Assessing Critical Illness trends - the facts behind the stats

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Paper to be presented at

IAA LIFE Colloquium 2009

7 - 9 September 2009, Munich, Germany

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1 Motivation

Successful Critical Illness (CI) insurance pricing relies on accurate analysis of past experience and the projection of future trends. An essential question is how to derive best estimate future trends for CI business. Typically trend estimation is the application of statistical methods to a set of data. Drawing a trend line through data seems simple. Assessing trends in CI claim rates, however, is somewhat more challenging.

In recent years members of various actuarial bodies in their different capacities have been studying past data to look for clues on future trends. In this study we focus on identifying the underlying reasons for the changes seen in the past – "the facts behind the stats". The knowledge and insights so gained will help in deducing appropriate assumptions on future trends. Furthermore, we have to consider future developments influencing current trends.

Different scenarios may apply for different time periods in the future depending on various factors e.g. changes in diagnostic evidence, advanced treatment methods, introduction or amendment of screening programmes or changes in risk factors. Some of these evolutions will have more or less effect than others on future claims experience whilst others again continue to affect trends only for some time to come. We also consider developments on the horizon that could affect future CI claim rates.

2 Background to the study

The illnesses included in the study are Cancer, Heart Attack, Stroke, Coronary Artery Bypass Surgery, Multiple Sclerosis, Benign Brain Tumour and Kidney Failure as these are the leading causes of CI claims in most markets. For cancer trends the most commonly diagnosed cancers and cancers exhibiting the biggest changes in incidence rates are identified and considered separately. This paper discusses some examples of the work done which we considered to be of special interest due to the nature of the effects observed on past data and due to the illness's major relevance for CI pricing as a whole.

We undertook research into historic trends in incidence of conditions based on population level data. While it is desirable to derive insurance pricing with reference to insured lives' experience this is not entirely possible as CI experience data has significant limitations for studies into trends. These limitations include low claim volumes and irregular contributions by life offices to industry-wide studies.

Population illness incidence rate statistics overcome the problems of low volume and generally tend to be collected in a consistent manner. These statistics include hospitalisation data and data from central registries. But adjustments have to be made to allow for differences between cases that are included in the population statistics and those that would qualify for a CI insurance claim. Some of these differences are:

- **clinical vs insurance definitions**
  In some markets standard definitions are used and even these have changed over time.
- **socio-economic differences**

The insured population tends to be more affluent and incidence rates can vary by socio-economic group.

- **repeat treatment of an illness vs first incidence**
  Hospital statistics record each admission for an illness while most CI products pay out only on the first occurrence of an illness (or severity level).

- **underwriting effect**
  The insured population is – generally speaking – healthier than the general population as lives with particular health conditions typically do not qualify for coverage.

The study was done for the UK market initially i.e. based on UK data as far as possible and allowing for market peculiarities. Non-UK data was considered where UK data was not available or insufficient. The UK is one of the CI markets that has standard CI definitions (Malaysia, Singapore, Taiwan, China and, to a limited extent, South Africa also have standard definitions). The Association of British Insurers (ABI) introduced the first set of model definitions in 1999. There have been several revisions over time and the latest set was released in April 2006. While assessing the effect of changes observed on population level data on CI claim rates, we took into account severity thresholds built into the ABI definition, its changes over time and differences compared to clinical definitions.

Another key difference between trends in insured lives versus the general population results from the fact that CI policies in the UK typically have smoker/ non-smoker distinct rates. For some conditions such as lung cancer and heart attack, smoking is an important risk factor and changes in smoking prevalence have had a significant effect on incidence rates. The insured lives' trend has to be adjusted for reductions in smoker prevalence that would not have been seen to the same extent within the smoker and non-smoker risk classification groups respectively. Therefore, we built a smoking model to understand how changes in incidence could be explained by changes in smoking prevalence.

Underlying reasons for changes identified may not be restricted to the UK market and models developed and the approach taken could have wider applicability (e.g. assumptions may vary between markets but a common model could be used). It is hence considered that findings detailed in the following sections are of international interest.

3 Executive Summary

The topics addressed in more detail in this paper are trends for heart attack and the effect of screening for cancer.

Recent trends in UK heart attack incidence rates show a clear increase after the introduction of new diagnostic criteria in 2000. The conventional markers were replaced by a new more sensitive marker: troponin. The ABI heart attack definition first explicitly referred to troponin in 2002. 4 years later a new definition was introduced requiring not only the existence or raise of troponin but also a minimum threshold level. Taking into account the severity level in the CI definition, the increase in the claim rate as a result of the introduction of troponin is expected to be lower than the increase in incidence observed in the general population.

However, the positive trend of underlying risk factors for heart attack as witnessed during the 1990s most probably continued and may have dampened the increase in incidence caused by the change in diagnostic criteria post-2000. Studies suggest that most of the improvements pre-2000 can be explained by the reduction in smoking prevalence. As CI policies in the UK have typically smoker/non-smoker distinct rates, we build a model to correct for these effects. Results from the model show that differences in trend patterns by smoking status were not as significant in the period 2000 to 2006 as they were pre-2000. There are various possible reasons, but the main point may be that the reduction in smoking prevalence has already been levelling off in the last decade.

Furthermore, this paper considers the possible effect on the future trends of heart attack the new UK Cardiovascular Screening Programme that was introduced in April 2009 has. Depending on assumptions made on the effectiveness of the programme different possible projections of future trends are probable. There may be considerable potential for further reductions due to better control of blood pressure and cholesterol. On the other hand, future trends in heart attack rates also depend on success in managing adverse risk factors such as obesity and diabetes which have shown increasing trends, but have been outweighed by favourable trends for other risk factors in the past.

Further, we assessed the effect of cancer screening. Results of historical trends in breast cancer incidence are an example of how a formal screening programme increases and accelerates detection rates (at least for a particular period and age group). To explain historical trends we considered past developments in breast cancer screening in the UK but also evaluated the effect of recent extensions to the screening programme and other developments (e.g. sustained increasing prevalence of risk factors, reductions in use of HRT) on future trends.

There is no formal screening programme for prostate cancer in the UK. Various studies indicate that a significant proportion of men develop prostate cancer during their lifetime but many do not display any symptoms and are therefore not diagnosed with cancer. With the PSA test becoming widely used for elective prostate cancer screening significant increases in incidence rates have been observed. The ABI's Best Practice document suggests to exclude early stage prostate cancers in the CI cancer definition since 2002. Thus, in terms of claims some of the increases in incidence could be offset by the reduction in the proportion of cases that qualify for a claim.

