Cancer Diagnostics 2.0 – What Does It Mean for Insurers?

by Karin Neelsen, Gen Re, Cologne

The general media has drawn a lot of attention to promising medical research in the field of cancer diagnostics. Headlines proclaiming the availability of new “simple blood tests” to diagnose tumours have appeared on a regular basis. Gen Re has conducted its own research within the medical community to look behind the – at times – rather simplified information played out in the media. The ultimate goal has been to gauge what these emerging techniques imply for insurance, especially Critical Illness (CI) products where protection against the risk of cancer plays an important part.

The most prominent emerging techniques are based on blood samples – often combined with DNA sequencing methods – referred to as “liquid biopsies.” These are targeted at finding circulating tumour cells (CTCs), circulating tumour DNA (ctDNA) or microRNA/exosomes in the blood. Another method that has received attention is refined imaging technologies, such as MRI scans, allowing differentiation of normal and cancerous cells.

This article will not only describe the medical background and implications of new technologies – focusing on solid cancer detection – but also take a look at the broader picture of what CI insurance is all about, and what needs to be taken into account for continuously offering a successful protection for major diseases.

Current cancer detection

Currently, cancer is diagnosed or confirmed by histopathological evidence from a tissue sample extracted in a biopsy and examined under a microscope. This methodology is essential for diagnosis of almost all cancers, unless the tumour site means taking a tissue sample is too risky (for example, in the brain).

Results of the histopathology, together with physical examination and imaging tests, form the basis of cancer staging. Staging is the method of describing the extent to which a cancer has grown and spread, either locally or to distant sites in the body.

Staging systems, as described by the American Joint Committee on Cancer (AJCC) or almost identically by the Union for International Cancer Control (UICC), in the majority rely on tumour size, lymph node involvement and existence of metastasis.
Challenges and opportunities for the insurance industry

Current terms and conditions of CI policies covering cancer typically require the finding of malignant cells characterised by uncontrolled growth and spread, confirmed through histopathological evidence. The medical experts are in agreement that histopathology is most unlikely to be replaced as the gold standard in cancer diagnosis in the near future. This is expected to change only if and to the extent that new diagnostic means provide added value, i.e. more detailed information on staging and/or adequate treatment.

While these new technologies develop, it makes good sense to revisit the language in CI benefit triggers and consider a future where new tests may lead to vastly different evidence for cancer claims than what is common today. In the case of a cancer claim, how would a claims manager make a decision based on just a positive result of a liquid biopsy with confirmation by the attending physician that cancer is present?

Certainly, cancer definitions in the insurance context require uncontrolled growth, invasion of tissue and histopathological evidence, so the requirements of the definition would not be fulfilled in the circumstances described above. However, should liquid biopsies become the gold standard for cancer diagnosis and have proven excellent accuracy, this requirement may no longer be possible to uphold.

On the other hand, further developments may come along with measurable thresholds, which could actually help the insurance industry in phrasing severity levels, according to the intent of most of today’s policies – to cover cancer of specified severity or critical cancer only. Scenarios are also imaginable where the majority of neoplasms are detected in very early – i.e. pre-malignant stages – and can be successfully treated so that eventually the burden of invasive cancers is reduced.

Even if the technology is available, its wide application is not necessarily a certainty. To be used in population screening in the context of national health systems, any of these tests will have to take high hurdles in terms of evidence-based accuracy, cost-effectiveness and treatability of...
Circulating Tumour Cells

Circulating tumour cells (CTCs) in the peripheral blood were first described in the 19th century.3 More recently, methods have been developed for detection, isolation and characterising CTCs in multiple different cancers arising in solid organs. The stage at which a tumour may shed tumour cells in the bloodstream is not fully understood by medical scientists and is assumed to vary by tumour type, size and/or aggressiveness.

With “CELLSEARCH”, so far one technology has been approved by the U.S. Food and Drug Administration (FDA) for evaluating CTCs in order to assess patient prognosis or predict progression-free and overall survival.

For advanced cancers, CTCs are present only in very low concentrations, e.g. 10-100 cells per millilitre of blood compared to more than 1 million white blood cells per millilitre of blood. Looking at sensitivity and specificity, CTCs are rarely found in healthy people or in people with non-malignant tumours.4

A significant part of samples from patients with metastatic carcinomas in various cancer sites showed no detectable CTCs, without clear evidence as to which factors – such as vascularisation of the tumour, sites of metastasis or aggressiveness of the tumour – had contributed to the wide range of results in number of detected CTCs.

The vast majority of publications discuss the application of CTC testing in patients with advanced cancers for improvement of treatment and prognosis, and one of only two available studies applying CTC testing as a diagnostic tool touched upon screening a high-risk group of 168 patients with chronic obstructive pulmonary disease (COPD) for lung cancer. CTCs proved to be useful sentinels for early detection of lung cancer in 3% of these COPD patients.5

Circulating Tumour DNA

Circulating tumour (or cell-free) DNA (ctDNA) originates from tumour cells and can be found in the blood of a cancer patient. Testing for ctDNA provides opportunities for minimally invasive cancer diagnosis, prognosis and tumour monitoring. In the context of cancer, testing for ctDNA involves finding known mutations identical to those in common tumours. Cancer has heterogeneous genetic mutations that may alter at different stages.

While some common mutations can be searched for, ctDNA testing may miss the cancer DNA if the test is not specifically aimed at the mutation that exists at that time. The need to test for separate cancers means ctDNA is unlikely to be useful for screening all cancers. Abnormal cells commonly develop but can be killed by host immune cells. ctDNA may simply be part of this process rather than from any tumour that could ever be identified.

