

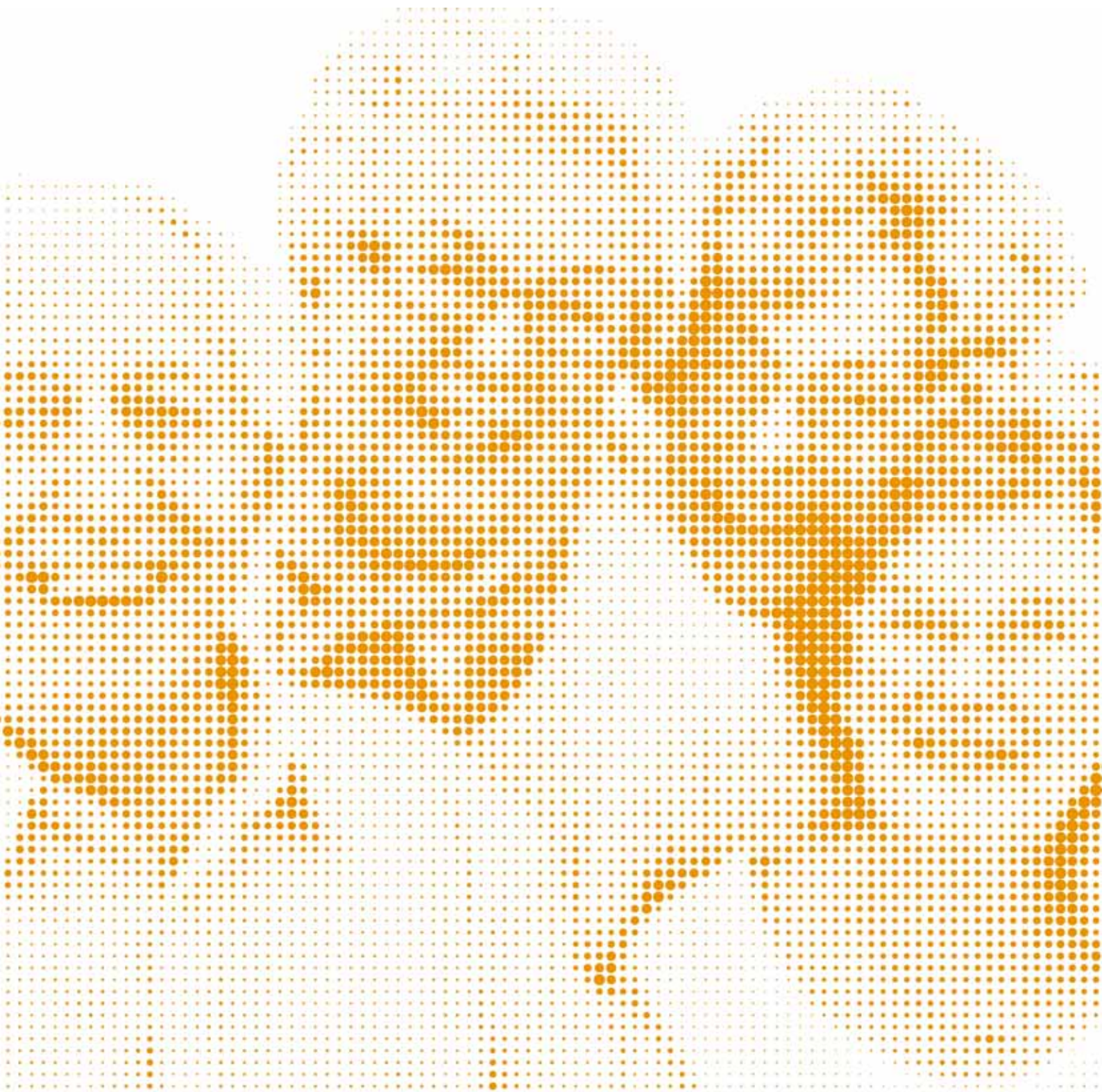
A window into the future: Understanding and predicting longevity



Unprecedented increases in life expectancy experienced in recent decades have been consistently underestimated, causing funding difficulties for employers, insurers and governments. Forward-looking models provide better estimates of future longevity and will play a vital role in the overall solution, which should be driven by public and private bodies working together.

Table of contents

A history of underestimation	3
What impacts mortality?	4
Traditional methods of forecasting future life expectancy	6
The multiple factors influencing future life expectancy	8
Building a forward-looking, scenario-based model of future life expectancy	11
Focused future research	14
Looking into the future for breast cancer	14
Looking into the future for prostate cancer	16
How can this knowledge be interpreted into a mortality model?	18
The future of understanding and predicting life expectancy	18
Conclusion	20



A history of underestimation

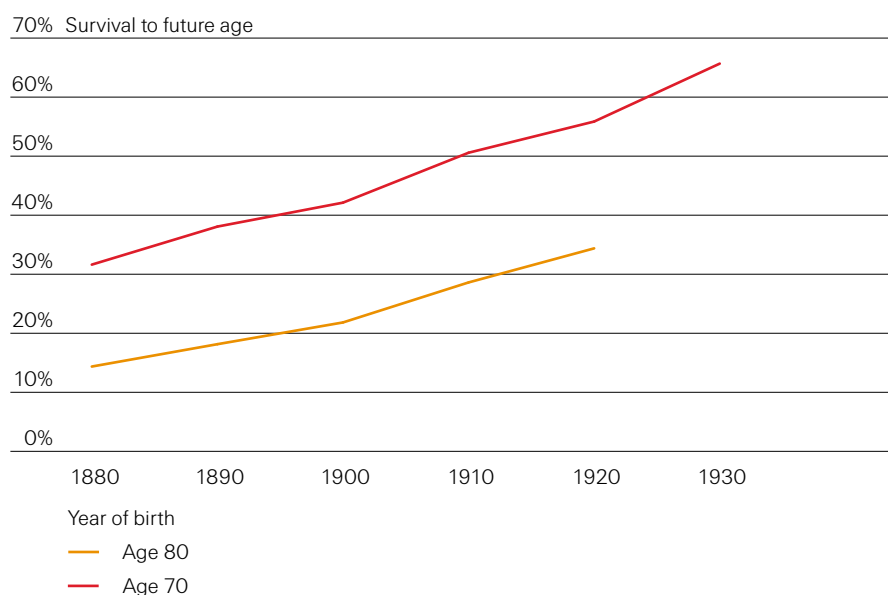
Increasing life expectancy is one of the success stories of the 20th and 21st centuries. A Swiss male born in 1900 lived to an average age of about 51¹. Current estimates suggest that a Swiss male born a century later could expect to live more than 35 years longer².

These mortality improvements demonstrate just how far society and science have come. Medical and healthcare advances, improved living conditions, and healthier lifestyles, have all helped prolong our lives.

Pension funds have under-reserved for longevity risk – the financial risk that people live longer than expected – resulting in additional, unexpected liabilities.

