QQUIP

Quest for Quality and Improved Performance

Estimating health and productivity gains in England from selected interventions

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QQUIP and the Value for Money project

QQUIP (Quest for Quality and Improved Performance) is a five-year research initiative of The Health Foundation. QQUIP provides independent reports on a wide range of data about the quality of healthcare in the UK. It draws on the international evidence base to produce information on where healthcare resources are currently being spent, whether they provide value for money and how interventions in the UK and around the world have been used to improve healthcare quality.

The Value for Money component of the QQUIP initiative provides a series of reports that enable comparisons to be made between the scale of benefits and costs across a number of different disease groups. It also provides a methodological framework for examining the costs and benefits of national policies for treatment of conditions such as coronary heart disease and mental health.

For more information visit www.health.org.uk/QQUIP

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Introduction

Over the last decade the British Labour Government has presided over unprecedented increases in levels of spending on the National Health Service (NHS). But Opposition parties now claim that this record growth in NHS expenditure has been misspent, and some commentators are already predicting that the next British general election will be fought over the productivity of public services. In anticipation of this, the Prime Minister Tony Blair has emphasised the urgency with which the NHS must deliver efficiency from its huge extra investment: between 2003/04 and 2007/08, NHS expenditure is planned to increase each year by more than 7 per cent in real terms from about £60bn in 2003/04 to £90bn in 2007/08. Hence, if NHS productivity is to increase, the average annual monetary value of growth in output over this period needs to exceed £6bn.

In response to the Atkinson Review into government output and productivity, the NHS will increasingly be subject to a new way of measuring its productivity to assess whether the 'increased spending on the NHS has been justified in terms of cost-weighted activity and improvements in quality of care (including gains in health). Work so far has put a monetary value of £30k on gains in health, measured in Quality-Adjusted Life Years (QALYs).

Ministers, officials and managers of strategic health authorities and primary care trusts need to understand the impacts of their policies and priorities both on the health of populations and on the new way of measuring NHS productivity. But standard approaches of setting priorities require development to provide such information.

An approach to estimating health and productivity gains

Researchers from The Health Foundation's Quest for Quality and Improved Performance (QQUIP) have developed an approach for analysing the relative scale of benefits of health policies to help assess where money might be spent to greatest effect. Their approach builds on the convergence of recent methodological developments for measuring the impacts of health policy interventions on target populations. The method involves analysing the impacts of a policy intervention in terms of various measures of the current Burden of Disease (BoD) and the BoD that is 'avoidable' from the intervention, measured by:

- deaths
- Years of Life Lost (YLLs): the difference between age at the time of 'avoidable' death and the expected life of someone of that age in England
- Years Lived with a Disability (YLDs)
- Disability-Adjusted Life Years (DALYs): the sum of YLLs and YLDs, with and without discounting.

Using their method it is also possible to estimate:

- gains in Quality-Adjusted Life Years (QALYs), which the researchers assumed to be broadly equal to discounted DALYs
- the monetary values of 'avoidable' deaths and gains in QALYs
- the net costs of an intervention

- the gains or losses in NHS productivity (assuming a QALY gain is worth £30k).

The researchers chose three interventions as a means of testing whether their approach can be generalised:

- improving prescribing statins to reduce high cholesterol: premature mortality from coronary heart disease (CHD) is high in England in comparison to other causes of death, and also in comparison to rates of CHD in other countries. The researchers developed models to estimate the benefits and costs of two policies to improve prescribing: to achieve the guidelines of the National Service Framework (NSF) for CHD, which aims to reduce levels of cholesterol for patients assessed as having a high risk of a CHD event, and simply to reduce levels of high cholesterol.
- utilising intensive glucose control to better manage Type 1 diabetes: levels of control of glycosylated haemoglobin (HbA1c) are poor for over 80 per cent of the population with Type 1 diabetes aged between 6 and 24. Good glycaemic control reduces the risks of long-term consequences of diabetes such as blindness, kidney failure and nerve damage. The researchers developed two models to estimate benefits and costs of implementing intensive glucose control to improve glycaemic control for all Type 1 diabetics under two scenarios: in the short run (up to five years), whatever the stage of disease, and in the long run (in a 'steady state') at the onset of the disease.
- meeting the target of the *National Suicide Prevention Strategy (NSPS) for England* to reduce the number of suicides: suicide is relatively common in young people and accounts for more deaths than traffic accidents. The NSF for Mental Health identified various risk factors for suicide and policies for prevention. The researchers estimated the benefits and costs of achieving the target for reducing suicide as set out in the strategy.

Findings

Improving prescribing statins

Estimated annual benefits from achieving CHD NSF guidelines include:

- 13,000 fewer deaths
- 490,000 fewer YLLs
- 470,000 fewer undiscounted DALYs (with an increase of 20,000 YLDs)
- 210,000 more QALYs (or discounted DALYs)
- £15 billion from 'avoidable' deaths
- £6bn from QALYs gained.

Achieving the CHD NSF guidelines would cost an estimated £500 million (direct costs) and £55m (net costs) annually. The estimates of the benefits of prescribing statins simply to reduce levels of high cholesterol are less reliable but are about double those of achieving the CHD NSF guidelines. Improving prescribing for cholesterol therefore looks alone to have potential to deliver the scale of gains in output to match the massive increases in NHS expenditure and have a significant impact on the productivity of the NHS.

Utilising intensive glucose control

Estimated annual benefits include:

First five years	Steady state
• 10 fewer deaths	400 fewer deaths
• 400 fewer YLLs	13,000 fewer YLLs
• 1,400 fewer YLDs	10,000 fewer YLDs
• 1,800 fewer undiscounted DALYs	23,000 fewer undiscounted DALYs
• 1,400 more QALYs (or discounted DALYs)	17,000 more QALYs
• £10m from 'avoidable' deaths	£400m from 'avoidable' deaths
• £40m from QALYs gained	£500m from QALYs gained

The direct annual costs of intensive glucose control for Type 1 diabetes are estimated to be about £370m. In the first five years the net annual costs are estimated to be about £340m, which would exceed the monetary value of the benefits. In the steady state, the estimated net annual costs are about £250m, which is less than the monetary value of the benefits. Therefore, intensive glucose control is likely to worsen NHS productivity if introduced to all diabetic patients in the short run (with net annual loss of £300m), but improve NHS productivity if introduced at the age of onset in the long run (with net annual gain of £250m). However, neither would have a significant impact on the productivity of the NHS.

Meeting the target of the NSPS

Estimated annual benefits include:

- 600 fewer deaths
- 23,000 fewer YLLs (and undiscounted DALYs)
- 10,000 more QALYs (or discounted DALYs)
- £700m from 'avoidable' deaths
- £300m from QALYs gained.

The annual costs of implementing the strategy are approximately £20m, which has a minimal impact on the estimated monetary value of QALYs gained (£300m): however, while this would improve NHS productivity, it would not have a significant impact.

Overall findings

This approach has been designed to enable those responsible for the formulation of health policies to understand the impacts of these policies on both the health of national/local populations and the new measures of NHS productivity. Our approach allows comparisons both across and within disease groups.

Research implications

Conducting this research has revealed three issues that need to be taken into account when examining the impact of health policies.

First, the research has shown that estimating impacts of interventions on the new measures of NHS productivity reveals inadequacies in the data that are routinely collected and in the evidence that is reported. These difficulties do not invalidate the principal findings of this research but they do point to the kinds of improvements that are required for better estimates to be made.

Second, assessing interventions in terms of their impacts on NHS productivity will tend to prioritise interventions for common diseases where prevalence is high and there are significant benefits from treatment (as is the case for statins). However, there are often other reasons than productivity for investing in a disease area, and this should not be the only criterion used.

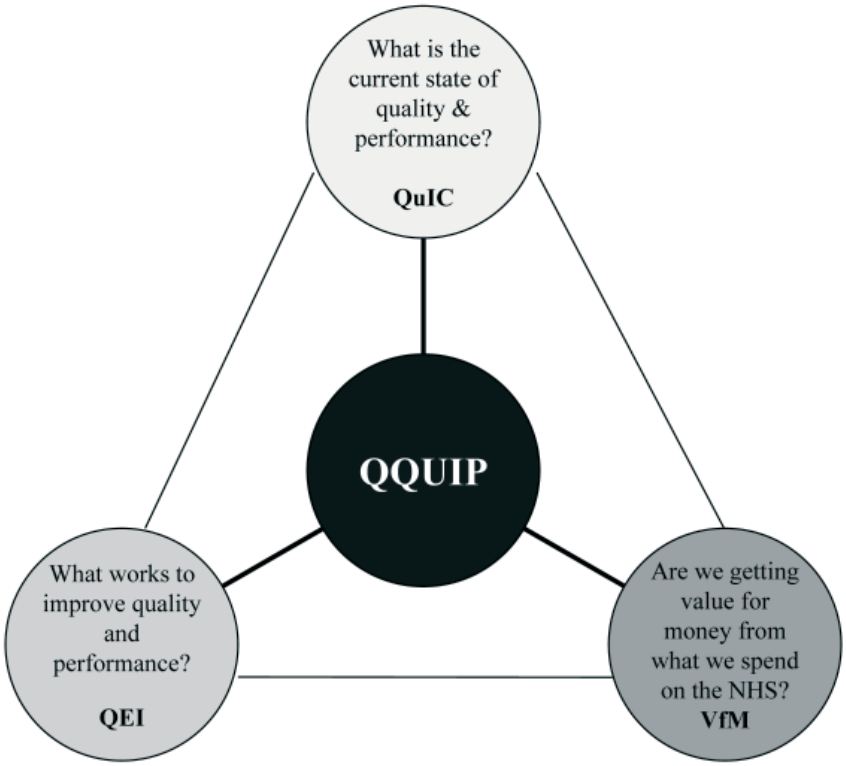
Third, the two ways of giving monetary values of benefits of policies in measuring gains in NHS productivity – the value of a statistical life (at over £1m) and by QALYs (at £30,000/QALY) – can lead to very different results.

1. Introduction

This report is a part of one stream of work of QQUIP (Quest for Quality and Improved Performance), a major five-year, £2.5 million research initiative of The Health Foundation and launched in July 2005. QQUIP is independently collecting, analysing and reporting on a wide range of data about current healthcare performance and capacity for improvement, measured by both quality and cost-effectiveness. It is in the process of providing coherent and accessible information on where healthcare resources are currently being spent in England and whether that investment provides value for money. It is drawing on the international evidence base to produce a comprehensive series of overviews that describe the range and diversity of interventions used to seek improvements in system performance, and to summarise their impact and effectiveness. Figure 1 shows the three main streams of work of QQUIP:

- Quality Information Centre (QuIC): a database that draws together available data on quality and performance, focusing in the first instance on England and using other countries for comparative purposes. This is being made available via a dedicated, searchable website (www.health.org/qquip).
- Value for Money (VfM): development of methods that link data on expenditure, outputs and outcomes to provide information on cost-effectiveness. The aim is to undertake these analyses within and across disease groups (for example, cardiovascular disease and mental health).
- Quality Enhancing Initiatives (QEI): a series of structured reviews of a wide range of interventions or initiatives designed to improve quality of healthcare. The reviews present the research evidence regarding impact and effectiveness.

