Circulatory disease in the NHS: measuring trends in hospital costs and outputs

Draft – Not for quotation without authors' permission

Adriana Castelli[*$] and Peter C. Smith[*]

[*]*Centre for Health Economics, University of York, York YO10 5DD, England.*

Abstract

The Atkinson Review has stimulated great interest in measuring the macro productivity growth of the NHS, an important consideration when deciding how much public money to devote to the NHS. However, it is also important to gain an understanding of the productivity of individual programmes of care, so as to ensure that resources are allocated efficiently within the NHS. This is an exploratory study of the feasibility and usefulness of developing measures of growth in outputs, costs and productivity of a single programme of care within the NHS: hospital treatment of circulatory disease.

We use 'continuous inpatient spells' of emergency, elective and day case treatment as our activity data, embracing all Hospital Resource Groups relevant to circulatory diseases to estimate trends in the volume of activity from 1998/99 to 2003/04. We also use mortality that occurs within 30 days of admission to quality-adjust our crude measure of activity.

Over the study period, activity has increased by 3.90% per annum. Adjusting this for the improvement in 30 day mortality rates increases the annual growth to 4.48%, reflecting the major improvement in outcomes over the study period. We also demonstrate how further quality adjustment could be undertaken, using patient-reported outcome measures collected by BUPA.

Trends in total reference costs for the programme over the study period suggest that the NHS has used its physical resources more efficiently in this programme (securing annual improvements in physical productivity of up to 2% per annum). However, because of the increased prices it has paid for its inputs, the cost-effectiveness of this programme has declined by anything up to 0.8% per annum over the study period.

[$] Correspondence to: Centre for Health Economics, University of York, York YO10 5DD UK. E-mail: ac52@york.ac.uk

1. Introduction

There is increased interest in measuring the productivity of health systems, defined as the ratio of certain outputs to the associated levels of inputs. In the English National Health Service (NHS) this has been manifest at the micro-level in the work of the National Institute for Health and Clinical Excellence (NICE), at the meso-level in the increased attention to programme budgeting in primary care trusts (PCTs) and at the macro-level in the work of the Office for National Statistics (ONS) in the development of whole system productivity measures.

This paper examines macro-level national productivity for a single programme of care – circulatory disease – in the hospital setting. Circulatory disease is defined as problems relating to the heart and the circulation of blood in central and peripheral vessels. It includes both coronary heart disease (CHD) (problems relating to atheroma of the coronary arteries) and cerebrovascular disease (problems due to interruptions to the blood supply of the brain).

We use the output growth index developed in Dawson *et al.* (2005) to calculate output measures for all circulatory diseases in England, for the time period 1998/99 to 2003/04. Activity is adjusted for survival rates, both in-hospital and in-hospital and thirty days. Patient-reported outcome measures are used for two procedures – coronary artery bypass graft (CABG) and percutaneous transluminal coronary angioplasty (PTCA) – as an illustrative example only, to highlight the potential of introducing more general health outcomes into the output growth index.

2. Background

According to the World Health Organisation (WHO, 1997, p.7) diseases of the heart and circulation are accountable for about 30 per cent of overall deaths in the world, every year. In the UK only, coronary heart disease (CHD) and cerebrovascular disease are responsible collectively for 29.2 per cent of total deaths (Office of Health Economics, 2003).

There has been substantial attention from the Department of Health towards the reduction of deaths from circulatory diseases. In particular, *Saving Lives: our healthier nation* (DH, 1999) sets the target to reduce "death rate from coronary heart disease and stroke and related diseases in people under 75 years by at least two fifths by 2010". Indeed, mortality rates for all circulatory diseases have been decreasing in the time period 1993-2004, by about 37 per cent, equivalent to an average decrease of 4.2 per cent per year.

It remains to be established whether these reductions in death rates can be attributed to the working of the NHS or to other factors, such as smoking cessation, take up of healthier life-styles, innovation in treatment technology, including innovation in drugs. A study by Unal *et al.* (2005) investigates which factors have been more likely to contribute towards the reduction in mortality rates for CHD in England and Wales. Their results show that 58 per cent of CHD mortality decline is attributable to

reductions in the major risk factors[1], with the remaining 42 per cent due to increased treatment of individuals, including secondary prevention.

However, if one wants to measure the performance of a health system, overall or in a specific area of care, a different approach needs to be followed. The Atkinson Review has heavily informed the measurement of government outputs, inputs, and productivity. It focused on general ways of dealing with this type of measurement in the National Accounts, providing a methodological framework and underlying principles[2]. In particular, it stresses that "the output of the government sector should […] be measured in a way that is adjusted for quality" (Principle B, Atkinson Review, 2005). Measuring quality of government output is of great importance and different ways are suggested in the report. (Atkinson, 2005). This is in line with requirements set out by European Commission to all member states (European Commission, 2002) in terms of incorporating in their national accounts quality and changes in quality. Further, it is stressed that in measuring the output of public services these should be aggregated in a way that takes into account the benefits it secures for society (social valuation) rather than the costs that are incurred in their production.

In general, the literature on the measurement of health care output and productivity can be divided into two major areas: overall health system measures and disease specific measures. Overall measures aim at assessing and valuing the output and productivity of a whole health system, whereas disease-specific or patient-based measures focus on single diseases or areas of healthcare. The most challenging task is to incorporate quality changes into these measures, especially so as these account as the most important source of productivity change in many sectors of the economy.

The measure of NHS output presented in Dawson *et al.* (2005) overcomes the old cost weighted activity index used by ONS and the DH. The "produce" of health sector is quantified not simply by counting mere activities such as diagnostic tests, surgical procedures or outpatient visits. They distinguish between *activities*, *outputs* and *outcomes*. Activities refer to counts data, such as number of operations, diagnostic tests, etc. Outputs are understood as bundles of activities that are required by any course of treatment provided by the healthcare sector.

Their main focus is, however, on outcomes and on how to measure and incorporate them into their output growth index. Outcomes constitute all the characteristics that are part of the process of care and that are valuable to individuals in their contact with the healthcare sector as patients, and therefore contribute to the 'quality' of care received. These are identified as improvements in health state, and measures of patient experience such as waiting time, choice of date of treatment, certainty of date of treatment, food, and physical environment.

An ideal index – value weighted output index (VWOI) – is developed to capture the value produced by the NHS. It adjusts volumes of activity to take account of changes in quality; in particular, it incorporates adjustments for health outcomes, life expectancy, and it also takes into account any possible detrimental effect caused by

[1] The study lists as major risk factors: smoking, cholesterol and blood pressure.
[2] The Atkinson Review refers to it as the 'principled framework' and it includes nine principles.

having to wait for treatment. Weights (π_k and π_W) are attached to these characteristics that reflect the marginal value that society places on them:

$$I_{yt}^{xq} = \frac{\sum_j x_{jt+1}\left[\left(a_{jt+1}-k_j\right)\left[\left(1-e^{-r_L L_{t+1}}\right)\pi_k\right]\right]/r_L - w_{jt+1}\pi_W}{\sum_j x_{jt}\left[\left(a_{jt}-k_j\right)\left[\left(1-e^{-r_L L_t}\right)\pi_k\right]\right]/r_L - w_{jt}\pi_W} \quad (1)$$

where x_{jt} is the amount of activity (number of operations, consultations, diagnostic tests, etc) undertaken in period t; a_{jt} is the probability of surviving treatment j at time t; k_j is equal to h^0_j/h^*_j, where h^0_j is a measure of patient-recorded health outcome before treatment and h^*_j is a measure of patient-recorded health outcome after treatment. π_k and π_W are the marginal social values respectively for a QALY and for non-health outcomes such as waiting time.

The principal problem in using the ideal index to measure NHS output is that health outcome data for all NHS care are currently not available. Dawson *et al.* (2005) and Castelli *et al.* (2007) use a limited set of 'before and after' measures of health for 29 treatments to illustrate the construction of the above index.

An interim approach is suggested – cost weighted output index (CWOI) – which re-introduces costs weights into the output measure but also adjusts the output measure to take account of changes in quality. The interim index (Laspeyre's form) proposed is:

$$I_{yt}^{xq} = \frac{\sum_j c_{jt} x_{jt+1} \frac{\left(a_{jt+1}-k_j\right)}{\left(a_{jt}-k_j\right)}\left[\frac{\left(1-e^{-r_L L_{jt}}\right)}{r_L} - \frac{\left(e^{r_W w_{jt}}-1\right)}{r_W}\right]}{\sum_j c_{jt} x_{jt}} \quad (2)$$

The interim index allows one to adjust NHS output to take into account changes in survival rates, in health outcomes, life expectancy and in waiting times.