Testing for ctDNA is thought simpler than testing for CTCs because fewer technological adaptations are needed and sampling windows are longer.6 It is also a more sensitive marker since it is present in over 80% of advanced cancers, including in many patients in whom CTCs are not detectable. Another aspect is that there is more ctDNA than CTCs detectable in the blood of cancer patients. Most studies include numbers based on detectable ctDNA in people with advanced malignancies or tumours that are already large enough to be diagnosed easily using current techniques, again aiming at improved outcomes in these patients.

Revisiting sensitivity and specificity, a study of patients with various cancer types found ctDNA in more than 75% of those with advanced pancreatic, ovarian, colorectal, bladder, gastroesophageal, breast, melanoma, hepatocellular, and head and neck cancers, but the study found ctDNA in less than 50% of primary brain, renal, prostate or thyroid cancers.7

Trials of ctDNA are underway to predict hepatocellular cancer in hepatitis B virus carriers and to detect nasopharyngeal cancer in Epstein-Barr virus carriers.8 Here, however, the test only identifies the persistent virus associated with the cancer and not the cancer itself; histology is still required to confirm cancer diagnosis. Furthermore, for 20 out of 1,318 patients identified with persistent raised levels of ctDNA, only three were diagnosed with nasopharyngeal cancer, the other 17 being false positive samples identified at the same time.

MicroRNA and Exosomes

In the recent past, both microRNA and exosomes have emerged as a promising field of research in cancer diagnosis, prognosis and therapeutics. Exosomes, which are small vesicles involved in the process of breaking down metabolic waste, act as shuttles for bioactive molecules, such as microRNA, between cells. Research suggests that tumour cells release excessive amounts of exosomes, potentially influencing tumour growth or building of metastases. There is evidence that exosomes play critical roles in almost all aspects of cancer, such as transformation of normal cells into cancer cells, tumour growth or tumour metastasis, thus having some potential as diagnostic biomarker.9 The majority of circulating microRNA is concentrated in the exosomes. Also, the circulating microRNA itself could be a promising non-invasive biomarker. Studies in both areas, however, suggest that the exact mechanisms and complex roles of exosomes and microRNA in cancer development need to be explored further “for the proper use of…biomarkers in evidence-based medicine.”10 Given the early stage of research in the context of exosomes and microRNA, there is as of yet no information on their accuracy.

Refined Imaging Technology

Imaging technology can detect tumours, but for distinction between benign growth and cancerous tissue, a biopsy is typically required. A recent study suggests that fine-tuned MRI scanning could one day make at least some biopsies unnecessary.

Researchers show that imaging can detect sugars attached to a particular protein, allowing for normal and cancerous cells to be differentiated. The technology is at a very early stage and has so far only been tested with lab-grown cancer cells and mice.

To show if the technique has any value in human cancer diagnosis requires “much more testing”.11,12
adjust the need for large scale population studies.

The rapidly falling cost of DNA sequencing, combined with the amount of venture capital flowing into private biotech companies, will lead to tests being offered in the private sector and could thus be of interest to high net-worth individuals who are effectively managing both their health and their insurance portfolios. These people might be more inclined to undergo such tests in exchange for a potential payout of the sum insured under their Critical Illness policy.

The AJCC staging of cancer has taken “circulating cells” into account for breast cancer staging. An additional category has been created, supplementing the current distinction between metastases present (M1) or not present (M0) by “M0(i),” which is defined by the presence of circulating tumour cells. While there has been no change to the overall group staging applied, it is not certain this will remain unaltered in the future. Application of higher group stages, based on additional information gained through the blood tests, could thus have an immediate impact on tiered products where the benefit amount is directly linked to the stage at diagnosis.

**Conclusion**

Cancer is the leading cause of claim under Critical Illness (CI) insurance, which means its diagnosis has the strongest impact on the insurers’ experience. The new tests described here are still in their infancy but have the potential to overhaul the diagnostic process – with yet unknown consequences for the frequency of cancer detection.

Much depends not only on continued technical progress of the new technology but also on national health systems using it in combination with existing screening. Even if the diagnostic approach does not undergo dramatic change immediately, it is possible that a very different level of cancer incidence rates than that we currently observe will emerge in future.

In CI it is important to review disease definitions regularly, adjusting them to the highest standard in terms of being future-proof and following objective, measurable severity criteria. The latter in particular prevents the cover shifting from substantial support after survival of a life-threatening disease to a payout for incidental findings of an asymptomatic one. A shift like this could render CI products unaffordable as common minor diseases are being covered where no substantial insurance need meets significant benefit payouts.

Pricing should allow for the level of uncertainty being outlined here, be it by offering cover on a reviewable basis only or by including additional margins commensurate with the associated risk. Applying expertise to assess the progress in cancer diagnostics will allow insurers to continue to offer the fullest range of living benefits to those most in need of financial support following a serious illness.

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**About the Author**

**Karin Neelsen** heads the Product Underwriting team within the department Research & Development. Her team facilitates the sharing of expert knowledge globally and supports the markets with the design and pricing of life insurance products. Karin is a member of the German Actuarial Society (DAV) and has worked in life reinsurance since 2000. She worked as Account Manager and Senior Treaty Underwriter in various markets before taking over as head of Product Underwriting in 2012. She can be contacted at Tel. +49 221 9738 752 or karin.neelsen@genre.com
11 http://www.hopkinsmedicine.org/news/media/releases/mri_based_on_a_sugar_molecule_can_tell_cancerous_from_noncancerous_cells.
Since the first Dread Disease Survey in the mid-1990s, Gen Re has made a continuous effort to help the industry understand the emerging experience and the potential risks associated with this living benefit, also known as Critical Illness, Serious Illness or Trauma Cover. The current sixth survey covers the period 2008-2012 and largely adopts the methods and layout of the previous surveys.