Figure 1: The three main streams of work of QQUIP



The QQUIP initiative follows the seminal report by Leatherman and Sutherland (2003), *The Quest for Quality in the NHS: A mid-term evaluation of the ten-year quality agenda*. The authors characterised the quality agenda for the National Health Service (NHS) in England as likely to be the 'most ambitious, comprehensive, systemic and intentionally funded effort to create predictable and sustainable capacity for improving the quality of a nation's healthcare system' (Leatherman and Sutherland, 2003, p. 1; 2004). Their analysis of quality is organised into six domains:

- effectiveness
- access
- capacity
- safety
- patient-centredness
- disparities.

This analysis is based on an examination of three different kinds of data: snapshots, trends and international benchmarks. Their later report on quality in England (Leatherman and Sutherland, 2005, pp viii–xxiv) shows good progress in access, mixed progress in effectiveness, capacity and patient-centredness, and persistent problems in safety and disparities.

Leatherman and Sutherland's report drew attention to a number of areas where there were shortfalls in the quality of care. However, their report did not indicate the relative scale of benefits that might follow from policies to tackle these shortfalls and, hence, indicate where money might be spent to greatest effect.

This paper presents a promising approach to developing a framework to produce this information. It builds on the convergence of recent methodological developments for measuring reductions in the Burden of Disease (BoD) in Disability-Adjusted Life Years (DALYs) and gains in health in Quality-Adjusted Life Years (QALYs).

This section explains why such an approach is needed to evaluate policies and set priorities, and how it relates to the way that the value for money of the massive increases in spend on the NHS will be assessed using the new way of measuring NHS productivity (see below).

Securing Our Future Health: Taking a long-term view (referred to as the Wanless Report) (Wanless, 2002) provided a justification for the substantial annual real growth in expenditure on NHS resources to finance improvements in quality of care and gains in health. The report emphasised the importance of rigorous independent auditing to:

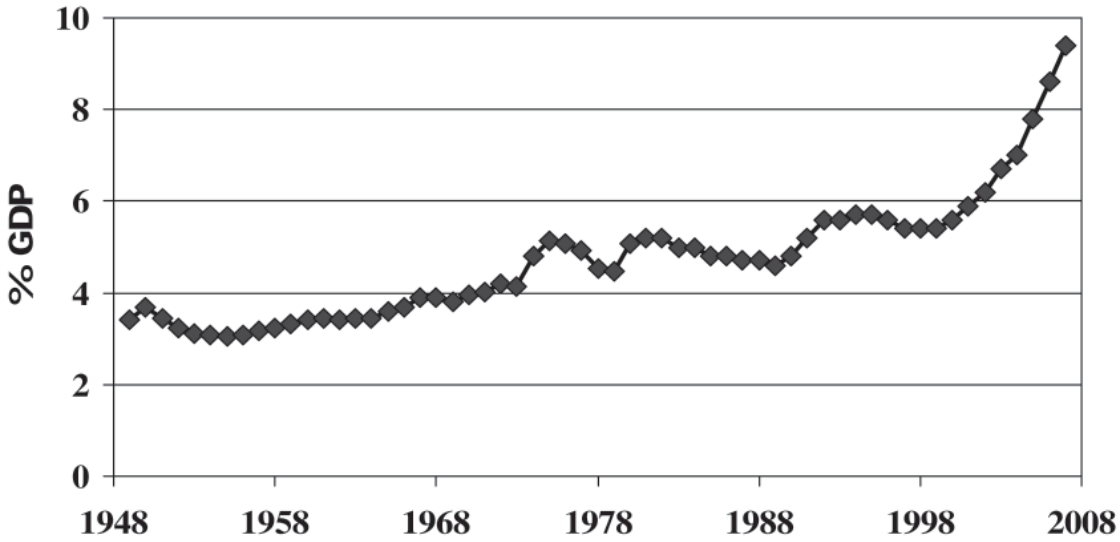
- ensure that money is being well spent
- enable policy to be periodically re-assessed
- allow continuing trade-offs to be made and debated publicly.

The new way of measuring NHS productivity seeks to apply one of the fundamental principles of the Atkinson Review that 'output of the government sector should in principle be measured in a way that is adjusted for quality, taking account of attributable incremental contribution of service to outcome' (Atkinson, 2005). To put it another way, this new way of measuring NHS productivity offers one assessment of whether the way in which the extra funding of the NHS has been spent is justified in terms of delivering improvements in quality

of care and gains in health (which was the rationale for the extra funding, as developed by the Wanless Report).

Martin and Smith (2006), as part of QQUIP's analysis of value for money, reviewed the recent studies of NHS productivity (Dawson *et al*, 2005; Department of Health, 2005a; UK Centre for the Measurement of Government Activity, 2006). These studies give snapshots of the past (from 1998/99 to 2003/04) with varying estimates of productivity that are marginally positive or negative. Figure 2 shows UK spending on the NHS as a percentage of GDP from 1948 to 2008, and shows that increases in spending on the NHS between 2003/04 and 2007/08 are without precedent. Over these five years, NHS expenditure is planned to increase each year by more than 7 per cent in real terms from about £60bn in 2003/04 to £90bn in 2007/08 (Department of Health, 2002a). Hence, if NHS productivity is to increase over this period, the average annual monetary value of growth in output needs to exceed £6bn. The estimated average annual gains in output, from accounting for improvements in quality, between 1998/99 and 2003/04, were about 1 per cent (UK Centre for the Measurement of Government Activity, 2006). It is likely that NHS productivity, measured by applying the Atkinson principle, will fall from 2003/04 (Maynard and Street, 2006). As Black *et al* (2006) have pointed out, the next British general election will probably be fought over the productivity of public services, with Opposition parties having already claimed that the unprecedented growth in NHS expenditure has been misspent. The Prime Minister has emphasised the urgency with which the NHS must deliver efficiency from its huge extra 'investment' (Edwards, 2006). If the Government and the NHS do not know the impacts of current policies on productivity, they are flying blind into a likely future storm over the productivity of the NHS when the period of unprecedented increases in NHS funding ends in 2008. Assessing these impacts requires an economic analysis of healthcare policies and priorities.

Figure 2: UK spend on the NHS as a percentage of GDP



Clive Smee's (2005, pp 79–99) authoritative account of two decades of economic analysis in the Department of Health (DH) conveyed clearly the intermittent way in which some national policies were informed by cost-effectiveness analysis, while others were not. Good examples of the former are the development of the *National Service Framework for Coronary Heart Disease* (DH, 2000) and the establishment and work of the National Institute for Health and Clinical Excellence (NICE). Counter-examples include Smee's (2005, pp 24–25) extraordinary account of his daughter's boyfriend doing the compound interest calculations on the afternoon

of Sunday 16 January to estimate the implications of the Prime Minister's commitment made on the *Breakfast with Frost Programme* that morning to increase NHS spending to the OECD average (which has been described as 'the most expensive breakfast in British history'). As Smee pointed out, variable use of cost-effectiveness analysis in the development of national service frameworks (NSFs) caused Wanless (2002) to recommend that 'future NSFs should be fully costed to incorporate detailed information about cost-effectiveness'; he reiterated that recommendation two years later (Wanless, 2004). The absence of an overarching framework to set priorities across the different programmes may explain why Sir Nigel Crisp, then Chief Executive of the NHS in England, was flummoxed by a question on cost-effectiveness by the Public Accounts Committee (2005, pp Ev 9–10) regarding the report by the National Audit Office (2005) on stroke care. Within the NHS the situation is, if anything, worse. As Smee pointed out, there is limited and poorly organised analytic capacity. A recent account of priority setting of two primary care trusts (PCTs), using an explicit scoring mechanism to prioritise proposals for new funding, pointed out that other pressures had a greater impact on the final scores than NICE guidance (Iqbal *et al,* 2006). Wanless (2002) called for NICE to examine older technologies and practices, but PCTs still lack information on what they ought to stop doing to be able to afford the increased costs of implementing NICE guidelines (Maynard and Street, 2006).

Two methodological approaches have been developed to inform the setting of priorities:

- Cost per Quality-Adjusted Life Year (cost/QALY) gives an estimate of the cost-effectiveness of interventions. QALYs are estimates of benefits that weight life years for quality of life (giving a weight of 'one' for perfect health and 'zero' for death). The QALYs gained by an intervention are the difference between two future trajectories of QALYs with and without the intervention. This is illustrated by Figure 3, which is based on a DH report on healthcare output and productivity (2005a). The report states that (p 20):

  > *'This shows the expected pattern of health status, h^o (t), if no treatment is given at time t_0. In the absence of treatment the patient will have declining health status and will die at time t_2. However, if treatment is given, the patient follows h*(t). They are a little bit worse from time t_0 to t_1 – for example, after-effects of surgery – and then improve significantly in health status. There is gradual decline in health, but the patient lives till t_3 – longer than they would have done without treatment.'*

  Estimates of cost/QALY offer a common basis for comparing different interventions in terms of how much needs to be spent on each to produce the equivalent of one year of perfect health: the lower the cost/QALY, the more efficient an intervention is assumed to be (Williams, 1985; Drummond *et al*, 1997).

- Disability-Adjusted Life Years (DALYs) are estimates of the Burden of Disease (BoD) in populations that add Years of Life Lost (YLLs) from premature mortality with Years Lived with a Disability (YLDs) (giving a weight of 'zero' for perfect health and 'one' for death). Figure 3 represents the health of an individual who lives in full health until age t_1, contracts a disease and lives with a disability from age t_1 to age t_2 when, due to a complication, their health deteriorates further until death at age t_3. In the DALY framework, we measure the gap between the profiles of actual health and the ideal (where the individual lives in full health until a defined reference point – we used life expectancy of the UK population in our models). DALYs are represented in Figure 3 by the area above the health profile. DALYs give a common basis for estimating the scale of BoD from different causes (World Bank, 1993; Murray and Lopez, 1996; Murray and Evans, 2003).