The estimates of NHS output growth are on average equal to 3.62 per cent when outputs are simply weighted by their respective costs, i.e. without any quality adjustments, over the time period 1998/99 – 2003/04. Introducing changes in survival rates and effects on health yields an average output growth of 3.79 per cent[3]; estimates of NHS output growth using the interim index (2) are also on average equal to 3.79 percent over the time period considered.

To produce a measure of NHS total factor productivity growth, one needs to look at the inputs used by the healthcare sector. The most important input is labour, accounting for about 75 per cent of total hospital expenditures. Labour is quality adjusted for qualifications and skills.

[3] Health outcomes data from BUPA and York Trust were available for 29 treatments, which were mapped to Healthcare Resource Groups (HRGs) for elective and day cases only. For the remaining elective and day case HRGs an estimate of k= 0.8 was chosen, equal to the average value of all health outcomes. Non-electives HRGs were assigned a value equal to half the value of k. Authors conceded that there was empirical basis for theses choices.

The combination of input shares with growth in real terms leads to the calculation of total input growth and subtracting this from output growth yields total factor productivity growth rates. On average these show a negative productivity growth for the NHS as a whole, with the unadjusted index equal to -1.75 per cent. Quality adjustments on both outputs and inputs yields a smaller negative growth, which on average was equal to -1.59 per cent over the time period 1998/99 – 2003/04.

ONS has subsequently taken these measures forward (Lee, 2004 and UKCeMGA, 2006).

Disease specific measures have been developed mainly in the US literature on how to obtain disease specific measures of value for money. Although these measures are usually developed in the context of price indices for health care; the literature seems closely related to the problem of calculating output indices. In the UK, Mai (2004) has developed a diagnosis based approach in measuring health care output.

Cutler *et al.* (2001) estimate price indexes for medical care. Two types of medical care price indices are analysed: a service price index (SPI) and a cost of living (COL) index. The SPI simply calculates the amount of money required in every time period to purchase the same bundle of goods and services. Applied to the healthcare sector, this requires identifying a representative bundle of medical care goods and services and observing it through time. Unfortunately, the SPI does not have a utility (or value) interpretation. As Cutler *et al* (2001) point out in their paper, if the quality of a certain bundle of goods and services changes over time, the SPI will not be able to capture it. Therefore, there is a need to develop an index that allows one not only to measure the value of healthcare good and services at a given time period, but also to measure changes in the quality and hence utility of these goods and services over time.

The cost of living index enables one to do just that. It is based on patients' welfare. Consumers purchase goods and services to maximise a certain utility function. Utility is affected directly by some goods and services that are beneficial to them per se, such as cars, computers, and clothes. Healthcare goods and services also yield utility to consumers. However, this is achieved indirectly as the benefits derive not from the consumption of healthcare goods and services but of their indirect (beneficial) effect on their health.

Cutler *et al.* (2001) consider a consumer affected by a series of diseases, indexed by d. For each of those diseases an individual receives medical care treatment md(t), a vector of constant-quality treatments. Any change in the quality of a treatment or any new developments in the medical field are registered as additions to the available set of treatments. Assuming that a person can be affected by only one disease, a representative consumer faces the following utility function

$$U = U\left[Y - P_M M - P_I I, H(M, K, E), L - T_M\right] \tag{3}$$

Where Y denotes an individual's exogenous income; M indicates medical treatment with price P_M; I represents the quantity of a constant-quality insurance policy with price P_I. L is leisure time and T denotes time devoted to medical treatments. H represents the individual's health state which is a function of medical treatment M, medical knowledge K and the environment E.

The first term of the utility function represents non-medical care consumption, the second represents health and the third is non-medical care time. It is also worth noting that the equation does not make any assumption about the way medical treatment decisions are taken or medical prices are set.

As medical care and its price, medical knowledge, the environment and the time dedicated to medical care change over time, Cutler *et al.* (2001) pose the question: what is the correct price index for changes between periods 0 and 1, assuming that the consumer optimises in each period of time? Hence, they introduces an amount of money C that the consumer needs in period 1 so as to make her indifferent between living in period 1 and 0. In the Laspeyre's form, C will be the solution of the following expression

$$U\left[Y - P_{M1}M_1 - P_{I1}I_1 + C, H\left(M_1, K_1, E_1\right), L - T_{M1}\right] = \\ = U\left[Y - P_{M0}M_0 - P_{I0}I_0 + C, H\left(M_0, K_0, E_0\right), L - T_{M0}\right] \tag{4}$$

C can be considered as the change in the cost of living. A positive C indicates an increase in the cost of living. Scaling C by the income to produce utility in period 0 attains the price index

$$\text{cost of living} = 1 + C/Y \tag{5}$$

C can be derived from (4) by simple first order difference approximation. The change in the cost of living is made up of three parts: additional spending on medical care and insurance, monetary value of health over time, and time cost (travel time and waiting time) of receiving medical care.

Further, estimating the values of the variables in the cost of living equation is problematic, but not impossible. Alternative methods are presented in Berndt *et al* (2001). Cutler *et al.* (2001) use a direct measurement method that focuses on a particular disease and estimates empirically the changes in treatment costs and medical outcomes for that disease in their application to heart attack. In particular, they want to measure and price health improvements after a heart attack has occurred. They use an outcome adjusted index that takes into account changes in treatment and medical practice. The index also incorporates improvements in the length of life after a heart attack and the extension of life expectancy due to new treatments. Cutler *et al.* (2001) introduce quality changes via mortality data[4].

Their results show 'substantial reductions in the cost of living for people with a heart attack' (p 342). Quality of life after a heart attack has improved or is unchanged, showing a declining quality adjusted COL index for the time period of their study. Their results contrast with that obtained using SPI, which show increases in the range between 1.5 and 3.5 per cent annually.

Following Cutler and other US researchers, Mai (2004) proposes a diagnosis-based approach to measure healthcare output for CHD. In particular, she proposes two alternative index measures of healthcare output which are aggregated by patient and

[4] They also explore the use of QALYs.

diagnosis respectively. Her two indices take into account technological change and the introduction of innovations in existing treatments, and still use cost shares to weight together volumes of output.

Construction of the two measures requires more complex data than just counts of activity. The cost weighted patient index (CWPI) uses as the volume measure the number of patients treated with a given treatment. In fact, patients may be administered a number of activities, when undergoing a particular course of treatment. Hence, in the CWPI the weights will reflect the average cost share of not just a single activity, but the total average cost of the treatments the patient received.

The cost weighted disease index (CWDI) allows for the possibility that a disease may be treated with different types of treatments. Hence, simple counts of patient numbers undergoing a particular treatment cannot be used as the volume measure as it would fail to adjust for the substitution of treatments that may well occur over time. In the long term, the substitution of treatments may likely shift patients from a particular treatment course to another and counting just patients would not allow for this substitution effect. Further, as different treatments may have different outcomes on patients' health, these should be added using 'quality adjustment weights' (Mai, 2004).

Her results show that the output of treating AMI/angina grows in all measures, but that it grows much faster when using the disease based index. According to Mai, this shows that over the time period considered there has been substitution from CABG to PTCA, that is, from a more expensive treatment to a cheaper one. In the CWAI, a substitution between CABG and PTCA would result in a negative growth, as the cost weight attached to CABG is higher than the one attached to the cheaper PTCA, although they are the same in terms of outcome. CWDI overcomes this drawback by assigning a common weight to both alternative interventions; hence, it implicitly increases the weight given to PTCA which had also seen the highest increase in its volume measure.

We propose a third approach in measuring disease specific NHS output growth. We use the interim index developed in Dawson *et al.* (2005) and apply it to a specific programme of care.

3. Data sources and methods

3.1 Data sources

The Hospital Episode Statistics (HES) database and the National Schedule of Reference Costs database are our primary source for data. We present data on elective and day cases inpatient stays and non-elective (emergency) inpatient stays. The National Schedule of Reference Costs' unit costs data for elective and day cases and non-elective inpatient stays is organised and presented by Healthcare Resource Group (HRG). HRGs will, therefore, represent the base type unit for our analysis.