The last two decades have seen a far greater proportion of people living into their 70s and 80s throughout the industrialised world (Figure 1). Greater awareness of the dangers of smoking and developments in the treatment of heart disease are key reasons behind this trend, while potential advancements in the treatment of cancer and dementia could lead to further improvements in life expectancy.

Figure 1: Improving longevity with later years of birth, males, Switzerland



Source: Human Mortality Database, 2008 figures

¹ Observed mortality – source: Human Mortality Database, 2008 figures.

² Cohort life expectancy – source: Statistique Vaud, Tables de mortalité longitudinales pour la Suisse, April 2006.

With this positive news come significant financial challenges that require governments, individuals, employers and insurers to understand the drivers if they are to appreciate future trends:

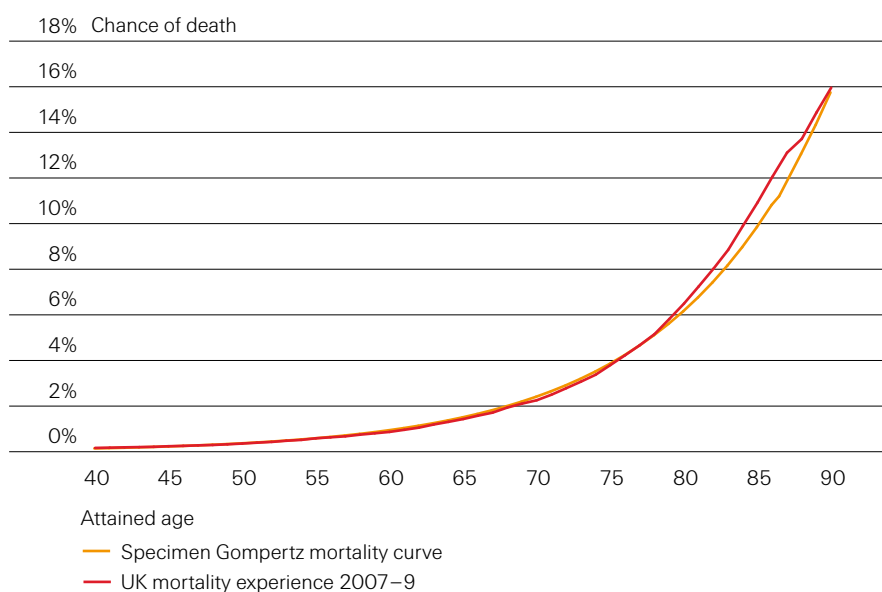
- Governments have to predict longevity when setting state pension provision, retirement ages, appropriate taxation levels and healthcare programmes
- Employers must appropriately fund pensions and benefits promised to employees in retirement
- Insurers need to meet their customers' requirements by providing annuities and life insurance, pricing products appropriately and demonstrating that they are sufficiently capitalised to meet future uncertainties
- Individuals are increasingly being expected to make separate provision to fund their retirement income

There are considerable differences in opinion over the likely range of future life expectancy. In recent decades, projections produced by governments and professional bodies have underestimated how long people will live. This has contributed to employer pension funds under-reserving for longevity risk – the financial risk that people live longer than expected – resulting in additional, unexpected liabilities.

What impacts mortality?

Actuaries and medical doctors are united in their desire to understand what influences human mortality. Mathematician Benjamin Gompertz was the first to observe in 1825 that mortality rates increase exponentially with age, in that the chance of death approximately doubles every eight years of life (Figure 2).

Figure 2: Application of Gompertz mortality curve



Source for UK mortality experience: Human Mortality Database, 2011

Age is therefore also classified as a key risk factor for predicting a person's life expectancy. Other risk factors include gender, prior disease, access to treatments, occupational hazards and smoking.

However, when data is not readily available for certain risk factors, proxies can be found. For example, where a person lives may not be a risk factor, but it can provide proxies for risk factors such as access to healthcare.

Year of birth is a valuable proxy. It helps map exposure to different risk factors over the lifetime of a group of people, and assess the potential impact on their future longevity. For example, those born in Germany, the UK and Japan in the early 1930s not only benefitted from warnings on the dangers of smoking in the 1970s, but also from successive developments in treatment options and clinical guidance for high blood pressure and high cholesterol.

Year of birth is a valuable proxy when analysing future longevity. It can help map exposure to different risk factors over a lifetime and assess the potential impact.

Uncertainties for how risk factors and proxies will develop pose a significant challenge when making predictions about future longevity. One estimate suggests that, today, a 65-year-old woman in the UK can expect to live another 20.9 years and a 75-year-old 13.1 years³. But a number of other estimates could be put forward and reasonably supported.

It is even more difficult to assess how long a 75-year old woman might live in ten years' time. Figure 3 illustrates just some of the medical advances that took place between 2000 and 2010.

Figure 3: ABC News and Med Page Today's top-ten US medical advances of 2000 – 2010

1. Human genome discoveries reach the bedside
2. Doctors and patients harness information technology
3. Anti-smoking laws and campaigns reduce public smoking
4. Heart disease drops by 40%
5. Stem-cell research: laboratory breakthroughs and some clinical advances
6. Targeted therapies for cancer expand with new drugs
7. Combination drug therapy extends HIV survival
8. Minimally invasive and robotic techniques revolutionise surgery
9. Study finds heart and cancer risk with hormone replacement therapy
10. Scientists peer into mind with functional MRI

³ UK Government Actuary Department, 2011.

Traditional methods of forecasting future life expectancy

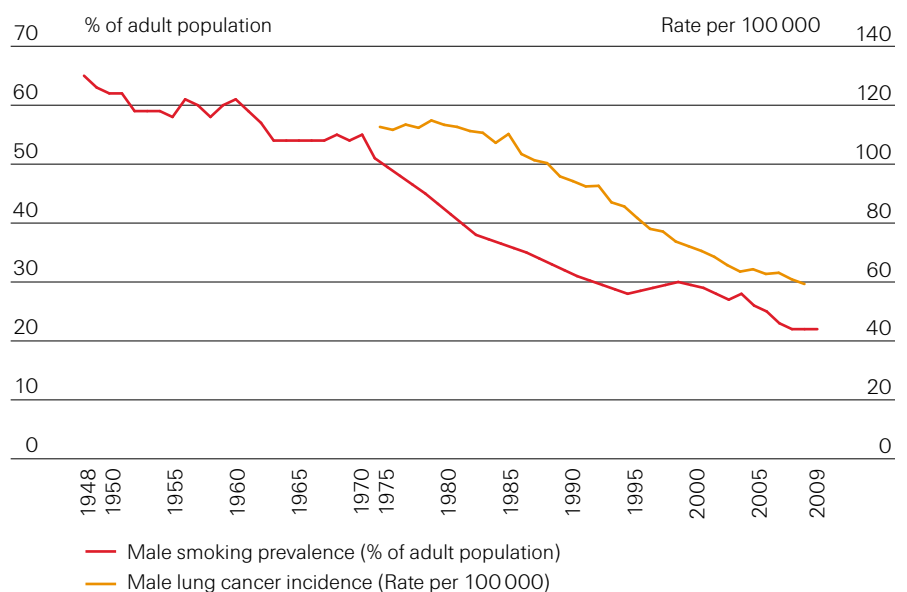
There are two traditional approaches for forecasting life expectancy. The most widely used is a blending approach, combining current rates of mortality improvement with a long-term future assumption. This assumption could be based on historical trends, or a judgement of the potential for further improvements in life expectancy.