Furthermore, we discuss the likelihood of introduction of a population-based screening for prostate cancer in the UK considering results from two different prostate cancer screening trials. The introduction of a population-based screening still remains controversial. The screening trials demonstrated that higher PSA testing rates can prevent prostate cancer deaths but a large number of men have to be screened and treated for potentially harmless cancers to prevent one death.

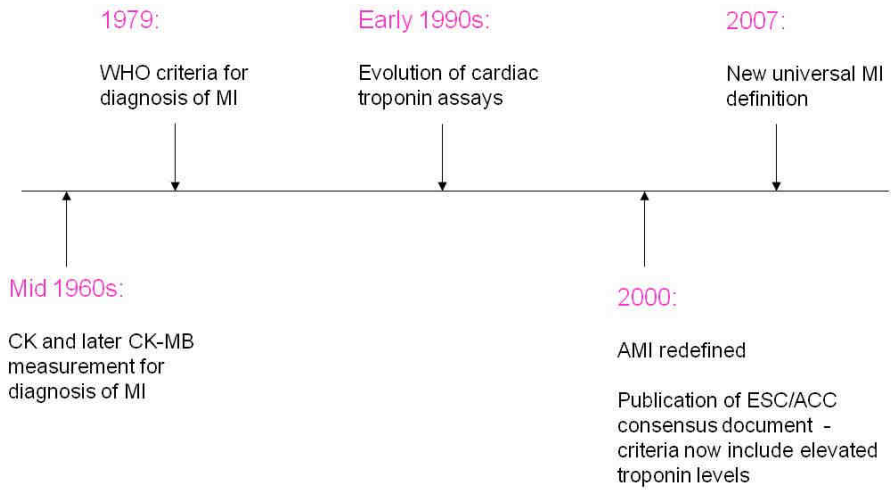
4 Heart Attack

4.1 Effect of changes in heart attack diagnosis

Diagnostic techniques for heart attack have advanced rapidly over the past decade. The initial standard for diagnosing myocardial infarction (MI) has been the World Health Organization (WHO) definition, which requires any two of three criteria: typical symptoms (i.e. severe and prolonged chest pain), unequivocal electrocardiographic changes, and elevated cardiac enzymes such as raised creatine kinase (CK) or the MB fraction of creatine kinase (CK-MB) levels. In 2000, the American College of Cardiology (ACC) and the European Society of Cardiology (ESC) published a new definition that for the first time included elevated troponin levels.

Interest in the definition of MI has recently been revived by the publication of the consensus document of the ESC/ACCF/AHA/WHF* task force for the redefinition of myocardial infarction[1]. The task force convened in order to develop a new universal definition for MI that could be employed in both daily practice and in clinical investigation. With regard to cardiac biomarkers troponin remains the preferred marker for diagnosis of MI and the definition requires detection of rise and/or fall of the marker with at least one value above the 99th percentile of the upper reference limit. In addition, the new universal definition defines different subtypes of MI which are considered to have significantly different prognostic and therapeutic implications (Fig. 1).

Figure 1 – Timeline of changes in clinical MI diagnosis



Cardiac troponin T (cTnT) and I (cTnI) are markers of heart muscle damage. When someone has a heart attack troponins are released into the bloodstream which is why the presence of troponin in the blood is indicative of heart attack. Because troponin is a more sensitive measure than the conventional markers, small previously undetected heart attacks that may have been previously classified as severe, stable or unstable angina can now be classified as a heart attack.

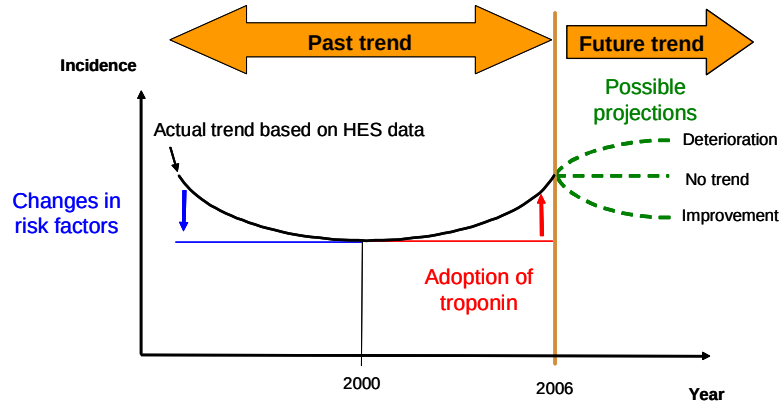
* ESC-European Society of Cardiology, ACCF-American College of Cardiology Foundation, AHA-American Heart Association, WHF-World Heart Federation

Since the publication of the new criteria, a number of studies assessed the implications of the redefinition of MI. While we expected an increase in the incidence rates following the introduction of new criteria for the diagnosis of MI in 2000, the extent of this increase remained unclear. The results which we will present show the actual increase in heart attack incidence as seen in the UK after the new diagnostic criteria were introduced. This once-off change (observed over a period of time during which the new diagnostic methods were fully implemented) presents a challenge with regard to estimating current and future CI claim rates for heart attack.

4.1.1 Actual increase in diagnosed heart attacks in the UK

For the analysis we used data from Hospital Episodes Statistics (HES). HES data are collected by the National Health Service (NHS) and contain information about the care provided to NHS patients in England. Figure 2 is a simplified representation of the observed historical trend and shows three possible outcomes for future trends.

Figure 2 – Heart attack trend model



Historical heart attack incidence rates by sex and age-band show a u-shaped pattern over the study period 1989 to 2006†, with similar trends for males and females and also for different age groups. For the first period, 1989 to 2000, a considerable decrease in the incidence of heart attacks was observed. This improvement is assumed to be largely due to improvements in cardiovascular risk factors, e.g. reduction in smoker prevalence, better control of blood pressure, advanced medical interventions (angioplasty, by-pass surgery) etc. This is confirmed by various studies assessing the impact of risk factors for heart attack.

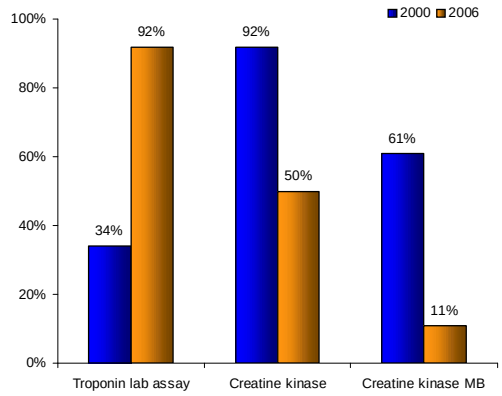
After the introduction of new criteria for diagnosis of MI in 2000, which emphasises the role of troponin, a clear increase in incidence of heart attack as classified in the hospital statistics was observed in both sexes and for all age groups. For people aged 40-59 years the incidence of first-ever heart attacks increased by 2.3% per annum for males and 3.4% per annum for females between 2000 and 2006, which corresponds to a total increase of 14.6% and 22.1% for the complete period respectively. There

† HES data is based on financial year basis (1 April to 31 March), e.g. data year 2006 contains information for the period from 1.04.2006 to 31.03.2007.

may still have been improvements in risk factors as observed in the pre-2000 period, but the effect may have been outweighed by the impact of changes in diagnostic criteria.