A total of 84 companies from seven markets participated this time submitting data on more than 100 million in-force policies as at the end of 2012. About 1.2 million claims were captured during the study period (see Figure 1). Similar to the last survey, traditional products make up the bulk of the business with nearly 96% of policies, while juvenile policies rank second at 2.3% and cancer-only policies third at 1.3%. Female-only polices contribute only 0.6%, while male-only polices are negligible at 0.02%.

All major market players in China and Singapore participated, with an estimated coverage of 96% and 89% respectively. We estimate the actual coverage in the Hong Kong market amounts to about 95%. Additionally, the survey covers 48% of the individual business in Australia, 42% in Indonesia and 55% in Malaysia.

The China market alone reported about 90% of the policies and claims in our survey. Within that market, more than 70% of the share was from the two biggest life insurers; we therefore make a weighted adjustment so that the overall findings are not overwhelmed by the significant exposure and claims from these two companies.

For purchase behaviour and claims analysis, only traditional products were included. For claim analysis and actual versus expected ratios, data from the first and second policy year was excluded as this may be affected by selection effects.

**Purchase behaviour**

Figure 2 shows the distribution of in-force policies by age band. In all markets except Malaysia, more than half of the in-force policies are from the age band 30-49. Compared with Asian companies, Australian insurers seldom sell policies to juveniles and young adults.

Female adults in Asian markets, except Indonesia, are more willing to purchase a Dread Disease policy than males, perhaps explained by the high numbers of female insurance agents who find it easier to sell to another female. This is reflected by the higher female-to-male ratio observed in our survey portfolio compared with the general population (see Table 1). In Australia this is reversed. For juveniles, this pattern does not hold. For example, in China, the female-to-male ratio is only 74% in our survey portfolio, much lower than the 86% ratio in the general population.

We also compared the average sum insured of in-force policies among markets and against the previous survey (see Figure 3). Sum insured is
positively correlated to the economic status of the market. Two of the developed markets, Hong Kong and Singapore, sold much bigger policies than the three developing markets of China, Malaysia and Indonesia. The exceptionally high sums insured observed in the Australia market probably result from the low initial premiums on offer — so-called stepped premiums that are recalculated on each policy anniversary gradually rising over time.

Compared with our last survey, sum insured in China has increased from USD 6,150 to USD 7,574, or 23%. For new business, the sum insured has reached USD 11,166 in 2012, about four times as it was in early 2000.

Claims analysis

Claim declinature rate varies significantly by market, ranging from 5.6% in Malaysia to 25.9% in Indonesia (see Table 2). More than a half of the claims turned down in the Indonesian market are attributed to “disease not covered”, suggesting a poor understanding of policy provisions by both insured and sales people.

Figure 4 shows how the claim declinature rates have changed in our survey series. Except for Hong Kong, declinature rate in other markets is lower in the current survey than in the previous ones. The

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Table 1 – Female to male ratio of in-force policies and general population

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>Hong Kong</th>
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<th>Indonesia</th>
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<td></td>
<td>Market</td>
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<tr>
<td>0-19</td>
<td>74%</td>
<td>86%</td>
<td>94%</td>
<td>93%</td>
<td>90%</td>
<td>95%</td>
</tr>
<tr>
<td>20-29</td>
<td>112%</td>
<td>97%</td>
<td>124%</td>
<td>99%</td>
<td>103%</td>
<td>92%</td>
</tr>
<tr>
<td>30-39</td>
<td>114%</td>
<td>96%</td>
<td>130%</td>
<td>116%</td>
<td>111%</td>
<td>91%</td>
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<tr>
<td>40-49</td>
<td>114%</td>
<td>96%</td>
<td>129%</td>
<td>119%</td>
<td>107%</td>
<td>95%</td>
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<tr>
<td>50-59</td>
<td>129%</td>
<td>97%</td>
<td>121%</td>
<td>101%</td>
<td>116%</td>
<td>95%</td>
</tr>
<tr>
<td>60+</td>
<td>159%</td>
<td>105%</td>
<td>149%</td>
<td>110%</td>
<td>151%</td>
<td>104%</td>
</tr>
<tr>
<td>Overall</td>
<td>105%</td>
<td>95%</td>
<td>124%</td>
<td>106%</td>
<td>105%</td>
<td>95%</td>
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</table>

Population female to male ratios were obtained from government websites.

Table 2 – Number of claims by claim status and declinature rate

<table>
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<tr>
<th></th>
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<th>Indonesia</th>
<th>Australia</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Admitted</td>
<td>968,305</td>
<td>17,913</td>
<td>22,652</td>
<td>9,998</td>
<td>5,755</td>
</tr>
<tr>
<td></td>
<td>Declined</td>
<td>78,677</td>
<td>2,676</td>
<td>1,348</td>
<td>707</td>
<td>2,014</td>
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<tr>
<td>Declinature rate</td>
<td>9.4%</td>
<td>13.0%</td>
<td>5.6%</td>
<td>6.6%</td>
<td>25.9%</td>
<td>9.8%</td>
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</table>

Company weight adjustment was made for the declinature rate in China market.

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Figure 3 – Average sum insured (USD) of in-force polices

Figure 4 – Declinature rates by market and Dread Disease Survey
A breakdown of admitted claims (see Table 3) suggests that, for males, cancer is still the leading cause in most markets. However, its contribution varies significantly and is generally lower in Southeast Asian (SEA) countries. This is the result of the lower incidence of cancer and the higher risk of coronary artery disease in this area. Because of the limitation in claim coding/description provided by participating companies, we use ischaemic rates in Hong Kong were actually dropping, but went up again since 2007. The improvement in China is largely due to a reduction of the first year declinaturity rate from more than 36% for the period 2004-2008 to 26%. Another contributing factor is that in November 2009 the Chinese regulator introduced a two-year incontestability clause making it more difficult to cite non-disclosure.