The other approach relies on stochastic models. This involves the development of actuarial models – based on historical mortality experience – that capture underlying trends and variability. These computer-based models are then used to generate future forecasts, without attempting to provide an underlying explanation.

Models failing to consider the importance of historical and emerging information run a greater risk of misestimating future trends.

Analysing past experience is important in identifying which drivers of life expectancy might continue and which will fade in importance. For example, certain events in the past – such as the fall in the prevalence of smoking and the subsequent effects on lung cancer diagnoses – cannot re-occur (Figure 4).

Figure 4: Lung cancer incidence and smoking trends, Great Britain, males 1948–2009



Source: Cancer Research UK, 2010. Smoking data weighted after 1998. Data obtained from GHS, ONS; smoking data prior to 1974 from Wald and Nicolaides-Bouman, 1991; actual lung cancer incidence data 1975 – 2008 from Cancer Research UK

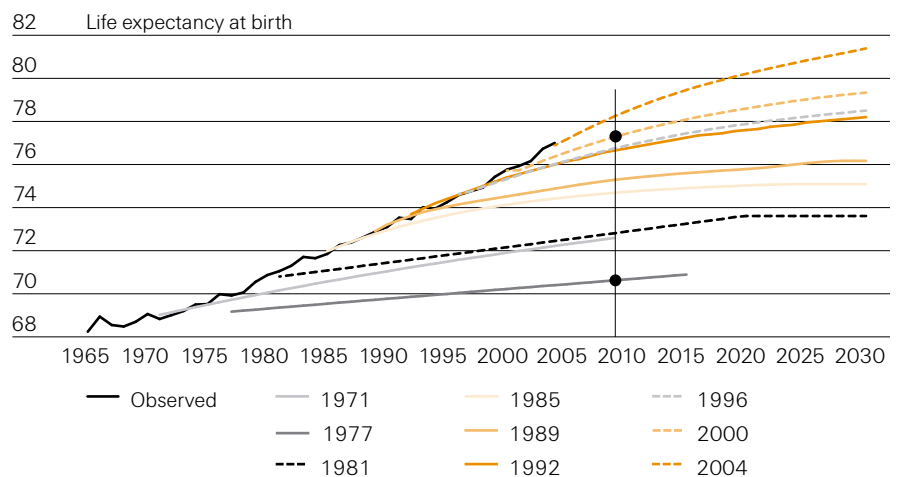
Public health initiatives – like smoking bans in public places and increased taxation on tobacco – have played a key role in reducing the popularity of smoking. However, as a result of these historical successes, the improvements to life expectancy related to smoking will not be as significant in the future.

This means that new drivers are needed to continue historical trends – a fact often overlooked by standard projection models.

Models failing to consider the importance of historical and emerging information run a greater risk of misestimating future trends, producing projections that cannot be readily explained or justified.

Figure 5 demonstrates how previous projections have underestimated future life expectancy, causing funding difficulties for pension plans and insurers. For example, the life expectancy of a UK male born in 2010 was estimated to be 71 years in 1977. By 2000, this estimate was revised to more than 77 years.

Figure 5: Actual and projected life expectancy at birth, UK males.



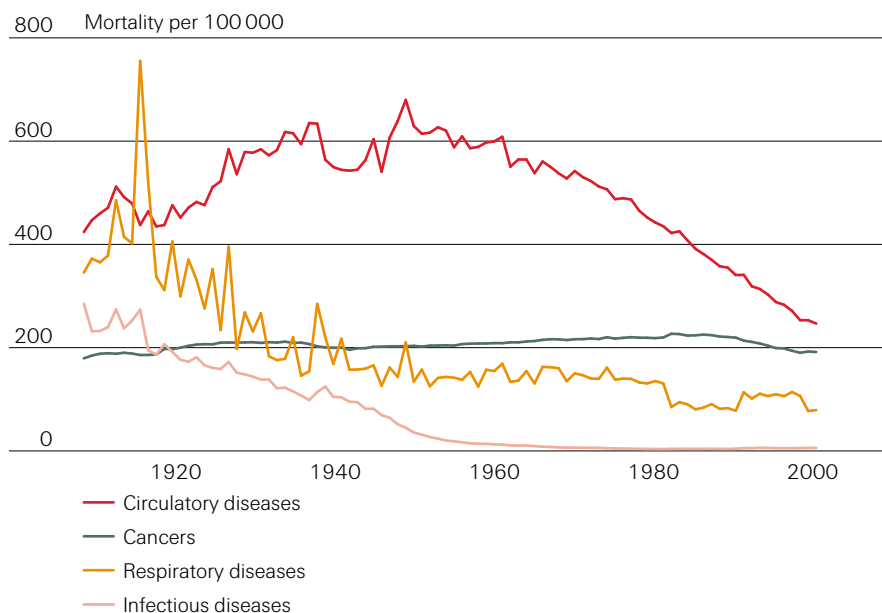
Source: Chris Shaw, "Fifty Years of United Kingdom National Population Projections: How Accurate Have They Been?", Population Trends, 128, Office for National Statistics, 2007

Every generation has a unique life history of shared events and innovations. One generation might be less susceptible to disease than the next, but the later generation could live longer through medical advances or having healthier lifestyles. The complex interaction between risk factors, disease and treatment means that historical trends do not tell the whole story.

The multiple factors influencing future life expectancy

Reductions in mortality from ischaemic heart disease, the key circulatory disease covering both angina and heart attacks, have been the main driver in developed countries' recent dramatic longevity improvements. Figure 6 illustrates just how substantially the number of deaths due to circulatory diseases has fallen since the 1950s.

Figure 6: Mortality by cause, England and Wales



Source: British Actuarial Journal 12, Richards, Kirkby & Curry, 2005. Reproduced with kind permission of Stephen Richards

Numerous developments in our understanding and management of disease and related risk factors have helped save many lives. These include:

Social factors not only include the fall in the number of smokers, but also an increased awareness of the lifestyle traits that can cause ischaemic heart disease. Thanks to media awareness campaigns and other initiatives, more people now appreciate the benefits of taking regular exercise and of a healthy diet.

