increases in many countries as surgical techniques have improved and the risk associated with the surgical procedure has decreased. At the same time, most developed countries have seen a decrease in heart attack incidence in line with growing awareness of the importance of diet and exercise, as well as improved preventative treatment in the form of drugs to control hypertension and cholesterol levels as well as increased angioplasty and bypass surgery procedures.

Especially when the raw data is several years' old, it is crucial to allow for trends when estimating the future incidence of CI conditions.

3. Foreign to Local

CI incidence rates vary substantially from one country to another and from one ethnic group to another. Hence, unless two countries are geographically and ethnically similar, it is rarely advisable to simply adopt the CI incidence rates for a foreign country to price CI benefits in the local market.

The spread of CI benefits around the world has highlighted very large differences in the incidence of different CI conditions. The table below shows how the distribution of CI claims by cause varies substantially in different CI markets. For males, as one moves from South Africa to the UK to Australia and finally to East Asia, the proportion of claims due to cancer increases substantially and the proportion of claims due to heart attack and bypass surgery decreases. In East Asia, the incidence of kidney failure is noticeably higher than in the other countries. One final point to note, hidden in the data, is the very large proportion of claims in the UK due to multiple sclerosis (a large proportion of the claims included in the "Other" category), a condition rarely seen in the other countries shown in the table.

	Cause of Claim	South Africa	UK	Australia	East Asia
Males	Cancer	36%	42%	51%	58%
	Heart Attack	37%	30%	22%	14%
	Stroke	8%	8%	6%	7%
	Coronary Artery Bypass	16%	7%	11%	6%
	Kidney Failure	1%	1%	<1%	4%
	Other	3%	12%	9%	11%
	Females	Cancer	89%	74%	87%
Heart Attack		<1%	2%	3%	1%
Stroke		7%	7%	4%	4%
Coronary Artery Bypass		<1%	1%	1%	<1%
Kidney Failure		<1%	1%	<1%	2%
Other		4%	16%	5%	6%

When adjusting incidence rates from foreign countries to a new country, a number of different types of data sources may be used:

- **Survey Data – Prevalence or Incidence**
As outlined in Section 6.4.2.1 above, survey data showing prevalence or incidence from a new country can provide some information about the appropriate level at which to set incidence rates, while maintaining the “shape” of the foreign rates by age and sex.
- **Mortality Data by Cause of Death**
In some countries, while detailed CI incidence data is not available, some information may be available on mortality rates by cause of death. Mortality ratios are sometimes used as an indicator of how CI incidence varies from one country to another. For example, if heart attack mortality in Country B is double heart attack mortality in Country A, then one could adopt the assumption that heart attack incidence in Country B is double heart attack incidence in Country A.
- **Incidence Studies by Ethnicity**
One other data source for setting Foreign to Local adjustments is studies of incidence rates by ethnicity. For example, there are large Indian immigrant populations in a number of developed countries around the world, including the UK, South Africa and Singapore. In these countries, there are a number of studies looking at variations in CI incidence by ethnicity and these could be used to set adjustments factors for conversion of UK, South African or Singaporean CI incidence to Indian CI incidence.

It should be noted however, that proxies for incidence such as prevalence or mortality are often imperfect and may exhibit different inter-country ratios compared to incidence rates. The ratio of CI prevalence or mortality between Country B and Country A will reflect variations between the two countries in the severity of the illness at diagnosis, variations in the quality of care available as well as variations in the true underlying incidence.

In general, CI cases in less developed countries will tend to be diagnosed later during the course of the disease and will exhibit higher post-CI mortality. Adjusting the rates from more developed Country A to less developed Country B will therefore generally understate CI incidence in Country B if prevalence is used to derive the Foreign to Local adjustment, and will generally overstate CI incidence in Country B if mortality is used to derive the Foreign to Local adjustment.

Caution should also be exercised for ethnicity studies as for some CI conditions (such as multiple sclerosis, which is associated with higher latitudes and colder climates) environmental and geographical factors can be just as important, if not more important, than ethnicity in determining incidence rates

Furthermore, actuaries should be aware that the use of crude or age-adjusted rates (ie not age and sex specific) may result in distortions because of underreporting at older ages in less developed countries. The ratio of crude or age-adjusted rates will tend to be weighted more heavily towards older ages and may not be directly relevant to the ages of most insured lives.