Table 3 – Leading Dread Disease claims by market

<table>
<thead>
<tr>
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<th>China</th>
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<th>Indonesia</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rank</td>
<td>%</td>
<td>Rank</td>
<td>%</td>
<td>Rank %</td>
<td>Rank %</td>
</tr>
<tr>
<td>Cancer</td>
<td>1</td>
<td>57.3%</td>
<td>1</td>
<td>66.1%</td>
<td>1</td>
<td>51.7%</td>
</tr>
<tr>
<td>Ischaemic Heart Disease</td>
<td>2</td>
<td>19.4%</td>
<td>2</td>
<td>16.3%</td>
<td>2</td>
<td>34.5%</td>
</tr>
<tr>
<td>Stroke</td>
<td>3</td>
<td>11.9%</td>
<td>3</td>
<td>7.9%</td>
<td>3</td>
<td>6.9%</td>
</tr>
<tr>
<td>Kidney Failure</td>
<td>4</td>
<td>4.7%</td>
<td>4</td>
<td>2.4%</td>
<td>4</td>
<td>5.0%</td>
</tr>
<tr>
<td>Heart Surgery</td>
<td>5</td>
<td>1.8%</td>
<td>5</td>
<td>1.5%</td>
<td>5</td>
<td>1.7%</td>
</tr>
<tr>
<td>Paralysis</td>
<td>6</td>
<td>1.5%</td>
<td>9</td>
<td>0.4%</td>
<td>10</td>
<td>0.5%</td>
</tr>
<tr>
<td>Chronic Liver Failure</td>
<td>7</td>
<td>0.6%</td>
<td>0.2%</td>
<td>0.2%</td>
<td>0.0%</td>
<td>0.4%</td>
</tr>
<tr>
<td>Benign Brain Tumour</td>
<td>8</td>
<td>0.6%</td>
<td>6</td>
<td>1.4%</td>
<td>7</td>
<td>1.0%</td>
</tr>
<tr>
<td>Major Head Trauma</td>
<td>9</td>
<td>0.3%</td>
<td>0.1%</td>
<td>0.7%</td>
<td>0.1%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Major Burns</td>
<td>10</td>
<td>0.3%</td>
<td>0.0%</td>
<td>0.2%</td>
<td>0.0%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Total of top 10</td>
<td></td>
<td>98.4%</td>
<td>98.1%</td>
<td>97.2%</td>
<td>98.8%</td>
<td>99.1%</td>
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</table>

Females

<table>
<thead>
<tr>
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<th>Singapore</th>
<th>Indonesia</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rank</td>
<td>%</td>
<td>Rank</td>
<td>%</td>
<td>Rank %</td>
<td>Rank %</td>
</tr>
<tr>
<td>Cancer</td>
<td>1</td>
<td>80.3%</td>
<td>1</td>
<td>89.1%</td>
<td>1</td>
<td>85.8%</td>
</tr>
<tr>
<td>Stroke</td>
<td>2</td>
<td>7.3%</td>
<td>2</td>
<td>3.1%</td>
<td>2</td>
<td>3.6%</td>
</tr>
<tr>
<td>Ischaemic Heart Disease</td>
<td>3</td>
<td>4.1%</td>
<td>4</td>
<td>1.6%</td>
<td>3</td>
<td>2.7%</td>
</tr>
<tr>
<td>Kidney Failure</td>
<td>4</td>
<td>3.1%</td>
<td>5</td>
<td>1.3%</td>
<td>4</td>
<td>2.5%</td>
</tr>
<tr>
<td>Heart Surgery</td>
<td>5</td>
<td>1.4%</td>
<td>6</td>
<td>0.5%</td>
<td>7</td>
<td>0.6%</td>
</tr>
<tr>
<td>Benign Brain Tumour</td>
<td>6</td>
<td>1.1%</td>
<td>3</td>
<td>1.7%</td>
<td>5</td>
<td>1.4%</td>
</tr>
<tr>
<td>Paralysis</td>
<td>7</td>
<td>0.9%</td>
<td>0.1%</td>
<td>9</td>
<td>0.2%</td>
<td>8</td>
</tr>
<tr>
<td>Systemic Lupus Erythematosus</td>
<td>8</td>
<td>0.3%</td>
<td>9</td>
<td>0.2%</td>
<td>0.1%</td>
<td></td>
</tr>
<tr>
<td>Chronic Liver Failure</td>
<td>9</td>
<td>0.2%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
<td></td>
</tr>
<tr>
<td>Aplastic Anaemia</td>
<td>10</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.0%</td>
<td>0.1%</td>
<td></td>
</tr>
<tr>
<td>Total of top 10</td>
<td></td>
<td>98.9%</td>
<td>98.5%</td>
<td>98.1%</td>
<td>99.4%</td>
<td>98.2%</td>
</tr>
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</table>
heart disease (IHD) to contain the three conditions related to coronary atherosclerosis, i.e. coronary artery bypass graft (CABG), heart attack and other serious coronary artery disease (OSCAD). OSCAD is covered by most policies we collected in Indonesia and is a reason for the high percentage of IHD. In Hong Kong, where OSCAD is rarely covered but the claim coding is clearer, we found that the coverage of OSCAD may double the cost of IHD compared with coverage for heart attack and CABG only.

For females, the picture is different. While cancer incidence is highest in Hong Kong, it is not much lower in China and SEA countries. At the same time, the risk of IHD and stroke is much lower than for males in all markets. As a result, the proportion of cancer claims does not vary too much by market. Even in Indonesia, 75.1% claims are from this category.

More than 97% claims are from the top 10 claim causes for both males and females. This suggests that a campaign featuring the number of covered diseases adds little value for customers. It is worth noting that the current portfolio is still young, with an average in-force age lower than 40. With portfolios ageing, some conditions more specific to senior ages, such as Parkinson’s or Alzheimer’s disease, may contribute more claims in the future.