Figure 3: Expected time-streams of health with and without treatment

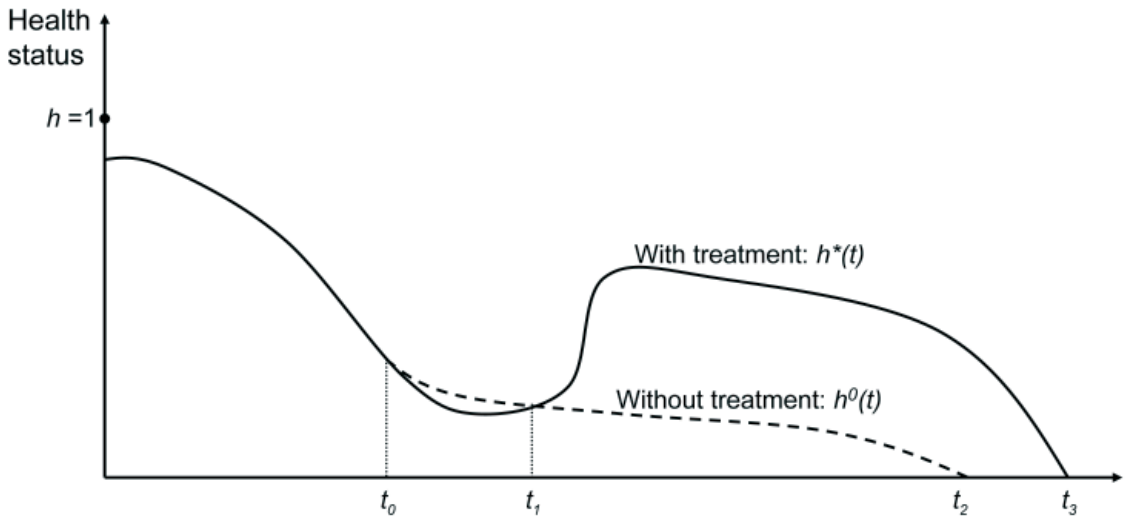
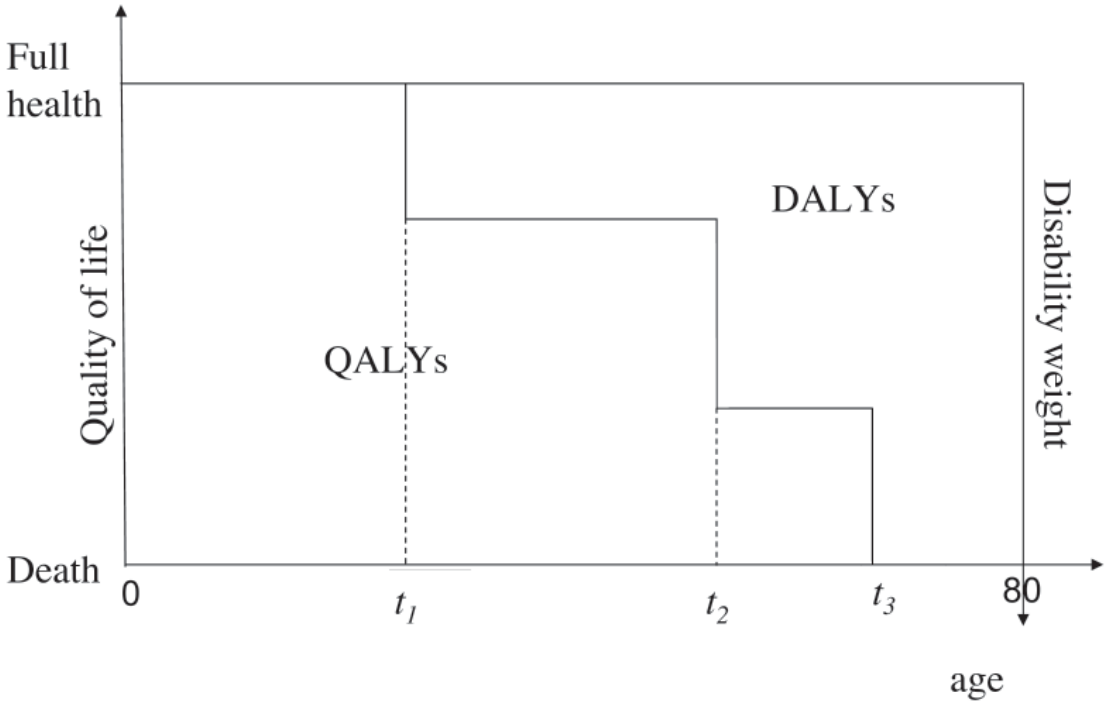


Figure 4: Gains in QALYs and reduction in DALYs for an illustrative health profile



We explain below how these different approaches have subsequently been developed to converge to produce information on cost-effectiveness of interventions in population in terms of reductions in BoD measured in DALYs, or gains in health in QALYs. If DALYs are measured from a fixed baseline, these are equal: in Figure 4, health in QALYs is represented by the area below the health profile. Let us consider an intervention that delayed the onset of a disease and its complication until age t'_1 and t'_2 and extended life until age t'_3. The grey area highlighted in Figure 5 represents the QALYs gained from the treatment as well as the DALYs 'avoided' from it. (Morton, 2007). We estimated the impacts of interventions on populations in terms of YLLs

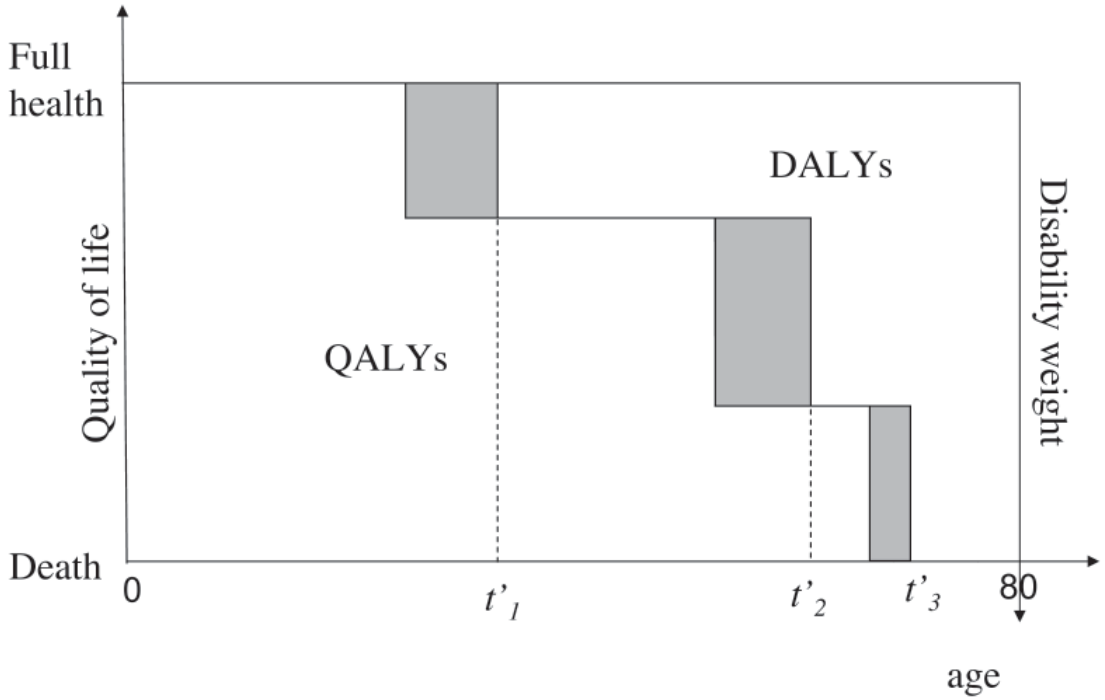
and YLDs, and hence DALYs but using population survival curves rather than a fixed baseline. On the above reasoning, we have assumed that our estimated of reductions in the BoD in discounted DALYs are approximately equivalent to gains in health in QALYs, so that we can use the value of £30,000 per QALY to put a monetary value on our estimates of benefits[1]. We are continuing to examine the methodological issues raised by translating results estimated between DALYs into QALYs.

Although the QALY and DALY methodologies aim to provide a way of measuring benefits on a common scale, this aim remains an aspiration given common serious methodological, ethical and empirical problems. There is still dispute over how to:

- measure states of illness (or health) and hence weight quality of life on a common scale
- weight improving quality of life against extending life
- weight future costs and benefits in terms of their current values
- account for uncertainty.

Each approach, as originally developed, was also subject to further different limitations as a basis for setting priorities.

Figure 5: Gain in QALYs and reduction in DALYs from an illustrative treatment on an individual



The objective of the methodology of cost/QALY is to show how to achieve value for money by prioritising interventions on the assumption that, if intervention X has a lower cost/QALY than Y, then X is the more cost effective and ought to have higher priority. This methodology assumes that what is required is marginal analysis; thus, it has three intrinsic limitations. First, studies of different ways of spending marginal increases in resources do not tell us whether the bulk of resources are being used currently most effectively (Hutubessy *et al*, 2003; Evans *et al*, 2005a); this is a fundamental issue faced by PCTs when deciding on future commissioning of services. Second, the methods of cost/QALY ignore the scale of gains in health, which is vitally important information for its impacts on both individuals and populations. Their limitations

were demonstrated by the famous attempt to set priorities in Oregon using the cost/QALY methodology. It showed that this methodology can give a higher priority to interventions of low cost and low benefit, on the grounds of cost-effectiveness, than to interventions with high cost and high benefit, thus giving tooth capping a higher priority than appendectomy (Hadorn, 1991; Eddy, 1991). This is a nonsensical approach to setting priorities for the NHS in its role as insurer because, as a society, we expect the NHS to cover costs of the latter in preference to the former. The cost/QALY methodology also ignores the number of people affected by an intervention.

The translation of national policies into decisions to change service delivery is a complex process. The lesson from star ratings is that the English NHS did have an impact on targeted performance by focusing on a few key targets, unlike Wales where there was no equivalent focus (Bevan and Hood, 2006a, 2006b). Hence, governments need to prioritise a few policies with the greatest beneficial impact. This requires information on both the ratios of cost to QALYs for policies and the size of the population affected. Indeed, it seems to us that a more logical order when examining policies is to estimate the potential scale of benefits first and their cost-effectiveness second, particularly as average costs will often depend on the scale of services to be provided (Hollinghurst *et al*, 2000).

The standard approach to estimating BoD in DALYs provides estimates of the BoD remaining given the current delivery of healthcare, which we here described as the 'current' BoD. This does not give us information on the 'avoided' BoD from the current delivery of healthcare. The sum of the 'current' and 'avoided' BoD gives the 'total' BoD, that is, the BoD which would exist in the absence of healthcare. This is indicated by Figure 6, which also separates the 'current' BoD into two elements: 'avoidable' and 'unavoidable', that is, BoD that is, and is not, amenable to reduction through the provision of healthcare (Bevan *et al*, 1998; Hollinghurst *et al*, 2000; Hollinghurst and Bevan, 2003). Estimates of the current BoD in DALYs are of no value in themselves, nor a good guide to the information we require on the 'avoidable' BoD. Figure 7 shows that estimates of the proportion of 'avoidable' to current BoD in DALYs in south west England varied greatly across different diseases: although the estimated current BoD in DALYs from heart disease was much greater than for depression, the estimated 'avoidable' BoD in DALYs for depression was greater than for heart disease (Hollinghurst *et al*, 2000).

