PRODUCTIVITY COSTS: PRINCIPLES AND PRACTICE IN ECONOMIC EVALUATION

PRITCHARD & SCULPHER

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OHE

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Clive Pritchard,
Office of Health Economics, London
and Mark Sculpher, *Centre for Health Economics, University of York*

Office of Health Economics
12 Whitehall London SW1A 2DY

ISBN 1 899040 76 5
Printed by BSC Print Ltd., London

Acknowledgements
We are grateful for comments from Werner Brouwer, Martin Buxton, Tony Culyer, Alison Keith and Adrian Towse and to Debra Lerner for permission to reproduce items from the Work Limitations Questionnaire.

About the authors
Clive Pritchard is a health economist at the Office of Health Economics. Mark Sculpher is a Senior Research Fellow at the Centre for Health Economics, University of York.

Abstract
The Secretary of State for Health has recently described health care as a form of 'social investment' which is 'of instrumental importance in improving national economic performance'. This concern with economic productivity is shared by decision makers in other countries, where the impact of health care on workplace productivity has been specified as part of the economic analyses to be submitted in support of claims for the public reimbursement of pharmaceuticals. While concern has been expressed about the potential bias of economic evaluations against the cost-effectiveness of treatment aimed primarily at the non-working population when these 'productivity costs' are included, there is a strong case for considering their importance in studies conducted from a societal perspective. There is, however, less agreement on how these costs should be estimated. The three generally recognised approaches to estimating productivity costs are the human capital approach, the friction cost approach and the approach recommended by the US Panel on Cost-Effectiveness in Health and Medicine. The friction cost approach responds to concerns that the human capital approach may overestimate productivity costs by ignoring any mechanisms which compensate for workers' absence due to illness or disability, particularly the availability of a surplus pool of unemployment. The approach advocated by the US Panel is distinguished from the other two primarily by the view that productivity costs are captured in the assessment of health effects when the quality adjusted life year (QALY) is used and thus any additional adjustments are minimal. This book summarises the debate between the proponents of each method and reviews a sample of studies from the Health Economic Evaluations Database (HEED) to ascertain how productivity costs have been measured in practice. In general, authors did not provide a clear statement of which of the three methods had been used, although the majority favoured the human capital approach. In those cases where the friction cost or US Panel approach had been used, application of the methods was relatively crude. Methodological considerations which might be considered good practice in the presentation of data on productivity effects, such as the use of sensitivity analysis, were observed in only a minority of studies. The paper concludes on the relative merits of the three approaches and recommends ways in which the estimation and presentation of productivity effects might be improved.

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1 INTRODUCTION AND BACKGROUND

Policy makers in many countries are concerned with evaluating the performance of health services in economic terms, by comparing the costs of a particular health care intervention with its benefits in terms of improved health. In this context, the relevant costs are not only the additional direct costs to the health care system of doctors, nurses, hospital beds, medicines and medical equipment but also the impact of the health care intervention on the wider economy, in particular in terms of (reducing) the costs of absence from work due to ill health. This concern with the broader impact of health services was expressed in a recent speech by the English Secretary of State for Health, Alan Milburn, who said that 'good health care is an imperative for improved productivity' (Milburn, 2000).

Just as direct costs represent scarce health care resources which have alternative uses, enabling an individual to remain in work rather than out of work saves scare resources. This value can be quantified in terms of the value of the lost productivity that is averted or the loss in gross income to the patient that is avoided – indeed, in economic theory, these two values are assumed, at the margin, to be equal. Even if the individual is protected from a loss of income by the existence of a social insurance scheme, a loss of production as a result of absence from work still represents a loss to society. This is because income support paid in the event of absence from work due to sickness is simply a transfer from the rest of society to the sick individual. If the sick worker received no income whilst absent from work, the value of lost production would be the same. The two cases merely differ in terms of who bears the cost of the lost production.

In the economic evaluation of health care interventions, the monetary value of lost production is generally combined with the direct costs of patient care but is frequently distinguished from them by the term 'indirect costs'. Traditionally, these costs have been measured using the human capital approach (Weisbrod, 1961). Recently, two alternative approaches have been put forward and 'productivity costs' suggested as the preferred terminology over indirect costs (Luce et al., 1996, Brouwer et al., 1997a). These new approaches have also introduced the concept of 'time costs' to indicate that elements of time other than work time, such as patients' leisure time, may also be affected by ill health. The objectives of this paper are to review the alternative methods that have been suggested, in theory, to value productivity costs, together with the debate surrounding them. The practical assessment of productivity costs is also reviewed using a sample of studies from the Health Economic Evaluations Database (HEED).

The precise definitions of these alternative methods will be presented in the next chapter, which explains each of the proposed measures and discusses the points of controversy between them. The current chapter presents the basic principles behind the identification and measurement of productivity costs, presents arguments for and against their inclusion in economic evaluation and reviews the recommendations to be found in guidelines on the methodology of economic evaluations. Chapter 3 reviews the ways in which productivity costs have been measured in practice, while chapter 4 concludes with some recommendations for the assessment and presentation of these costs in economic evaluations.

1.2 What do productivity costs include?

To set the debate in context, it is important to note that we are concerned with the inclusion of productivity costs in economic evaluations which measure the outcomes of health care interventions in terms of health gain. That is, we are primarily concerned with cost effectiveness analysis and cost utility analysis. Since its impact on productivity can be viewed as an outcome of health care, it is important to consider the question of valuing health outcomes. As we shall see, it has been suggested that one measure of outcome in particular, the quality adjusted life year (QALY), may incorporate at least some elements of the productivity effects of a health care intervention.

Productivity costs refer to loss of production due to illness and mortality. Just as different health care interventions vary in their effects on health, so they have different impacts on production. For example, in comparing two alternative treatments, one may require the patient to take more time off work during treatment but may then enable the individual to resume full-time work when, under the alternative, they would not be able to work. Both of these effects – the lost output while undergoing treatment and the subsequent increased output (under one treatment relative to another) with restored health – represent economic costs associated with the interventions being evaluated. Following the recommendation of The Panel on Cost-Effectiveness in Health and Medicine (the US Panel) (Luce et al., 1996), we treat patients' time spent receiving treatment as a direct cost and, therefore, exclude it from our discussion of productivity costs.

While the focus of much of the discussion surrounding the assessment of productivity costs has been on changes in paid working time, recent debates have drawn attention to the impact which ill health may have on non-paid working time (e.g. housework, child-care, voluntary work) and leisure time. Since, whatever its use (leisure, paid work or unpaid work), time is a scarce resource which has alternative valuable uses, the value of all forgone activities should be incorporated into a broad assessment of productivity costs potentially affected by illness and treatment. Again following the US Panel's recommendations (Luce et al., 1996), the value of working and non-working time lost to the sick individual is regarded as part of productivity costs. However, the value of time spent by family members or volunteers caring for sick friends and relatives is treated as part of the direct costs of care. In the US Panel report, Luce et al. (1996) suggest that such costs are clearly recognised as part of direct costs when the same services are purchased, for example, 'when a private duty nurse is hired to provide home care' (p. 179). While it is important to consider the impact of health care on these costs, our use of the US Panel definitions results in their exclusion from the present discussion of productivity costs.

Box 1 lists the various components of productivity costs and details those costs which are treated as productivity costs for the purposes of this paper. The last item – those costs associated with labour market adjustments in response to morbidity and mortality – will be discussed further in the next chapter.