A further breakdown of cancer claims by site suggests very clear geographical characteristics (see Figure 5). In China, liver, gastroesophageal and lung are the leading cancer sites for males and contribute about 50% of cancer cases. This is probably the result of the high prevalence of hepatitis B infection (for liver cancer), diet and infection of high-risk type of helicobacter pylori (gastroesophageal cancer) and high smoking rate (lung cancer). In Hong Kong and SEA countries, the contribution of the above cancers, especially gastroesophageal cancer, is much smaller. Instead, colorectal cancer (rank 1) and nasopharyngeal cancer (rank 2) play a very important role.

Nasopharyngeal cancer is known to be an endemic cancer commonly diagnosed in southern China and the SEA area. Decrease in incidence has been observed in the general population in the past decades. In Australia, prostate cancer is the leading cause of cancer claims, probably due to the high base risk, commonly prescribed screening and the loose claim criteria. In the past, a typical exclusion wording in Australian market might read “prostatic tumours, which are histologically described as TNM classification T1 or are of another equivalent or lesser classification, unless resulting in the surgical removal of the prostate”.

Among women, breast is the most common cancer site in all the six markets. In Australia it accounts for 60% of all cancer claims in female lives. In Hong Kong, Malaysia, Singapore and Indonesia, it is slightly less dominant, but still accounts for around 50% of cancer claims. In China, the proportion is
In Hong Kong, while male experience was still stable, female experience deteriorated from 101% to 109%. Considering the 1.6% improvement in death part, deterioration in acceleration Dread Disease part is even more significant. Breast cancer contributed a big portion to the worsening experience.

Both Malaysia and Singapore markets observed slight improvement in death part for both genders. Acceleration part also improved for both genders in Malaysia and females in Singapore. It is interesting that breast cancer incidence was observed decreasing in these two markets in our survey. However, population statistics did not show the similar trend according to the Singapore disease registry data. Further experience is needed to clarify.

**Conclusion**

The results of the Dread Disease survey 2008-2012, and a comparison with previous surveys, reveal significant heterogeneity between the markets in terms of purchase behaviour, claim declinature rates, claim cause distribution, disease incidence and trend. China, the biggest market for Dread Disease cover, is experiencing especially fast deterioration in both genders. Male A/E increased from 118% to 125% and female A/E increased from 98% to 110%. The deterioration was mainly from the acceleration Dread Disease element while the death part remained stable. For females, rapid increase in thyroid cancer incidence is the main reason for the deterioration. Worsening experience in breast cancer and cervical cancer is also a contributor. For males, the causes of the deterioration are more diversified. Thyroid cancer, stroke and heart attack are the main drivers of the trend.

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**Actual versus expected (A/E) ratios**

To keep consistency in our survey series, the number of expected claims was calculated using the graduated death with acceleration Dread Disease incidence rates for Hong Kong, Malaysia and Singapore from our 2000-2004 survey. Then we compared the A/E ratios between survey 2008-2012 and survey 2004-2008 in the four markets where credible experience is available for both surveys (see Figure 6). The China market experienced the fastest deterioration in both genders. Male A/E increased from 118% to 125% and female A/E increased from 98% to 110%. The deterioration was mainly from the acceleration Dread Disease element while the death part remained stable. For females, rapid increase in thyroid cancer incidence is the main reason for the deterioration. Worsening experience in breast cancer and cervical cancer is also a contributor. For males, the causes of the deterioration are more diversified. Thyroid cancer, stroke and heart attack are the main drivers of the trend.

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**Endnotes**

About the Authors

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The Risk of Change
by Bernhard Wolters, Gen Re, Cologne

In insurance it is customary to distinguish between three types of risk: volatility (random), change and error.1 To visualize the differences, consider 10 tosses of a coin with heads on one side and tails on the reverse. Asked to predict the number of times heads will appear, you may say “five,” but the actual result could be four or six. Random deviation from the expected number represents volatility.

The risk of change is that the coin becomes worn, shifting its centre of gravity and resulting in a systematically higher number of heads. In the end, we are all subject to the risk of error. An example is the “gambler’s fallacy”: after nine heads in a row, people with no basic knowledge of probability theory would erroneously expect the chance of tails on the tenth coin toss to be higher than 50%.2 While the relative impact of the volatility risk decreases with the number of coin tosses (the law of large numbers), the risks of change and error cannot be mitigated by increasing the number of tosses (read: the size of a portfolio of insured risks) because they affect all risks alike.

The manifestations of the risks of change and error are difficult to disentangle whenever predictions are involved.3

Who is to decide with hindsight whether an incorrect forecast was due to a change that was unforeseeable at the time the forecast was made? For this reason further reference to the risk of change in this article is also meant to encompass the risk of error. Past experience shows that insurers have reason to be mostly worried about the risk of change. This has amongst others been highlighted in numerous publications on Solvency II.4

Unlike volatility risk, the risk of change cannot be captured by stochastic models. In the following sections, we examine in more detail why this is the case. We will also explore whether or not there are ways to learn from past experience. Moreover, we take a brief look at how the risk of change is dealt with in non-insurance business and provide a number of valuable clues for the role that reinsurers can play in risk mitigation. This approach we then contrast with an alternative, in which reinsurance is replaced by higher amounts of retained capital.