Continued advances in medical treatments improve the chance of a patient's survival. For example, primary angioplasty is now preferred to clot-busting drugs, such as streptokinase, used immediately after a heart attack. Angioplasty uses a balloon to open up coronary arteries and then prevents subsequent collapse with small tubes, or stents. The latest generation of stents continuously release agents to prevent new tissue from blocking the damaged arteries.

Preventative methods may be preferable to treatment of chronic disease both in terms of cost and demand on resources. Clear guidance, approved by the medical profession, on appropriate monitoring and treatment can create more efficient practice. Early intervention can prevent coronary events and, for those at risk, drugs such as statins can reduce deaths from heart disease by 42% and reduce the probability of a non-fatal heart attack by 37%⁴.

The natural complexity of the human body means that it is only through considering multiple diseases that we can ever produce reasonable estimates of future trends. A “life course” approach – gathering data on the development of harmful risk factors, along with the diagnosis and treatment of new diseases from individual patient records – is a more complete solution for assessing human longevity.

Considerations for predicting future trends

A life course approach would consider far more than historical influences. As its name suggests, it would analyse relevant events that can occur over the course of a person’s life. In addition to gathering appropriate data, we should assess how future developments may impact our lives, including changes in society, medical practice or technological advances. The challenge is not only to set out a possible path for any future developments, but also to assess its likelihood and impact.

New treatments need to satisfy a series of clinical trials that test their safety and assess their effectiveness. Many are unsuccessful, but even successful clinical trials can take a decade or more to complete, and obstacles such as cost and current medical practices can delay widespread adoption further. For example, lovastatin, the first statin treatment to be isolated in 1978, took another 16 years before its benefits were widely recognised.

We should assess how future developments may impact our lives, including changes in society, medical practice or technological advances.

We have seen increases in research and development expenditure throughout the pharmaceutical industry, partly because of regulators’ increased demands. Perhaps in response, more combination therapies – involving the practice of combining already approved treatments – are being evaluated.

Using established therapies in combination has helped treat conditions such as high blood pressure. Doctors frequently use different combinations of ACE inhibitors, calcium channel blockers, diuretics and beta-blockers to achieve better control of hypertension.

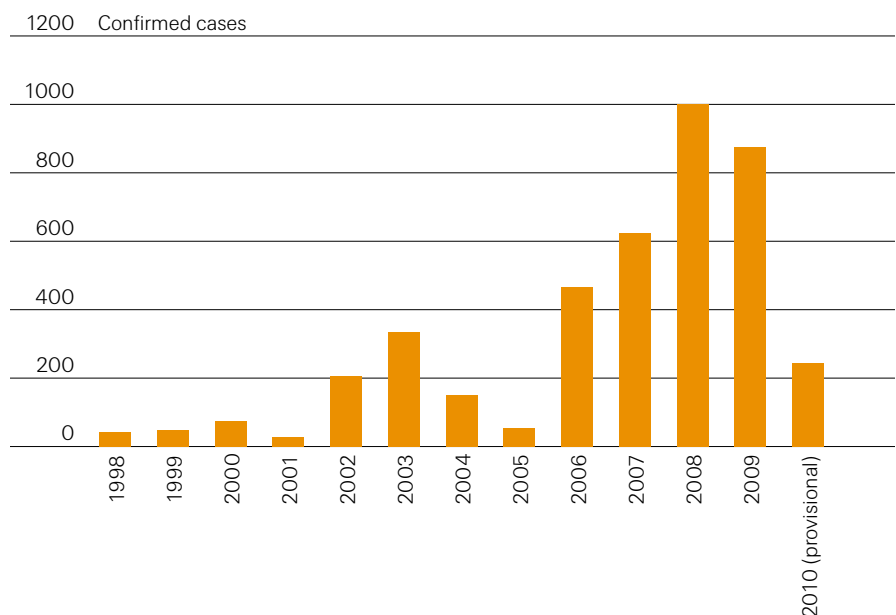
However, evaluating the benefits of a combined treatment through analysing the individual component treatments is complicated. For example, the claimed benefits of polypill – the preventative treatment that combines five drugs into one pill – are contentious. The daily tablet is said to reduce the risk of heart attack and stroke in the healthy population by 80%, but observers question these ambitious figures.

⁴ 4S Study (Scandinavian Simvastatin Survival Study), 1994.

Assessing whether a particular treatment in clinical trials will be adopted widely involves many considerations. These include understanding how the clinical trial system operates, the licensing process, the healthcare systems in that country, the costs of providing treatment and the likely timeline of any roll-out.

Acceptance by the medical profession is not the end of the story. The reaction to a discredited 1998 report – which stated that a combined vaccine against measles, mumps and rubella (MMR) could cause autism – meant that some children went unvaccinated against these diseases. This demonstrates how public distrust of some medical innovations could hamper future improvements (Figure 7).

Figure 7: Measles in England and Wales



Source: Health Protection Agency, 2011

As the lovastatin, polypill and MMR vaccine examples suggest, we may fail to predict the impact of a medical development and its usage. Perfect predictions are beyond our reach, but a better understanding of future developments is a key component of building a forward-looking model that attempts to predict future life expectancy.

Building a forward-looking, scenario-based model of future life expectancy

Most deaths follow an escalating pattern of disease as a result of harmful risk factors, with different diseases impacting one another in old age. This co-morbidity means that analysing diseases in isolation is not sufficient. Any model attempting to predict future mortality needs to track the interaction between different key diseases.

In order to build this type of mortality model, we need to develop a multi-disciplinary approach, using large patient databases that provide detailed information on individual diseases.

A multi-discipline approach to understanding mortality

Developing a multi-discipline approach would involve different professions combining their expertise to better understand and model future life expectancy. The many relevant professions include:

- **Actuaries** provide expertise and models for assessing the financial impact of uncertain, future events
- **Medical experts** such as family physicians and hospital specialists provide insights into future developments in the diagnosis of disease and treatment guidelines
- **Epidemiologists**, who are experts in public health research, analyse harmful risk factors that lead to disease and how this might progress
- **Pharmacologists** provide expertise on the development of new medical drugs and opinion on their potential impact
- **Demographers**, who understand societal trends, help aggregate the various influences to estimate future population sizes, broken down by age, essential for funding future longevity
- **Gerontologists** provide in-depth understanding of the physical, mental and social effects of ageing
- **Governments** have a vested interest in our improved understanding of longevity. Some countries might share high-quality, anonymised data on public health and behaviour

Systematic methods for collecting and disseminating information

International protocols have provided guidelines on how death certificates should be completed, but there are distinct differences between different countries and within the actual countries themselves.

Most developed nations have a long history of collating data from death certificates, although the amount of information captured from the certificate varies. For example, the US and the Netherlands record all diagnosed diseases on the death certificate in their national databases, whereas others just record a single cause of death.