The National Audit of Myocardial Infarction Project published a survey on management of acute coronary syndromes in England and Wales[2] which assessed the use of biomarkers to determine presence of myocardial necrosis (death of heart muscle). Increasingly troponin has become the standard myocardial infarction biomarker in UK hospitals, replacing the conventional markers CK and CK-MB. Figure 3 shows that in 2000 only 34% of hospitals in England used a troponin laboratory assay, whereas in 2006 the majority of hospitals (92%) used it. On the other hand, the use of creatine kinase and its MB fraction reduced significantly in the same period.

Figure 3 - Troponin versus CK measurement in hospitals in England and Wales, 2000 and 2006



4.1.2 Insured lives versus general population

So far the trends discussed are at a general population level. Any study to assess trends for CI business has to consider differences between trends for insured lives versus the general population.

Standard CI definitions were introduced in the UK with the publication of the 1999 ABI Statement of Best Practice. The original idea of a CI policy is to provide a benefit where the insured has suffered an event that will have a significant effect on his life. Definitions have been revised over time to “future-proof” the definition and maintain the same level of cover as anticipated under the original concept.

The ABI heart attack definition changed in May 2002 and again in April 2006. The change in 2002 recognised troponin as one characteristic marker of heart attack besides cardiac enzymes. Since 2006 the definition requires minimum troponin levels (see shaded box). Those heart attacks qualifying for a claim under the new ABI definition are more likely to have fulfilled the less sensitive pre-troponin medical diagnostic criteria for heart attack. Thus the increase in CI claim incidence as a result of the introduction of troponin should have been lower than the increase in incidence seen in the general population.

Current ABI model definition for heart attack (April 2006):

Heart Attack – *of specified severity*

Death of heart muscle, due to inadequate blood supply, that has resulted in all of the following evidence of acute myocardial infarction:

- Typical clinical symptoms (for example, characteristic chest pain)
- New characteristic electrocardiographic changes
- The characteristic rise of cardiac enzymes or Troponins recorded at the following levels or higher
  - Troponin T > 1.0 ng/ml
  - AccuTnI > 0.5 ng/ml or equivalent threshold with other Troponin I methods.

The evidence must show a definite acute myocardial infarction.

For the above definition, all of the following are not covered:

- Other acute coronary syndromes including but not limited to angina.

HES data provides no information on severity of events. There are several studies available that quantify the effect of troponin on heart attack incidence, but there are few that take into account a threshold comparable to the one in the ABI definition. In addition, it may be difficult to decline a claim where the cTnT is just below 1.0 ng/ml and the insured can argue that had the test been done at different time, the value would have been higher. Therefore heart attacks where cTnT levels are just under the 1.0 ng/ml are likely to qualify for a claim payment and should be included in pricing.

We had access to an unpublished data-set which included both the CK and troponin levels of suspected heart attack patients admitted to a UK hospital during 2007. We believe that this data set is reliable as it is consistent with results from other studies. We evaluated the data and tested different cTnT thresholds against CK elevation to determine how many additional heart attacks could qualify for claim if troponin was measured rather than CK. Results did not differ considerably by age and sex. Assuming that claims with a troponin T level of 0.8 ng/ml or more qualify under the ABI definition suggests that the increase in CI claim rates would be 25% of the observed increase in population incidence rates between 2000 and 2006.

4.2 Effect of reduction in smoking prevalence

As already mentioned, another key difference between population incidence and critical illness claim trends results from the effect of changes in smoking prevalence over time. Smoking is a risk factor for a number of conditions. Therefore, CI products typically have smoker- differentiated premium rates and population changes do not apply within each of these risk groups in the same way.

The changing smoking prevalence appears to have had the largest contribution of all risk factor changes in explaining the decline in the incidence of MI pre-2000[3, 4]. In the period 2000 to 2006 any further improvements due to reductions in smoking prevalence have been offset by the introduction of troponin. Any improvements masked by troponin have the implication that the increased diagnostic sensitivity of troponin has been understated.

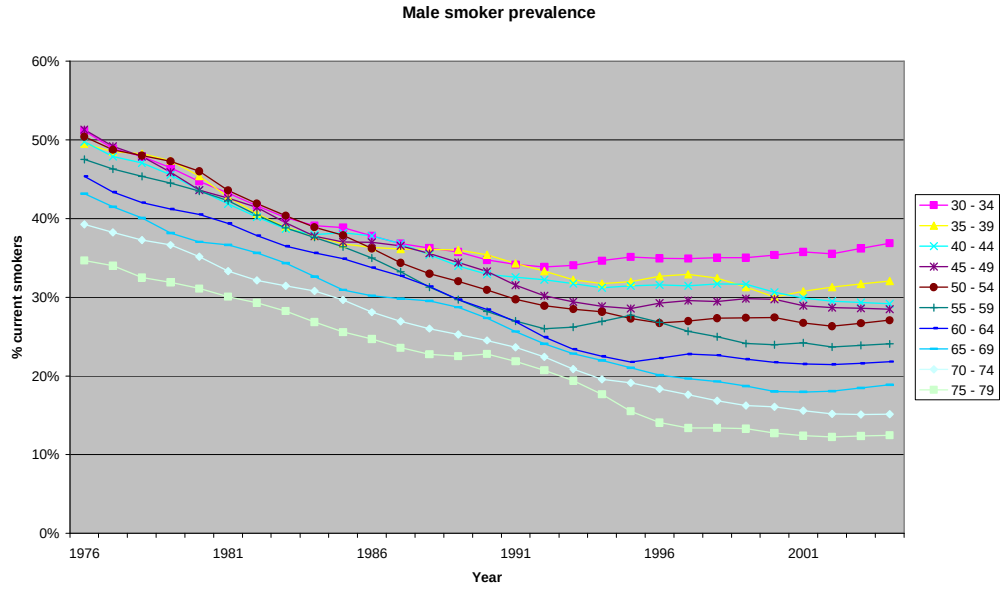
In order to derive trends for insured non-smokers and smokers separately, we built a smoking model. Thereby we took into account the movement of ex-smokers to the non-smoker group and the time it takes for health benefits to become apparent after smoking cessation. The parameter values that are needed for this model are:

- Risks of heart attack by smoker status (and duration since smoking cessation for ex-smokers) relative to the risk of heart attack for never-smokers;
- Actual past proportions of the population by smoker status. Proportions of current and never smokers can be obtained directly from the General Household Survey (GHS). Ex-smoker proportions by duration since smoking cessation need to be derived from time series data;
- Assumed proportions of the population by smoker status in the period between the last available GHS results and the presence; and
- Future proportions of insured lives by smoker status.