Figure 6: Different elements of BoD

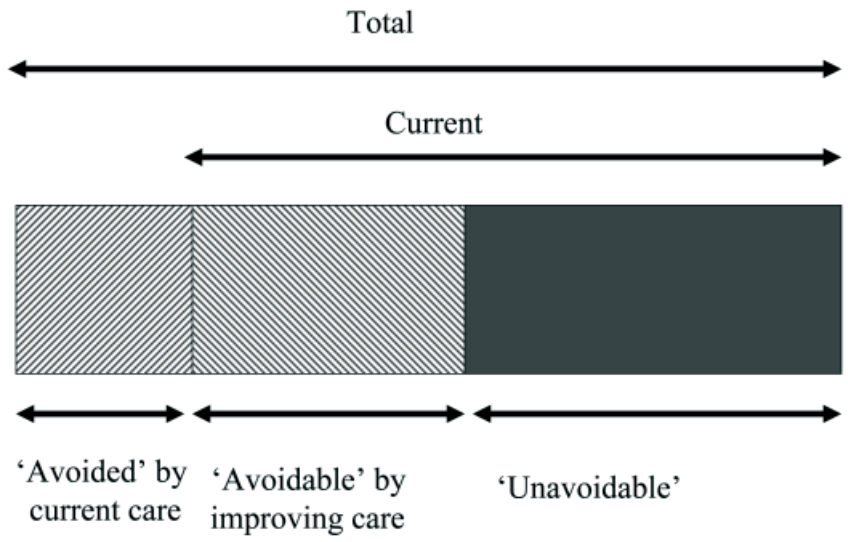
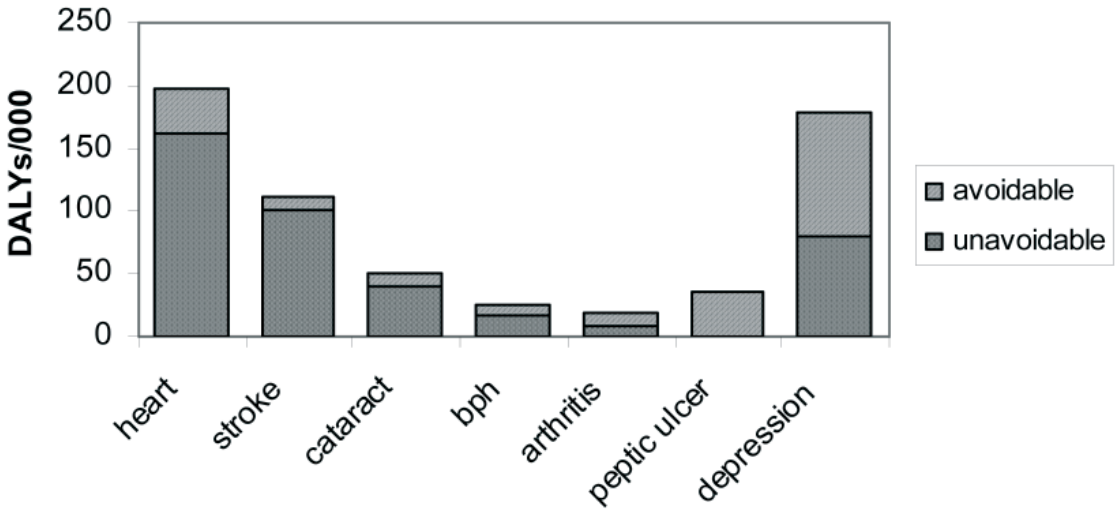


Figure 7: Estimates of 'avoidable' and 'unavoidable' BoD



Source: Hollinghurst et al (2000)

Estimates of current BoD from different diseases ought not be used to set priorities as they give an inadequate account of half the story (Bevan *et al*, 1998; Williams, 1999; Hollinghurst *et al*, 2000; Hollinghurst and Bevan, 2003). Attempting to set priorities using estimates of current expenditure on, and current BoD from, different diseases would suggest increasing resources where there is a heavy BoD, regardless of whether there is effective treatment (for example, lung cancer). It would also suggest reducing resources where there is little or no burden because of effective treatment being widely applied (for example, immunisation of children). To set priorities by relating DALYs to costs, we need to distinguish between three different components of BoD:

- DALYs that have been 'avoided' through current treatment (compared with what the outcomes would have been with no therapy) which, together with current costs, indicates cost-effectiveness of current practices
- DALYs that would be 'avoidable' through improving treatment (coverage, appropriateness or compliance) which need to be put alongside estimates of their costs to indicate potential cost-effectiveness of changing practices
- DALYs that are 'unavoidable' and cannot be reduced given current evidence, and therefore are irrelevant to assessments of cost-effectiveness.

To provide information to set national and local priorities we require methods that draw on both cost/QALY and DALYs by applying the framework of cost-effectiveness to populations (Hollinghurst and Bevan, 2003). This has been the common basis for three recent studies:

- research by Andrews and others into estimates of the cost-effectiveness of treating different types of mental health problems for the population in Australia (Andrews *et al*, 2004)[2] which produced estimates for different diseases of 'avoidable', 'unavoidable' or 'avoided' DALYs
- WHO's project, Choosing Interventions that are Cost Effective (CHOICE), which aims to provide the analytic basis for achieving Millennium Development Goals in developing countries by relating costs of interventions to their impact in terms of the 'avoidable' YLLs in populations (the difference between the aggregate number of healthy years lived by the projected population in the intervention and in the 'do nothing' scenario) (Hutubessy *et al*, 2003; Evans *et al*, 2005b)[3]

- analyses of NHS productivity that sought to estimate gains in QALYs (or 'avoided' discounted DALYs) for the population of England (Dawson *et al*, 2005; DH, 2005a; UK Centre for the Measurement of Government Activity, 2006; Martin and Smith, 2006) by applying the Atkinson principle.[4]

The information required to know whether policies will or will not have a beneficial impact on NHS productivity is subject to the various general methodological difficulties we identified above. For example, Andrews *et al* (2004) showed that for the population of Australia it appeared to be more cost effective to treat depression than schizophrenia. If these findings were to apply to England, the NHS would appear to be more productive by switching resources used for treating schizophrenia to depression. Andrews *et al* (2004) and Evans *et al* (2005b) recognised that the crude calculus of cost-effectiveness ought not drive policy choices. As estimates of productivity based on the Atkinson principle rely on that calculus, these estimates should not be the overriding criterion for deciding policies. However, it is better for ministers, officials, strategic health authorities and PCTs to have information on these impacts prior to making decisions rather than be surprised and disappointed by learning subsequently, in accounts for Parliament and the public, that policy impacts have been limited.

Our work is intended to provide information on value for money that relates to the new measures of NHS productivity using the Atkinson principle. What is reported here can only be a start in a new way of thinking about the impacts of future policies. We have had to make a number of assumptions because of serious gaps in the available evidence of effectiveness and of the incidence/prevalence of diseases. We aim to make these assumptions explicit and to identify the types of new information required for more accurate estimates to be made of impacts of future policies on NHS productivity.

2. The three selected interventions

This report aims to estimate health gains from three different interventions cited by Leatherman and Sutherland (2005):

- improving statin prescribing to reduce high cholesterol and risk of future coronary heart disease (CHD) events
- utilising intensive glucose control better to manage Type 1 diabetes
- meeting the target of the *National Suicide Prevention Strategy for England* (DH, 2002) to reduce the number of suicides.[5]

This section explains why these three interventions were chosen.

2.1 Improving statin prescribing

Leatherman and Sutherland (2005, p 20) reported that, in 1999, of six comparator countries, the UK had the second highest mortality rate[6] from CHD for people aged from 35 to 74 years of age. CHD caused over 100,000 deaths each year in the UK and was the most common cause of premature mortality (Petersen *et al*, 2005). Some of these deaths could have been 'avoidable' by prescribing statins to reduce levels of cholesterol.[7] Leatherman and Sutherland (2005, p 32) reported that the use of statins across Europe is extensive but variable: in 2000, about 24 Defined Daily Doses (DDDs)[8] were prescribed per 1,000 adults per day in England; Norway, with the highest rate of statin prescribing, had a rate two and a half times that of England (where there was incomplete coverage) (Majeed *et al*, 2000). There are wide regional variations in England despite large increases in prescribing rates (Healthcare Commission, 2005)[9]; of those being prescribed statins, about 30 per cent are prescribed a lower dosage than is required for effective prevention, and compliance varies between 80 and 95 per cent (Ward *et al*, 2005).

In this paper we report on estimates of benefits and costs of improving coverage, appropriateness and compliance in prescribing statins for two policies: one based on levels of cholesterol and CHD risk, and one based on levels of cholesterol only.

2.2 Utilising intensive glucose control

Leatherman and Sutherland (2005, p 37) reported that the levels of control of glycosylated haemaglobin (HbA_{1c}) in diabetic children (aged 0–16 years) in England, Wales and Northern Ireland was poor: in 2004, the National Paediatric Diabetes Audit found that fewer than one in five maintained their blood glucose readings within the recommended level. Good glycaemic control reduces the risks of long-term sequelae of diabetes such as blindness, kidney failure and nerve damage (Diabetes Control and Complications Trial, 1990, 1993, 1996). The results of the more recent audit (National Clinical Audit Support Programme, 2005) show poor control continues to be a serious problem for over 80 per cent of the population with Type 1 diabetes aged from 6 to 24 years.

In this paper we report on estimates of benefits and costs of intensive glucose control in patients with Type 1 diabetes by intensive therapy,[10] which reduces the median HbA_{1c} to between 7 and 7.5 per cent. We examine two policy scenarios: in the short run, that is, over the next five years, implementing intensive glucose control for all Type 1 diabetics and, in the long run, implementing intensive glucose control for Type 1 diabetics at the age of onset.

2.3 Meeting the target of the National Suicide Prevention Strategy (NSPS)

Leatherman and Sutherland (2005, pp 44–46) reported that in England, suicide accounted for more than 4,000 deaths and 400,000 YLLs for people aged under 75 each year. It was the leading cause of death among men aged from 15 to 24 years,[11] and the second most common cause of death among people under 35 years of age. However, they also pointed out that suicide rates in England and Wales are relatively low: they were the lowest when compared with countries outside the UK (Australia, Canada, New Zealand and the United States) and with Northern Ireland and Scotland (where the rate is almost twice that of England and Wales). The *National Service Framework for Mental Health* (DH, 1999) identified various risk factors for suicide and policies for prevention.

In this paper we report on estimates of reductions in BoD assuming that the target of reducing suicide by 20 per cent by 2010 from the 1997 baseline, as set out in the National Suicide Prevention Strategy (NSPS), is achieved. We used mortality statistics from 2003; the suicide rate in that year was about 7 per cent below the rate in 1997, so in our analyses we have assumed that achieving the NSPS target means a further reduction in suicide rates of about 13 per cent.

3. Our approach to estimating health and productivity gains

We have used common datasets for populations[12] for all three interventions and estimated their impacts in terms of six different elements:

- numbers of deaths
- Years of Life Lost (YLLs): the difference between age at the 'avoidable death' and the expected life of someone of that age in England[13]
- Years Lived with a Disability (YLDs) using mainly disability weights developed by the Dutch Disability Weight study (Stouthard *et al*, 1997)[14]
- Disability-Adjusted Life Years (DALYs): the sum of YLLs and YLDs (with and without discounting)[15]
- Quality-Adjusted Life Years (QALYs): we assumed these to be mainly equal to discounted DALYs
- monetary values for 'avoidable' deaths using the Department for Transport's valuation of a statistical life (at £1.145m at 2000 prices) (HM Treasury, 2003, p 62), and for QALYs (£30,000 as used by the DH in applying the Atkinson principle to estimate productivity gains from improvements in quality)[16].