Risk factors

Unlike gamblers, insurers derive probabilities from empirical data – the annual number of death cases or the annual number of car accidents. Their objective is to condense the available data into subgroups containing homogeneous and independent risks. This way insurers hope to minimize as much as possible their exposure to sampling error, i.e. the deviation of the composition of the insured portfolio from the composition of the population on which the claims data is based.5

The classification into subgroups is carried out by means of risk factors.6 It is known, for example, that people have a significantly higher mortality at age 80 than at age 20. Therefore, two separate age groups will each contain more homogeneous risks than one risk group of octogenarians and 20-year-olds together.
Next to age, gender is known to be a relevant risk factor in mortality, as is smoking. Figure 1 illustrates the fact that the frequency of an insured event depends on various risk factors.

The classification of empirical data by means of (a combination of) risk factors – for example, all 30-year-old female non-smokers – increases the degree of uniformity within each risk group. In practice we cannot expect to achieve perfect uniformity, nor should we; otherwise, each risk group during a given period of time would either remain claim-free or the totality of its individual risks would claim. In this deterministic world, insurance would lose its purpose. Even gambling is far from perfect uniformity. If it were perfect, there would be no volatility and “dice made alike and thrown alike [would] fall alike, and that [would be] the end of it.”

**Risk of change**

Unknown or accidental risk factors are all-pervasive, for example a falling roof tile or a blood clot in the brain. Such risk factors, which we cannot, or do not, statistically control for, are the cause of random fluctuation (volatility). In contrast, the risk of change can be described as the unforeseen and loss-making change of one or more of the risk factors (e.g. occupation or security standards in factories) used for the classification of the entities to be insured (underwriting factors).

Claims frequency is also influenced by environmental factors. Some examples include the effect of the economy on disability incidence rates, snow-packed roads on the loss frequency of motor insurers or the absence of extremely rare catastrophic events, such as a major pandemic or catastrophic factors.

Although known, they are not used in the classification of risks because they are assumed to indiscriminately affect the entire (data) population alike.

The risk of change also pertains to claims “severity” expressed as the total amount to be paid. This is the case whenever the latter depends on additional pricing parameters that are in turn subject to risk factors. For example, consider the termination rates in disability and long-term care products as well as the prices and wages pertaining to repair costs in third-party liability.

In summary, the risk factors underlying the risk of change include factors in the following subdivisions:

- Underwriting (e.g. occupation or safety standards)
- Environmental (e.g. lifestyle habits or weather conditions)
- Catastrophic (e.g. a pandemic or a terrorist attack)

Changes in risk factors can have an impact on both the claims frequency and the claims severity. They can occur irregularly and over time may also
Box 1: Five Methods of Dealing With Risk of Change

1. Continuous analysis

Sometimes uncertainty regarding relevant risk factors can be attributed to a lack of available information (epistemic uncertainty) rather than to irreducible unpredictability. To see this, consider the coin toss analogy.

We can content ourselves with the knowledge that in 50% of the tosses, a coin with heads on both sides is used. But we can also invest additional time and effort in order to find out exactly which tosses the double-headed coin comes into play. This knowledge would then allow us to increase the credibility of our unchanged prediction (75% heads) by cutting the standard error (volatility) in half.

In situations involving epistemic uncertainty, experience suggests an inclination to avoid thoroughgoing research in favour of makeshift stochastic models.

2. Limited exposure

The exposure regarding a certain risk should always be inversely proportional to the uncertainty surrounding possible adverse changes of its risk factors. In practice, however, one frequently encounters instances that appear to violate this rule. A typical example would be an insurer/reinsurer that prides itself on the expertise and competitive advantage it has acquired in a particular product line. As a result, it is rewarded with a significantly higher market share but eventually ends up with an unhealthy, disproportionate risk exposure.

3. Diversification

We have seen above that it is impossible to put a probability tag on the risk of change. The possible changes of the risk factors are virtually unique and therefore do not allow for any classification of similar recurring instances or any learning experience for that matter. On closer inspection, however, the question arises whether we can benefit from diversification by expanding both the product range and the geographical scope. As mentioned above, volatility is caused by unknown risk factors, and experience suggests that they cancel each other out, provided that the risks are uncorrelated (independent) or negatively correlated.

4. Specialization

The benefits of specialization are twofold: On the one hand, specialization implies concentration on a large number of equal or similar cases. It can therefore be considered as “an application of the insurance principle.” On the other hand, the specialist has more expert knowledge. Since the risk of change can be seen as varying in magnitude according to the quality of judgment on the part of those dealing with it, chances are that it will be significantly reduced by specialization.

5. Avoidance

In cases for which the above methods are unlikely to lead to any satisfactory results, avoidance remains the only viable solution.
In the Netherlands, for example, the number of single-person companies rose markedly during the past decade – typically as former employees are outsourced along with their functions. Self-employed individuals who work on their own find it much more difficult to make ends meet than do self-employed people with a workforce. Unsurprisingly they are at significantly higher risk of becoming disabled than the latter group.

The change of environmental factors is represented in Figure 2 by an upwards diagonal movement of the block. Had environmental factors remained constant, the block would have moved horizontally (along the dotted arrows). Unless the intermediate change of environmental factors since the time of the investigation is taken into account, the pricing will likely be off the mark. This is illustrated in Figure 2 by the risk group that lies outside the dotted rectangle.

Is the risk of change quantifiable?

If the probabilities for changes in risk factors were known, the risk of change would merge into the volatility risk. It would cease to exist because the problem of the predictability of change would find a stochastic solution. Only its variability – the volatility risk – would remain to be addressed.

Consider the following example: In the first round, a fair coin is tossed 10 times. In the second round, the setting is changed; in 50% of the tosses the fair coin is exchanged for a coin with heads on both sides (risk of change). The introduction of the quantifiable risk of change would merely change the probability distribution and the standard error (volatility) as follows:

Round 1: Heads (50%), Tails (50%);
standard error = 16%

Round 2: Heads (75%), Tails (25%);
standard error = 14%

The risk of change is necessarily confined to instances for which no probabilities are available. Only irregular events, trends or cyclical patterns that cannot be specified in terms of probability remain. Only irregular events, trends or cyclical patterns that cannot be specified in terms of probability remain.