4. *Population to Insured*

One of the most important CI pricing adjustments, required even where reliable local population data is readily available, is the adjustment from population incidence to insured lives. Fortunately for those pricing CI benefits in new countries, CI products have been sold for a number of years in other countries and these countries now have detailed experience studies allowing actuaries to compare insured life to population CI incidence for the major CI conditions in these countries, providing some idea of the impact of CI underwriting. Therefore, when developing CI incidence rates for new countries, actuaries generally use similar Population to Insured adjustments to those observed in foreign country experience studies.

Observed ratios of insured life CI incidence to population CI incidence have generally been in line with actuarial intuition. In developed countries, the overall ratio of insured life CI incidence to population incidence has usually been consistent with, but generally higher than the ratio of insured life mortality to population mortality (probably reflecting the increased scope for anti-selection for CI benefits). However, there has been considerable variation by CI condition. In general, the ratio of insured life cancer incidence to population incidence is substantially higher than the ratio of insured life heart attack incidence to population incidence. This is consistent with the observation that insurance underwriting is much better at detecting the risk factors for heart disease (eg obesity, hypertension, diabetes, high cholesterol, etc) than the risk factors for cancer.

5. CI Overlap

Another adjustment that is required when using population data is overlap adjustments. As CI benefits only pay on the first of potentially many CI events affecting an individual, some allowance for overlap may be necessary.

For example, one of the most significant overlaps for CI pricing purposes is between Heart Attack and Coronary Artery Bypass Surgery. Studies from Australia and the US indicate that roughly 50% of Coronary Artery Bypass Surgeries are associated with a Heart Attack (see [7]). Another major source of overlap arises if a “catch-all” condition such as TPD (Total and Permanent Disablement) is covered as one of the CI conditions (see Section 4.2).

When allowing for overlaps, care should be taken to ensure that the amount deducted for the overlap between two conditions does not exceed the incidence of either of the conditions.

6. Incurred But Not Reported (IBNR) Claims

While far fewer adjustments are generally necessary when the starting point for CI pricing is insured life experience data, one very important adjustment that needs to be borne in mind is a proper allowance for IBNR in the CI experience claims data. CI claims generally exhibit a much longer delay than death claims and a failure to allow adequately for IBNR has actually led to significant levels of CI mispricing in some developed CI markets.

For example, industry experience studies in the UK have traditionally been based on date of claim payment, rather than incurred date. With mortality studies, where claim delays are short and where the in force portfolio is generally fairly static over time, the impact of not allowing for IBNR is negligible. However, recent studies from the UK (see [5]) looking at the experience of CI business from 1999 to 2002, a period over which the volume of in force CI business was growing strongly, indicate that the average delay from CI diagnosis date to CI claim payment date is almost 6 months. Based on this data, it was estimated that a proper allowance for incurred (as opposed to paid) claims would increase the observed incidence of CI by around 15%. A study of CI experience in Ireland by the Society of Actuaries in Ireland came to a very similar conclusion (see [4]).

7. Other Adjustments

Other adjustments that may or may not be required depending on the nature and the quality of the data used include:

a. Underreporting Adjustments

Some types of population data may be subject to underreporting of cases. This problem tends to be more severe in developing countries, among lives resident in rural areas as well as among elderly lives, who would tend to be less likely to seek treatment for a particular condition.

b. Incomplete Coverage Adjustment

Some types of population data are understated because the cases included in the dataset are not representative of the entire population. One example of this is the UK HES (Hospital Episode Statistics) data which covers on government hospital admissions and excludes all hospital episodes in private hospitals. The final calculation of incidence rates needs to take this understatement into account.

c. Adjustment for Lack of Precision in Diagnosis / Procedure Codes

When using some types of hospital or other population data, the codes used to summarise the data may not exactly match those corresponding to a particular CI definition. One example is stroke, which is typically summarised as ICD-9 codes 430-438 covering "Cerebrovascular Disease". However, using incidence rates based on these ICD-9 codes would overstate the incidence of stroke as the codes will include a significant number of cases classified as "Transient Ischaemic Attacks", a condition that is specifically excluded from CI stroke definitions. These incidence rates will also fail to allow for any severity criteria in the stroke definition, such as requirements for "permanent neurological deficit", inability to perform "activities of daily living" or other measures of functional impairment.

6.4.2.3. Population Data specific to Critical Illness Conditions

As most of the risk related to CI benefits is concentrated in only a small number of CI conditions (cancer, heart attack, stroke, coronary artery bypass surgery, kidney failure), actuaries generally focus their attention on the incidence rates of these conditions. The paragraphs below provide an overview of the typical sources of population data used for CI pricing in developed countries, as well as some comments on the availability of similar data in an Indian context.