Reference costs data have been available since 1997/98. They suffer from the usual shortcomings associated with most routine costing data, including a concern about variations in the complexity of patients within an HRG category, variations in the quality of care provided, variations in accounting treatments, variations due to local hospital configuration and data errors (Jacobs and Dawson, 2003). However, the quality of data collected as well as the number of NHS activities covered has increased over time and – at an aggregate level – they are likely to be fit for the purposes for which we use them.

Quality of NHS hospital care is captured in terms of survival rates and health outcomes. Survival rates data can be obtained from the HES database and are available since 1998/99 onwards, whilst measures of health outcome for circulatory diseases are limited to two procedures only – coronary artery bypass graft (CABG) and percutaneous transluminal coronary angioplasty (PTCA). These are provided by BUPA, an independent healthcare provider (Vallance-Owen *et al.*, 2004).

3.2 Methods

We identify a series of diagnoses and procedures that are commonly known to belong to the broad category of circulatory diseases based on the DH programme budget area of 'circulation'. The DH programme budgeting categorisation presents three separate lists of diagnosis codes under circulation:

- coronary heart disease (PB-10A)
- cerebrovascular disease (PB-10B)
- other problems of circulation (PB-10X).

As activity and unit costs data are organised by HRG, the ICD-10 codes attributed to the circulation programme budget need to be mapped to the relevant HRGs. We use the online HRG explorer to map primary diagnosis and procedures to up to five alternative base HRGs. The mapping procedure allows us to produce a first list of HRGs, to which a further list of HRGs that are believed to fall under the broad definition of circulatory diseases is added. The total number of identified HRGs related to circulatory diseases is 57[5].

3.2.1 Outputs

Atkinson (2005) and Cutler and Huckman (2003) advocate disease-based or patient-based output measures as the optimal way to improve the measurement of output and productivity of a health system. Currently, however, routine administrative data do not directly track patients, and hence the resources used by them, in their journey within the NHS. An alternative measure is suggested in Dawson *et al.* (2005): continuous inpatient (CIP) of spells of NHS care. These, in fact, more clearly correspond to the journey that patients undergo across NHS settings, and are also

[5] See Appendix for the full list of HRGs complemented with volumes of activity and unit costs (Table A.1), and survival rates – both 'in-hospital' and 'in-hospital and 30 days' (Table A.2) – for the last year of the time used (2003/04).

"[…] less vulnerable to being miscounted if transfers among providers vary over time or if there are changes in 'how being under the care of a consultant' is defined (Dawson *et al.*, 2005, Lakhani *et al.*, 2005).

CIPS are generated by grouping together all episodes associated with the care received by a patient when treated anywhere within the NHS. The procedure allows one to link for a given patient episodes of care received in more than one provider (hospital), in the event that a patient[6] is transferred from one hospital (where the patient was first admitted) to another because, for example, current conditions of the patient require equipment available only in a highly specialised hospital. Admission details and patient identifier are used to link all episodes of care received by a given patient anywhere in the NHS to form CIPS of NHS care[7].

HRG codes are attributed to CIPS according to the HRG code associated with the initial diagnosis or first FCE. We follow the methodology set out in Dawson *et al*. (2005) to produce CIPS of NHS care data for our analysis.

There are a number of limitations associated with the way CIPS are constructed. First, important co-morbidities may be present which may be washed out by the coding procedure outlined above. Second, the case-mix of an HRG may well change over time. However, we accommodate for this latter drawback by applying in-year cost weights to NHS activity.

3.2.2 Quality adjustments

Quality of NHS healthcare is captured using survival rates and health outcomes.

Two measures of survival rate[8] can be extrapolated from the HES database, namely both 'in-hospital' and 'in-hospital and thirty days' (hereafter thirty days). 'In-hospital' death rates are determined by the number of patients that are discharged as dead. 'Thirty days' mortality rates link to the HES database additional deaths that occur within thirty days of discharge from hospital. Although in-hospital death rates (and hence survival rates) can be directly attributed to the working of the NHS, a number of patients are likely to die within a short period of being discharged. These deaths can usually be attributed to the medical treatment received; hence better reflecting any changes that occur in medical practice. It is, however, very important to choose a correct cut-off point for the attribution of deaths to the operating of the NHS as one would otherwise run the risk of attributing to the NHS deaths that are not under its direct control. The differences between these two measures of mortality rate are, however, not huge. Recent figures show a high correlation between in-hospital and thirty day survival rates for all HRGs, which in 2002/03 was 0.985 for elective inpatient stays and 0.991 for non-elective inpatient stays (Dawson *et al*, 2005).

The second quality indicator used in our analysis is health outcome. In principle, health outcome refers to the value added to each individual's health as a result of

[6] It appears that only around 1 percent of patients are transferred to another provider at the end of an episode (Dawson *et al*, 2005).
[7] For a full account on how to identify CIPS of NHS care, refer to Dawson *et al.* (2005).
[8] These are both calculated from mortality rates, as 1 – mortality rate.

contact with the health system. The main aim of a health system being the production or improvement of an individual's health, health outcomes seem the best measure against which to quality adjust the output produced by the public healthcare system. To determine fully the value added to an individual's health through contact with a health system, one should theoretically observe with and without treatment measures of health. However, health status is rarely observed in the absence of intervention, and moreover it would be ethically impossible to deny care to an individual when in need. As a practical alternative, therefore, Dawson *et al* recommend the collection of pre- and post-intervention measures of health status, also known as patient-reported outcome measures.

Data on patient-reported outcome measure are rare or non-existent. We are able to identify pre- and post- intervention measures of health status for only two of the 57 HRGs attributed to circulatory diseases, namely coronary artery bypass graft (CABG) surgery and percutaneous transluminal coronary angioplasty (PTCA). These data are made available by BUPA. We recognise that this constitutes an un-representative sample (with the usual limitations); however, we use this information as an example to illustrate the potential advantages and better estimation of NHS output growth measures that could be obtained were more data on patient-recorded outcome measures available.

Although incorporating survival rates into a healthcare service output growth index can be considered as a way forward to quality-adjust the measure of healthcare services, it is not free of problems. The most important is the issue of attribution, as increased survival rates (or any other health outcome) may be associated with a number of factors (epidemiology, demographics, technological advances in the pharmaceutical industry, etc) different from improvements in NHS practice. Further, the way that survival rates are introduced in the output measure (See Section 4.1) presumes a one to one relation between an increase in outcome and an increase in output. This is not fully correct, as the marginal gain from a contact with the NHS may be greater than the simple gain in QALYs deriving from a successful operation. We recognise that further thoughts should be given to these aspects.

3.2.3 Inputs

Inputs in the NHS constitute the resources used in the production of NHS activities and outputs. Together these contribute to the production of health outcomes. Inputs can be disaggregated into three different categories: labour, intermediate consumption (also called procurement) and capital consumption. Each of them contributes differently to the production of healthcare.

Data on inputs are available for the whole NHS; however, it proved impossible to use these data for the purpose of our analysis. Ideally, we should like to be able to apportion total volumes and expenditure on labour, intermediate consumption and capital consumption to each single diagnosis/procedure that falls under the category of 'circulatory diseases' or, failing this, to be able to produce a total figure for all circulatory diseases. This is not currently remotely feasible, and we must instead use unit costs as produced in the National Schedule of Reference Costs to populate the input side.

3.2.4 Unit Costs

The reference costs database attaches unit costs to finished consultants episodes. We use CIPS of NHS care as our unit of analysis for activities, to which we must attribute unit costs.