To estimate the total claim amount for various changes in risk factors, we require an exploration of what-if scenarios and notably the worst-case variant. In the recent past, such investigations were conducted to assess pandemic threat. The objective was to derive a plausible mortality increase, partly based on the data available from previous pandemics (most prominently the “Spanish” influenza outbreak of 1918-1919). However, the probability of a major pandemic itself continues to remain pure guesswork.

Can we learn from past experience?

An element of ad hoc learning is involved when it comes to the risk of change. This is mainly confined to singular changes, trends and sometimes cyclical patterns. Irregular changes and rare events do not allow for any successful adaptation of our predictions. Examples of singular changes include a sudden and politically motivated leniency of state authorities in the assessment of public disability claims or a major improvement in cancer diagnostics.

Trend parameters also play an important role in the calculation of longevity risk. We have seen attempts at modelling cyclical incidence rates which, in many markets, appear to be characteristic for the disability risk. However, such cyclical models introduce additional economic and/or behavioural parameters, which are in turn difficult to predict.

Overall, we must live with the fact that no matter how much experience was gathered in the past, we will always have significant, unquantifiable risk of change in the future. It is difficult enough to make sense of past experience and tell systematic change from volatility; more importantly, perhaps, the world is changing at an accelerating pace so whatever learning experience we already have is far from being able to protect us from the vagaries of the future.

Safeguards

The risk of change places us outside the actuarial realm where probability distributions can be consulted or constructed. It is equal in scope to entrepreneurial risk. Essentially, there is no difference between a car manufacturer worrying about the future demand for gasoline-fuelled vehicles in the face of rising ecological awareness and an insurer fearfully anticipating a major improvement in cancer diagnostics that is likely to increase the future number of Critical Illness claims.

Pointers may be taken from how economists have dealt with entrepreneurial risk. One of the first comprehensive treatments of the role of risk
in economic decision-making is attributed to the American economist Frank Knight almost a hundred years ago.

Knight made a distinction between measurable and unmeasurable risk. The first he called “risk”, the second “uncertainty”. How can we deal with (unmeasurable) uncertainty in a business environment? Knight came up with five methods that seem equally useful for dealing with the risk of change (see Box 1).¹⁸

**Benefits from reinsurance**

A closer look at Knight’s proposed safeguards reveals they are all inherent in reinsurance. Participating in the business written by the cedant, the reinsurer is the ideal partner in analysing and monitoring the risk. Unlike non-participating external consultants, the interests of the reinsurer and the cedant are perfectly aligned.¹⁹ Thanks to its various forms of risk-sharing, reinsurance tailors a cedant’s exposure to its risk appetite, benefitting them in two additional ways. On the one hand, the reinsurer can support developing new insurance covers that expand a cedant’s product range. On the other hand, a cedant can benefit from lower reinsurance premiums resulting from the reinsurer’s diversified portfolio in terms of product and region.

The worldwide activity of an international reinsurer implies a wealth of experience across many markets that is not available to the typical locally-oriented cedant. The reinsurer knows where the pitfalls are, what is promising and what is likely to cause a loss. The cedant can learn from the exploits of other markets.

The alternative, to replace reinsurance with higher amounts of retained capital, shuts the cedant out from the advantages of a long-term reinsurance partnership in managing the risk of change. By randomizing the latter, and treating it like volatility, Solvency II implies that reinsurance and capital are more or less perfect substitutes in containing the risk of change.

Yet the risk of change is essentially unmeasurable. Quantifying a phenomenon that is arguably characterized by its inherent unquantifiability may therefore imply a deceptive degree of certainty that can be abused to promote other interests.

**Conclusion**

Insurance is all about predicting the future on the basis of past experience. Unlike natural scientists who can manipulate nature to make it conform to the assumptions of their theoretical models, insurers cannot operate in a controlled experimental setting.

With the help of statistical methods, insurers can structure empirical data into homogeneous risk groups on the basis of a number of explanatory underwriting factors. However, they cannot anticipate or control the future development of factors, notably environmental ones, in the same way as a natural scientist can conduct subsequent experiments in an unchanged setting (such as a vacuum).

Success in insurance depends on close monitoring of risk factors. If changes remain unnoticed, pricing models will quickly get out of touch with reality. The monitoring task requires experience, expertise...
and good judgment. These three indispensable properties are external to the models themselves and cannot be substituted by capital alone. They form the backbone of the services reinsurers should ideally continue to offer their customers.

Endnotes

2 They may be forgiven for being wrong because even (risk averse) probability experts might, in this case, shy away from the following bet; pay US$ 300 now as an entry fee and win US$ 1,200 on heads (nil on tails). There are of course those who suspect the coin to be unfair. And they may be right in many real-life cases.
3 The same can, of course, be said of the volatility risk in relation to the risks of error and change; for instance, when it is unclear whether or not the early stages of deviations from the expected outcome can still be considered as random fluctuations or should rather be identified as a trend.
4 See for instance EIOPA-14-322 dated 27 July 2014, “The underlying assumptions in the standard formula for the solvency capital requirement calculation,” pp. 29-30: “The calibration of the life underwriting parameters captures changes in the level and trend of the parameters only...This is considered to be acceptable since volatility risk is thought to be considerably lower than the trend risk.”
5 Consider the formula for the standard error, \( \sigma / \sqrt{n} \), where \( \sigma \) is the standard deviation of the population and \( n \) the sample size.
6 In technical jargon: with the help of statistical methods one aims at identifying properties (e.g. age and production technology) in the insured entities (e.g. insured lives or factories), which exhibit a high positive correlation with the frequency of the insured event.
7 Knight FH. Risk, Uncertainty and Profit, New York, 1921, p. 218.
8 Ibid. p.218
11 Ibid. p. 15.
12 Spiegelhalter D.J., Riesch H. “Don’t know, can’t know: embracing deeper uncertainties when analyzing risk,” Philosophical Transactions of the Royal Society, 2011, p. 4731: “[aleatory is an essential, unavoidable unpredictability... and epistemic uncertainty reflects lack of knowledge or ignorance.]”
14 Ibid. p. 256.
15 This is true for an objective (frequentist) interpretation of probability. Proponents of a subjective interpretation of probability would claim to be able to estimate probabilities (degrees of belief) for the risk of change. But then again the risk of change would merge into the volatility risk.
**Our Publications**