1.3 The valuation of time

In addition to the identification and measurement of those components of time which are to be included as productivity costs in an eval-

Box 1

Time costs may potentially include a number of components. Those excluded from consideration here, because they are considered to be part of the direct costs of treatment, are the value of:

- Loss in patients' (paid or unpaid) work or leisure time while receiving treatment.
- Individuals' leisure or working time forgone to care for sick friends or relatives.

Those costs included as productivity costs in this paper are the value of:

- Loss in patients' working or leisure time as a result of morbidity.
- Loss in patients' working or leisure time as a result of mortality.
- Work or leisure time affected by labour market adjustments to mortality and morbidity in the work force.

uation, that time needs to be valued. In the case of sickness absence, the cost of time away from work can be regarded as the value of the work time forgone. This time equates to a loss in production which, in turn, can be valued using the payment made for that person's time, that is, the gross wage rate. The reason for using the gross wage rate is that, intuitively, an employer will stand to gain as long as the value of a worker's output is greater than the gross wage they are required to pay, and will employ workers up to the point at which, at the margin, the two are equal.

For unpaid work, such as work in the home or voluntary work, it may be argued that the best alternative activity is paid work and, therefore, any impact on unpaid work may be valued according to the net wage that a similar individual would receive in paid employment. Since the decision to undertake unpaid work implies that the value of that work to the individual is at least equal to the forgone wages from the alternative of paid employment, Luce et al. (1996) point out that this wage provides a lower bound on the value of time. However, they suggest that it 'may be close enough to the real opportunity cost of time to be used in a CEA' (p.202) (CEA = cost effectiveness analysis). On the other hand, Brouwer et al. (1998) argue against the implication of this approach which is that a relatively high value is placed on individuals' activities in the home, such as preparing meals or caring for children, for high earners. They prefer the alternative approach of using the rate paid for an equivalent marketed service, namely the wage rate of a professional housekeeper.

For unpaid work carried out in addition to paid work, the approach of Brouwer et al. (1998) is likely to be more realistic. Indeed, a person's choice to undertake activities that could be purchased suggests that the professional wage rate is greater than the value the individual attaches to that time and thus a maximum estimate. For unpaid work which displaces paid employment, forgone wages will provide a better estimate. Unpaid work is therefore one aspect of individuals' time where problems of valuation can arise, with the individual circumstances of the case being important.

1.4 Should productivity costs be included in economic evaluations?

The argument for including productivity costs in economic evaluations is that the societal perspective is the most appropriate for economic analysis (e.g. Russell et al. (1996), Johannesson and O'Conor (1997)). In this case, all costs should be taken into account, no matter who incurs them, and allowance should be made for all non-resource effects, no matter who experiences them. As Drummond et al. (1997) point out, productivity costs are, in principle, no different from the labour inputs included in the direct cost estimate. However, they also acknowledge that the inclusion of productivity costs is contentious. The two arguments which might be advanced against including productivity effects in an economic evaluation are, firstly, ethical and, secondly, methodological:

i) There are potentially undesirable ethical implications of placing a higher value on interventions which benefit the working rather than the non-working population. Allowing productivity effects to enter the analysis may thus discriminate against groups such as the elderly, and making resource allocation decisions on the basis of such analyses could serve to exacerbate existing inequalities in health (such as poorer access for unemployed people) which could potentially conflict with policy objectives (Koopmanschap and van Ineveld, 1992). Luce et al. (1996) question whether it is ethically acceptable to value the time of women less than that of men in economic evaluation because they are often in lower paid jobs. Olsen and Richardson (1999) argue that society may wish to ignore some production gains on the grounds that to take account of them 'would have unacceptable distributional consequences' (p.21).

ii) It may be valid for productivity effects to be excluded when the only outcome of interest from health care is health gain measured, for example, by the QALYs. Gerard and Mooney (1993) argue that the implication of using the QALY as the measure of benefit is that the opportunity cost of health care resources being employed in one way is the forgone QALYs elsewhere in the health care system. Since the opportunity cost of other (non-health service) resources, such as patients' time, is not restricted to the production of QALYs, these should be excluded from the analysis when QALYs (or health gains, generally) are deemed to be the only outcome of interest. They argue that a wider societal perspective requires the use of cost benefit analysis, in which all consequences (changes in resource use, health effects and non-health effects) are valued in monetary terms.

While they acknowledge the force of the first argument, Koopmanschap et al. (1995) argue that the exclusion of productivity effects would be to deny the reality that production losses influence the scarcity of resources. Both direct costs and productivity costs should therefore be included in the analysis and the extent of the trade-off between efficiency (maximisation of health gains) and equity should be made explicit. Moreover, the problem can be seen as an issue of taking into account all elements of time, not simply paid working time, rather than one of inclusion or exclusion of productivity costs. To exclude productivity costs is implicitly to attach a zero valuation to patients' time. In order to solve the potential ethical problem of valuing the time of different individuals at different rates, time could be valued equally for all patients, whether that time was lost from paid work (and regardless of differences in wage rates), unpaid work or leisure activities. Russell et al. (1996) suggest that the national average wage may be used to value the time of different workers equally, rather than the wage rates specific to each individual undergoing treatment.

In response to the argument that productivity costs should only be considered in the context of cost benefit analysis, Koopmanschap and Rutten (1996b) suggest that non-health care costs can be incorporated into the analysis without the requirement for cost benefit analysis. Taking the example of two programmes which incur equal health care costs but different societal costs, they argue that the resources made available by using the lower cost rather than the higher cost alternative can be added to the health care budget or, indeed, other budgets such as those for education and housing, to produce QALYs. The programme with the higher societal costs therefore has higher opportunity costs in terms of QALYs foregone. The concept of a societal cost effectiveness (or cost utility) analysis has also been developed as a way of justifying the inclusion of all costs (including productivity costs) in studies which use health gain as their measure of effect (Johannesson and O'Conor (1997), Johannesson (1995), Johannesson and Meltzer (1998)). Within this framework, the objective would be to maximise health gain subject to a maximum societal willingness to pay for a unit of health gain, which takes the focus away from the narrow perspective of a health care budget.

In the theoretical debate, there is no overall consensus on whether productivity costs should be taken into account (Drummond et al., 1997), although a recent influential report advocated their inclusion (Russell et al., 1996). From an economic perspective, patients' time has a real opportunity cost and, in some cases, may exceed the direct costs of treatment. The force of the ethical argument against considering productivity costs may be reduced somewhat by observing that the results of an economic evaluation are expressed in terms of mean cost and effectiveness. Where productivity costs are included, treatment recommendations can be made on the basis of an estimate of these costs averaged across relatively low paid and relatively highly paid individuals, without needing to know into which category a particular individual falls prior to treatment. If a person's occupation is implicitly taken into account when, for example, setting priorities between patients on a waiting list, then it can be argued that productivity costs should be brought explicitly into the analysis.

The objection that interventions generally benefiting the non-working population (such as the elderly) would appear less favourable than those which primarily benefit the working population could be addressed by exploring the distributional consequences of policy proposals. Where some groups were felt to be discriminated against in the allocation of resources due to the impact of productivity costs on cost-effectiveness, some weighting of health gain could help to tackle the inequity identified. Therefore, there are strong arguments that productivity costs should be included in economic evaluations, particularly when there is the opportunity to collect data prospectively, as this is likely to give more accurate estimates than if they are made retrospectively (Drummond, 1992).