Several assumptions are made in terms of parameters, methodology and adjustments for insufficient data that will not be detailed in this paper.

The graph below shows smoker prevalence over time for different age groups.

Figure 4 – Male smoker prevalence by age group



Smoking prevalence decreased significantly in all age groups until the early 1990s. The change in prevalence has been flatter since then. There has been some increase in the prevalence in the age group 30 to 34 in recent years.

Relative risks of MI, allowing for reduction in risk by time since quitting smoking are obtained from various medical and epidemiological studies[5, 6, 7, 8]. The risk of heart attack for current smokers is approximately 4 to 5 times the risk for a never-smoker in the age group 35-54, and approximately 2 to 3 times increased for ex-smokers relative to never-smokers. The model assumes that the risk of heart attack for ex-smokers is the same as that of never-smokers 10 years after quitting smoking[9].

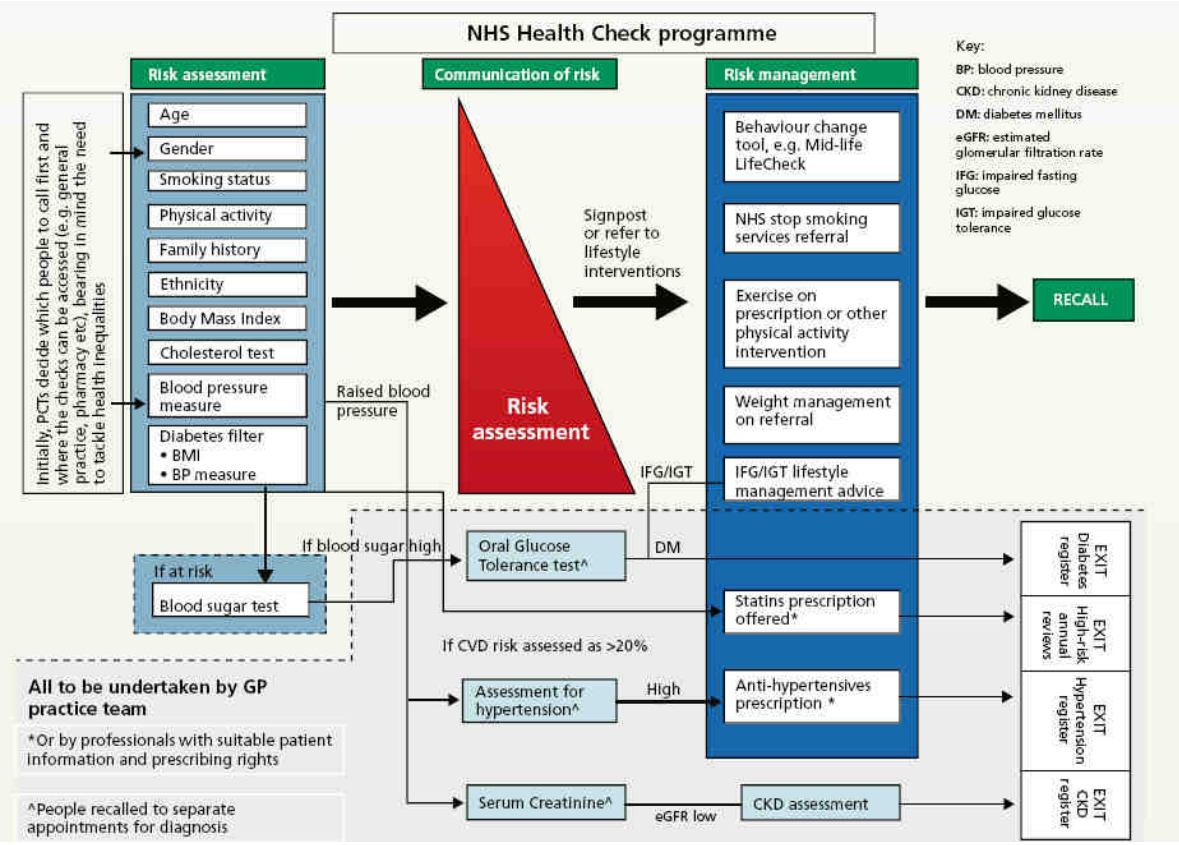
After combining all of this information in the model it was found (as expected) that differences in incidence rates of heart attack by smoker status are significant. However differences in trend patterns by smoker status were negligible in the period 2000 to 2006. Possible reasons are:

- The trend in incidence of heart attack is affected by various factors, not just changes in smoking prevalence;
- The reduction in smoking prevalence has been levelling off in recent years and reductions were not as significant as they were pre-2000;
- The most significant reductions in risk of heart attack occur within the first 5 years after smoking cessation so the benefits of smoking prevalence reductions in the 1980s and 1990s have little impact on heart attack incidence rates post-2000.

4.3 Effect of Cardiovascular Screening Programme

In April 2008 the UK government announced its plans to offer a systematic and integrated programme of vascular risk assessment and management. Implementation of this programme, now called “NHS Health Check”, began in April 2009. It will be offered to all people aged 40-74 years with repeated screening every 5 years, with Primary Care Trusts (PCTs) deciding who to screen first. The panel of tests will include blood pressure, non-fasting cholesterol and a test for glucose metabolism (if at high risk of diabetes). Height, weight and smoking history are also taken into account. Those defined as being at high risk includes those with a Body Mass Index (BMI) >30, those with a family history of diabetes and those with hypertension. There will be assistance and specific interventions for people at higher levels of risk.