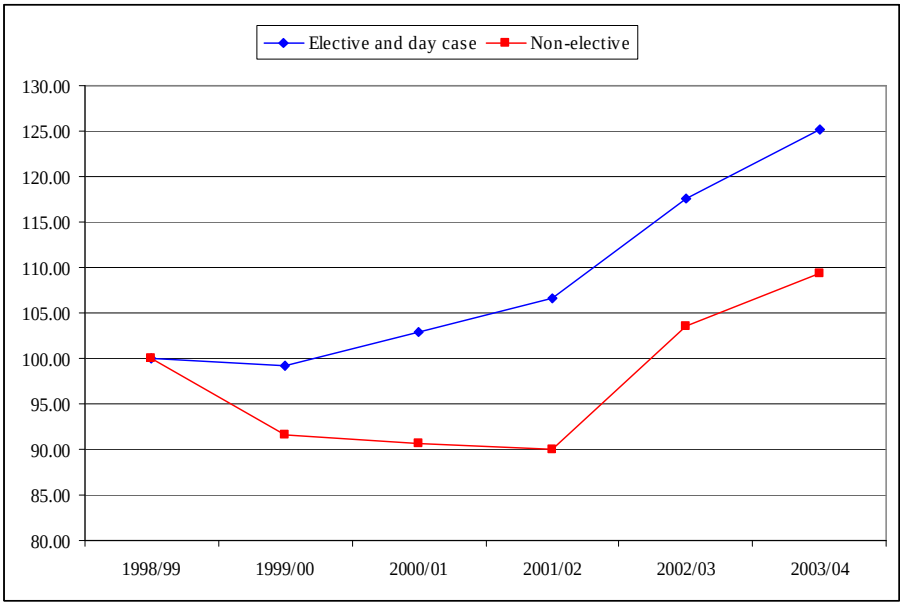
The procedure we followed is to attribute to a given CIPS of NHS care the spell type of the HRG as determined by the first episode of care received. The unit cost is then calculated as the ratio of the total cost of all spells assigned to the HRG in question over the total number of spells assigned to the HRG. The cost of each spell is calculated as the sum of the unit costs of all the underlying FCEs that it is composed of.

4. Output and productivity measures of circulatory diseases

We present in this section growth in NHS hospital output for circulatory diseases in the period from 1998/99 to 2003/04. We use the cost weighted output index (CWOI) developed in Dawson et al. (2005), in its unadjusted form. We demonstrate the impact on the CWOI of adjustments made for one quality dimension: survival rate. For illustrative purposes only, we analyse the effect on output growth of introducing more general health outcomes into the equation. We do this using two HRGs for which we have health outcomes measures: CABG (E04) and PTCA (E15).

Before presenting our results, we briefly outline some of the features of the data we used. All graphs are standardized so that 1998/99 is given an index of 100. Figure 1 shows growth in CIPS for both elective and day cases and non-electivity HRGs for each year from 1998/99 to 2003/04. Volumes of activity growth are weighted using 2003/04 unit costs for our set of HRGs.

Figure 1: Growth in elective and day case and non-elective activity, cost weighted



Volumes for elective and day cases show a steady increase, compared to the base year, except for a slight decrease in 1999/00. In 2003/04, volumes of weighted elective and day case CIPS are about 30 per cent higher than in 1998/99. Non-elective activity growth shows a sharp decrease up to 2001/02, with a high growth in the last two years of the time series.

Survival rates for most of the HRGs included in our data set show an increase over the time period 1998/99 to 2003/04 for both 'in-hospital' and 'in-hospital and 30 days' data. We present here a selection of trends in survival for some high volume HRGs, for elective and day cases and non-elective procedures[9], separately for in-hospital and thirty days survival rate.

Figure 2: Trends in in-hospital survival rate for high volume elective and day case HRGs, 1998/99 – 2003/04

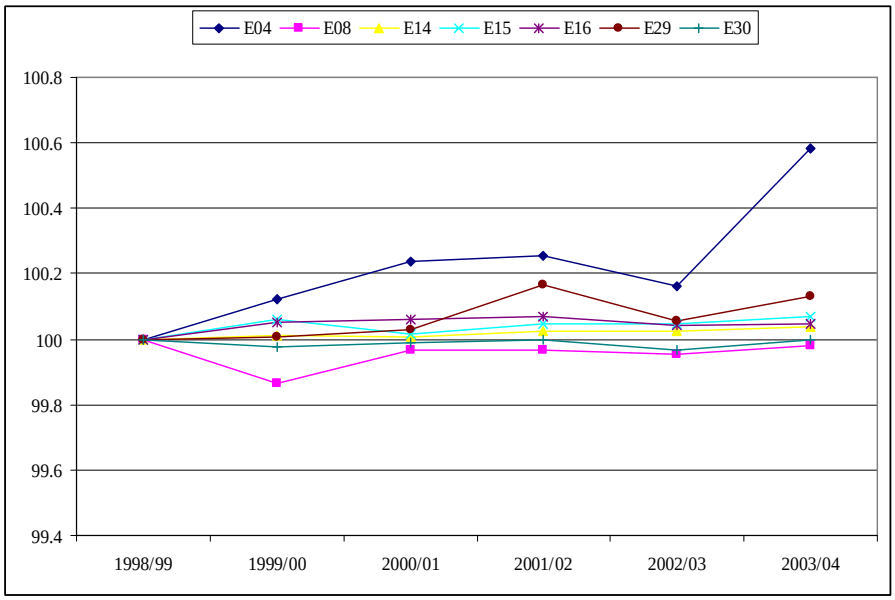
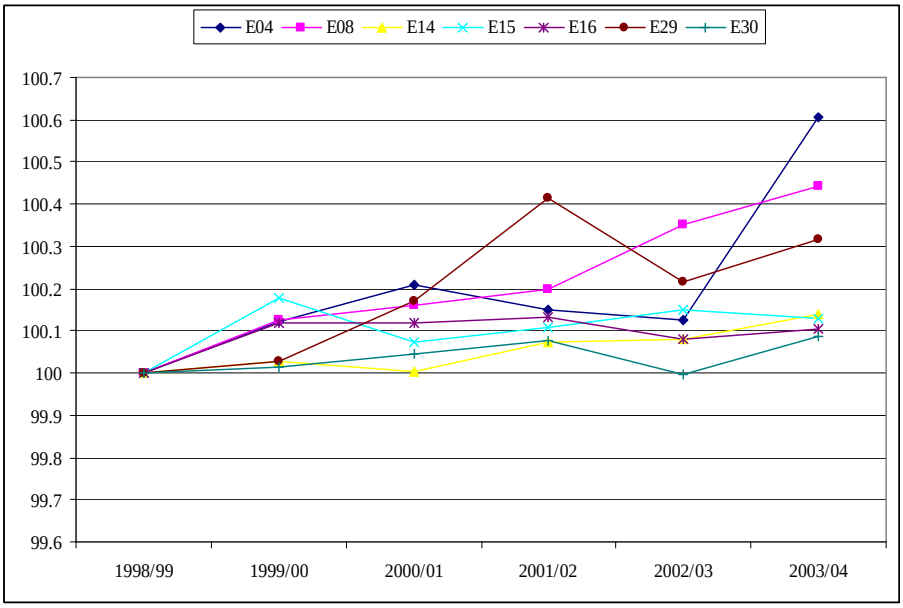


Figure 2 plots growth in in-hospital survival rate for some high volume elective and day case procedures. These show a slight increase or steady state in survival rates, compared to the base year. For some procedures (HRGs E04, E08, E09, E15 and E30), the change in survival rates does not follow a monotonic trend, in some cases registering a negative change in immediate years after 1998/99 before improving. The increase, where registered is, however, marginal; only 0.6 percentage points are added for example for CABG (E04) procedures. All survival rates are, in fact, already very close to 100 per cent in each year.

Similar changes in growth are registered for thirty days survival rate (see figure 3).

[9] For a more detailed analysis of trends in volumes, survival rates and costs for circulatory diseases, see Castelli A *et al.* (2006).

Figure 3: Trends in thirty days survival rate for high volume elective and day case HRGs, 1998/99 – 2003/04



A more marked change in survival rates growth over the time period under investigation is recorded for non-elective procedures, for both in-hospital and thirty days rates (see Figures 4 and 5). Also for non-elective procedures the change in survival rates does not always follow a monotonic pattern.