Whether economic evaluations should include productivity costs, however, is a separate question from whether policy makers wish to take account of them. There may be practical problems, for example, in a health care decision maker being required to absorb the direct costs of treatment within the budget but not being able to take advantage of any offsetting productivity gains. The following section reviews the recommendations that have been made in published guidelines, particularly those developed in support of policy initiatives.

1.5 The policy context

Economic evaluation is now formally used in policy making in various parts of the world, primarily concerning the use of pharmaceuticals. Table 1 reports the stance taken towards productivity costs by guidance on the submission of economic evaluations developed in support of a number of these policy initiatives. In the most recent version of the Australian guidelines for economic studies, although the analyst is not encouraged to include costs other than direct costs, their inclusion may be justified, in which case they should be reported separately. In Ontario, the guidelines advocate evaluation from the societal perspective to include ‘indirect costs such as lost wages’ (Ministry of Health, 1994, p.1), again identified separately from direct costs. In Europe, Finland, Norway and the Netherlands are pursuing a similar policy of requiring economic data to be submitted in support of claims for public reimbursement of pharmaceuticals, while the Italian authorities use such information in price negotiations. All these countries recommend that economic evaluations include productivity costs. In England and Wales[1], where the advice given to the National Health Service (NHS) by the National Institute for Clinical Excellence (NICE) takes into account economic considerations, it is admissible (although not encouraged) for submissions to NICE to include productivity costs.

Table 1 also reviews guidelines for good practice in the conduct of economic evaluations produced by government, academic or industry groups in various countries without a direct link to policy. The guidelines produced by the Canadian Coordinating Office for Health Technology Assessment, the joint UK Department of Health/ Association of the British Pharmaceutical Industry (ABPI) guidelines and those developed by the US Panel all recommend that a societal perspective be taken, including the costs of time. Likewise, those developed in Belgium, France and Germany, state either that productivity costs may or should be included in the analysis. The only guidelines, of those reviewed here, which specify that productivity costs should be excluded are those produced by the private health care insurer Blue Cross/Blue Shield in the US and by the Pharmaceutical Management Agency (PHARMAC, the body which manages pharmaceutical subsidy expenditure) in New Zealand.

1 The Health Technology Board for Scotland will advise the NHS in Scotland on the clinical and cost-effectiveness of new and existing drugs and treatments. In Northern Ireland, responsibility for health policy resides with the Northern Ireland Assembly and its Executive Committee of Ministers.

Table 1 **Treatment of productivity costs in the development of guidelines for economic evaluations**

Guideline	**Include productivity costs?**	**Their recommendations**
Australia (Commonwealth of Australia, 1995)	Allowed	The guidelines 'are based on a comparison of health benefits and net costs from the perspective of society as a whole' but 'it should not be assumed that there is an economic benefit to society through the patient's return to productive capacity'.
Belgium (Belgian Society of Pharmacoepidemiology, 1995)	Yes	'the relevant costs include direct medical (…) and non-medical costs (…), indirect (working time lost) and intangible costs (suffering)'
Canada (Canadian Coordinating Office for Health Technology Assessment (CCOHTA), 1997)	Yes	'all costs and benefits should be identified regardless of who incurs the costs or who receives the benefits'
Finland (Ministry of Social Affairs and Health, 1999)	Yes	'The costs shall include all the direct health costs and comparable social costs'
France (Collège des Economistes de la Santé, 1997)	Allowed	'The indirect costs (benefits) may appear in a study where the management strategy or disease being considered justifies this'
Germany – Hannover consensus group (Hannoveraner Konsensus Gruppe, 1999)	Yes	'direct and indirect resource consumption should be analyzed with the help of opportunity costs'
Italy (Italian Group for Pharmacoeconomic Studies, 1997)	Yes	Evaluations 'should adopt the point of view of society and must therefore consider every type of cost (direct health costs, direct non-health costs, indirect costs)'
Netherlands (Sickness Funds Council, 1999)	Yes	'an analysis must cover ALL the likely costs and benefits, irrespective of who actually bears these costs or receives these benefits'
New Zealand (Pharmaceutical Management Agency Ltd (PHARMAC), 1998)	No	'the HFA/PHARMAC perspective in CUA is to consider only health benefits and direct HFA and patient costs. Where indirect costs and non health related benefits are important it is likely that they will be recognised within PHARMAC's Decision Criteria'

Norway (Norwegian Medicines Control Authority, 1999)	Yes	'the economic consequences which the health programme will have for the society as a whole and for the State should always be stated'
Ontario (Ministry of Health, 1994)	Yes	'The societal perspective that incorporates both direct and indirect costs and clinical outcomes should be presented in a disaggregated fashion'
UK (Department of Health/ Association of the British Pharmaceutical Industry (DH/ABPI), 1994)	Yes	'Indirect costs should normally be included in a societal perspective'
UK (National Institute for Clinical Excellence, 2000)	Allowed	'The wider costs (e.g. to patients or carers) and benefits (e.g. a reduction in disability that allows continuation of employment) of treatment can be taken into account'
US Blue Cross/Blue Shield (Langley, 1998)	No	'pharmacoeconomic evidence should be restricted to those studies which are considered appropriate to the information needs of Blue Cross and Blue Shield'
US Panel (Russell et al., 1996)	Yes	'The Reference Case is based on the societal perspective'

2 THEORETICAL CONTRIBUTIONS TO THE VALUATION OF PRODUCTIVITY COSTS

2.1 Overview

The objective of this chapter is to outline the different approaches towards the assessment of productivity costs and to review the main points of contention between them. The methodological debate summarised here focuses on two key issues with regard to the incorporation of productivity costs into economic evaluation. Firstly, there has been a longstanding concern that traditional methods of valuing productivity costs may overestimate their importance by not taking account of factors which, in reality, help to mitigate the impact on production of morbidity and mortality.

The impact of long term absences on production may be reduced by replacing the absent worker from individuals who are currently unemployed (Williams, 1992). In the event of a short term illness, Drummond (1992) noted that loss of production may be limited as a result of others performing the tasks of the sick individual or that person making up for lost time upon his or her return to work. Severens et al. (1998), for example, found that their estimates of productivity costs due to absence from work with dyspeptic complaints were reduced by three quarters when compensating mechanisms were taken into account.

The second key issue is the extent to which monetary estimates of productivity costs and measures of health outcome may be capturing the same effect. For example, Russell (1986) has suggested that including a monetary valuation of a productivity gain for an intervention as well as the health gain amounts to valuing the same effect in two different ways and, therefore, constitutes double-counting. This argument has been taken up particularly with regard to evaluations using outcome measures – typically the QALY – which include a valuation of an individual's health status. Box 2 describes some circumstances under which double-counting may occur.

2.2 Measurement of productivity costs

Aside from ensuring that they are not counted twice, an accurate estimate of productivity costs will depend on obtaining appropriate mea-

Box 2 **Double-counting of productivity costs in economic evaluation**

Problems can potentially arise when health status is valued within the outcome measure in an economic evaluation (e.g. as a utility or preference value within the QALY). This is because of the way individuals interpret valuation exercises.