Figure 5 – NHS Health Check programme. *Source: Putting prevention first – Vascular Checks: Risk assessment and management, published April 2008, DOH*



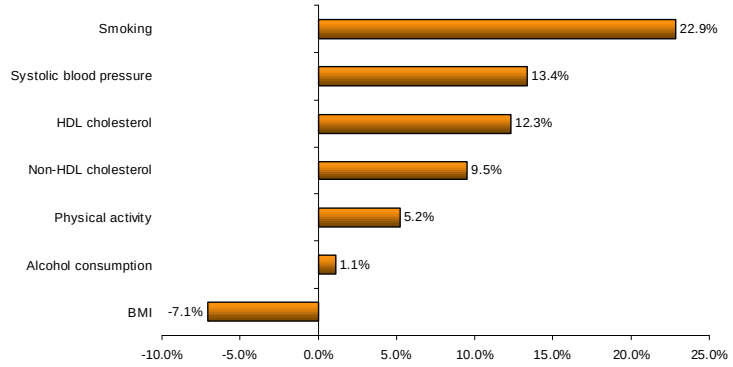
If patients with elevated risk of cardiovascular disease are taking preventive medicine on a wider scale, one would expect CI claim rates for cardiovascular conditions such as heart attack and stroke to fall in the general population. In order to assess the potential for further improvements as a result of better management of adverse risk factors, we undertook research to identify and understand the risk factors that have already contributed to changes in heart attack rates pre-2000. We then considered the remaining scope for improvements.

4.3.1 Improvements explained by risk factor changes

The British Regional Heart Study examined changes in cardiovascular risk factor and incidence of MI over 25 years from 1978 in a cohort of 7735 men[10]. During this time the age-adjusted hazard rate of MI decreased by 3.8% per annum, which corresponds to a 62% decline over the complete period. Approximately half of this decrease can be explained by a combination of changes in the major risk factors over this time. The largest contribution has come from the reduction in smoker prevalence, which alone statistically explained 22.9% of the observed decline, followed by changes in systolic blood pressure (13.4%), HDL cholesterol (12.3%) and non-HDL cholesterol (9.5%). Physical activity explains

5.2% of the decline. Changes in alcohol consumption had little impact (1.1%), whereas adverse developments of the Body Mass Index (BMI = kg/m^2) lead to an increase in the hazard rate of MI (-7.1%). However, the BMI effect has been outweighed by the favourable changes in other risk factors (Fig.6).

Figure 6 – Percentage of fall in hazard of a first myocardial infarction by risk factor



4.3.2 Potential for further changes in future

Smoking

As already mentioned the decline in smoking prevalence appears to have levelled off in the last decade. Further significant reductions do not seem likely.

Hypertension

According to the Coronary Heart Disease Statistics 2008 edition published by the British Heart Foundation rates of hypertension have dropped slightly in England since 1998, for both men and women at all ages. The largest decreases occurred at older ages.

A study by Falaschetti et al.[11] evaluated whether blood pressure management has improved in England between 2003 and 2006. Awareness of hypertension increased in the general population (from 62% in 2003 to 66% in 2006), the increase being more significant amongst women (from 64% to 71%) than in men (from 60% to 62%). Similarly, the proportion treated had risen significantly overall (from 48% to 54%) and in women (52% to 62%), but not in men (43% to 47%) (Tab. 1).

Table 1 - Comparison of awareness, treatment, and control of hypertension, by sex, between 2003 and 2006 England

	2003 (%)		2006 (%)	
Variable	**Men**	**Women**	**Men**	**Women**
Awareness of hypertension	60	64	62	71
Proportion treated	43	52	47	62
Control rates	21	23	24	32
Control rates among those on treatment	48	44	52	53

Control rates (defined as systolic blood pressure <140 mm Hg and diastolic blood pressure <90 mm Hg) of those deemed hypertensive were overall only 22% in 2003. And although improved between 2003 and 2006 particularly in women, statistics still show inadequate levels of blood pressure control and further potential for improvement.

Cholesterol

According to the Coronary Heart Disease Statistics 2008 edition the prevalence of raised total cholesterol fell between 1994 and 1998, but increased slightly between 1998 and 2003. Between 2003 and 2006 the prevalence of raised total cholesterol in men has decreased in all age groups with the largest decrease in the 75 and over group. Similar trend patterns were observed for women except for the 45-54 age group in which prevalence was slightly higher than in 2003.

A meta-analysis by Brugts et al.[12] showed that treatment with statins significantly reduced the risk of major coronary events (odds ratio 0.70) amongst patients without established cardiovascular disease but with cardiovascular risk factors over a mean follow-up period of 4 years. With regard to the Cardiovascular Screening Programme it seems that there is significant potential for better control of cholesterols with use of statins which should in turn lead to further reductions in heart attack incidence.

Diabetes

Diabetes is a significant risk factor for heart attack. According to the Coronary Heart Disease Statistics 2008 edition the prevalence of diabetes is increasing. Since 1991, the prevalence of diagnosed diabetes has more than doubled in men and women in each age group.

The cross-sectional survey by Holt et al.[13] of 3.6 million patients' records in the UK aimed to estimate the number of people with evidence of undiagnosed diabetes. Around 1% of the UK population is thought to have undiagnosed or unrecorded diabetes. This means 20-25% of people with diabetes have not been diagnosed (Tab. 2).

Table 2 – Undiagnosed diabetes in the UK

	Age band years	Prevalence of diagnosed diabetes per 100	Prevalence Undiagnosed per 100	Percentage undiagnosed
Female	<15	0.15	0.03	20%
	15-24	0.40	0.17	43%
	25-44	1.01	0.56	55%
	45-64	4.05	0.99	24%
	65-74	9.91	1.84	19%
	>75	10.39	3.57	34%
Male	<15	0.15	0.03	20%
	15-24	0.42	0.13	31%
	25-44	1.23	0.36	29%
	45-64	5.85	1.30	22%
	65-74	13.53	2.44	18%
	>75	13.95	3.45	25%
Total	all ages	3.54	0.90	25%

One-third of people aged 40 years and over who have not been diagnosed with diabetes has undergone blood glucose measurement in the past 2 years. The use of simple electronic searches allows identification of those people with possible undiagnosed diabetes. One of the aims of the Cardiovascular Screening Programme is to identify people at high risk of, or with undiagnosed diabetes which can then either be prevented or better controlled. This may lead to favourable changes in heart attack incidence in future.

4.3.3 Outlook – discussion of future trends

The new universal definition for myocardial infarction confirms troponin as the “gold standard” for diagnosis of heart attack. The increase heart attack incidence in the period 2000 to 2006 can be explained by the adoption of troponin. This increase should be a once-off effect and there is little scope for further increases given that 92% of UK hospitals are using troponin. This change should therefore be reflected in base CI insurance incidence rates (with adjustments for the ABI definition severity levels) but not in future trends.

Depending on assumptions made there are different possible projections of future trends. There appears to be little scope for further improvements resulting from reductions in smoking prevalence. Research studies claim that there is still considerable potential for further reductions, especially with better control of cholesterol and blood pressure which should be reinforced by the Cardiovascular Screening Programme.

However, increased rates of obesity and diabetes which have to date been outweighed by the favourable trends for other risk factors, may limit the extent of the reduction and possibly lead to increases in heart attack rates. The success of the Cardiovascular Screening Programme in managing these risk factors will be a determining factor.