Figure 4: Trends in in-hospital survival rate for high volume non-elective HRGs, 1998/99 – 2003/04

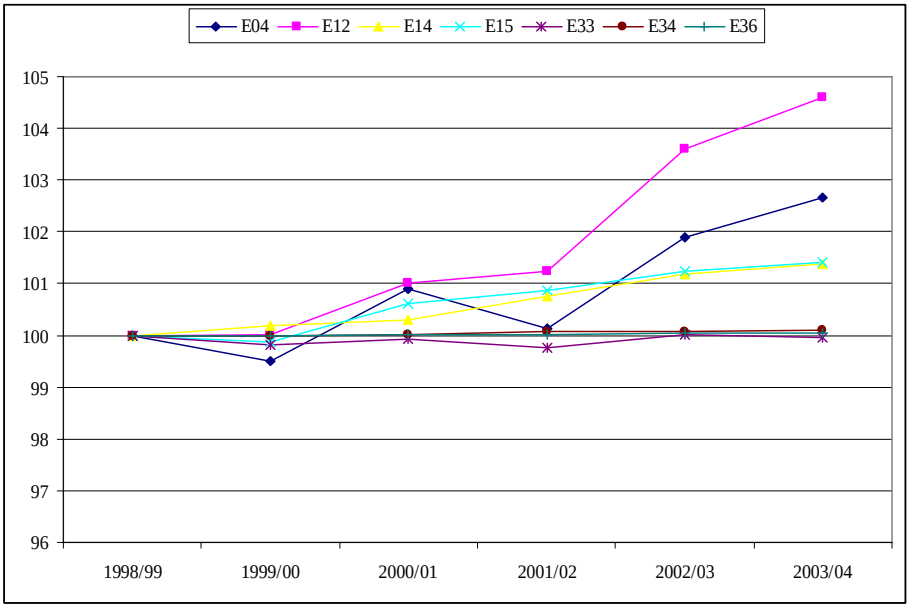
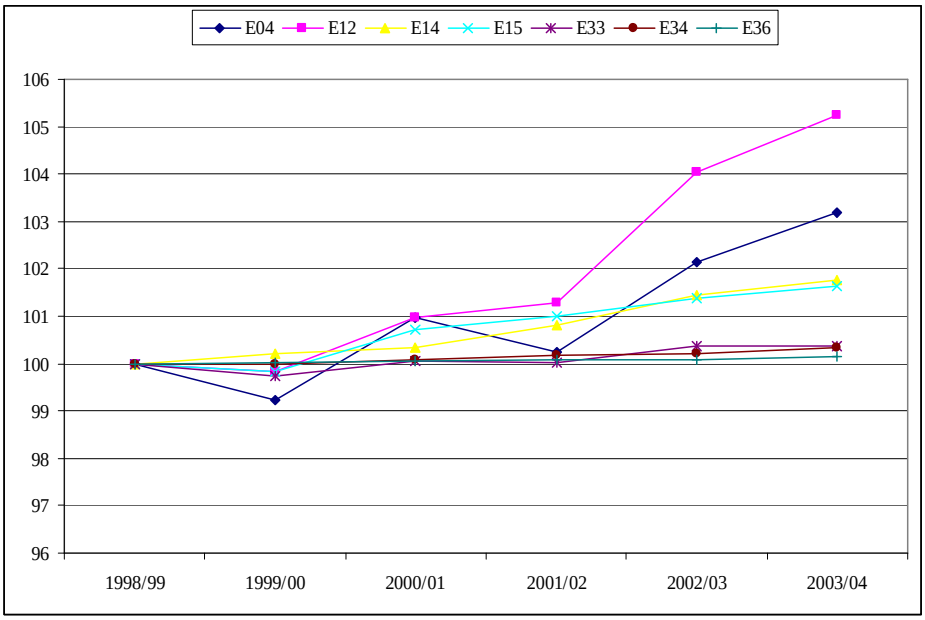


Figure 5: Trends in thirty days survival rate for high volume non-elective HRGs, 1998/99 – 2003/04



4.1 Simple CWOI and CWOI with survival adjustment

The first set of figures produced is the simple CWOI for our set of NHS hospital activity for circulatory diseases. This index aggregates activity by weighting it by unit costs, equivalent to multiplying the ratio of activities by their cost shares. The formula is:

$$(6)\quad I_{ct}^{x} = \frac{\sum_j x_{jt+1} c_{jt}}{\sum_j x_{jt} c_{jt}}$$

where x_{jt} is the amount of activity undertaken in period t and c_{jt} is the unit cost of activity j in time t. The index is a Laspeyres index, and hence uses the unit cost of the base year t.

We then introduce survival rates. We use both 'in-hospital' and 'in-hospital and 30 days' survival rates. The formula is:

$$(7)\quad I_{ct}^{x} = \frac{\sum_j c_{jt} x_{jt+1} \left(\frac{a_{jt+1}}{a_{jt}} \right)}{\sum_j c_{jt} x_{jt}}$$

We now add a_{jt+1}/a_{jt} to the previous equation, representing the improvement in the probability of surviving treatment j between time t and time t+1.

Table 4.1 summarises this first set of calculations. NHS output for circulatory disease has on average increased over the time period from 1998/99 to 2003/04. The unadjusted output CWOI suggests an average annual growth in output of 3.9 per cent, although there is annual variation in the estimated amount of growth, especially

between 2001/02 and 2002/03. This is due to exceptional increases in activity in a number of HRGs, for both electives and day cases, and non-electives.

Table 4.1 Cost Weighted Output Index simple and with survival adjustment - time series -

	CWOI	CWOI with in-hospital survival rate	CWOI with in-hospital and 30 day survival rate
1998/99 - 1999/00	2.23%	1.47%	1.36%
1999//00 - 2000/01	2.86%	3.22%	3.33%
2000/01 - 2001/02	3.24%	3.31%	3.42%
2001/02 - 2002/03	6.28%	8.03%	8.37%
2002/03 - 2003/04	4.88%	5.73%	5.93%
Average growth	**3.90%**	**4.35%**	**4.48%**

Introducing the quality adjustment produces higher growth rates in the indices, both on average and for any given year, except for 1998/99 to 1999/00. This is expected because of the improved survival rates registered. The use of 'in-hospital and 30 days' survival rates yields a higher adjustment than 'in-hospital' survival rates for all years except for 1998/99–1999/00.

Overall, using 'in-hospital' survival rates leads to an average annual increase in the estimates of output growth of 0.45 per cent compared with the unadjusted CWOI, while the 'in-hospital and 30 days' measure of survival adds 0.58 per cent compared to the unadjusted CWOI. The increase reflects the gradual improvement in survival rate over the period under consideration

4.3 Introducing patient-reported outcome measures

We now consider the introduction of health effects in measuring the NHS output growth. Table 4.2 shows before (h^0_j) and after (h^*_j) treatment measures of health outcomes for the two procedures.

Table 4.2 Before and after health outcomes

		Health outcome	
HRG description	**HRG**	h^0_j	h^*_j
Coronary Bypass	E04	0.50	0.73
Percutaneous Transluminal Coronary Angioplasty (PTCA)	E15	0.54	0.79

These health outcomes measures were attributed to elective inpatient and day case procedures. Health status before treatment for patients undergoing PTCA is slightly higher than that recorded for patients undergoing CABG; the health status after treatment is also higher for patients who had a PTCA procedure.

We expect the before and after health status for patients treated in an emergency setting to differ quite substantially from patients treated as elective and day cases. Assigning an appropriate measure of before and after health outcome to non-elective

cases is not a trivial exercise. Therefore, we undertook a sensitivity analysis to investigate the impact that different values of before and after health status for non-elective procedures have on the output growth index.

We estimated the following output growth indices for these two HRGs:

- CWOI
- CWOI with survival adjustment ('thirty days' survival rate only)
- CWOI incorporating survival and health adjustment.

The formula of our index incorporating survival and health adjustments is:

$$(8)\quad I_{ct}^{x} = \frac{\sum_j c_{jt} x_{jt+1}\left(\frac{a_{jt+1} - k_j}{a_{jt} - k_j}\right)}{\sum_j c_{jt} x_{jt}}$$

The notation of the index formula is unchanged, except for k_j, which is equal to h^0_j/h^*_j, where h^0_j is a measure of patients' health status before treatment and h^*_j is a measure of patients' health status after treatment. In estimating this equation it is necessary to introduce a threshold for HRGs with poor survival rate. If survival rates are below the chosen threshold level, only the change in survival is taken into account. Not making this adjustment would result in the index being too sensitive to changes in a_j for activities with small or negative $(a_{jt+1} - k_j)$ or $(a_{jt} - k_j)$. We currently have little evidence on which to base such a threshold, and so have rather arbitrarily had to choose one of 90 per cent of survival rate. Future empirical research should seek to validate this choice.

Table 4.3 shows the estimates of output change for CABG and PTCA. Both the estimates for CWOI incorporating survival and health adjustments use the value of before and after treatment health status for elective and day case procedures.