Any analysis based on cause of death information might be unreliable for a number of reasons:

- Determining the final cause of death can be difficult: this is particularly relevant for elderly people, who are more likely to have multiple diseases
- Estimating future life expectancy by trends in cause of death can underestimate prospective improvements: trends in less common causes may be hidden or distorted by very common causes that are expected to be less important in the future

However, there are now more extensive sources that provide data on patients throughout their lives. These are available to academic and commercial researchers for use in their analyses. One example is the General Practice Research Database (GPRD), a live database of over five million patients in the UK.

GPRD provides high quality information on people with a prior history of disease. The database can be analysed in detail by clinical diagnoses, treatments, laboratory tests, family history and lifestyle information. It also contains valuable information on healthy people and this helps us model future trends in the wider population.

This information enables us to create a mosaic, which identifies patterns of individual disease and co-morbidity within the population by age and gender. The real value of this mosaic is that it provides a framework for considering the impact of different forward-looking scenarios.

Defining scenarios

A scenario could be a timeline of developments with a common theme, such as introducing professional guidelines into clinical medical practice. Alternatively, it might summarise the variety of treatments and risk factor behaviour in society at a future date.

However the scenario is defined, it's essential that we are realistic about how far in the future we can make informed predictions for individual diseases.

The process of taking a new treatment from initial clinical trials through to authorisation and widespread use in clinical practice might take 15 years or more. This means that horizons beyond 15 years could be influenced by treatments that are profoundly different to those that we are investigating today.

Examples of scenarios

Different countries are at different stages of development in the treatment of particular diseases. We might want to assume that laggard countries will catch up with leaders in the diagnosis or treatment of a disease. For instance, the five-year EUROcare surveys of cancer survival often highlight Sweden as a leading example.

Such a scenario would need to explain why these differences between countries existed, perhaps in terms of stage at diagnosis or the extent of clinical follow-up in treatment. It may be that genetic, economic or cultural factors would prevent full convergence between countries.

Taking a new treatment from clinical trials to widespread use might take 15 years. This means that longer horizons could be influenced by treatments quite different to those we are investigating today.

A more detailed approach would be to analyse the accessibility and take-up of individual treatments or changes in individual risk factors over a defined period. This would be a very intensive process, albeit one producing highly valuable insights.

A simpler alternative builds on current interest in the use of combination therapies to achieve particular targets. This could involve proposing targets for, say, blood pressure or total cholesterol levels, based on current clinical guidance stating when treatment is advisable.

This is the type of approach taken by the American Heart Association, through the Impact 2020 initiative, setting targets on the indicators of good health known as LifeSimple 7 (Figure 8).

Figure 8: LifeSimple 7 – Impact 2020 targets

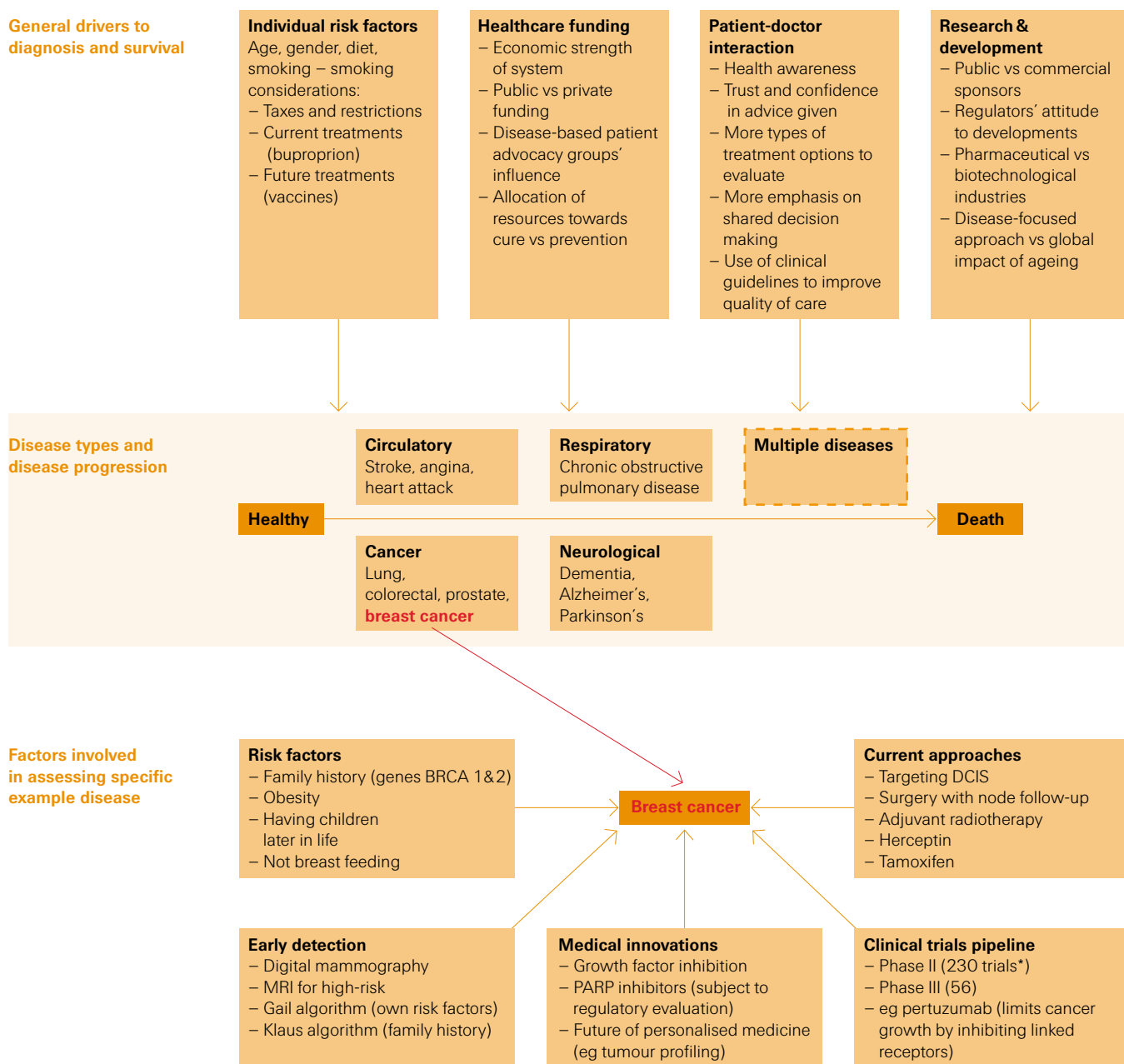
Get Active	Physical activity for 150 mins a week at moderate intensity
Control Cholesterol	Cholesterol concentration less than 200 mg/dL
Eat Better	4 or 5 key components of healthy diet
Manage Blood Pressure	Blood pressure at or below 120/80 mmHG
Lose Weight	BMI of between 18.5 and 25
Reduce Blood Sugar	Fasting blood glucose less than 100 mg/dL
Stop Smoking	All smokers to quit

Source: American Heart Association

Any life course model will need to develop different scenarios for future diagnosis and survival rates (Figure 9).