This paper now outlines the methods we have used for each intervention, gives results, and concludes with a discussion of the approach and findings. Detailed technical reports on the modelling of each of these interventions (Airoldi *et al*, 2006; Morton *et al*, 2006; Oliveira *et al*, 2006) are also available.

3.1 Improving statin prescribing

The costs of statins have fallen dramatically as some patents have ended. This means that studies of cost-effectiveness using old data on costs are no longer valid, and adds weight to the argument for policies for prescribing statins more widely. It is also now possible for patients to buy statins without a prescription; indeed, there have been various calls to add statins to the water supply. Hence, two different approaches have been advocated for reducing CHD risk by reducing levels of cholesterol by statin prescribing and we have developed models of the impacts of each:

1. a risk-based approach, as in the CHD NSF, which aims to reduce levels of cholesterol in individuals who are assessed to be at high risk only (DH, 2000). Our risk-based model is consistent with, and similar in structure (and results) to, the DH model.

2. a cholesterol-based approach that aims simply to reduce levels of cholesterol where these are high (Manuel, Kwong et al, 2006). We use the CHD NSF (DH, 2000) definition of high cholesterol (as having a serum cholesterol concentration greater than 5mmol/l), which applies to about 80 per cent of the population in England aged between 45 and 64. This approach is justified by evidence that the relationship between cholesterol and mortality and morbidity is independent of other risk factors, continuous and exponential (Law and Rodgers, 2005).

Both models have been designed to estimate the 'avoided' and the 'avoidable' burden of disease (BoD) and:

- use deterministic (dynamic) simulation techniques[17]
- use detailed information on population (by age, risk and prescribing) to model transitions between states and, hence, disease progression by year
- make simplifying assumptions
- do not take account of interactions between risk factors (such as hypertension and cholesterol)[18] or between the benefits of statins in reducing BoD for conditions other than CHD (such as stroke).

Both models assume that:

- individuals who start taking statins do so for the rest of their lives (or until they are 75 years old)
- statin prescription has a short run impact in reducing cholesterol and CHD risk, with most of the reductions achieved in the first three years, and those achieved at six years approximate to the long-term reduction (Law and Rodgers, 2005)
- the effectiveness of statins is a function of levels of cholesterol/CHD risk, age, sex and year of treatment
- current prescribing practice has 80–95 per cent compliance and 70 per cent appropriateness (Ward, Jones *et al,* 2005; Peterson and McGhan, 2005; Healthcare Commission, 2005)
- about two million individuals were prescribed statins in 2003 (DH, 2005b)
- side-effects of prescribing statins are limited (Law and Rodgers, 2005; Ravnskov, Rosch *et al,* 2006).[19]

We describe here the basis of the risk-based model. Oliveira *et al* (2006) give a full description of both models.

Our risk-based model is similar to the DH model in that the population at risk was defined approximately and estimated using data from the *Health Survey for England 2003* (National Centre for Social Research, 2003). The risk for the population without a history of CHD was estimated by the Framingham equations and the risk for population with a history of CHD was estimated with risk data from the Health Protection Study Group (2005). Our model and the DH model differ in scope and purpose. Our model estimated the impact of statins on CHD only while the DH model focused more broadly on cardiovascular diseases. The DH model was designed to estimate the 'avoided' BoD only; our model is designed to estimate both the 'avoided' and 'avoidable' BoD and produce detailed estimates of the components of the 'avoidable' BoD (from improving coverage, appropriateness and compliance).

Our model uses a population-based approach and follows that of Manuel, Kwong et al, (2006) and Manuel, Lim *et al* (2006) to estimate risks of fatal and non-fatal CHD events attributable to high cholesterol. It divides the population into two groups – those with and those without a history of CHD – and estimates the impact of statins on the risk of a CHD event from lowering cholesterol in combination with other risk factors. The model handles CHD non-fatal and fatal events as follows:

- there are two outcomes of non-fatal events: survival with increased risk of a future CHD event, or initial recovery followed by death from the disease process within 28 days

- fatal and non-fatal events are dependent on age, sex, risk group and whether individuals are prescribed statins[20]
- reductions in fatal events through statin prescribing reduce YLLs but increase YLDs (these interactive effects have to date been ignored in the literature).

Our model uses five subpopulations in terms of risk (see Figure 8):[21]

- low risk (that is, no history of CHD and no CHD risk from other factors)
- high CHD risk but without a history of CHD, divided into those who are being effectively prescribed statins and those who are not being prescribed statins
- high CHD risk from a history of CHD, divided into those who are being effectively prescribed statins and those who are not being prescribed statins.

Figure 8: Five subpopulations with risks of CHD

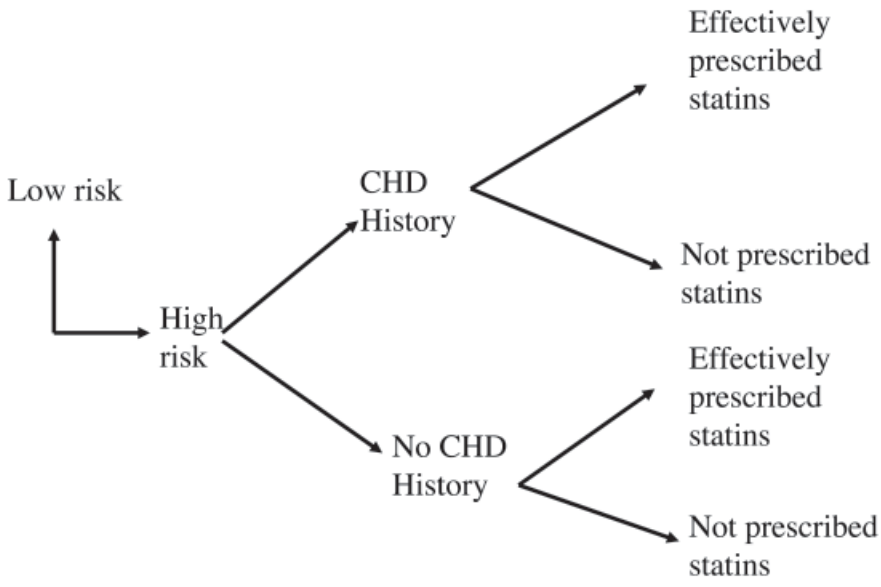


Figure 9 outlines how the model changes numbers in the different states using rates for mortality (shown by continuous lines) and non-fatal acute myocardial infarctions (AMIs) (the main influences are shown by dotted lines). The model of the impact of statins on risk assumes a linear dose–response relationship between prescribing statins and mortality risk (as described in the literature). Changes in the subpopulations with and without treatment depend on prescription coverage, compliance and appropriateness of prescribing statins. For each year, deaths result from applying the specific mortality rates to the five subgroup populations. All mortality rates have baseline mortality from causes other than CHD and account additionally for CHD mortality. The number of non-fatal AMIs is estimated by the model as a function of:

- the initial population with a history of CHD
- rates of incidence of CHD
- levels of prescription
- mortality rates for all the groups (these depend on rates of prescribing).

The model estimates mortality and morbidity simultaneously. The change in the population with CHD (which is used to estimate YLDs) is the difference between the population with a

history of CHD for that year and the previous year. The population group with a history of CHD was defined using available data and includes angina, AMI and other heart problems. However, the incidence of new cases was estimated from AMI only (which can be directly related to case fatality rates) and, hence, excludes heart failure and angina. The omission of non-fatal heart failure is unlikely to have a significant impact as this condition has a relatively low incidence and high case fatality rate. Hence, much of its BoD is captured by the YLL model (Petersen *et al*, 2005). The omission of incidence of angina pectoris is more important as this has a lifetime incidence about nine times that of myocardial infarction.[22] Because of a lack of data, our model accounts for recurrence of CHD for fatal events only by using CHD mortality rates for the population with a history of CHD.

Figure 9: Outline of risk-based CHD model[23]

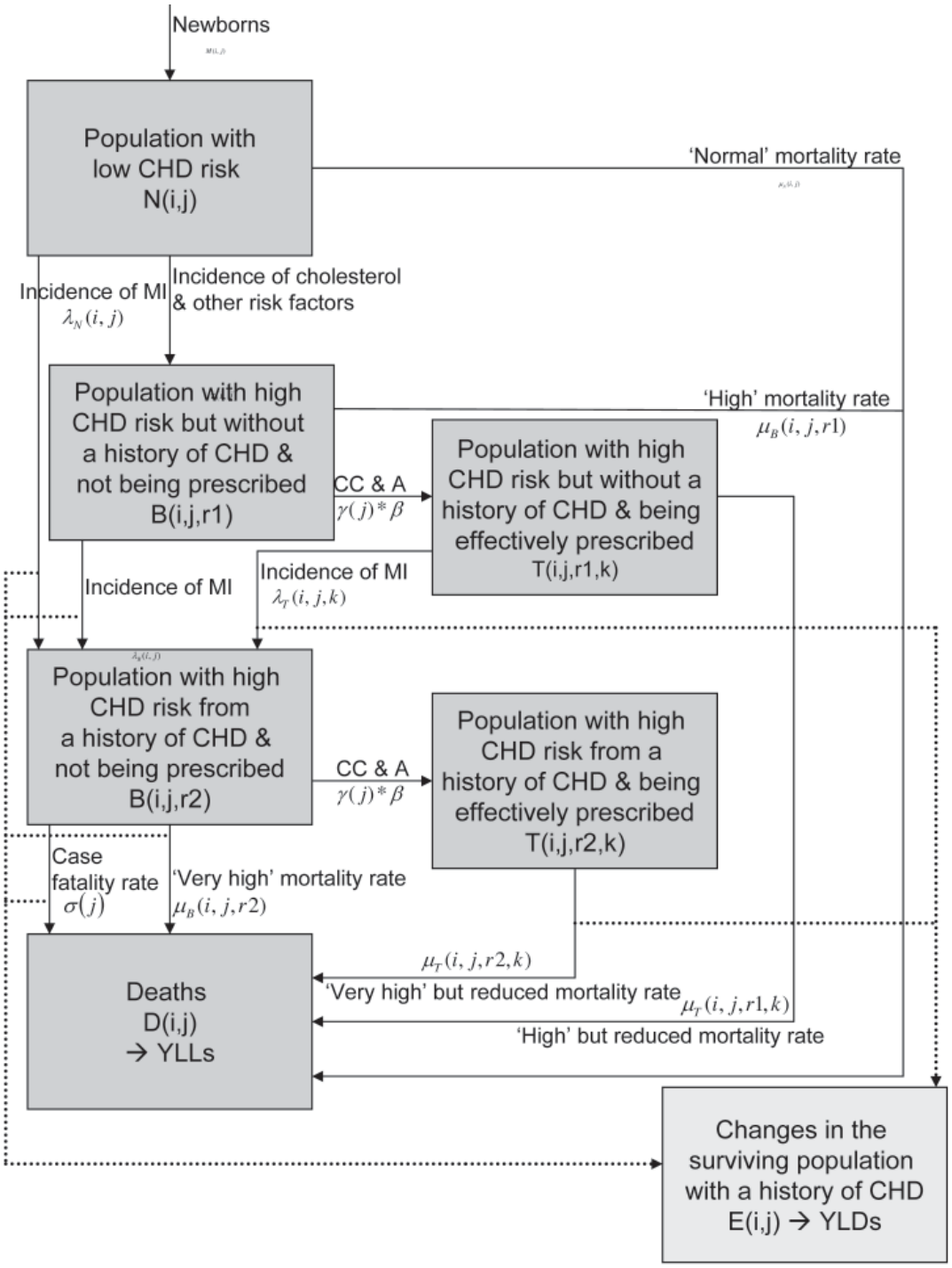
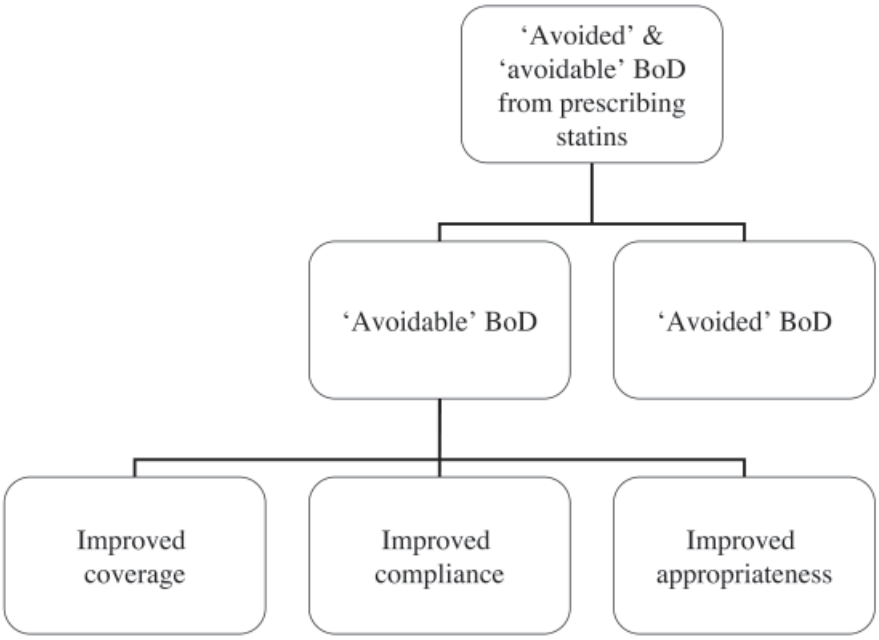