5 Effect of screening for cancer

At the very least a screening programme accelerates the diagnosis of cancer. It may also reduce the number of cancer cases as in the case of cervical cancer where treatment of pre-cancerous cells can stop cancer from developing.

Cancers which are reported at a later age but could have been diagnosed at an earlier age had they been diagnosed at the time are called prevalent cancers. Cancers which are reported in the age group in which they could first possibly be diagnosed are called incident cancers. Cancers which would not have been diagnosed in a person's lifetime if they had not been detected by a screening programme are regarded as over-diagnosed cancers.

In the first round of a screening programme, cancers detected may be prevalent or incident. Cancers detected in people who have previously been screened should mostly be incident. Interval cancers (those diagnosed between screenings) may arise in this group. Some reasons for this may be:

- A long gap between screenings relative to the development of cancer; and
- Cancer that was present at the time of the screening but missed (less sensitive screening tests are more likely to miss cancers that are present).

Not everyone who is eligible for screening will take it up. Cancers will continue to be diagnosed outside of screening programmes.

Those in the youngest age group that qualifies for screening should continue to experience incidence rates in line with those seen when the screening programme is first introduced plus any underlying trend. This is because these people are all going through screening for the first time and the cancers will be prevalent and incident. In age groups that would have been screened previously, cancer incidence rates should reduce from first round screening levels by the number of prevalent cancers detected in these age groups when the screening programme was first rolled out.

A screening programme where the test is highly sensitive and maximum take-up rates are achieved quickly and remain stable should result in a once-off change in registration rates by age which stabilises at a new level. Subsequent trends should come only from underlying trends. Historically there has been higher take-up of screening among more affluent people who in turn are more likely to have CI insurance. This means that, especially in the prevalent round of screening, incidence rates are likely to be higher than those seen in the general population. Ignoring cancers which are prevented because of screening activity, the total number of cancers diagnosed for a cohort should stay the same or increase where there is over-diagnosis. The cancers should however be detected earlier which should make them more treatable and improve survival rates.

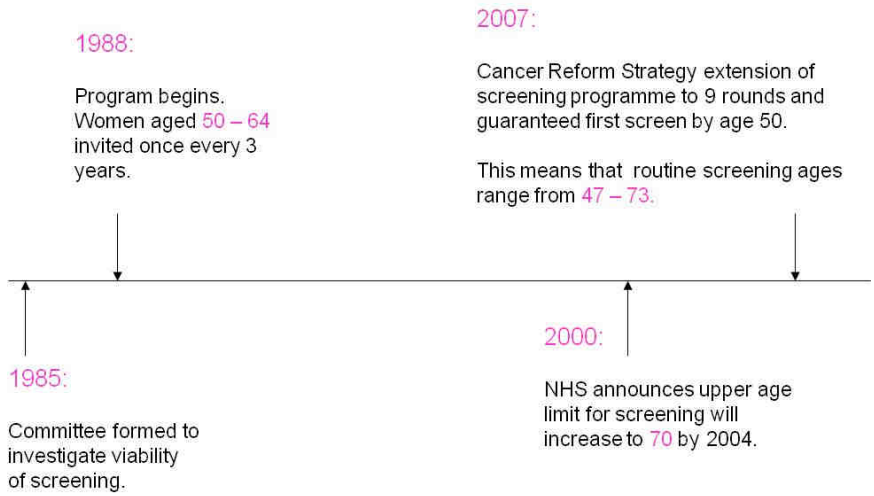
5.1 Effect of formal screening for breast cancer

Breast cancer is the most commonly diagnosed cancer among women. In England in 2006 it accounted for 31.5% of all cancers diagnosed in women and 47.7% of cancer diagnosed in women aged 41 to 60.

5.1.1 NHS Breast Cancer Screening Programme

In the UK the NHS Breast Screening Programme (NHSBSP) was set up in 1988 and achieved national coverage by the mid-1990s. By 1995 all screening units had completed the "prevalent" round (i.e. the round in which women are screened for the first time). Up to 2003, the programme offered mammograms every three years to all women aged 50 to 64 years. All women over age 65 could request a mammogram but Table 3 shows that this was not commonplace.

Figure 7 - NHS Breast Cancer Screening Programme development



In the 2002/03 financial year women aged 65 to 70 started to receive routine invitations to attend screening[14]. The change was originally proposed in 2000. The table below shows the numbers of women screened by the NHS between April 1998 and March 2008.

Table 3 – Breast Screening Statistics: number of women screened

Year	below age 50	age 50 - 64	age 60 -64	age 65 - 70	age 70+
2007/08	36,023	1,278,775	418,180	346,288	52,114
2006/07	36,251	1,461,929	380,266	380,485	58,823
2005/06	33,877	1,465,560	359,521	373,085	52,763
2004/05	32,623	1,187,387	338,531	219,783	38,051
2003/04	34,064	1,175,481	316,308	176,052	33,622
2002/03	37,421	1,161,208	314,208	120,703	28,046
2001/02	41,147	1,122,344	300,440	78,910	32,064
2000/01	46,857	1,148,811	308,213	76,196	26,888
1999/2000	50,616	1,175,841	319,510	71,709	24,725
1998/99	46,440	1,097,751	302,075	67,603	20,516

The acceptance rate of screening invitations has been in the 75% range at least since the late 1990s. The review of the April 2006 to March 2007 period showed that first time attendance had dropped below

the target rate of 70%. Around 5% of women screened in between 2005 and 2007 requested screening without an invitation.