Figure 9: Considerations when building a forward-looking, disease-centred approach for assessing future longevity

This diagram provides an overview of just some of the many considerations for building a forward-looking, disease-centred model. It illustrates the breadth of information required for such an approach and demonstrates how general drivers influence individual, and multiple, diseases. Taking the example of breast cancer, the diagram also highlights examples of considerations at an individual disease level.



*As of June 2011

Focused future research

When assessing specific diseases, establishing scenarios involves analysis of the potential developments affecting that particular disease. The examples of breast cancer and prostate cancer can be used to demonstrate where research might focus, making best use of resources and giving a more robust insight into future longevity.

Looking into the future for breast cancer

We have seen significant increases in breast cancer diagnosis in many developed countries, and this partly reflects an increase in the incidence of the disease. Women are having fewer children, having them later in life, having their first period earlier and are widely exposed to the contraceptive pill and hormone replacement therapy. All of these non-genetic factors increase the risk of breast cancer.

More effective screening will help increase the detection of breast cancer in younger age groups and this could help reduce mortality rates further.

Well-developed screening programmes in many countries are commonplace. The National Cancer Institute in the US recommends that women over the age of 40 have screening mammographs every one to two years and these programmes will increase the likelihood of detecting breast cancers at an early stage.

For ductal carcinoma in situ (DCIS) – the most common type of breast cancer in women – the identification and treatment of the disease are very important as such early cancers are more likely to progress into a more serious condition.

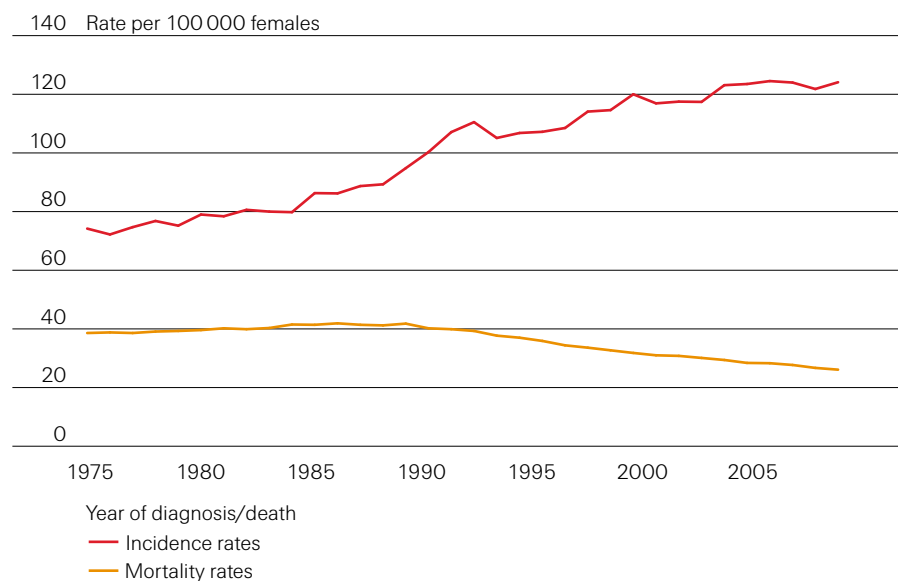
Assessing the impact of screening programmes

Looking forward, the chance of people developing breast cancer is likely to remain stable, but overall diagnosis rates may increase by extending screening programmes to women of younger ages.

Investigations of younger women are likely to be focused on those women who might have a particularly high risk of breast cancer, as identified through the risk algorithms of Gail and Klaus.

A number of studies have investigated how screening approaches might affect the detection of lesions in young adults, with MRI being suggested as an alternative to two-view digital mammography. More effective screening will help increase the detection of breast cancer in these age groups and this in turn could help reduce mortality rates further (Figure 10).

Figure 10: Breast cancer incidence and mortality rates in Great Britain, females, 1975–2008



Source: Cancer Research UK

Improved diagnosis and its effect on breast cancer survival rates

Improvements in screening have already led to changes in the distribution of cancer by stage, and have had a positive impact on subsequent survival.

Attribution analysis can determine the relative importance and value of any changes – similar to quantifying the importance of smoking to lung cancer, among other diseases, as identified by epidemiologists Peto and Doll. Such analysis has highlighted that the major contributor to improved survival rates for breast cancer was the drug tamoxifen, with only a relatively minor contribution from screening programmes.

Going forward, the expectation is that further survival improvements will be driven by the combination of screening and intervention in a systematic manner.

New treatments for breast cancer

There have been encouraging developments in new treatments, either for the direct treatment of cancer, or in conjunction with surgery. The most widely known treatment is Herceptin, a monoclonal antibody used for the treatment of HER 2, or hormone-sensitive, cancers. Herceptin, which blocks cancer cells and prevents them growing, has been approved widely, but there are significant differences by country in the recommendations for using other monoclonal antibodies.

Monoclonal antibodies, along with treatments such as tyrosine kinase inhibitors, lead the way for treatment that hold out the prospect of individualised medicine, tailored to a person's DNA. Highly-advanced biological technology, including DNA micro-array analysis, can help decide the most appropriate treatment in terms of effectiveness and the avoidance of adverse side effects.

Looking into the future for prostate cancer

The considerations for developing scenarios for prostate cancer are somewhat different. The main risk factor for prostate cancer is age, but another factor is race. Males belonging to some racial groups experience a higher prevalence of prostate cancer than others.

What impact do screening programmes have?

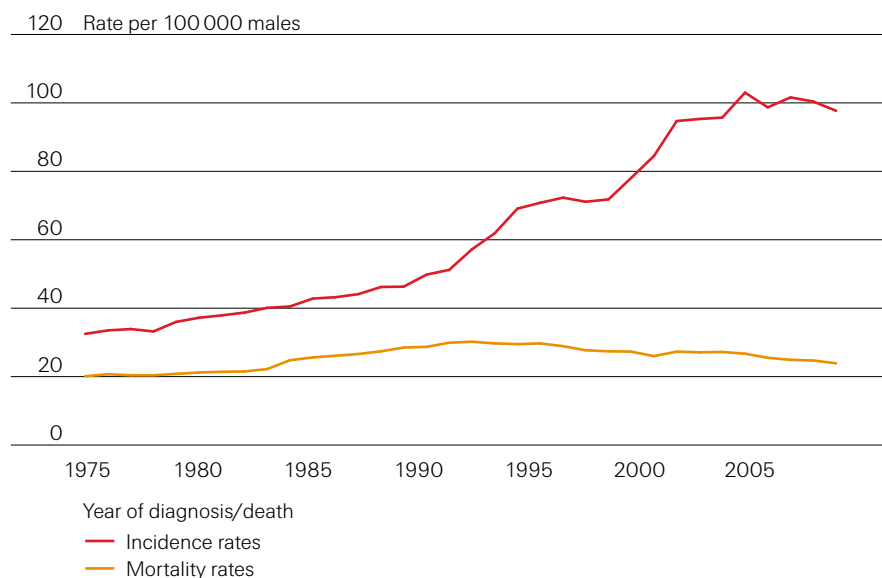
Although there is no known formal screening programme in any country, men in the US and UK can request prostate-specific antigen (PSA) tests – which measure prostate activity – and US males have done so in very high numbers.