- Johannesson (1997) and Brouwer et al. (1998) suggest that people implicitly take account of leisure time when valuing states of health. In this case, attaching a monetary value to changes in leisure time is unnecessary and would be double- counting.
- A second possibility of double-counting is when patients pay for part of their health care costs themselves, since individuals may take into account the change in health care consumption when comparing and valuing different health states. In this case, including the patient's (out of pocket) direct costs in the overall cost estimate in a study would amount to double-counting since they would also be incorporated into the QALY. This should not be a problem in countries where health care is fully financed by the state or another third party payer but, elsewhere, the problem could be avoided by asking respondents to assume that they will not incur health care costs as a result of ill health (Johannesson, 1997).
- Finally, an issue which has generated much recent debate. It is possible that individuals may take account of any loss of income when absent from work with illness and implicitly allow for this impact when valuing health states (Garber et al., 1996). Therefore, including a separate estimate of the value of lost productivity as a monetary amount in the cost estimate would represent double-counting, at least in part. Dispute has arisen over whether it is acceptable to regard productivity costs as fully incorporated into the QALY, through the effect of lost income on the value individuals attach to health states, or whether, instead, they should be included in the cost calculation (Brouwer et al. (1997a,b), Weinstein et al. (1997)). If a monetary value is attached to these productivity costs, health state valuation should be conducted with respondents explicitly asked to assume no loss of income when sick.

sures of the amount of work (and leisure) time affected by illness and treatment. One source of evidence on absenteeism is the literature, reviewed by Johns (1994), which has either used samples of individuals or large-scale household surveys to obtain data on absence from work generally. The accuracy of self-reporting has been investigated by

Revicki et al. (1994) amongst a random sample of employees of a single organization. They compared reported absence from work on the basis of respondents' recall over the previous four weeks and three months with time card records completed weekly over the same periods and found a close correspondence between the two. A similar study by Severens et al. (2000) found that over 95% of reported sickness absence had a perfect correspondence with registered data with recall periods of two and four weeks, declining to 57% for six months and 51% for 12 months recall.

Absence from work is not, of course, the only means by which productivity losses can occur; another aspect is impaired performance at work. Among the employees of one Dutch company, Brouwer et al. (1999) found that, on an average day, over 7% of respondents reported health problems while at work. While this study suggests that productivity losses without absence may be a general problem, they are likely to be more significant for some illnesses than others. For example, van Roijen et al. (1995) estimated productivity costs due to reduced productivity at work with migraine in the Netherlands of between 277 million and 1,455 million Dutch guilders, in excess of the costs attributable to absence from work. Based on estimates for average effectiveness at work of 42% for men and 34% for women from the American Migraine Study, Hu et al. (1999) put the costs of migraine-related reduced productivity in the US at US$1,420 million for men and US$4,026 million for women.

In a trial among migraine patients from 15 clinical centres in the US, Cady et al. (1998) found that, over an eight hour shift, those in the placebo group experienced an average of over 100 minutes time lost to reduced effectiveness. Davies et al. (1999) estimated effectiveness in paid work performance of 48.6% in the usual therapy arm of a trial among patients with migraine, using the Migraine Work and Productivity Loss Questionnaire. In other disease areas, Testa and Simonson (1998) estimated a retained productive capacity of 87% in the placebo arm of a study among diabetics while Kessler and Frank (1997) reckoned that psychiatric disorders in the US were responsible for 31 work cutback days (days on which workers had to cut back on what they did or did not get as much done as usual) per month per

Box 3 **Illustrative items from the Work Limitations Questionnaire**

In the past 2 weeks, how much of the time did your physical health or emotional problems make it difficult for you to do the following?

	All of the time (100%)	*Most of the time*	*Some of the time (about 50%)*	*A slight bit of the time*	*None of the time (0%)*	*Does not apply to my job*
a. do your work without stopping to take breaks or rests	☐1	☐2	☐3	☐4	☐5	☐0
b. stick to a routine or schedule	☐1	☐2	☐3	☐4	☐5	☐0
c. keep your mind on your work	☐1	☐2	☐3	☐4	☐5	☐0
d. speak with people in person, in meetings or on the phone	☐1	☐2	☐3	☐4	☐5	☐0
e. handle the workload	☐1	☐2	☐3	☐4	☐5	☐0

Note: Items a. and b. are from the Time Demands scale. Items c.and d. are from the Mental-Interpersonal Demands scale. Item e. is from the Output Demands scale.

In the past 2 weeks, how much of the time were you ABLE TO DO the following without difficulty caused by physical health or emotional problems?

(Mark one box on each line)

	All of the time (100%)	*Most of the time*	*Some of the time (about 50%)*	*A slight bit of the time*	*None of the time (0%)*	*Does not apply to my job*
a. walk or move around different work locations (for example, go to meetings)	☐1	☐2	☐3	☐4	☐5	☐0
b. use hand-held tools or equipment (for example, a phone, pen, keyboard, computer mouse, drill, hairdryer, or sander)	☐1	☐2	☐3	☐4	☐5	☐0

Note: Items a. and b. are from the Physical Demands scale.

Source: Work Limitations Questionnaire, © 1998, The Health Institute; Debra Lerner, Ph.D.; Benjamin Amick III, Ph.D.; and GlaxoWellcome, Inc. All Rights Reserved.

100 workers. Greenberg et al. (1993) put the cost of work incapacity due to depression in the US at US$12 billion.

The potential importance of impaired performance at work is recognised by those generic (as opposed to disease specific) questionnaires which have been developed to measure the impact of illness and treatment on productivity. Examples are the Health and Labor Questionnaire (van Roijen et al., 1996) and the Work Productivity and Activity Impairment (WPAI) measure (Reilly et al., 1993). As well as questions concerning paid and unpaid work, both of these instruments attempt to measure the impact of morbidity on work productivity. Box 3 reproduces some of the items from a third survey instrument, which focuses exclusively on the impact of illness on performance at work, the Work Limitations Questionnaire (Lerner et al., 1998). It should be noted that this questionnaire collects information on the amount of time in the last two weeks during which the respondent has been limited in their ability to undertake various job demands. A separate algorithm is required to convert the different scale scores (ranging from 0 to 100) into an estimate of health-related productivity costs. The questionnaire was designed to enhance the potential for measuring reduced productivity at work, has been extensively validated and is intended to be of use to employers and disability management professionals (including physicians) (Lerner, 2000).

2.3 Valuation of productivity costs

There are three proposed methods by which productivity effects can be incorporated into an economic evaluation. The two methods for placing a monetary value on these costs are the human capital approach and the friction cost approach. The third method is to include part of the value of these effects in the assessment of health outcomes, as recommended by the US Panel (Luce et al., 1996). As well as there being substantial differences between the different methods, there is also some common ground. For example, the US Panel approach has elements of both the human capital and friction cost approaches, while the proponents of the friction cost approach recommend that the valuation of one component of time costs, namely leisure time, be incorporated into the health effects (Brouwer et al., 1997b).

In the following discussion, productivity costs as a result of morbidity are distinguished from those resulting from mortality; effects on the individual being treated are separated from those on other members of society; and the treatment of work time is distinguished from the treatment of leisure time. Since the methods are primarily concerned with work time, the consideration of leisure time is left until the end of the chapter.

2.4 The human capital approach

The human capital approach is the traditional method of valuing productivity costs for economic evaluation. Weisbrod (1961) was one of the earliest users of the method in the context of health care evaluation. Historically, it is also the method which has most often been used to estimate productivity costs. The method focuses on the impact of health care on lost work time, whether through illness or death to the individual undergoing treatment. In general, work time is valued according to the gross wage. The rationale given by Weinstein et al. (1997) for this is that 'in a well-functioning labour market, productive output and the compensation to the worker are equal, because they represent the same resource' (pp.506-507). This is one of the implications of standard neoclassical economic theory on which the approach is based; the main tenets of the debate which are relevant to the present discussion are reported in Box 4. The method is summarised in Table 2.