1. Cancer

Almost all developed countries and many developing countries have cancer registries affiliated with the IARC (International Agency for Research on Cancer) that collect data on cancer incidence and mortality in particular regions. Each cancer registry produces regular reports with estimates of population cancer incidence in a standard format, split by sex, by 5-year age band and by cancer site.

Because of the wide availability of reliable cancer registry data, there is usually little need to rely on other types of population incidence data for pricing of cancer benefits.

In India, these data are available from cancer registries in Ahmedabad, Bangalore, Chennai, Delhi, Mumbai, Nagpur, Poona and Trivandrum (see [13]). However, it should be noted that a common problem with cancer registries in less developed countries is the underreporting or under-ascertainment of cancer incidence, particularly among elderly lives (Section 6.4.2.2 Point 7a). Such underreporting problems may result in the population incidence (based on a broad cross-section of socio-economic classes) understating the insured life incidence (likely to be based on higher socio-economic classes with greater awareness of cancer screening and better access to medical care).

2. Heart Attack

Heart attack or myocardial infarction registry data is somewhat less common than cancer registry data, although such registries have been established in a number of countries and cities around the world. Often, these registries are part of a worldwide collaboration such as the WHO MONICA project (multinational MONItoring of trends and determinants in CARdiovascular disease) or GRACE (Global Registry of Acute Coronary Events).

Where available, data from heart attack registries is usually the most suitable for CI pricing purposes as it enables the separation of "first-ever" heart attacks from second and

subsequent heart attacks, providing the best match for CI benefit payments and minimising the need for pricing adjustments. In developed CI markets, where registry data is not available, reliance is usually placed on local hospital data.

In India however, it would appear that there is no registry or hospitalisation data available, meaning that the derivation of heart attack incidence rates would need to rely on foreign data with a number adjustments to local conditions. Anecdotal evidence in India (see [1] and [12]), supported by several studies of multi-ethnic populations in countries where large numbers of ethnic Indians have settled (such as [9] and [15]), suggest that the incidence of heart attack among Indians is comparatively high compared to other countries.

3. Stroke

While there are a number of stroke registries throughout the world, comprehensive registries that allow for calculation of incidence rates are very rare. Hospitalisation data is more readily available, but does not usually provide a good match to typical definitions of stroke used in CI products.

As alluded to in Section 6.4.2.2 Point 7c, the definition of stroke used in CI products is usually much stricter than the definition used that may be used by the medical profession in diagnosing a stroke. Stroke registries and hospitalisation data generally provide little information on the extent to which stroke cases satisfy severity criteria, such as requirements for “permanent neurological deficit”, inability to perform “activities of daily living” or other measures of functional impairment.

India is similar to most other countries around the world in that reliable population data on stroke incidence is not available. However, the high prevalence of stroke risk factors such as hypertension, diabetes and cardiovascular disease would suggest that Indian incidence of stroke should be towards the upper end of the global scale (see [2] and [3]). However, most studies comparing differences in stroke incidence between different ethnic groups show Indian incidence of stroke to be similar to European or Chinese stroke incidence (such as [9]).

4. Coronary Artery Bypass Surgery

As coronary artery bypass surgery or grafting (CABG) is inevitably performed in a hospital setting, registry data is generally just a more refined version of hospitalisation data, sometimes with additional information concerning repeat procedures, the number of vessels for which bypass surgery was performed and the disease indicators for bypass surgery.

As with most other CI conditions, there is limited reliable information in India concerning the incidence of CABG (see [1] and [12]). In any case, the little population data that is available is likely to be heavily affected by issues related to access and affordability of surgical care. Using incidence rates for the population would most likely understate the incidence of CABG for insured lives as a large proportion of the Indian population would not have access to CABG treatment, even if recommended by a doctor. Among insured lives, especially those with CI policies, problems related to access and affordability would disappear, provided that the CI sum assured were sufficient to meet the cost of CABG. While current Indian population CABG incidence rates appear to be less than one-tenth of the levels observed in developed CI markets, the difference in CABG incidence between insured lives in India and those in developed CI markets is likely to be much lower.

In line with most other countries over the last few decades, CABG incidence is likely to undergo a significant upward trend in India over the coming years and actuaries should be

prudent in their allowances for future trends in CABG incidence, especially given the high prevalence of coronary artery disease and the increasing affluence of Indian society.