This has transformed the distribution of prostate cancers by stage in the US, with many more cancers being diagnosed prior to the development of any symptoms. Many of these cancers would not become a threat during a man's lifetime given their slow growth.

Newer forms of PSA analysis consider the rate of change in test results over time, for example, and such tests reduce the number of incorrect diagnoses and unnecessary interventions.

The prospects for future diagnosis trends are likely to vary by country. In the 1990s, the US showed that more widespread testing could lead to dramatic increases in diagnoses before a broadly stable and higher rate of prostate cancer is reached. We have now seen this pattern in the UK and other countries that have provided screening without a national programme (Figure 11).

Figure 11: Prostate cancer incidence and mortality rates in Great Britain, males, 1975–2008

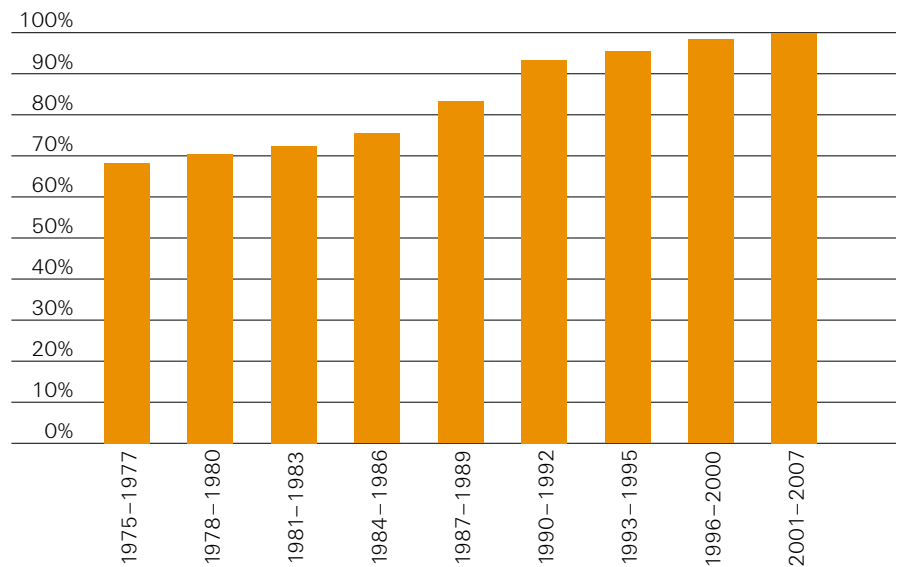


Source: Cancer Research UK

Improved diagnosis and its influence on prostate cancer survival rates

Survival trends from the point of diagnosis would also be expected to vary by country depending on the amount of PSA testing. The inclusion of many early-stage cancers in the US has transformed the five-year survival rates to approximately 99% (Figure 12).

**Figure 12: Cancer of the prostate:
five-year relative and period survival rates – US males**



Source: US National Cancer Institute, 2011

This high survival rate again suggests the unthreatening nature of some prostate cancers. Urologists often recommend regular monitoring of the condition – known as active watching – rather than any treatment or surgery to classify the type of prostate cancer.

Prostate cancer treatments

When considering intervention, surgery is the default choice in most cases. There is also the prospect of other treatment options such as hormone therapy, radiotherapy and ultrasound, enhancing or even replacing surgical options. Urologists in the US take a particularly strong line on intervention, with only 10% of diagnosed prostate cancers being followed up with active watching.

How can this knowledge be interpreted into a mortality model?

The development of a disease-centred mortality model involves committing resources to scenario development according to the importance of that disease to the overall model. For example, the use of Herceptin might improve life expectancy for those with advanced breast cancer by a number of months. However, these valuable improvements for those affected would only translate into a relatively small increase in the life expectancy of the entire population.

It may be more useful to concentrate on early intervention for breast cancer, where there is more potential for significant improvements in longevity. Therefore, research should focus on developing scenarios that consider earlier detection of breast cancer, with the potential benefits to subsequent survival.

In contrast, there are significant differences in the distribution of prostate cancer by stage between countries. Here, resources should centre on how widespread adoption of testing could lead to convergence between countries, as well as how innovations in treatment would improve the survival of cancers at a similar stage.

Overall, it is necessary to develop and quantify suitable scenarios for future diagnosis rates and survival rates after diagnosis for use in a life course model. This is relevant for each disease – or combination of diseases – that is tracked in the model.

What is perhaps less obvious is that a single scenario will not be sufficient. Considering a number of alternative scenarios for each disease, and how these interact with different scenarios for other diseases, will help achieve an understanding of potential uncertainty in future experience.

The future of understanding and predicting longevity

The concepts outlined in this report take into account a number of forward-looking factors that can provide detailed information on future life expectancy. This information would be very useful for governments, insurers and pension funds.

Models are limited by the quality or quantity of data that is available on a particular subject. Public databases have become more widely accessible to commercial organisations in recent years. With such valuable resources at their disposal, organisations that carry longevity risk should take advantage of the opportunity to improve their understanding.

An important element of managing longevity risk will be the development of robust, predictive approaches, and a disease-centred model would help in this area.

The future is highly uncertain, but a key benefit of predictive approaches is that they can increase confidence in the pricing and funding of future retirement income solutions. However, holding longevity risk continues to be a major challenge for pension funds, insurers and governments and better methods need to be developed to share the risk appropriately.

A disease-centred mortality model, based on forward-looking scenarios, can play a key role in the evaluation of longevity risk and the building blocks presented in this report are essential for the model's development.

It is clear that scenario development would need to be a continuous and long-term project. It would be advantageous for the various interested parties to act in collaboration, perhaps through a forum with a specific mandate to develop key areas of research.

Forward-thinking predictions for mortality would also further develop the capital market for longevity risks, which is needed to create additional capacity to transfer financial risks associated with longevity. The creation of a liquid market would require many developments, such as improved investor education, accounting standards and access to more consistent and granular data. Forward-looking mortality models could be helpful in setting a price for trades to take place.

Recommendations for pension plan stakeholders

Employers and pension plan managers who currently provide a guaranteed retirement income for their employees need to examine their options carefully. They should appreciate the risk of under-reserving against member longevity and should consider ways to mitigate against future, increased liabilities. However much analysis is undertaken, considerable financial uncertainty will always remain.