Table 4.3 Cost Weighted Output Index simple, with survival and health adjustments - time series -

	CWOI	**CWOI with 'in-hospital and 30 day' survival rate**	**CWOI with survival and health effect** (i)	**CWOI with survival and health effect** (ii)
1998/99 - 1999/00	-0.70%	-0.67%	-0.46%	-0.47%
1999//00 - 2000/01	5.37%	5.65%	5.83%	5.86%
2000/01 - 2001/02	7.23%	7.20%	7.14%	7.14%
2001/02 - 2002/03	15.43%	15.68%	15.80%	15.81%
2002/03 - 2003/04	4.66%	5.01%	5.57%	5.58%
Average growth	**6.40%**	**6.58%**	**6.77%**	**6.79%**

The unadjusted CWOI suggests an average annual growth in output for CABG and PTCA of 6.4 per cent. These results demonstrate the volatility inherent in using a small sample. In particular, there is a large increase in the index of 15.43 per cent

between 2001/02 and 2002/03. This is driven by an increase in activity for non-electives CABG and PTCA procedures of respectively about 61 per cent and 42.1 per cent between 2001/02 and 2002/03.

On average, the introduction of survival adjustment adds 0.18 per cent to the simple CWOI. Survival rates for these two HRGs did not change much in the time period considered, and they are quite high. Nevertheless, the incorporation of survival rates into the index equation shows the extra value that is captured by this quality adjustor. Failure to incorporate it would have resulted in an underestimate of the value of output and its growth added by the NHS over the time period considered.

The figures in columns (i) and (ii) in Table 4.3 show estimates of CWOI adjusted for survival and health outcome. Column (i) shows estimates for which we used a value for before and after health measures for non-elective CABG and PTCA procedures equal to half the average of the values for elective and day case procedures. Thus, non-electives CABG and PCTA values for h^0_j and h^*_j were set equal to 0.26 and 0.38 respectively. This choice assumes that the effect on health of either procedure on patients admitted to hospital as emergency cases is not affected by the choice of the procedure and that both sets of patients show similar severities in their conditions. It further assumes that the two procedures are randomly assigned to emergency cases, that is, they are perfect substitutes.

However, this is not always the case. As shown in Table 4.2, the health status before and after treatment of patients who underwent a revascularisation procedure differs (albeit slightly) between patients treated with CABG and patients treated with PTCA. Further, the choice of performing a CABG procedure rather than a PTCA may well be affected by the patient's medical history and risk factors. Hence, we also experiment with a separate set of values for before and after treatment health measures for non-electives CABG and PTCA patients. We used a value of health status measure equal to half the value of their respective electives and day cases measure. Thus, h^0_j and h^*_j were equal to 0.25 and 0.36 respectively for CABG, and 0.27 and 0.40 for PTCA. Column (ii) of Table 9 shows the impact of these choices on growth estimates.

Estimates in column (ii) are slightly higher than estimates in column (i). Overall, incorporating health effects into the CWOI, alongside survival rate, adds between 0.37 per cent and 0.39 per cent to the average annual increase in output growth compared with the unadjusted CWOI, depending on the value of before and after health effects that are assigned to non-elective procedures. Compared to CWOI with survival adjustment only, health effects lead to an average annual increase in the estimates of output growth of between 0.19 (column i) and 0.21 (column ii) per cent.

4.4 Inputs

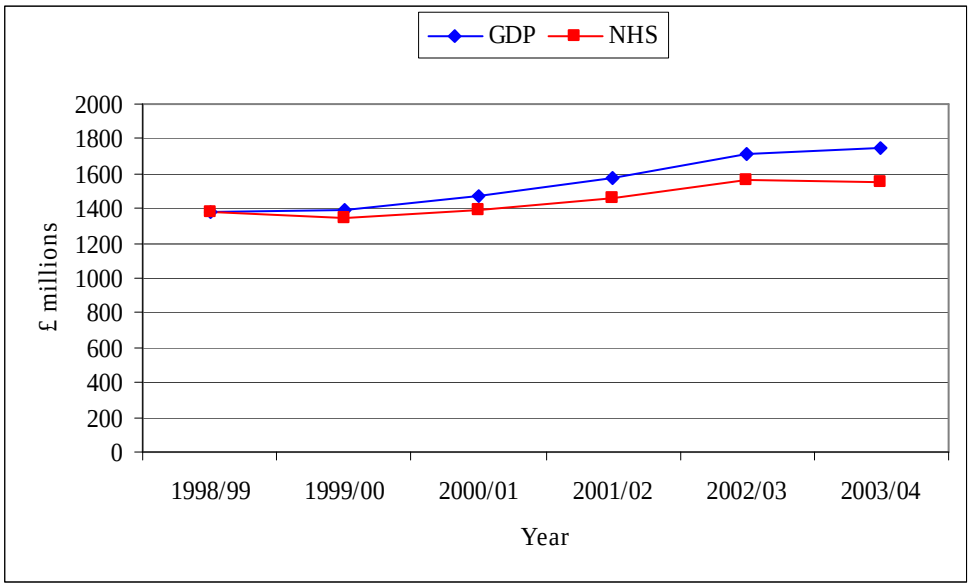
Measurement of trends in inputs to the hospital treatment of circulatory disease is problematic. In principle, we require details of physical inputs such as labour, capital and pharmaceuticals to construct such an index. However, no such data are available; instead we must rely on the NHS estimates of reference costs for individual treatments. These often which often depend on crude accounting choices by NHS provider and fail to properly measure the value of all inputs. In the case of labour, by

far the most important input used in the production of health care (about 75 per cent of total health expenditures), simply look at its cost fails to take into account of the type of workers employed, and their quality as expressed by their skills and qualifications; and how these change over time.

In 2002/03, unit costs for elective procedures varied from £394 for deep vein thrombosis to just under £27,000 for heart and lung transplant procedures; unit costs for non-electives varied from £499 for chest pain to £34,000 for heart transplant.

Figure 6 shows the implied total expenditure on HRGs associated with circulatory disease across the six-year period. The results are presented in 1998/99 prices, deflated using both the GDP deflator and the NHS Pay and Prices Index. Both show a steady increase in real expenditure from £1.4 billion in the first year. The GDP deflator is likely to be more appropriate for indicating the real increase in inputs used by the NHS as it reflects the price of goods and services throughout the entire British economy, rather than the cost of goods and service purchased by the NHS. It implies a growth of 5.3 per cent per annum in circulatory disease hospital inputs over the six-year period. This is in line with ONS estimates of total NHS input growth over the same period (between 4.8 per cent and 5.5 per cent depending on the methodology used).

Figure 6: Total expenditure on circulatory diseases using GDP deflator (GDP) and NHS Pay and Prices Index (NHS), 1998/99 – 2003/04



4.5 Productivity growth

While we have been able to estimate outputs in an analogous fashion to the ONS, we have been unable to replicate its methodology for inputs, as it is not infeasible to assign NHS inputs such as labour and capital to specific treatments with any reliability. Instead, based on reference costs, we have indicated that in very rough terms (using the GDP deflator) the costs of hospital treatment of circulatory disease have increased by 5.3 per cent per annum in real terms. If this estimate is correct, it

would imply that the cost-effectiveness of this programme of care has been marginally falling over the period under scrutiny.

If the NHS price deflator is used a different story emerges, as it implies that output has grown relative to inputs measured at constant NHS prices. A very tentative conclusion is that the NHS has used its physical resources in this disease programme more efficiently to secure annual improvements in physical productivity of up to 2 per cent per annum. However, because of the increased prices it has paid for its inputs, the cost-effectiveness of this programme has declined over the study period.

5. Conclusions and implications for policy and future research

This report has presented an exploratory study of the feasibility and usefulness of developing measures of growth in outputs, costs and productivity of a single programme of care within the NHS: hospital treatment of circulatory diseases.

Productivity is the ratio of an aggregate measure of outputs to an aggregate measure of inputs for the chosen programme of care. The key methodological challenges are:

- choosing the appropriate measures of NHS activities
- adjusting those measures for the quality of care
- aggregating the measures into a single measure of output
- identifying the associated inputs in the form of a single measure of costs
- tracking these measures consistently over time.

We have demonstrated that it is feasible, using hospital spells as the unit of activity, to develop quite refined models of the output of a programme of care. The development of HRGs has assisted greatly in this endeavour, yielding estimates of costs as well as counts of activities. For programmes of care outside hospitals future challenges will include developing analogous measures of activity in a community and primary care setting, and incorporating drugs and other prescribing into the model.

Output growth for hospital treatment of all circulatory diseases has increased over the time period we considered. In pure volume terms, the increase is of the order of 3.9 per cent per annum, but incorporation of quality data in the form of survival rates implies an increased rate of 4.5 per cent per annum. This is clearly crude, but the recent improvement in survival rates in many procedures for circulatory disease yields quite a large improvement in estimates of annual rates of output growth. However, it is in line with ONS estimates, which set the equivalent annual increase in outputs for the whole of the NHS (including primary care and prescribing) at about 5 per cent.