5. Kidney Failure

In most developed markets, fairly useful information concerning the incidence of end-stage kidney failure is collected and published by renal registries. These registries are often also involved in the tracking of kidney failure patients across various different dialysis centres and the compilation of kidney transplant waiting lists. As a result, they generally provide fairly comprehensive data on the population incidence of kidney failure.

Where a central renal registry does not exist, data may sometimes be obtained from local dialysis centres, which can at least provide an indication of kidney failure prevalence in a particular geographical area.

In India, it would appear that no central registry of kidney failure patients exists. However, an analysis of the kidney failure cases that are diagnosed in India, studies of kidney failure among ethnic Indians in developed countries, as well as an analysis of kidney failure risk factors suggests that the incidence of kidney failure in India is likely to be higher than in developed countries (see [10] and [14]).

6.4.3. Proportion of Deaths due to Critical Illness Causes k_x

For the derivation of k_x factors, reliance is generally placed on population data as cause of death data for insured lives is rarely available with a sufficient level of credibility.

The limited insured lives cause of death data that do exist (see [16]) suggest that k_x for insured lives is not significantly different from the overall population, despite the impact of underwriting. Hence, it would appear that population k_x factors do act as a reasonable proxy for insured life k_x factors, at least in developed countries.

In India however, relatively little reliable information is available concerning causes of deaths, split by age and sex. Some limited cause of death data is available from the Mumbai Public Health Department's Registry of Deaths with deaths in Mumbai requiring medical certification, unlike other parts of India. Certain population studies in India using verbal autopsy (interviews with surviving relatives of the deceased to establish cause of death) are also available (see [8]).

Note that caution should be exercised with cause of death data that is not medically certified. In general, non-medically certified causes of death data tend to exhibit over-reporting of certain simple and easily understood causes of death such as heart attack. CI causes of death will also tend to be understated at older ages as more and more deaths tend to be attributed to vague causes such as "old age".

As a final check on the validity of k_x data, it is necessary to ensure that the total cost of accelerated CI benefits for each CI condition ($i_x - k_x q_x$) should not be negative at younger ages. At very old ages (usually beyond 80), it is theoretically possible for ($i_x - k_x q_x$) to become negative, reflecting the fact that the mortality of lives remaining in the CI portfolio at these extremely old ages (who have never suffered a CI condition) is substantially better than the overall mortality (q_x) of an insured life portfolio without CI acceleration benefits.

6.4.4. Mortality within the Survival Period i_{q_x}

The estimation of i_{q_x} has historically been relatively simplistic, with various medical journal papers published on 30-day survival or case fatality rates for the major CI conditions, particularly heart attack or stroke, where sudden death is common in the immediate aftermath of the CI event. Some consideration must however be given to trends, as 30-

day survival rates for conditions like Heart Attack and Stroke have improved considerably in recent years, certainly much faster than overall mortality rates.

For most other CI conditions, including Cancer, Bypass Surgery, Kidney Failure, etc, sudden death is rare and it is usually sufficient to set iq_x to zero, or at most one-twelfth of q_x .

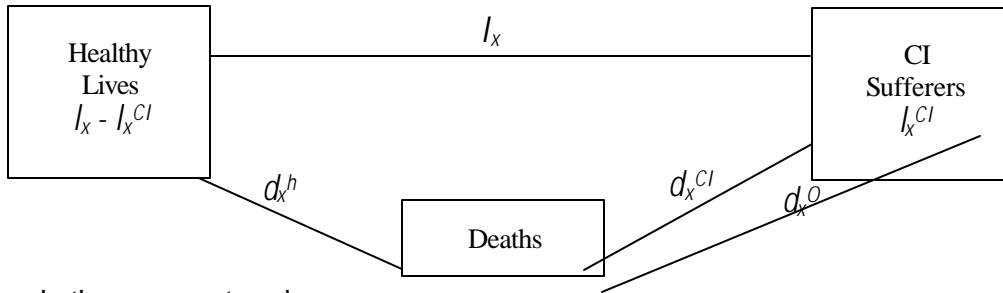
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Appendix – Pricing Formula for Accelerated Critical Illness

The multiple decrement model underlying an accelerated CI benefit can be represented by the diagram below:



Let's assume at each age x:

- l_x is the total number of lives in the whole population
- l_x^{CI} is the number of lives who have ever suffered a CI condition
- l_x is the number of lives diagnosed with a CI condition
- d_x^O is the number of deaths among CI sufferers due to causes other than CI conditions
- d_x^{CI} is the number of deaths among CI sufferers due to CI conditions
- d_x^H is the number of deaths among healthy lives (ie those who have not suffered a CI condition)

Assume first of all, that mortality rates due to causes other than CI among CI sufferers exceeds that for healthy lives by an extra mortality m .

$$\frac{d_x^O}{l_x^{CI}} = \frac{d_x^H}{l_x - l_x^{CI}} \cdot (1+m) \tag{1}$$

Let k_x be the proportion of deaths at age x due to CI conditions.

If we equate the number of deaths due to causes other than CI conditions at age x :

$$\begin{aligned} (1 - k_x) \cdot l_x \cdot q_x &= d_x^H + d_x^O \\ &= d_x^H + l_x^{CI} \cdot \frac{d_x^H}{l_x - l_x^{CI}} \cdot (1+m) && \text{from (1)} \\ &= d_x^H \cdot \frac{l_x + m l_x^{CI}}{l_x - l_x^{CI}} \\ &= q_x^H \cdot (l_x + m l_x^{CI}) \end{aligned}$$

$$\text{Hence } q_x^H = \frac{(1 - k_x) \cdot l_x \cdot q_x}{l_x + m l_x^{CI}}$$

If we assume that $m = 0$, that is, that mortality rates due to non-CI causes are the same irrespective of whether a person has suffered a CI or not, then this expression simplifies to:

$$q_x^H = (1 - k_x) \cdot q_x$$

In any case, we would note that l_x^{CI} (the number of lives with CI) remains very much less than l_x (the total number of lives in the population) until very advanced ages (generally

above 65). Hence, even if $m > 0$, the above approximation should be applicable for most ages at which CI benefits are offered.

In total therefore, the cost of a Death + Accelerated CI benefit is:

$$\begin{aligned} \text{Cost} &= \frac{i_x + d_x^H}{i_x - i_x^{CI}} \\ &= i_x + (1 - k_x) \cdot q_x \end{aligned}$$

where i_x is the incidence rate for CI.

About the Authors

Sunil Sharma

Author has more than 15 years experience in the Life Insurance Industry. He has been working with Swiss Re as an actuary for last more than 3 years and is currently working in Singapore for the South East Asia region. Prior to joining Swiss Re, he was working as Director, Operations with Phoenix Life and Annuity, Inc and was instrumental in setting up the Insurance Centre of Excellence for their US operation in Bangalore. Prior to this, he was heading the Actuarial Centre of Excellence (ACOE) with GE Financial Assurance, India. He joined GEFA in Richmond, Virginia, USA in 1998 as an Associate Actuary and worked in the area of product development. He later moved the product development and pricing processes to India, setting up and coaching the actuarial team to do experience studies and valuation along with product development for GEFA.

Sunil started his career in Life Insurance Corporation of India in 1990. During his 8 years of tenure in LIC he worked in almost all departments of the Branches and P&GS department. During his period in LIC he had the opportunity to work in the actuarial department of Ministry of Finance, Insurance Division for 2 years and provided major contributions in the projects related to crop insurance and social security schemes.

Sunil is a post graduate in physics and is a Fellow of Actuarial Society of India (FASI). He is also a member of editorial team of "Actuary India".

Lawrence Tsui

Author was born in Sydney Australia and graduated from the actuarial program at Macquarie University. He qualified as a Fellow of the Institute of Actuaries of Australia in 1997, joined Swiss Re in the same year and since then, has worked for Swiss Re in Australia, Switzerland, Singapore and Hong Kong. He is currently the Senior Products Actuary for Swiss Re's Life & Health business in the Asia-Pacific Region.

During his career, Lawrence has been heavily involved in the pricing, product design and risk management of Critical Illness business with a particular focus on Asian markets. He was co-author of a paper on Critical Illness and TPD Experience in Australia and New Zealand for the 1997 Centenary Convention of the Institute of Actuaries of Australia, the author of a paper on Female and Juvenile Critical Illness Products for the 2001 East Asian Actuarial Conference (EAAC) in Hong Kong and co-author of a paper on Epidemic Modelling and SARS for the 2003 EAAC in Manila. He was also heavily involved in the Life Insurance Association's project to standardise Critical Illness definitions in Singapore.

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