Figure 10 indicates the basis for estimates of the 'avoided' and 'avoidable' BoD from prescribing statins. The 'avoided' burden is the reduction in DALYs from the current coverage and current levels of appropriateness of prescribing. The 'avoidable' BoD is the reduction in DALYs from individual and population effects including:

- increases in the levels of effectiveness for patients already being prescribed statins through
  - improved compliance by patients
  - increases in doses prescribed by doctors to the appropriate level
- increases in coverage so that all individuals with high cholesterol and CHD risk are prescribed statins.

Figure 10: Components of the 'avoidable' and 'avoided' BoD from prescribing statins



The direct costs of statin prescribing include increased costs from drugs, laboratory screening for adverse effects, treatment of (rare) adverse events, consultations and hospital admissions. We have assumed those who do not comply with the treatment incurred no prescribing costs. We derived the increased direct costs of prescribing statins from multiplication of two estimates:

a) number of patients who Need to be Treated (NNT),[24] as estimated by our two models

b) the recent NICE estimate of the weighted average annual cost per person of statin prescribing (£46.47) (National Institute for Health and Clinical Excellence, 2006).[25]

As mentioned above, there are limitations to estimates of direct costs from earlier studies because of changes in the costs of statins following the expiry of patents. It is also difficult to compare results of different studies because of differences in definitions,[26] methodology (Wanless, 2002; Heart Protection Study Collaborative Group, 2005)[27] and changes in the volume of prescribing.

The net costs of statin prescribing are the direct costs less the savings from reduced use of services (including hospital admissions). NICE (2006) estimated the annual savings per patient prescribed statins to be about £41. Hence, the net annual cost of increasing prescribing in the risk-based model is only about £5 per patient.

3.2 Utilising intensive glucose control

Evidence shows that patients with Type 1 diabetes achieve the full benefits from intensive glucose control when they are introduced to it at age of onset, and that these benefits can take up to 20 years to be realised. The benefits for patients who already have moderate microvascular complications are limited. Hence, in seeking to estimate health gains, we developed models of impacts of intensive glucose control for all Type 1 diabetics over the next five years,[28] and at the age of onset of diabetes in the long run, in a future 'steady state' (although five years is an arbitrary choice it reflects a period between the immediate and long run).[29] In our view, examining costs and benefits in the long-run 'steady state' is more informative than using discounting to take account of a long time lag between the costs of an intervention and its benefits.

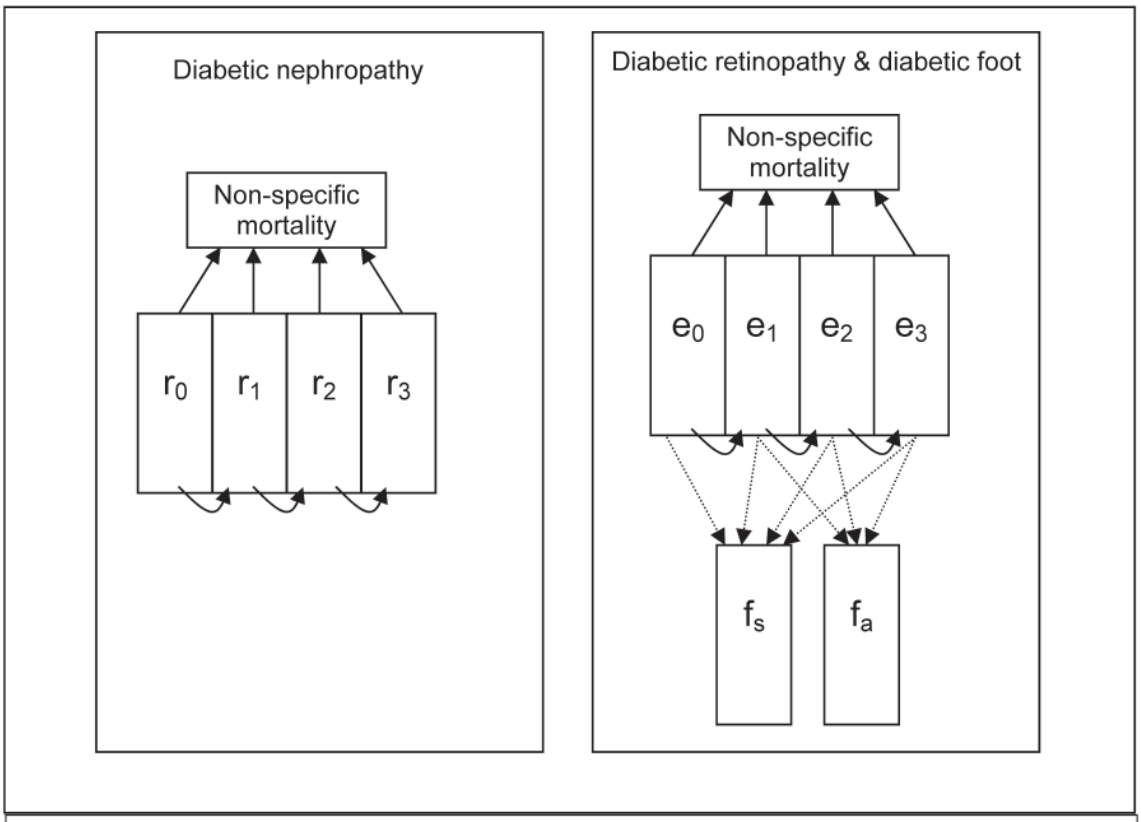
We modelled diabetes using a Markov chain; this is a common approach to modelling disease progression. It makes the simplifying assumption that the probability of transition from state A to state B does not depend on the patient's history before arriving in state A.[30] Figure 11 outlines the progression of Type 1 diabetes in nephropathy (left panel) and retinopathy (right panel). Nephropathy has its roots in microalbuminuria (an increased concentration of the protein albumin in the urine). This progresses to macroalbuminuria (alias overt proteinuria or 'clinical nephropathy') and to end-stage renal disease. Each of these stages is also associated with an increased mortality rate mainly due to cardiovascular disease (Laing *et al,* 1999a, 1999b; Soedamah-Muthu *et al*, 2006a, 2006b), with a particularly high excess mortality associated with macroalbuminuria (Rossing *et al*, 1996; Borch-Johnsen *et al*, 1985). The progression of retinopathy to blindness is associated with a higher mortality rate compared with the non-diabetic population. The effect of glycaemic control is modelled through transition probabilities (γ), which are lower for diabetic patients with $HbA_{1c} \leq 7.5$ per cent (a lower percentage means there is a slower progression of the disease to and through microvascular complications). The retinopathy model also estimates the BoD from ulcers, sores and amputation using the incidence rates of these complications associated with different degrees of retinopathy (Moss *et al*, 1992).

We combined the nephropathy and retinopathy diabetic foot models to estimate DALYs from Type 1 diabetes as follows. We estimated YLLs from the nephropathy model only, because albuminuria is the best predictor of all-cause mortality in Type 1 diabetes (Rossing *et al*, 1996).[31] We estimated YLDs from both the nephropathy and retinopathy diabetic foot models: the nephropathy model estimates YLDs from macroalbuminuria and end-stage renal disease, and the retinopathy–diabetic foot model estimates YLDs from uncomplicated Type 1 diabetes, moderate and severe visual impairments, sores, ulcers and lower extremity amputation. The effect of intensive glucose control on cardiovascular diseases will also reduce macrovascular complications such as non-fatal myocardial infarctions, non-fatal strokes and coronary revascularisations, although we have not estimated these gains in this paper.

As most death certificates of diabetic patients do not report diabetes as a cause of death, official statistics that report causes of mortality are unreliable for diabetes. We estimated mortality from diabetes using age-specific mortality rates from longitudinal studies (DCCT, 1996) on a prevalent population estimated using Harvey et al (2002). Mortality rates varies both according to age and severity of complication, but we could not find this information for England. We estimated

the incidence and severity of complications using other studies conducted in the USA and the Netherlands.

Figure 11: Outline of the model for diabetic nephropathy (left) and diabetic retinopathy and diabetic foot (right)



Diabetic nephropathy model	
r_0	Normo-albuminuria
r_1	Microalbuminuria (urinary albumin excretion ≥40 mg/24 hr)
r_2	Macroalbuminuria or overt-proteinuria (urinary albumin excretion ≥300 mg/24 hr)
r_3	End-Stage-Renal-Disease (ESRD)
Progression	Diabetic patients move through disease states according to annual transition probabilities.
Mortality	All-cause mortality.
Diabetic retinopathy	
e_0	No retinopathy
e_1	Background diabetic retinopathy (BDR)
e_2	Proliferative diabetic retinopathy (PDR)
e_3	Severe visual loss
Progression	Diabetic patients move through disease states according to annual transition probabilities. See table A4 in Appendix 2.
Mortality	All-cause mortality.
Diabetic foot	
f_s	Sores /Ulcers
f_a	Amputation

DALYs	**YLDs** +	Years lived in each state *s* weighted for the disability associated with the state.
	YLLs	Years of Life Lost to premature (excess) mortality attributable to diabetes.