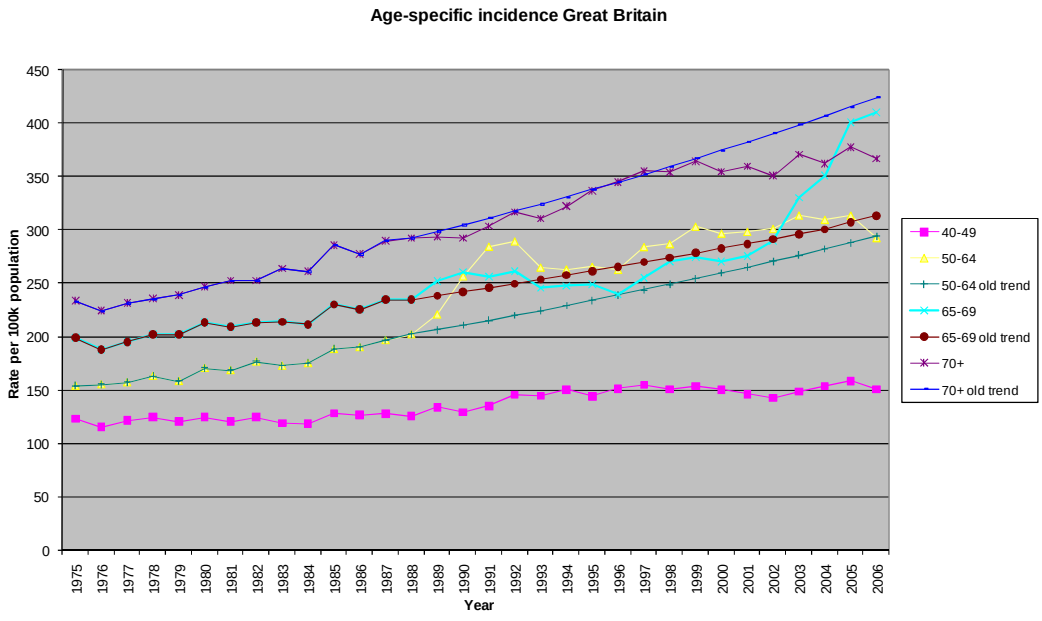
The NHSBSP now diagnoses about half of all breast cancers found in women in the target age range of 50 – 70 years, with the remainder occurring in women who do not attend screening or who present symptomatically in the interval between screens.

The Cancer Reform Strategy (2007) stated that the screening programme will be expanded to cover all women between ages 47 and 73.

5.1.2 Effect of screening on breast cancer incidence rates

The following graph is based on data obtained via the Cancer Research UK website. These statistics reflect invasive breast cancer (ICD10 code C50). In situ breast cancers are classified under a different code and are not reflected in these statistics. In addition to plotting the observed incidence rates, estimated trends in the absence of screening have been plotted by assuming that the log-linear trend in incidence rates from 1975 to 1988 would have continued and then projecting the incidence from 1988 onwards.

Figure 8 – Breast cancer incidences by age, Great Britain



From 1975 to 1988 the breast cancer incidence rate was increasing by 1 to 2% per annum for all age groups. It is believed that this reflects increased proportions of women in the population with breast cancer risk factors such as late first pregnancy, fewer pregnancies and use of hormone replacement therapy (HRT).

The peak in the early 1990s for females in the age group 50 – 64 years coincides with the introduction of the breast cancer screening programme. The peak was 32% higher than the incidence rate that would have been predicted had pre-screening trends continued. This level is maintained for the youngest age group that is eligible for screening (50 – 54 years) because cancers that have appeared recently (incident cancers), as well as those that have been present for some time (prevalent cancers), are detected for the first time. The subsequent reduction in incidence for age group 50 – 64 years comes from the age range 55 – 64 years as cancers reported at these ages in subsequent screening rounds should mostly be incident cancers.

5.1.3 Outlook for breast cancer trends

The extension of the screening programme will result in a once-off change in the incidence rate shape which should settle to its long-term shape in a few years' time.

Incidence rates should increase for age group 47 to 50 which will be the ages that continue to experience the prevalent round of screening in future. This means that incidence rates for ages 50 to 52 should decrease as screen-detected cancers should mostly be incident cancers in future.

The new incidence rate levels achieved for age group 65 to 70 should be maintained. A possible decrease may arise if the result seen is a representative of a prevalent round screen for ages at the upper end of this age band whereby some of the cancers detected at these ages are detectable at age at the lower end of this age band.

The extension of the breast cancer screening programme to age 73 should result in increased incidence at ages 71 to 73.

The sustained, increasing trends which have been linked to increasing prevalence of risk factors suggest that increases in incidence will continue for the foreseeable future. Some of the high past rates of increase may be offset by reductions in use of HRT since 2003 when the results of studies were published which showed the significant risk of breast cancer associated with HRT[15].

5.2 Effect of informal screening for prostate cancer

The National Institute for Health and Clinical Excellence (NICE) guidelines for the diagnosis and treatment of prostate cancer state that if men lived long enough, they would almost all die with histological evidence of prostate cancer. This does not mean that these prostate cancers would be detectable, even with a good screening test. This statement is based on the results of autopsy studies where the prostate can be examined more thoroughly than is possible where the patient is alive. Nevertheless incidence rates can potentially be higher if more effort is put into finding these cancers.

5.2.1 Screening methods and incidence rates in different countries

Four procedures are commonly used to diagnose prostate cancer: digital rectal examination (DRE), the Prostate Specific Antigen (PSA) blood test, trans-rectal ultrasound (TRUS) and needle biopsy.[16] NICE recommends that DRE and PSA tests be conducted if the patient presents with symptoms[17] but there is evidence of testing among asymptomatic men[18]. NICE recommends biopsy if the DRE and/or PSA findings and/or family history suggest risk of prostate cancer.

There is no population-based screening programme for prostate cancer in the UK. The risk of prostate cancer is explained to the public who can then make an informed choice regarding screening. Many other countries, including the USA and Australia, take a similar approach but screening rates vary.

The PSA test began to be used in UK in the early 1990s. It was estimated that in 2002, 6% of UK men aged 45 – 84 years had a PSA test in that year. A third of these tests were performed on asymptomatic men. The annual PSA testing rates were 1.4% in 1994 and 3.5% in 1999 (Melia et al, 2004).

In the US PSA testing was introduced in 1986 where age-standardised prostate cancer incidence rates peaked in 1992.[19] In the 3-year period up to 1993, 50% of men in the at-risk age group with no prior diagnosis of prostate cancer had been screened at least once. 34% had been tested exactly once in this 3-year period (Andriole et al, 2009). Age-specific incidence rates for the period 2000 to 2006 exceed rates for the period 1992 to 2006 for all age groups below 60.[20]

In Australia, in the mid-1990s, over 20% of men over age of 40 had had at least one test (Melia, 2005). Age-standardised Incidence rates peaked in 1994 but incidence rates below age 70 have continued to increase by between 5% and 10% p.a. over the period 1995 to 2005 (see Table 4).[21]

Table 4 - PSA testing rates

Country	Year	Testing rate	Source
UK	1994	1.4% p.a.	Melia et al (2005)
	1999	3.5% p.a.	"
England	2004	8.6% p.a.	Melia et al (2008)
Australia	1996	20% of men aged 40+ tested in last year	Melia et al (2005)
USA	1993	34% of men aged 55 – 74 screened once within prior 3 years 44% screened at least once	Andriole et al (2009)
	1997	54% of men aged 50+ screened at least once	Melia et al (2005)

Draisma et al[22] estimated that a single screening test for asymptomatic men at age 55 would result in a mean acceleration in diagnosis of 12.3 years in 73% of cases diagnosed as a result of PSA testing. The other 27% of diagnosed cases would not have otherwise been diagnosed in the patient's lifetime (i.e. these are overdiagnosed cases). At age 75 diagnosis is accelerated by 6 years and 56% of cases are overdiagnosed. Etzioni et al[23] estimated a mean acceleration in diagnosis of 5 to 7 years for men aged 60 to 84 years and an overdiagnosis rate of 15% to 37%, varying by race.