With the human capital method, productivity costs due to mortality are measured by the lost gross wages during the period of time from the age at which death occurs to the usual retirement age. Thus, with a future likely retirement age of 65, the benefit of an intervention restoring full health to an individual who would otherwise have died at the age of 25 is the present value of the total gross income expected to be earned over the following 40 years. Retirement age will not be the same for all individuals but will depend on their private and state pension arrangements. The value of production maintained due to

Box 4 **The human capital approach and neoclassical economic theory**

It is assumed in this framework that individuals and firms seek to maximise their utility and profits, respectively, from the activities in which they are involved. From the firm's point of view, as additional, or marginal, employees having similar skills are taken on, the value of the firm's production increases but by successively smaller amounts. It is assumed that the contribution of each additional employee to total production falls as more workers are employed. As long as the gross wage paid by the firm is less than the contribution to output of the marginal worker, then the firm can gain by employing more workers. On the other hand, if the gross wage is greater than the contribution of the marginal worker, then the firm will reduce its employment. Profit maximisation will involve the firm employing workers up to the point at which the marginal contribution to production is equal to the gross wage. This reasoning forms the basis for using the gross wage as the value of lost production during absence from work.

Table 2 **The human capital approach**

Mortality	**Morbidity**
Productivity costs are the present value of lost gross wages from time of death to retirement age. A life prolonging intervention reduces productivity costs by the gross wages earned over the additional life years.	Productivity costs are the present value of lost gross wages over the period of illness. An intervention which avoids ill-health reduces productivity costs by the gross wages earned over the duration of illness prevented.

health care interventions which have a favourable impact on morbidity is measured in a similar way to the mortality case, using the gross wage over the period of absence avoided. As Liljas (1998) points out, the human capital approach is also able to value lost time from unpaid work by, for example, using the gross wage rate earned by individuals undertaking similar work on a paid basis. Thus, the value of time forgone from caring for a sick relative could be valued at the gross wage of a care assistant.

2.5 Criticisms of the human capital approach

Koopmanschap and van Ineveld (1992) argue that the human capital method provides an estimate of potential lost production as a result of disease, rather than the loss that would be experienced in practice. In reality, they argue, there are compensating factors for absence from work due to mortality or morbidity, with organisations adjusting to the illness or death of their employees so that production losses are minimised. Production losses are still experienced but they occur principally during the period required to replace the productive activity of an absent worker. The period of time organisations require to restore production levels is known as the friction period.

It is argued that the human capital approach adopts the unrealistic assumption of 'full employment', with the numbers out of work limited to the level of frictional unemployment. This is the level of unemployment that will always be present since vacancies take time to fill and there is never a perfect correspondence between the demand for and supply of labour. In the event of full employment, replacing a deceased worker from amongst the frictionally unemployed will not add to production because that individual would have found employment anyway. The firm which takes this person on will not suffer a loss of output but a loss will be experienced by the alternative employer who would otherwise have employed this individual and actual production losses will be close to the human capital estimates. However, it is argued that full employment is a restrictive assumption which rarely conforms to economic reality.

If unemployment persists at a level above that of frictional unemployment – that is, there is involuntary unemployment – then long term work absence or deaths in the work force can be made good by recruiting from this pool of unemployed, who would not otherwise have found employment. Beyond the friction period required to make this replacement, it is argued that there is no impact on production except to the extent that adjustments in the labour market have medium term macroeconomic effects. Koopmanschap and Rutten (1993) suggest that these may result from a number of influences such as the impact absence from work has on labour productivity and consequently on international competitiveness. A macroeconomic model of the economy is required to evaluate such medium term effects.

2.6 The friction cost approach

The friction cost approach is most closely associated with a group of economists at Erasmus University, Rotterdam (the Erasmus group), including the critics of the human capital approach noted above, and is described in a series of publications (Koopmanschap and van Ineveld (1992), Koopmanschap and Rutten (1993), Koopmanschap and Rutten (1996a,b), Koopmanschap et al. (1995)). The preferred definition of productivity costs (and time costs) by the proponents of the friction cost approach is given in Box 5 and the approach is summarised in Table 3.

2.6.1 The mortality case in the friction cost approach

In the friction cost approach, the existence of involuntary unemployment limits production losses due to death to the period required to replace the deceased worker from the ranks of the unemployed. It is

Box 5

Brouwer et al. (1997a) define productivity costs according to the friction cost approach as follows:

‘costs associated with production loss and replacement costs due to illness, disability and death of productive persons, both paid and unpaid’.

Brouwer et al. (1998) define time costs as follows:

"The patient’s ‘time costs’ are equivalent to productivity costs plus the impact of changes in time use on health-related quality of life, as a result of illness and disability’.

Table 3 **The friction cost approach**

Mortality
Deceased workers are replaced from the unemployed. Productivity losses (and corresponding gains from health care) are limited to the friction period and medium term macroeconomic effects.
Morbidity – permanent disability/long term illness
Workers experiencing illness or disability longer than the friction period are replaced from the unemployed, with the same implications as for the mortality case.
Morbidity – temporary illness
Output may be made up on return to work or by internal labour reserves, with the impact limited to medium term effects. Alternatively, increases in costs in the form of temporary workers or use of overtime can be approximated by the lost output of the sick worker.

argued that the duration of vacancies may stand as a proxy for this period. In addition to lost production over the friction period, productivity costs include the costs of filling the vacancy and training new personnel. If replacement is from within the organisation or from another organisation, with the resulting vacancy being filled in the same way, then there will be a 'replacement chain' (Koopmanschap and Rutten, 1996b, p.DS62) with a position ultimately being filled by an unemployed person. The income formerly earned by a worker who dies is now earned by the individual who was previously unemployed and there are no income or production losses from a societal point of view in the long run. Correspondingly, the gains in production from an intervention which prolongs life will be limited to the friction period (ignoring any medium term macroeconomic effects).

2.6.2 The morbidity case in the friction cost approach

In the case of permanent or long term disability leading to somebody having to stop working for a period in excess of the friction period, the implications are similar to those of the mortality case since replacement is assumed after the friction period (Koopmanschap et al., 1995). Those who become disabled such that they have to give up work will be replaced from the ranks of the unemployed and the effects on production beyond the friction period are limited to the medium term macroeconomic impact.

For the case of the employee who experiences a short term illness, the following four situations are possible (Koopmanschap and Rutten, 1996b):

1. Both costs and production are unaffected. This would be the case if work can be made up by the sick employee upon his or her return to work. Alternatively, the organisation may hold internal labour reserves, the opportunity cost of which will depend on the probability of their being gainfully employed elsewhere and will be low if unemployment is well in excess of the level of frictional unemployment. However, permanent labour reserves may raise labour costs and give rise to medium term macroeconomic consequences.
2. Production stays the same but costs increase. This would be the case if colleagues of the sick worker work overtime or, alternatively, temporary workers from the organisation's own reserves or from outside agencies are used. The costs of overtime working or the use of temporary agencies tend to be higher than average labour costs.
3. Production falls but costs remain the same, in which case the loss of output is the relevant productivity cost.
4. Production falls while costs increase, with a shortfall between the production of additional permanent or temporary employees and the level of production previously achieved by the absent employee.