Employers and pension plan managers need to assess their potential longevity exposure and decide whether it is best to retain it or pass some, or all, of it onto a third party that may be better placed to take on, and aggregate, the risk. Such a third party should have made the appropriate investment – in terms of both funding and resource – into an effective mortality model and hold the financial capacity to manage such a long-dated commitment.

Stakeholders should consult widely before entering into any decision and make sure that any solution is durable as well as adaptable in the long term.

Recommendations for the insurance industry

Insurers can work together through their industry bodies and in partnership with their reinsurers to manage longevity risk effectively. As regulatory regimes, such as the European Union's Solvency II, recognise reinsurance as appropriate mitigation against longevity risk, this will help them support capacity for annuities and other innovative products to fund people's retirements.

An important element of managing longevity risk will be the development of robust, predictive approaches, and a disease-centred model would help in this area. The significant investment and the expertise required to develop such an approach would mean that close relationships between insurer and reinsurer are vital.

Reinsurers and insurers (re/insurers) should also work individually and together to educate potential investors and create demand for capital market solutions. This could address concerns over the finite longevity risk capacity in the insurance industry.

Recommendations for governments and regulators

Many governments in the industrialised world have recently increased state retirement ages in recognition of the significant improvements in life expectancy since pension benefits were first introduced. It is logical that retirement ages should relate to the expected longevity of citizens and more forward-looking approaches can help create a fairer system, along with demonstrating the differences in life expectancy between various groups within society.

Governments can also share detailed anonymised data with appropriate parties on the prevalence of disease within their countries. They can then work with experts in mortality to achieve a more granular understanding of current and future mortality rates. This would help them develop plans for funding future state benefits.

As with all employers, governments need to consider their options in carrying longevity risk – especially through providing defined-benefit pensions to employees – and decide whether or not it is appropriate to pass this risk onto a third party.

Under Solvency II regulation, EU insurers can propose internal models to evaluate their capital requirements, instead of relying on the standard formulae set by regulators. Models must be used in day-to-day risk assessment, calibrated to consider extreme scenarios and based on relevant, high-quality data.

Governments, employers and insurers should work together to achieve a long-term, sustainable infrastructure for retirement provision including the sharing of longevity risk.

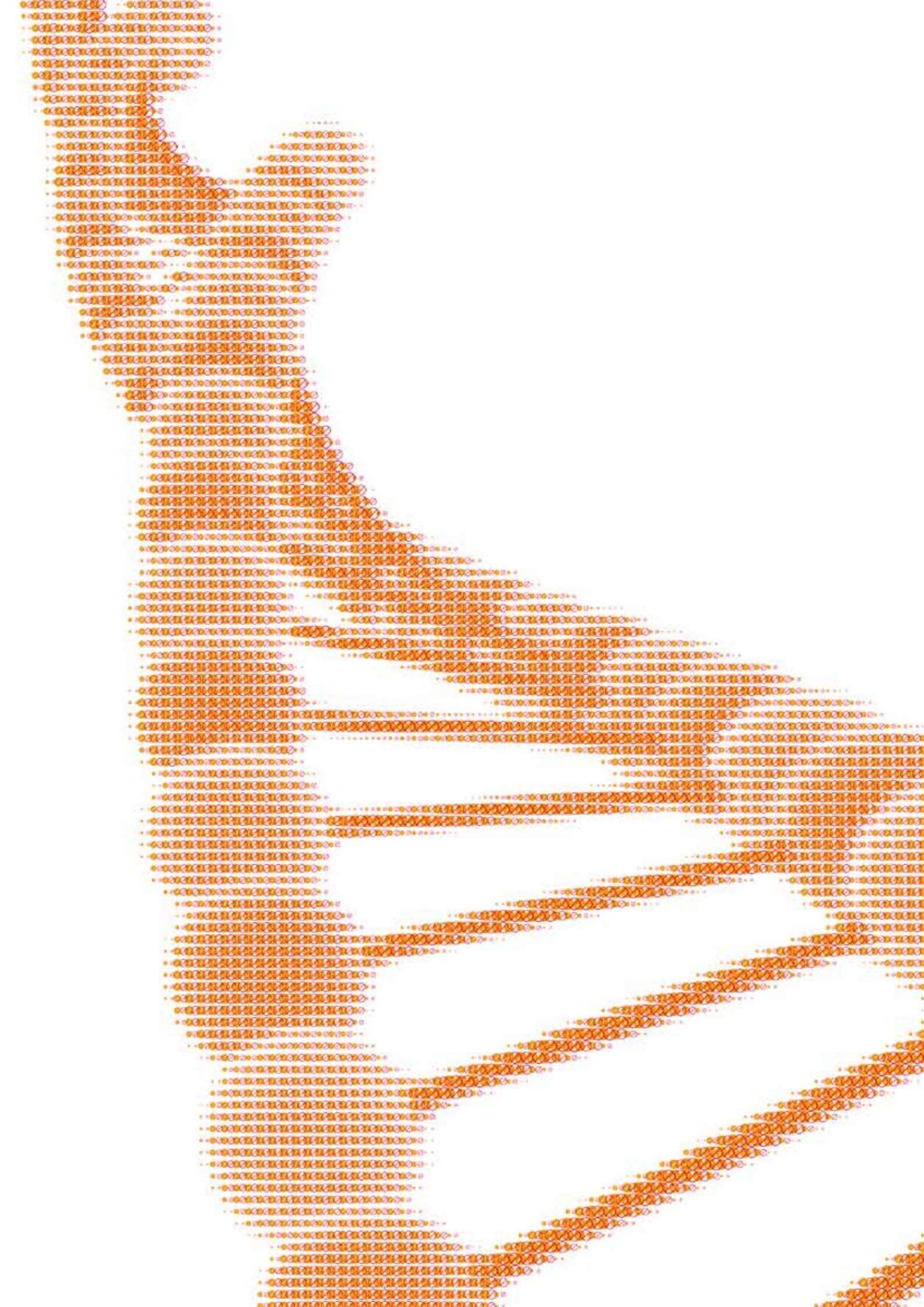
The forward-looking structure of a predictive mortality model is consistent with the demands of the regulators. Any scenarios must demonstrate the potential variability of outcome.

The realistic nature of this approach will be of interest to insurance and pension regulators in understanding the main drivers and risks for future experience. Similar examples include Swiss Re's influenza pandemic model, which provided regulators with vital information on the potential impact of interventions in 2007.

Conclusion

A predictive, forward-looking mortality model will not solve the potential financial problems caused by dramatic increases in life expectancy throughout the world. Instead, it is one of many essential components in creating an overall solution, which would involve the contribution of both the public and private sectors.

Governments, employers and re/insurers should work together to achieve a long-term, sustainable infrastructure for retirement provision including the sharing of longevity risk. An improved understanding of what will influence future mortality will help tackle the looming pension crisis and assist societies in making suitable provision for people's longer lives.



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Understanding and predicting longevity

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