We have estimated costs to the NHS associated with diabetes management. These include the additional costs of intensive glucose control for the whole of the diabetic population that are easy to estimate: drugs, equipment, monthly specialist visits and measurement of HbA_{1c}. We also estimated savings from reductions in the costs of treating the sequelae of diabetes for renal disease (including dialysis), eye disease and diabetic foot (including amputation). We estimated cost-effectiveness and the gain in output (using the Atkinson principle) of intensive glucose control for the Type 1 diabetes population in England.

3.3 Meeting the target of the National Suicide Prevention Strategy (NSPS)

In our research, suicide prevention offers a contrast to chronic diseases and a start in modelling the 'avoidable' BoD from mental health problems; in the NSF for Mental Health suicide prevention was the only policy that was quantified in a way that could be used in modelling. Hawton (1998), in arguing strongly for maintaining a national target for suicide prevention, pointed out that for mental health to avoid slipping backwards in the league of health priorities, there needed to be a clear and measurable mental health target, and that suicide seemed to be the only realistic candidate: 'whilst a target related to effective detection and treatment of depression might seem ideal, given the incidence of depression and its consequent disability, it is difficult to imagine what this might be'. As mentioned above, we did not seek to model the effect of a specific medical intervention on suicide rates – as for CHD and Type 1 diabetes – or the long-term health impact of a change in behaviour. Rather, we sought to establish the immediate impact of a change in behaviour.[32] The reason for this is that, as suicide prevention is achieved by a mix of public health and clinical interventions, there is no single clinical intervention we can model analogous to prescribing statins for CHD or intensive glucose control for Type 1 diabetes. Of course, suicide does have a close link to mental health, with almost all people who commit suicide suffering from some psychiatric condition (Cavanagh *et al*, 2003); future work will examine this linkage in more detail.

We modelled the 'avoidable' BoD from suicide prevention by assuming that the Government's target of a reduction in the suicide rate by 2010, as set out in the *National Suicide Prevention Strategy for England* (NSPS) (DH, 2002), is achieved. This means that 13 per cent of deaths are 'avoidable'.[33] To translate YLLs into DALYs or QALYs requires some kind of quality-adjustment as not all 'avoidable' YLLs would be lived in perfect health. In the absence of a model of psychiatric illness, one way of deriving a crude lower estimate of the QALY equivalent is to weight the YLLs by 0.8. This means assuming that everyone prevented from committing suicide experienced a state of continuous mild depression for the remainder of their life. This is an extremely pessimistic assumption and understates the true gains.

The key source of data on suicides that we used was the mortality statistics, which are compiled, based on death registration and published annually in four volumes (DH1–DH4) by the Office of National Statistics (2003). For suicides by strategic health authority we used the full version of the Compendium, which is published on an ongoing basis by the National Centre for Health Outcomes Development.[34] We found no data on costs of suicide prevention initiatives in the NSPS (DH, 2002), the *International Handbook of Suicide and Attempted Suicide* (Hawton and Van Heeringen, 2002) or a recent key text called *International Suicide Rates and Prevention Strategies* (de Leo and Evans, 2004). *Choosing Life*, the Scottish suicide prevention strategy (Scottish Executive, 2002), aims to save about 120 lives a year and estimates that the costs of its programmes in new money are about £4m a year.

4. Results

Table 1 reports annualised average estimates for each disease, and benefits and costs of the three interventions in terms of:

- deaths and the monetary value of deaths
- YLLs, YLDs, DALYs and QALYs, and the monetary value of QALYs
- direct and net costs of each intervention.

Table 1: Current BoD from Type 1 diabetes, CHD and suicides, and annualised average estimates of benefits and costs of the interventions

	Current BoD[35]			Impacts of intervention				
				Statins		Type 1 diabetes		Suicide
	CHD	Type 1 diabetes	Suicide	Risk-based model	Cholesterol - based model	1st five years	Steady state	
Deaths (000s)	150	2.0	4.5	13	30	0.01	0.4	0.6
Monetary value of deaths (£bn)	170	2.3	5.2	15	34	0.01	0.4	0.7
YLLs (000s) (undiscounted)	4,100	65	164	490	690	0.4	13	23
YLDs (000s) (undiscounted)	4,100	32		-20	130	1.4	10	
DALYs (000s) (undiscounted)	8,200	97		470	810	1.8	23	
QALYs (000s) (discounted)	4,300	65	74	210	540	1.4	17	10
Monetary value of QALYs (£bn)	130	2.0	2.2	6	16	0.04	0.5	0.3
Total costs of intervention (£m)				500	1000	370	370	20
Net costs of intervention (£m)				55	110	340	250	

4.1 Improving statin prescribing

The estimates of the average current BoD from CHD from current levels of statin prescribing are about 150,000 deaths, 4m YLLs and YLDs, and 8m undiscounted DALYs and 4m QALYs (or discounted DALYs). The monetary values of the current BoD are £170 billion from deaths and £130bn from QALYs (or discounted DALYs). The estimated benefits from improving prescribing to achieve the guidelines of the CHD NSF are reductions in the BoD of about 13,000 deaths, 490,000 YLLs and 470,000 undiscounted DALYs (with a small net increase in BoD of 20,000 YLDs), and a gain of 210,000 QALYs (or discounted DALYs).

The direct and net costs of statin prescribing are estimated to be £500m and £55m. These have minimal impact on the estimated monetary value of gains of £15bn from 'avoidable' deaths and £6bn from QALYs gained (or 'avoidable' discounted DALYs). The estimates from the cholesterol-based model are less reliable but indicate benefits that are about double those from the risk-based model. Hence, improving prescribing of cholesterol looks alone to have potential to deliver the scale of gains in output to match the average annual increases of about £6bn in NHS expenditure between 2003/04 and 2007/08; and hence to have a significant impact on the productivity of the NHS. Our work suggests that it may be worth exploring a policy of prescribing statins to those with high levels of cholesterol.

4.2 Utilising intensive glucose control

The estimates of the average current BoD from Type 1 diabetes are about 2,000 deaths, 65,000 YLLs and 32,000 YLDs, and 97,000 undiscounted DALYs and 65,000 QALYs (or discounted DALYs). The monetary values of the current BoD are £2.3bn from deaths and £2bn from QALYs (or discounted DALYs). The estimated benefits from intensive glucose control in the first five years and at the 'steady state' are reductions in the BoD respectively of about 10 and 400 deaths, 400 and 13,000 YLLs, 1,400 and 10,000 YLDs, and 1,800 and 23,000 undiscounted DALYs, and a gain of 1,400 and 17,000 QALYs (or discounted DALYs). These are underestimates of the benefits as they do not include reductions in BoD from non-fatal myocardial infarctions, non-fatal strokes and coronary revascularisations; this qualification also applies to our estimates of the monetary valuation of these benefits.

We estimated the direct costs of intensive glucose control to be about £370m. We also estimated the net costs of intensive therapy in the first five years to be £340m and to exceed the monetary values of the benefits: £10m from 'avoidable' deaths and £40m from QALYs gained. In the 'steady state', we estimated the net costs of intensive therapy to be £250m, which is less than the monetary values of benefits: £400m from 'avoidable' deaths and £500m from QALYs gained. Therefore, intensive glucose control is likely to worsen NHS productivity if introduced to all diabetic patients in the short run (with net annual loss of £300m), but improve NHS productivity if introduced at the age of onset in the long run (with net annual gain of £250m). However, neither would have a significant impact on the productivity of the NHS.

4.3 Meeting the target of the National Suicide Prevention Strategy (NSPS)

The estimates of the average current BoD from suicides are 4,500 deaths and 164,000 YLLs; estimates of the 'avoidable' BoD from achieving the NSPS targets are 600 deaths and 23,000 YLLs. In these estimates we assumed that those who were prevented from committing suicide did not succeed with a later attempt. Hawton and Fagg (1988) report that the rate of successful suicide by those who have already attempted suicide is about

1 per cent in the year following the first attempt and declines after that, which suggests that our estimates are robust. One estimate of monetary values of the current BoD from deaths is £5.2bn; the estimate of 'avoidable' deaths from suicide prevention is about £700m. Weighting discounted YLLs by 0.8 gives underestimates of the current BoD to be 74,000 discounted DALYs (or gains in QALYs) and the reductions in BoD from achieving the NSPS to be 10,000 discounted DALYs (or gains in QALYs).[36] The monetary valuation in QALYs of the current BoD is about £2.2bn; the gain from suicide prevention is about £300m. Assuming the estimated costs for Scotland apply to England, the costs of saving 600 lives would be about £20m, which is much less than the estimated monetary values of benefits. Hence, if the NSPS target were achieved at the estimated costs of Scotland, this would result in an improvement in NHS productivity, but would be of little significance.

5. Discussion

Leatherman and Sutherland (2005) identified scope for improving the health of the population of England through improving statin prescribing, improving glucose control in young people with Type 1 diabetes and reducing suicides. This paper reports estimates of the relative scale of benefits that might follow from policies to tackle them. To provide these estimates we have had to make a number of assumptions because of gaps in the data and available evidence. We have underestimated benefits from each intervention: for improved prescribing of statins we did not take account of reductions in strokes, angina pectoris and heart failure; for intensive glucose control of Type 1 diabetes, we did not take account of reductions in non-fatal myocardial infarctions, non-fatal strokes and coronary revascularisations; and for suicide prevention, although we assumed the government target would be achieved, we have made pessimistic assumptions about the quality of life of those who were prevented from committing suicide. All our estimates are also subject to the continuing controversies of seeking to measure benefits on a common scale. Hence, although we have demonstrated the feasibility of the approach we have outlined, and have aimed to produce consistent estimates of benefits on a common scale for the three interventions, our estimates are subject to these caveats.

Nevertheless, we believe that our principal findings are robust. Comparing our estimates for current BoD from CHD from high cholesterol, Type 1 diabetes and suicides, and the 'avoidable' BoD from different interventions, shows that:

- of the three interventions, only improving statin prescribing looks to have the potential for a significant impact on the future productivity of the NHS
- intensive glucose control for Type 1 diabetes at the onset of the disease offers the greatest proportionate gains in benefits in the long run (assuming 100 per cent compliance); these benefits are much greater than a short-term policy of introducing intensive glucose control for all people with Type 1 diabetes
- it is important to take account of YLDs as well as deaths and YLLs
- the monetary values of benefits for 'avoidable' deaths are much greater than for 'avoidable' DALYs for statin prescribing (by more than 100 per cent) and suicides (by more than 70 per cent), but not for Type 1 diabetes.

There is a question as to whether our results could have been inferred using a simpler approach, as in retrospect they might have been expected on the grounds of prevalence or incidence of the different conditions. For example, it is easy to derive information that shows that the estimated prevalence in England of high cholesterol is about 160 times that of Type 1 diabetes.[37] But we also require estimates of the 'avoidable' BoD from different interventions. This can only be estimated by modelling the links between incidence/prevalence and effectiveness in the way that we have done.