In the first of these scenarios, there are no short term costs but medium term effects generated, for example, by the impact of labour costs on international competitiveness (Koopmanschap and Rutten, 1993) need to be taken into account. In the other three, it is argued that productivity costs may be approximated by an estimate of the lost production of the sick employee during the period of absence (Koopmanschap et al., 1995). The impact of an intervention which

Table 4 **Comparison of human capital and friction cost estimates of productivity costs from all illness, excluding macroeconomic effects, for the Netherlands in 1988 (billions of Dutch guilders)**

Cost category	Friction costs	Human capital costs
Absence from work	9.2	23.8
Disability	0.15	49.1
Mortality	0.15	8.0
Total (as a percentage of net national income)	9.5 (2.1%)	80.9 (18%)

Source: Koopmanschap and Rutten (1996b)

prevented or curtailed the illness would, therefore, be the production of the treated worker during the period of absence which would otherwise have occurred. The estimates should allow, it is recommended, for the finding that a given reduction in annual labour time leads to a smaller percentage reduction in labour productivity per year. For absences shorter than the friction period, Koopmanschap et al. (1995) estimate the costs of absence to be 80% of the production value during the period of absence in their 'main variant' calculation. This is based on a previous estimate for the Netherlands that a 10% decrease in labour time would lead to an 8% fall in production.

While the estimate of productivity costs may not be greatly dissimilar to that used in the human capital approach in the case of short term morbidity, the friction cost approach differs markedly in its estimates of productivity costs due to mortality or long-term morbidity. The differences in friction cost and human capital estimates for morbidity and mortality, respectively, are illustrated in Table 4 with data from the Netherlands.

2.7 Criticisms of the friction cost approach

The main objection of Johannesson and Karlsson (1997) and Liljas (1998) to the friction cost treatment of mortality is that the absence of productivity costs after the friction period implies that the opportunity cost of labour is set at close to zero after the friction period. Both argue that, in order to be consistent in the analysis, the same approach would have to be taken towards direct health care costs, a large part of which takes the form of labour costs (e.g. the time input of health care professionals and the labour costs incurred in producing other inputs such as medicines). Applying a value close to zero to direct labour inputs would substantially reduce the costs of health care interventions. It is this impact which, they suggest, illustrates the unreasonableness of the friction cost approach.

According to these critics, the friction cost approach implies a highly unrealistic scenario in which unemployment could be solved if the number of hours worked by employed workers was reduced and those hours were worked instead by the unemployed. Moreover, it is contended that the possibility of a vacancy due to mortality being filled by someone who is already employed, rather than unemployed, implies the existence of at least two friction periods. Thus, the friction cost approach does not properly account for the possibility of a chain of vacancies culminating in an unemployed person finding employment. Johannesson and Karlsson (1997) also suggest that the value of changes in life-years due to mortality is included in the health outcomes of that programme if QALYs or life-years are used. Therefore, including them as a cost item would constitute double counting. This argument is reflected in the approach adopted by the US Panel (see below).

For periods of illness shorter than the friction period, Johannesson and Karlsson (1997) claim that the friction cost estimate of productivity costs as 80% of the value of production is inconsistent with economic theory. For this adjustment to be appropriate, a worker's gross wages would have to be greater then the value of his or her production, in which case that worker would not be employed (Liljas, 1998). The same applies to the use of internal labour reserves: they would not be employed unless their output was at least equal in value to their gross wages. In the event that production levels are restored by workers making up for lost time, this could only be done at the cost of them working harder or accepting reduced leisure time. Liljas (1998) acknowledges that the human capital approach may overestimate this cost if it is less than the gross wage but argues that it is unlikely to be negligible.

2.8 Response to the criticisms of the friction cost approach

In the mortality case, Koopmanschap et al. (1997) reject the argument that their approach implies a zero opportunity cost of labour after the friction period. Firstly, the method includes medium term macroeconomic effects beyond the friction period. More fundamentally, the approach should be seen as a means of attempting to explore the practical implications for production and costs of mortality and morbidity based on a realistic assessment of the adjustments which take place in the economy. Thus, Brouwer and Koopmanschap (1998) regard as a misuse of the method the suggestion that it implies a means by which unemployment may be solved. The main difference between the approaches is accounted for by the assumption adopted in the human capital approach that labour markets always reach an equilibrium at full employment so that there is no potential for replacing sick workers. In contrast, the existence of involuntary unemployment is accepted in the friction cost approach with the result that long term absence from work need not result in a loss of output beyond the friction period.

The method is capable of further refinement, for example, with respect to the valuation of the costs of internal labour reserves, on which work is currently being conducted. Replacement of absent workers may be more complicated than in the simple model, perhaps involving a chain of replacements or a particular scarcity of certain types of labour, either of which would prolong the friction period. Nevertheless, the existence of involuntary unemployment which can compensate for long term absence from work is defended as more realistic than the assumption that there is permanent full employment.

As far as the costs of short term absences are concerned, Brouwer and Koopmanschap (1998) argue that firms do not, in practice, adhere to the textbook assumptions concerning firms' behaviour which Liljas (1998) claims are violated by the friction cost approach. They point out that their 80% adjustment for the responsiveness of output to changes in labour time is applied to average output per worker, rather than to the wage rate. It is not inconceivable, they suggest, for labour costs to be around 80% of average value added[1].

With regard to the existence of internal labour reserves, sick workers making up lost output on return to work and cancelling of less important work, Brouwer and Koopmanschap (1998) acknowledge that these were not included in the empirical estimates. Although reliable estimates of their magnitude were not available at the time, further research may help to clarify whether these costs are sufficiently large to warrant inclusion. The criticisms of the friction cost approach, and the responses to them, are summarised in Table 5.

2.9 Incorporation of productivity costs into health effects: the US Panel approach

As a generic measure of health outcome, the QALY represents health in terms of life expectancy (life-years) and the value attached to health status experienced during those years. However, the process of valuing health status may complicate the appropriate methods for valuing productivity costs (Sculpher and O'Brien, 2000). The issue which has been the subject of much recent debate is the possibility that individuals may take account of any loss of income when valuing health states where loss of working time is likely due to ill-health. If this occurs, an

1 In economic theory, a profit maximising firm will employ labour up to the point at which the addition to gross wage costs from employing an additional worker is equal to the additional revenue gained by doing so. Assuming that each additional worker adds successively fewer units to total output (diminishing marginal returns), then even in a perfectly competitive product market in which all output is sold at a common price, average revenue per worker will fall as more employees are taken on. Since average revenue per worker is falling, the contribution of each additional worker to total revenue (the marginal revenue per worker) will be below the average. Therefore, taking 80% of average revenue per worker as the value of an individual worker's output may be a reasonable approximation. It is worth noting that, if extra workers can be taken on at the same wage rate, then the average gross wage will be equal to the addition to the wage bill from employing additional workers and will be an accurate measure of the marginal employee's output. However, if the wage rate must be increased to attract additional workers, then the average gross wage will be less than the addition to the wage bill from employing an extra worker and so less than the value of his or her output at the optimal level of employment.