Assuming a 10-year acceleration in diagnosis and a 27% overdiagnosis rate and applying this to incidence rates for England in 2005 suggests that population incidence rates at age 55 could increase 5 times in the presence of population-based screening. With a 20% take-up rate the increase would be just under 2 times.

The rate of prostate cancer detection in the presence of screening depends on the screening protocols being followed. In the European Randomised Study of Screening for Prostate Cancer centres conducted PSA tests mostly at intervals of 4 years. 82% of men in the screening group were screened at least once. A PSA level in excess of 3.0 or 4.0 ng/ml was as an indication for referral for biopsy. 8.2% of men in the screening group were diagnosed with prostate cancer during the course of the study. In the control group 4.8% of men were diagnosed with prostate cancer. It is not known how many people in the control group went for screening of their own accord.

In the US Prostate, Lung Colorectal and Ovarian Cancer Screening Trial annual PSA tests were offered to the screening group with compliance of 85%. Those with suspicious readings were referred to their doctor who then determined whether a biopsy was needed. In the screening group cancer was detected among 7.4% of subjects (1.16% per year). In the control group 6.1% of subjects were diagnosed with prostate cancer. PSA testing rates in the control group were as high as 50% in some years.

The smaller difference in detection rates between the screening and control group in the US study suggests that a higher proportion of people in the control group in the US study went for screening.

The European study results suggest that incidence rates could increase to 170% of European incidence between the early 1990s and 2006 in the presence of a formal screening program. The US study suggests that diagnosis rates are 1% per year for men aged 55 to 74 in the presence of high rates of screening. In England the crude diagnosis rate between ages 55 and 74 in 2005 was 0.35%.

Cancers detected by screening tend to be smaller and have a lower grade than cancers detected in the absence of screening and are therefore less likely to meet the ABI definition. In the European Randomised Study of Screening for Prostate Cancer 35.5% of tumours were size T1 in the control group while 54.3% were size T1 in the screening group. 54.8% of tumours in the control group and 72.2% of tumours in the screening group had a Gleason score of 6 or less.

In the US study the 59% and 65% of tumours had a Gleason score of 6 or less in the control and screening groups respectively.

In terms of claims some of the increase in incidence could be offset by the reduction in the proportion of cases that qualify for claim.

5.2.2 Proportion of prostate cancers that qualify for claims

In the period 1999 – 2002 the ABI cancer definition did not include a severity hurdle for prostate cancer. From 2002 only prostate cancers with Gleason Score greater than 6 or having progressed at least to clinical stage T2 would qualify for a claim.

Tumour size T2 can be felt on examination or is detectable by means of imaging. Tumour size T1 cannot be felt or detected via imaging and are found incidentally in resected prostate tissue (sizes T1a and T1b) or by means of needle biopsy performed because of elevated PSA levels (size T1c).

Gleason score indicates how different the tissue structure of the tumour is from the structure of normal tissue. A higher Gleason score indicates significant differences and suggests that the tumour may grow quickly. Gleason scoring is subjective as it relies on the judgement of the pathologist.

The European Randomised Study of Screening for Prostate Cancer provides information on screen-detected cancer by stage at diagnosis[24]. Tables 5a and 5b show the differences in proportions of prostate cancers diagnosed with early stage prostate cancer - stage T1 and Gleason Score 6 or less - not covered under the ABI cancer definition between the screening group and the control group.

Table 5a – Prostate cancer by stage at diagnosis

T Stage at diagnosis	Screening group	Control group
T1/T1A/T1B	3.5%	6.4%
T1c	57.5%	41.9%
T2	29.3%	30.6%
T3	8.5%	17.4%
T4	1.1%	3.6%

Table 5b – Prostate cancer by grade at diagnosis

Gleason score at diagnosis	Screening group	Control group
2-6	72.2%	54.8%
7	20.3%	28.8%
>7	7.4%	16.4%

The percentage of smaller and lower grade cancers is significantly higher in the screening group than in the control group. Thus, changes in number of claims due to increasing awareness and uptake of PSA testing may be less than seen in the general population, because these early stage prostate cancers are excluded in the ABI definition.

5.2.3 Outlook for prostate cancer trends

The results of the European Randomised Prostate Cancer Screening Trial showed that screening reduces prostate cancer mortality by around 20%. However to achieve this result 1,410 men aged 50 – 74 would need to be screened to save one life. This does not mean that formal screening will not be introduced. 1,224 women aged 40 – 74 need to be screened for 14 years to prevent one breast cancer death but the service is offered by the NHS. The costs and benefits need to be weighed up.

The results of the US Trial show that there is no benefit in formalising prostate cancer screening and further increasing take-up of testing. PSA testing rates are already high in the US as evidenced by the high rate of testing in the screening group of the study.

The decision to introduce population-based screening for prostate cancer will take the results of these trials into account but will also be subject to political pressure. Such a screening programme appears to be possible but not guaranteed in the near future.

Should such a population-based prostate cancer screening programme materialise in the UK, the level and shape of incidence rates by age could approach the levels seen in the US where informal screening rates are high. The increase in prostate cancer claims may be less than that the increase in incidence seen in the population because of the severity criteria inherent in the ABI definition and the low size and grade of screen-detected as opposed to symptomatically diagnosed prostate cancers.

6 Conclusion

Projection of trends is an important part of pricing for CI business. More sensitive diagnostic techniques, more advanced treatment methods, improved control of underlying risk factors and screening have affected trends over the last decade.

Our research into changes seen in the historic incidence rates enables us to understand the story behind past trends. The knowledge and insights so gained helps us to assess how these changes will affect future trends. We have also considered new changes that may come about in future and will possibly affect risk factors and diagnosis of illnesses.

As outlined in this paper there is data available but these data is not always ideal. While it is desirable to determine insurance pricing with reference insured lives' experience, this is not possible with the available CI experience data. Thus, we used population statistics and adjusted results to allow for differences between insured lives and the general population. This includes allowing for differences in medical and insurance definitions.

In addition to using this information to construct projections it is important to think about weaknesses in current definitions that could mean that vast numbers of policyholders diagnosed with medical conditions with little impact on lifestyle are able to claim.

Finally, monitoring CI experience and the prediction of future trends is a continuous process and one that is paramount to the success of this product.

Endnotes

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