Because of the lack of health outcome measurement in the NHS (other than survival data), we are unable to say with any confidence whether it is securing improvements in the quality of life after treatment. However, we have demonstrated how this might be done, using health status measures of before and after treatment based on SF36 data from BUPA. This analysis was merely illustrative for CABG and PTCA procedures only, and we had to make many heroic assumptions in incorporating the

data into the index. However, for these two interventions, we found that consideration of the quality of health outcomes added about 0.2 per cent per annum to the estimates of productivity growth.

In our view, routine collection of measures of health outcomes by the NHS should be an urgent priority for numerous reasons, such as improved patient care, informing patient choice, surveillance of clinical performance and resource allocation. It would also permit the development of more secure measures of output growth, based on the health improvement experienced by patients as a result of NHS treatment.

At this stage of development we also consider health outcomes to be the most important element of quality to incorporate into the model of NHS output. However, there is also a case for exploring the feasibility and usefulness of incorporating non-health aspects of NHS quality into the model, such as measures of the patient experience and waiting time. Other aspects of output that may be important in some programmes of care include the benefits of treatment to the patient's carers, and the implications of NHS activities for labour productivity and social care expenditure.

A crucial methodological consideration concerns the weights to be applied to the separate NHS output activities. The diverse hospital spells that make up this programme of care do not confer equal patient benefits. We have followed the conventional practice in weighting treatments according to their estimated costs, acknowledging that this is far from ideal.

Finally we note that reliable measures of physical inputs to NHS care are very scarce below the measure of whole organizational entities. Until micro-costing of patients becomes widespread, any productivity measures for programmes of care will have to rely on very crude measures of inputs.

Acknowledgments

This study was funded by the Health Foundation under the Quest for Quality and Improved Performance (QQuIP) initiative. Thanks are due to anonymous reviewers.

References

Atkinson T (2005), *Atkinson Review: Finale report. Measurement of Government Output and Productivity for the National Accounts*. Palgrave Macmillan.

Castelli A, Dawson D, Gravelle H and Street A (2007), 'Improving the measurement of health system output growth'. *Health Economics*, vol. 16(10), p. 1091 – 1107.

Castelli A, Smith PC (2006), 'Circulatory disease in the NHS: Measuring trends in hospital costs and output'. Centre for Health Economics research paper 21. University of York.

Cutler DM, McClellan M, Newhouse JP and Remler D (2001), 'Pricing heart attack

treatments', in Cutler DM and Berndt ER eds (2001). *Medical Care Output and Productivity,* Chicago University Press.

Dawson D, Gravelle H, O'Mahony M, Street A, Weale M, Castelli A, Jacobs R, Kind P, Loveridge P, Martin S, Stevens P and Stokes L (2005), *Developing New Approaches to Measuring NHS Outputs and Productivity.* Centre for Health Economics Research paper 6. University of York.

Department of Health (2006), *Reference Costs 2004/05.* Department of Health.

Department of Health (2005), *The Coronary Heart Disease National Service Framework: Leading the way. Progress Report*. Department of Health.

Department of Health (2005a). *Healthcare Output and Productivity: Accounting for quality change*. Department of Health.

Department of Health (1999), *Saving Lives: Our healthier nation*. The Stationery Office.

European Commission (2002), '*Decision 17 December N2002/990/EC*'. European Commission: Brussels.

Jacobs R and Dawson D (2003), 'Variation in unit costs of hospitals in the English National Health Service'. *Journal of Health Services Research and Policy*, vol 8, pp 202–08.

Lakhani A, Coles J, Eayres D, Spence C, Rachet B (2005), 'Creative use of existing clinical and health outcomes data to assess NHS performance in England: Part 1 – performance indicators closely linked to clinical care'. *British Medical Journal* 330: 1426-1431..

Lee P (2004), 'Public service productivity: health'. *Economic Trends*, vol 613, pp 38–59.

Mai N (2004), 'Measuring health care output in the UK: a diagnosis based approach'. *Economic Trends*, vol 610, pp 64–73.

Office for National Statistics (2005) *The Blue Book*. ONS.

Office of Health Economics (2003), *Compendium for Health Statistics: 2003/04*. OHE.

Organisation for Economic Co-operation and Development (2006), *Health Data 2006*.
OECD.

UK Centre for the Measurement of Government Activity (UKCeMGA) (2006), 'Public service productivity: health'. *Economic Trends*, vol 628, pp 26–57.

Unal B, Critchley JA and Capewell S (2005), ‘Modelling the decline in coronary heart disease deaths in England and Wales, 1981–2000: comparing from primary prevention and secondary prevention’. *British Medical Journal*, vol 331, p 614–19.

Vallance-OwenA, Cubbin S, Warren V, Matthews B (2004), ‘Outcome monitoring to facilitate clinical governance: Experience from a national programme in the independent sector’. *Journal of Public Health* vol 26(2), p 187–192.

Williams A (1985), ‘The economics of coronary artery bypass grafting’. *British Medical Journal*, vol 291, pp 326–29.

World Health Organisation (1997), *The World Health Report 1997: Conquering, suffering, enriching humanity*. WHO.

Table A.1 – List of HRGs attributable to Circulatory Diseases, activity and unit costs for 2003/04

HRG	HRG Description	Activity 2003/04		Unit Costs 2003/04	
		Elective & Day Cases	*Non-Electives*	*Elective & Day Cases*	*Non-Electives*
A01	Intracranial Procedures Except Trauma - Category 1	1386	542	2983	2592
A02	Intracranial Procedures Except Trauma - Category 2	3117	2327	3215	4659
A03	Intracranial Procedures Except Trauma - Category 3	2256	2533	4929	6331
A04	Intracranial Procedures Except Trauma - Category 4	2584	2064	7286	8494
A05	Intracranial Procedures for Trauma w cc	24	645	3695	6237
A06	Intracranial Procedures for Trauma w/o cc	244	2130	1805	4154
A16	Cerebral Degenerations >69 or w cc	3602	9664	2075	4166
A17	Cerebral Degenerations <70 w/o cc	5105	4526	1164	1687
A19	Haemorrhagic Cerebrovascular Disorders	672	16702	3470	2727
A20	Transient Ischaemic Attack >69 or w cc	213	13085	1896	1262
A21	Transient Ischaemic Attack <70 w/o cc	95	5442	807	725
A22	Non-Transient Stroke or Cerebrovascular Accident >69 or w cc	1351	48565	4354	3504
A23	Non-Transient Stroke or Cerebrovascular Accident <70 w/o cc	872	13965	2059	2286
D10	Pulmonary Embolus >69 or w cc	357	6657	1112	2008
D11	Pulmonary Embolus <70 w/o cc	636	6502	670	1430
E01	Heart and Lung Transplant	4	8	25472	27132
E02	Heart Transplant	79	52	12803	31198
E03	Cardiac Valve Procedures	6612	962	8530	10213
E04	Coronary Bypass	14991	2437	6359	7260
E05	Other Cardiothoracic Procedures with Cardiopulmonary Support	4856	914	3857	4991
E06	Other Cardiothoracic Procedures without Cardiopulmonary Support	812	765	4276	4970
E07	Pacemaker Implant for AMI, Heart Failure or Shock	214	733	4141	3810
E08	Pacemaker Implant except for AMI, Heart Failure or Shock	9566	7037	3594	4267
E09	Cardiac Pacemaker Replacement/Revision	5566	795	2702	3200
E10	Other Circulatory Procedures	5883	3001	925	2705
E11	Acute Myocardial Infarction w cc	187	15835	2829	2130
E12	Acute Myocardial Infarction w/o cc	367	61582	1985	1480
E13	Cardiac Catheterisation with Complications	1419	656	786	3226
E14	Cardiac Catheterisation without Complications	96093	15891	843	2886

Table A.1 – List of HRGs attributable to Circulatory Diseases, activity and unit costs for 2003/04 – continued