Table 5 **Criticisms of the friction cost approach**

	Criticism	Response
Mortality	Implies that the opportunity cost of labour, including direct labour iputs, is zero after the friction period.	This is not the conclusion of the proponents of this approach; medium term macroeconomic effects are incorporated.
	More than one friction period to allow for if the deceased worker is initially replaced from the employment.	A chain of replacements lengthens the friction period rather than creating multiple friction periods. The method can embrace this refinement.
Morbidity	Apparent solution to unemployment by reducing hours worked by the employed.	This misunderstands the purpose of the approach to estimating production changes.
	Adjustment using internal labour reserves is costly for the firm while the sick incur the cost of a loss of leisure if their hours increase on return to work.	Empirical estimates did not include these effects due to lack of information concerning their magnitude but research is continuing.
	Method is incompatible with textbook assumptions about firms' behaviour.	Textbook assumptions are not satisfied in reality; the 80% adjustment is, in any case, applied to average output, not wages.

additional estimate of the value of lost productivity as a monetary value in the cost estimate would constitute double counting. Dispute has arisen over whether it is acceptable to regard productivity effects as being allowed for partly or wholly in individuals' valuation of health states, through the effect of any perceived loss of income on overall welfare, or whether, instead, they should be included in the cost calculation.

Box 6

Luce et al. (1996) define productivity costs to include the following:

- Lost or impaired opportunities to work or enjoy leisure as a result of illness.
- Lost productivity due to death.

Time costs included in published analyses are identified as the two items above plus the following which are considered by the US Panel to be **direct** costs:

- Time spent by patients consuming health care.
- Time of informal carers looking after sick friends and relatives.

In the US Panel's Reference Case, the inclusion of productivity costs in the measure of health effects is the preferred approach, the Panel recommending that analysts use health state values which implicitly incorporate the impact of illness on ability to work and financial loss (Gold et al., 1996). The Panel's definitions of productivity costs and time costs are presented in Box 6 and the approach is summarised in Table 6. Productivity costs related to changes in mortality are fully accounted for in the health effects when these are expressed as life years or QALYs, and those related to morbidity are deemed to be in health state values when QALYs are used.

Table 6 **The US Panel approach**

Mortality	**Morbidity**
Impact of health care on work time for the sick individual is permanent and fully accounted for by life years or QALYs. Deceased workers may be replaced from the unemployed. 'Consumption externalities' and costs to the employer are incurred in the friction period only and should be valued in monetary terms.	QALYs take account of the impact on income (and hence general wellbeing) for the individual providing health state values. This impact lasts for as long as the individual is away from work. Consumption externalities and costs to the employer (in the friction period) should be valued in monetary terms.

While the impact on the individual receiving treatment can, in principle, be allowed for in the measure of health effect, an individual's (net) income (and hence this approach) will not reflect the full value of production. The difference between gross and net income – that part of a worker's output from which others benefit via taxation, and the source of 'consumption externalities' – should, in principle, be accounted for in monetary terms (Weinstein et al., 1997). In addition, short-term costs borne by the employer to replace lost workers should be valued in monetary terms. The US Panel approach can therefore be viewed as being similar to the human capital approach, albeit with productivity costs expressed as a component of health rather than in monetary terms, but incorporating elements of the friction cost approach.

2.10 Criticisms of the US Panel approach

The Erasmus group has expressed a number of reservations concerning the US Panel's approach of including a large part of productivity costs within the health effects component of an economic evaluation (Brouwer et al., 1997a). The first is that the valuation of health status is not intended to capture the impact of non health-related events such as loss of income. They argue that, when health state valuation exercises do not refer to the effects of changes in income, then individuals may or may not implicitly incorporate these effects into their health state valuations. Sculpher and O'Brien (2000) have undertaken a review of five multi attribute utility measures (EuroQol EQ-5D, Health Utilities Index, Quality of Wellbeing Scale, Rosser Index and 15D) for their approach, if any, towards income changes. Only one of these measures (the Health Utilities Index) could be regarded as directly ruling out the effect of income changes by instructing respondents to assume no change in their financial position. It is also the only one of the five not to include descriptive items of direct relevance to the ability to work. All the others contained such items, for example, 'unable to perform usual activity' in EQ-5D and 'unable to undertake any paid employment' in the Rosser scale, but could be classified neither as ruling in nor as ruling out income effects. Whether and to what extent respondents have incorporated the impact of changes in income into the valuations used to scale these instruments is therefore unclear.

The way in which individuals formulate values for health states is clearly crucial to the validity of the US Panel approach. It remains a matter of dispute whether it can be assumed that the impact of ill health on a person's income is incorporated into their set of valuations or whether the question can be posed in such a way that it is accounted for. A relevant consideration here is the point made by Brouwer et al. (1997a), Meltzer and Johannesson (1999) and Sculpher and O'Brien (2000) that individuals may be protected from a loss in income while sick by the existence of social or private insurance arrangements. Weinstein (1999) simply argues that to value productivity costs in monetary terms presents a greater risk of error by double-counting than the possibility of not including them at all.

In addition to reservations concerning morbidity costs in the US Panel approach, it is also worth contrasting the long term implications with those of the friction cost approach. According to the latter, income lost to workers through death or disability lasting longer than the friction period is matched by an increase in income by their replacements from the unemployed. This means that changes in income and production are limited to the friction period, except for the medium term macroeconomic impact. In comparison, as Brouwer et al. (1997a) point out, the US Panel's proposition that changes in income are captured by QALYs implies that income changes beyond the friction period are included since responses to health state valuation exercises will relate to the entire period of the illness. In the case of an intervention which improves survival, the US Panel approach recognises a production gain for the entire period over which survival is increased in the same way as the human capital approach, but this is expressed as part of QALYs rather than in monetary terms. The relevance of this point of contention depends upon the differential treatment of leisure time for the unemployed by the US Panel and Erasmus group, an issue dealt with in section 2.12 below.

2.11 The valuation of leisure time – sick or deceased workers

Death results in a loss of production and of leisure time while morbidity causes a loss of production and an increase in the amount of leisure time for the individual affected. In the human capital approach, there is no generally accepted way of valuing leisure time, but it would be consistent with the tenets of the human capital approach to value leisure time at the net wage (see Box 7). Alternatively, the value of leisure time during periods of ill-health can be assumed to be close to zero, if the individual cannot enjoy the increased leisure time, or it can be regarded as part of the QALY (Liljas, 1998). The friction cost approach does not treat leisure as part of productivity costs but the Erasmus group have recommended that leisure time be included as part of overall time costs. They suggest that changes in the value of leisure time can be expressed in terms of quality of life (Brouwer et al., 1998) and regard the QALY as an appropriate measure when allowing for changes in the ability to enjoy leisure time (Brouwer et al., 1997b). The same approach is taken by the US Panel (Weinstein et al., 1997). In contrast with the human capital approach, both the Erasmus group and the US Panel consider the possibility that a sick or deceased worker will

Box 7 **The valuation of leisure time based on neoclassical economic theory**

From the individual's point of view, it is assumed that there are no restrictions on the choice between the number of hours worked and the number of hours spent in leisure activities. The more hours that are spent at either work or leisure, the lower the subjective satisfaction from additional, or marginal, hours earning income or engaged in leisure activities, respectively. Workers then maximise their utility by choosing that combination of hours worked and hours spent at leisure where the marginal levels of satisfaction from work and leisure are equal. In other words, the value of an additional hour of leisure is equal to the additional earnings from an hour worked, or the net wage. Assuming that all job contracts are voluntarily entered into, the net wage paid compensates the worker fully for the loss of leisure.