- **Risk Insights – Vol.19, No 3**
  
  In this edition Kimberley Wang provides some highlights of Gen Re’s ongoing study of the Disability Income market in New Zealand. Ross Campbell considers the potential for digital health and wearable technology to shape the future. Joanne Tan discusses the importance of monitoring trends in health insurance.

- **Underwriting Focus 2015, No 2**
  
  This edition focuses on sports. Annika Tiedemann looks at extreme sports to challenge the perception that the risks outweigh the benefits. Ross Campbell describes how an active sporting life brings improvements to general health. Åsa Beijer outlines new research on scuba diving. Birgit Jenssen discusses a revised approach to assessing mountaineering risk and Hanna Könen reviews the safety of private aviation.

**Client Seminars**

- **Gen Re, Australia** hosted its first Actuarial Forum on 16 September. James Louw, Chief Actuary, and Robert Kerr, Senior Account Executive, presented on the theory and practice of GLMs with a practical example using R software.

- **Gen Re, Australia** held an Underwriting Forum on Thursday 15 October that explored “Interpreting CT Angiograms and Coronary Calcium Scores” and was attended by 13 delegates from major companies in the industry.

- **Gen Re, China** ran the Gen Re Management Course in Chongqing 18-23 October, attended by 26 participants from client insurance companies in mainland China, Indonesia, Singapore, Taiwan and Thailand.

- **Gen Re, Australia** hosted its annual “Aspire” seminar in Auckland on 20 October, which was attended by 80 clients from 12 companies. Presenters and presentations included the following: Andres Webersinke, Managing Director, “The Age of Disruption”; Matthew Ramjan, Chief Underwriter, “The App-solute Story”; Carol Smit, Head of Claims, “Let’s Get Direct – The Good, The Bad and The Ugly”; Robert Kerr, Senior Account Executive, “State of Advice” on changing advisor remuneration; and Anthony Callaghan, from AHC Investigations, “What You Don’t Know You Don’t Know” on smart private investigations. Also, Viviane Murphy, Senior Account Executive, chaired a panel discussion on “Terminal Illness”.


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Gen Re, Singapore hosted “Managing Health and Critical Illness Risks” in Ho Chi Minh City, Vietnam on 28 October, which was attended by 46 clients from 12 companies. Dr. Wolfgang Droste, Chief Advisor Asia, presented “Dread Disease: the 2008-2012 Experience,” Irene Ng, Regional Chief Underwriter Asia, presented “Cancer Development and Challenges for (Re)Insurers” and “Monitoring Health Experience,” and Silvia Zhang, Senior Pricing Actuary, Gen Re Singapore, presented “Guaranteeing Critical Illness Rates”.


Gen Re, Vienna held its annual social event in Bucharest on 18 November. Friedrich Müller, Unit Manager Life/Health Europe, Gen Re Cologne, welcomed guests to an evening recital by Romanian artists – soprano Rodica Vica and guitarist Maxim Belciug.

Gen Re, London hosted a Senior Executives’ Forum on 8 December. Speakers included William Rotatori, CEO, GR-NEAM; Chip Clark, President, GR-NEAM; Dr. Mark Bale, Deputy Director, Genomics Science & Emerging Therapies, Health Science & Bioethics Division, Department of Health; Professor Richard Barker, Director of the Centre for the Advancement of Sustainable Medical Innovation (CASMI); Dr. Paul Redmond, Director of Student Life at the University of Manchester, and Steven Mendel, CEO, Boughtbymany.com.

Gen Re, Australia held a claims forum on 3 December with the theme “Work Conditioning: Restoring Function for Work and Life,” which explored the impact of intervention and exercise physiology programmes. A total of 20 representatives from various companies attended.
Industry Meetings

> **Stelio Rossi**, Senior Underwriter, Gen Re Milan, presented “Gen Re Dread Disease Survey on Asian Markets” at the Association of Italian Life Insurance Medicine conference on 10 October in Milan.

> **Viviane Murphy**, Senior Account Executive, Gen Re Australia, and ALUCA NSW president, led the ALUCA (Australasian Life Underwriting and Claims Association) professional development day on 13 October. James Louw, Chief Actuary, Gen Re Australia, presented “Life Insurance 2020 – Will Technology Be a Game Changer?”

> **Dr. Himanshu Bhatia**, Senior Medical Consultant, Gen Re Support Services Mumbai, presented “Cancer – From Sin to Science” at the Association of Insurance Underwriters, Know Your Life 2015 conference in Mumbai 17 – 18 October.

> **Dr. Chris Ball**, Consulting Medical Officer, Gen Re London, presented “Evolving Embodiment of Risk: The Case of Alzheimer’s Disease” at the Singapore Actuarial Society Health and Retirement Conference on 23 October, and at the Institute and Faculty of Actuaries Momentum conference on 3 December.


> **Tad Montross**, Chairman and CEO of General Re Corporation, spoke on “Global Reinsurance Market Trends” at the Executive Series Dinner in Sydney on 12 November, where two tables were hosted by Gen Re Australia.