HRG	HRG Description	Activity 2003/04		Unit Costs 2003/04	
		Elective & Day Cases	*Non-Electives*	*Elective & Day Cases*	*Non-Electives*
E15	Percutaneous Transluminal Coronary Angioplasty (PTCA)	21577	13358	2826	3589
E16	Other Percutaneous Cardiac Procedures	7632	2357	2164	2316
E17	Endocarditis	70	941	2930	4648
E18	Heart Failure or Shock >69 or w cc	1933	44111	1843	2195
E19	Heart Failure or Shock <70 w/o cc	826	9995	1324	1629
E20	Deep Vein Thrombosis >69 or w cc	2510	11459	524	1377
E21	Deep Vein Thrombosis <70 w/o cc	3900	12168	397	835
E22	Coronary Atherosclerosis >69 or w cc	895	4470	2425	2362
E23	Coronary Atherosclerosis <70 w/o cc	900	3351	1915	1815
E24	Hypertension >69 or w cc	352	2745	919	1389
E25	Hypertension <70 w/o cc	519	3178	647	838
E26	Congenital or Valvular Disorders >69 or w cc	1187	4040	3166	3222
E27	Congenital or Valvular Disorders <70 w/o cc	2116	3519	2816	2353
E28	Cardiac Arrest	50	2224	1853	1351
E29	Arrhythmia or Conduction Disorders >69 or w cc	7101	49767	674	1422
E30	Arrhythmia or Conduction Disorders <70 w/o cc	9052	36168	522	686
E31	Syncope or Collapse >69 or w cc	900	47113	967	1331
E32	Syncope or Collapse <70 w/o cc	1082	22996	553	600
E33	Angina >69 or w cc	817	60108	2178	1219
E34	Angina <70 w/o cc	768	51828	1986	925
E35	Chest Pain >69 or w cc	550	51389	1055	830
E36	Chest Pain <70 w/o cc	1228	113429	741	484
E37	Other Cardiac Diagnoses	2710	13812	1209	1527
E99	Complex Elderly with a Cardiac Primary Diagnosis	1063	33339	2536	2711
P25	Cardiac Conditions	434	1423	1356	1378
Q01	Emergency Aortic Surgery	114	1391	3620	4545
Q17	Peripheral Vascular Disease >69 or w cc	3608	11056	1828	2671
Q18	Peripheral Vascular Disease <70 w/o cc	3507	4983	966	1698

Table A.2 List of HRGs attributed to Circulatory diseases, Survival rate

HRG	HRG Description	Survival rate 2003/04			
		In-hospital		30 days and in-hospital	
		Elective & Day Cases	*Non-Electives*	*Elective & Day Cases*	*Non-Electives*
A01	Intracranial Procedures Except Trauma - Category 1	0.9978	0.9576	0.9964	0.9520
A02	Intracranial Procedures Except Trauma - Category 2	0.9955	0.9665	0.9901	0.9506
A03	Intracranial Procedures Except Trauma - Category 3	0.9889	0.8549	0.9831	0.8426
A04	Intracranial Procedures Except Trauma - Category 4	0.9861	0.9236	0.9826	0.9129
A05	Intracranial Procedures for Trauma w cc	0.9583	0.8211	0.9583	0.8103
A06	Intracranial Procedures for Trauma w/o cc	0.9877	0.8987	0.9836	0.8950
A16	Cerebral Degenerations >69 or w cc	0.9641	0.8984	0.9499	0.8732
A17	Cerebral Degenerations <70 w/o cc	0.9945	0.9565	0.9918	0.9483
A19	Haemorrhagic Cerebrovascular Disorders	0.9268	0.6804	0.9208	0.6665
A20	Transient Ischaemic Attack >69 or w cc	0.9765	0.9886	0.9765	0.9783
A21	Transient Ischaemic Attack <70 w/o cc	1.0000	0.9993	1.0000	0.9980
A22	Non-Transient Stroke or Cerebrovascular Accident >69 or w cc	0.8894	0.7913	0.8701	0.7757
A23	Non-Transient Stroke or Cerebrovascular Accident <70 w/o cc	0.9862	0.9315	0.9828	0.9280
D10	Pulmonary Embolus >69 or w cc	0.9972	0.9775	0.9916	0.9650
D11	Pulmonary Embolus <70 w/o cc	0.9984	0.9952	0.9984	0.9915
E01	Heart and Lung Transplant	0.7500	0.8750	0.7500	0.8750
E02	Heart Transplant	0.8734	0.8654	0.8734	0.8462
E03	Cardiac Valve Procedures	0.9599	0.8832	0.9562	0.8822
E04	Coronary Bypass	0.9886	0.9662	0.9866	0.9650
E05	Other Cardiothoracic Procedures with Cardiopulmonary Support	0.9924	0.9073	0.9907	0.9018
E06	Other Cardiothoracic Procedures without Cardiopulmonary Support	0.9778	0.8692	0.9753	0.8522
E07	Pacemaker Implant for AMI, Heart Failure or Shock	0.9813	0.6650	0.9720	0.6500
E08	Pacemaker Implant except for AMI, Heart Failure or Shock	0.9983	0.9635	0.9955	0.9560
E09	Cardiac Pacemaker Replacement/Revision	0.9986	0.9823	0.9950	0.9748
E10	Other Circulatory Procedures	0.9971	0.9442	0.9952	0.9352
E11	Acute Myocardial Infarction w cc	0.7807	0.8042	0.7701	0.7869
E12	Acute Myocardial Infarction w/o cc	0.8823	0.8964	0.8742	0.8876
E13	Cardiac Catheterisation with Complications	0.9979	0.9539	0.9951	0.9494
E14	Cardiac Catheterisation without Complications	0.9993	0.9859	0.9978	0.9820

Table A.2 List of HRGs attributed to Circulatory diseases, Survival rate - continued

HRG	HRG Description	Survival rate 2003/04			
		In-hospital		30 days and in-hospital	
		Elective & Day Cases	*Non-Electives*	*Elective & Day Cases*	*Non-Electives*
E15	Percutaneous Transluminal Coronary Angioplasty (PTCA)	0.9984	0.9847	0.9965	0.9809
E16	Other Percutaneous Cardiac Procedures	0.9990	0.9592	0.9980	0.9486
E17	Endocarditis	0.9709	0.8851	0.9709	0.8745
E18	Heart Failure or Shock >69 or w cc	0.9094	0.8484	0.8945	0.8281
E19	Heart Failure or Shock <70 w/o cc	0.9782	0.9261	0.9709	0.9147
E20	Deep Vein Thrombosis >69 or w cc	0.9984	0.9816	0.9956	0.9658
E21	Deep Vein Thrombosis <70 w/o cc	0.9997	0.9983	0.9995	0.9953
E22	Coronary Atherosclerosis >69 or w cc	0.9754	0.7976	0.9709	0.7866
E23	Coronary Atherosclerosis <70 w/o cc	0.9956	0.9707	0.9933	0.9689
E24	Hypertension >69 or w cc	0.9915	0.9428	0.9886	0.9307
E25	Hypertension <70 w/o cc	1.0000	0.9934	0.9981	0.9918
E26	Congenital or Valvular Disorders >69 or w cc	0.9815	0.9110	0.9739	0.8962
E27	Congenital or Valvular Disorders <70 w/o cc	0.9934	0.9701	0.9924	0.9616
E28	Cardiac Arrest	0.3800	0.3068	0.3400	0.2897
E29	Arrhythmia or Conduction Disorders >69 or w cc	0.9970	0.9710	0.9934	0.9611
E30	Arrhythmia or Conduction Disorders <70 w/o cc	1.0000	0.9968	0.9993	0.9951
E31	Syncope or Collapse >69 or w cc	0.9866	0.9642	0.9733	0.9520
E32	Syncope or Collapse <70 w/o cc	1.0000	0.9953	0.9972	0.9927
E33	Angina >69 or w cc	0.9755	0.9837	0.9706	0.9766
E34	Angina <70 w/o cc	0.9974	0.9979	0.9961	0.9964
E35	Chest Pain >69 or w cc	0.9927	0.9887	0.9891	0.9814
E36	Chest Pain <70 w/o cc	1.0000	0.9991	0.9976	0.9979
E37	Other Cardiac Diagnoses	0.9834	0.9337	0.9790	0.9222
E99	Complex Elderly with a Cardiac Primary Diagnosis	0.8775	0.7341	0.8578	0.7084
P25	Cardiac Conditions	0.9977	0.9824	0.9977	0.9789
Q01	Emergency Aortic Surgery	0.8509	0.6125	0.8421	0.6089
Q17	Peripheral Vascular Disease >69 or w cc	0.9745	0.7951	0.9692	0.7616
Q18	Peripheral Vascular Disease <70 w/o cc	0.9980	0.9712	0.9963	0.9652