This paper has demonstrated the start we have made in modelling three key areas where we plan future research: cardiovascular disease, mental health and diabetes. The three interventions were chosen as a means of testing whether our approach can be generalised. Our method is designed to enable those responsible for the formulation of policies to understand the impacts of changes in terms of gains in health of national or local populations, and to understand their impacts on the new measures of NHS productivity. Our approach allows comparisons both across and within disease groupings.

We have emphasised the new approach to measuring NHS productivity because we believe that the extent to which the NHS has delivered value for money from the massive

increases in spending since 2001 will be an issue in the lead up to the next British general election. Until 2005, the Government could rightly assert that the old way in which NHS productivity was measured, in terms of cost-weighted activity, was irrelevant to assessing NHS performance as it failed to account that the main focus of government policies was on improvements in quality. But the new measures of NHS productivity do purport to assess whether the extra NHS funding has delivered value for money in improving quality, and these estimates offer the kind of audit called for by the Wanless Report. Thus, it is prudent for ministers and officials who are planning and choosing policies to understand how a policy is likely to perform when subjected to this new kind of scrutiny.

This paper has aimed to show how that can be done and the results that follow. All three interventions look to be worthwhile but only one (improving statin prescribing) would have a significant impact on NHS productivity. Suicide is the most common cause of death in young men and preventing a suicide offers the prospect of many years of life in good health. Intensive control of Type 1 diabetes can, given 100 per cent compliance, reduce current BoD of Type 1 diabetes by 30 per cent. But we have shown that for both their gain in terms of NHS productivity is limited. We have emphasised that this finding should not be used to set priorities. However, those who are responsible for national and local policies need better to understand the different perspective produced by the new way of assessing NHS productivity.

Endnotes

1 Estimates of BoD in YLLs only need to be weighted to produce estimates equivalent to QALYs as done by the Department of Health (2005a and 2005b).

2 The researchers modelled three optimal treatment scenarios for each disorder: current coverage, 'at optimal' coverage and 100 per cent coverage.

3 See WHO (2003); Evans *et al* (2005a, 2005b, 2005c). The project has produced results for HIV/AIDS (Hogan *et al*, 2005), child health (Edejer *et al*, 2005), tuberculosis (Baltussen *et al*, 2005), malaria (Morel *et al*, 2005) and maternal and neonatal health (Adam *et al*, 2005).

4 Thus, for example, using cost-weighted activity gives output value of a statin prescription to equal its cost of £27. The Department of Health (2005a) estimated the value of each prescription from estimating that statin therapy in 2003 added 77,000 life years (compared with no therapy) for the 1.9 million patients who took the drug, which produced a marginal benefit of 0.0038 life years. Assuming the monetary valuation of a QALY as £30,000, this gave an output value of £115 in terms of gains in health (and increased overall NHS average output growth by 0.81 per cent a year). Although it is often thought that NICE uses a benchmark of £30,000 per QALY in deciding whether or not new therapies are cost effective, Raftery (2006) points out that NICE does not use a fixed threshold value.

5 Because suicide prevention is achieved by a mix of public health and clinical interventions, there is no single clinical intervention we can model analogous to prescribing statins for CHD or intensive glucose control for Type 1 diabetes.

6 The United States had marginally higher rates, but the UK rates were much higher than in Sweden, Germany, Australia and France; compared to France, UK rates were four and three times higher for males and females.

7 For example, a long-term change of 0.6mmol/l concentration among middle-aged men corresponds to a coronary risk change of at least 25 per cent and hence has the potential to decrease mortality and morbidity from CHD by 30 per cent (Beaglehole and Dobson, 2005).

8 A DDD is the average maintenance dose per day for a drug's main indication in adults.

9 Although strategic health authorities with the highest levels of CHD tend to have the highest prescribing rates (Boyle, 2004), as those with low prescribing rates have not had the greatest increases, there has been little progress in reducing variations in these rates.

10 This included: administration of insulin at least three times a day (or with an insulin pump); insulin dosage, dietary intake and exercise adjustment according to results of self-monitoring of blood glucose; self-monitoring of blood glucose at least four times per day; monthly measurement of HbA_{1c}; monthly visit to the diabetic centre and specialist calls during the month to review regimens.

11 The Government announced a drive to reduce the suicide rates in young men in May 2006 (www.dh.gov.uk/AdvancedSearch/SearchResults/fs/en?NP=1&PO1=C&PI1=W&PF1=A&PG=1&RP=20&PT1=suicide+young+men&SC=__dh_site&Z=1).

12 All estimates use three common datasets for the population in England in 2003: demographic data on age and gender per strategic health authority, life expectancy tables of population in England, and age-specific mortality rates.

13 We did not follow the original DALY method of estimating YLLs using the highest value of life expectancies in the world (Murray and Lopez, 1996; Murray *et al*, 2002) but used *English* life tables.

14 We see these as better indicators of the BoD for a developed country than those devised for developing countries. This gave, for example, a weight of 0.29 for diabetic nephropathy (that is, 3.4 years lived with diabetic nephropathy are equivalent to a year of life lost through premature mortality). As there were no Dutch Disability Weights for myocardial infarction we used the value (0.605) reported by Mathers *et al* (2004). We assumed that the disability from renal complications can be meaningfully added to the disability from eye complications – that is, the disability of a patient with both nephropathy and severe retinopathy contributes 0.43 + 0.29 YLDs (0.72 YLDs). This seemed to us to be equivalent to other conditions with a disability weight of about 0.72, for example, schizophrenia with several psychotic episodes and some permanent impairments; a year of a child/adolescent in permanent stage with complex not curatively operable congenital heart disease; permanent impairments after severe skull/brain injury, and cancer of the stomach irradically removed or disseminated carcinoma.

15 We followed the convention, in estimating DALYs, of discounting benefits at 3 per cent per year (so that a gain in a life year in a year's time is worth only 97 per cent of a life year now). This is a little lower than the 3.5 per discount rate used by NICE.

16 The differences between outputs valued using these estimates and actual expenditures indicate the degree to which each intervention would add to the productivity of the NHS.

17 More complex stochastic simulation models have been developed by Babad *et al* (2002) and Cooper *et al* (2002) for prevention and treatment of coronary heart events respectively. The first study modelled the CHD disease process, CHD fatal and non-fatal events and treatments uptake, delay, compliance and effectiveness. That model is, however, still under development and is designed for providing information on the impacts on healthcare resources of different primary prevention strategies.

18 The WHO CHOICE project has analysed the impacts of simultaneous changes of blood cholesterol and cholesterol on cardiovascular diseases using risk-scoring models (Lopez *et al* 2006), but the objectives and methods of that study differ from ours.

19 Nonetheless, many of the unknown potential side-effects from statins have been reported (Ravnskov *et al*, 2006) and include: heart failure, myalgia and rhabdomyolisis, mental health problems and neurological symptoms, and cancer. Despite many adverse effects from statins first being recognised in the post-marketing surveillance process, their frequency is likely to be understated because few doctors report them. In addition, there might be a selection bias from trial studies as those studies exclude patients with other diseases (Ravnskov *et al*, 2006).

20 The effect of statins prescribing on the rate of events depends on the period for which these have been taken.

21 There are two additional groups, defined in terms of fatal and non-fatal events (used to estimate DALYs): deaths represented and changes in the surviving population with a history of CHD.

22 Lifetime incidences were computed using 2003 incidence data (Petersen *et al* 2005), and assuming a population at risk that is 50 per cent males and 50 per cent females and are, per 1,000 births, 28.5 for angina pectoris and 3.6 for myocardial infarction.

23 Deaths in the diabetic population are caused by 'normal' mortality, that is, the mortality rate as in the non-diabetic population, and 'excess' mortality due to diabetes. Only 'excess' mortality generates YLLs for the estimate of BoD from diabetes.

24 The NNT is also useful to compute the ratio of reductions in DALYs (or gains in QALYS) to the number of people being treated.

25 Alternatively, we could have multiplied estimates of the average DDD per patient treated and the average cost per DDD (Walley *et al*, 2004). However, this would have required further assumptions and additional data.

26 Franco *et al* (2005) showed statin therapy to be consistently cost effective only for high levels of risk. They found that although the cost-effectiveness of statins depends mainly on absolute risk, important heterogeneity remains after adjusting for this. They called for economic analyses to increase their transparency to reduce their vulnerability to bias and their reproducibility. For the UK, several studies that considered statin costs and hospitalisation costs (Heart Protection Study Collaborative Group, 2005) have indicated that statin therapy is cost effective for a wider range of individuals with vascular disease or diabetes than previously recognised (particularly with lower-priced generics), and that it would be appropriate to consider reducing the estimated level of vascular event risk at which statin therapy is recommended.

27 These include follow-up period, different categories of costs, and not indicating which treatment and definition was used for non-fatal events.

28 To derive the estimated impact on the population over a five-year period we modelled changes in the current population from ageing and mortality, but omitted births (this is known as a 'closed population model') so the size of the population reduced over time.

29 To derive the estimated impact on the population in the long run, in a future 'steady state', we modelled a population cohort of new cases of different ages. We simulated changes over time by assuming that the total size and age distribution of the population is stable so that as individuals died they were replaced by individuals of their age when they died.

30 However, we used different transition probabilities by age group.

31 Only a minority of deaths of diabetic patients report diabetes as their underlying cause. For instance, the total number of annual deaths in the population of insulin-dependent diabetes was less than 30 in 2003 (Office of National Statistics, 2003). In contrast, the predominant cause of increased mortality is cardiovascular diseases, where the hazard ratio compared to non-diabetic subjects is as high as 7.2 (Soedamah-Muthu, 2006a).

32 Although there is no timelag between the prevention of a suicide and the benefit from that prevention, there may be a timelag between the initiation of some suicide prevention activities (for example, a promulgation of standards to make some institutional environments safer) and the prevention of suicide; but we have not modelled this.

33 Given reductions in suicide rates since 1997, the Government's target of reducing suicides by 20 per cent from the 1997 baseline means that 13 per cent of deaths are 'avoidable'. This gives similar results to assuming that the national suicide rate is equal to the lowest age-standardised suicide rate experienced in any strategic health authority.

34 The full version of the compendium is available to the NHS, but the details we required are not in the published version. We are grateful to the Office for National Statistics for supplying us with this data.

35 Note because of differences in modelling there were minor differences in the estimates of the BoD in the steady state from those estimated for the first five years for Type 1 diabetes. The results given here are for the first five years.

36 The current BoD is 93,000 discounted YLLs and the reductions in BoD are 13,000 discounted YLLs.

37 The estimated prevalence for men and women of high cholesterol is about 66 per cent (about 27 million persons) (Petersen et al, 2005) and for Type 1 diabetes, for all persons, about 3 per cent (about 166 000 persons) (Forouhi et al, 2006). In our analysis of Type 1 diabetes we have used data from Harvey et al 2002, which gave us a diabetic population of 168,000 people.

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