Table 7 **The valuation of leisure time in the three approaches**

	Mortality	**Morbidity**
Human capital approach	Not usually considered. If the life-year or QALY is used as a measure of health, the value of lost leisure time is accepted as being valued within those measures of outcome. When other outcomes are used, it would be consistent with the tenets of the human capital approach to value lost leisure time according to the net wage.	Not usually considered. The value of changes in leisure time is accepted as being valued within the QALY if it is used as a measure of health outcome. When other outcomes are used, it would be consistent with the tenets of the human capital approach to value lost leisure time according to the net wage.
Erasmus group	Loss of leisure time for deceased workers, and corresponding gains from life extending interventions, are a dimension of health and can be captured by QALYs. The value of leisure time losses (gains with intervention) for the unemployed as a result of mortality within the employed work force is assumed to be close to zero.	The impact on leisure for the sick/disabled worker is captured by QALYs. Changes in leisure for the unemployed (in the case of permanent disability) are again assumed to be of zero value.
US Panel approach	Impact of health care on leisure time for the sick individual is fully accounted for by QALYs. Loss of leisure for the unemployed who replace deceased workers is assumed of equal value to the income gained.	QALYs take account of the impact on leisure for the individual treated. Loss of leisure for the unemployed who replace long term disabled workers is assumed of equal value to the income gained.

be replaced from the unemployed, as discussed in the following section. All three approaches to valuing leisure time are compared in Table 7.

2.12 Leisure time for the unemployed

In the case of a worker who dies or becomes permanently disabled and is replaced from the unemployed, the individual who was previously unemployed loses leisure time. The change in leisure time for the unemployed has not been discussed in descriptions of the friction cost approach, as noted by Weinstein et al. (1997). However, the Erasmus group have argued that the unemployed would willingly give up their leisure time to take a job and, therefore, the value of leisure time to them is low (Brouwer et al., 1997b). In contrast with the Erasmus group, the US Panel regard the value of lost leisure time for the unemployed upon replacing a deceased worker to be equal to the value of the income from employment. Balancing the lost leisure against the increased consumption opportunities for the unemployed, Weinstein et al. (1997) argue that 'it is usually implicitly assumed that this net transaction results in no net cost or benefit to society' (p.507).

2.13 Human capital, friction cost and US Panel approaches compared

Table 8 summarises the key points of the three approaches to the valuation of productivity costs outlined above. The Erasmus group recommendations on leisure time are here treated as aspects of the friction cost approach.

Table 8 **Summary of the three approaches**

	Mortality	Morbidity
Human capital approach Key references: Weisbrod (1961) Johannesson (1996) Johannesson and Karlsson (1997) Liljas (1998)	Productivity costs are valued as the present value of lost gross wages from age at death to retirement age. It, therefore, includes changes in income to deceased worker and lost consumption externalities (Johannesson, 1996). Leisure time can be included in the QALY (Liljas, 1998).	Productivity costs are valued as the present value of lost gross wages over the period of illness. The QALY can be used to take account of the impact on leisure.
Friction cost approach Key references: Koopmanschap and van Ineveld (1992) Koopmanschap and Rutten (1993) Koopmanschap and Rutten (1996a) Koopmanschap and Rutten (1996b) Koopmanschap et al. (1995) Koopmanschap et al. (1997) Brouwer et al. (1997a) Brouwer et al. (1997b) Brouwer and Koopmanschap (1998) Brouwer et al. (1998)	Deceased workers are replaced from the unemployed after a friction period, during which time society incurs lost production and the employer incurs recruitment and training costs. Beyond this, productivity costs (valued in monetary terms) are limited to medium term macroeconomic effects. QALYs incorporate the impact of ill-health on patients' leisure time; for the unemployed, leisure time is of negligible value.	For disability beyond the friction period, production changes are the same as for the mortality case. For short term illness, productivity costs are not dissimilar to the human capital estimate. QALYs capture the impact on sick workers' leisure.

Table 8 **Summary of the three approaches *(continued)***

	Mortality	Morbidity
US Panel approach Key references: Luce et al. (1996) Weinstein et al. (1997)	Life years or QALYs capture the impact on the deceased worker over what would otherwise have been their expected lifetime; similar to a life years or QALY version of human capital costs. The gain in income for the unemployed is offset by a loss of leisure. Consumption externalities and employers' friction costs are valued in monetary terms.	QALYs capture the change in income and leisure for sick workers for the full duration of the sickness. Consumption externalities and employers' friction costs are valued in monetary terms.

3 THE ASSESSMENT OF PRODUCTIVITY COSTS IN PRACTICE

3.1 Introduction

The general consensus amongst policy makers, and academic groups with an interest in economic evaluation methodology, that productivity costs are important is not matched by agreement on the appropriate method of estimating these costs. Among those guidelines which specify a preferred method, only the Italian ones favour the human capital approach. The Netherlands guidelines explicitly recommend the friction cost approach, the logic of which is accepted by the Australian Pharmaceutical Benefits Advisory Committee and the academic German guidelines. The French guidelines (which are not directly linked to the policy making process) find neither human capital nor friction cost approaches entirely satisfactory while the Norwegian authorities allow either to be used.

The purpose of this chapter is to review the ways in which productivity costs have been assessed in practice in economic evaluations using a sample of studies from the Health Economic Evaluations Database[1] (HEED) up to and including February 2000. Identified studies which take account of productivity costs are categorised, where possible, according to whether they attach a monetary value to these effects by using the human capital approach or the friction cost approach, or, instead, deal with them within the measure of outcomes.

3.2 Search method

The search of the HEED database (OHE, 2000) was restricted to applied studies – that is, original economic evaluations. The search was further restricted to cost effectiveness analyses (CEAs) and cost utility analyses (CUAs), since these are the types of study to which the guidelines of the US Panel on Cost-Effectiveness in Health and

1 The HEED database contains structured reports on economic evaluations, cost of illness studies and cost analyses of health care technologies, identified by searches of online databases, by manual searching of journals and from publication lists of academic and government bodies. Studies can be original evaluations (applied studies), reviews of applied studies, methodological studies, policy papers, letters or editorials.

Medicine are applicable and over which there has been most disagreement in the methods literature. In order to limit the sample to a manageable number, only studies published from 1996 onwards were considered. The two illustrative examples of Reference Case analyses included as appendices to the US Panel report have, therefore, been included in the sample of studies reviewed.

The search for applied CEAs and CUAs gave a total of 1,086 references, of which 120 (11%) were recorded as having included 'indirect' costs. In compiling the database, 'indirect' costs has been given a wider interpretation than the definition of productivity costs used here, so that fewer than this number included productivity costs on the US Panel definition. Given the overwhelming concern expressed in methodological guidelines that economic evaluations should adopt the societal perspective, it is surprising that so few studies estimated productivity costs. While it would be of interest to examine how each of these studies had dealt with productivity costs, we decided to focus on CUAs and CEAs which had used the outcome measure of life years or QALYs gained. This approach was dictated partly by pragmatic considerations but also because, according to the US Panel, productivity costs are implicitly incorporated into the analysis when life years (mortality costs) or QALYs (mortality and morbidity costs) are used. Limiting the search in this way gave 57 studies, of which three were excluded immediately: one gave no information about how productivity costs were estimated, in the second no valuations were provided and the third was an abstract rather than a full article.

On further inspection, a further 14 studies were excluded because the only monetary valuations of time they included related to aspects of time not regarded as productivity costs for the purposes of this paper (patients' time undergoing treatment and caregivers' time), nor was it clear that productivity costs were deemed to be included in the health effects.

For the final group of 40 studies, we report the type of economic evaluation, the intervention being evaluated and the method used to value productivity costs. We report whether mortality or morbidity costs (or both) have been considered, the source of information used to value productivity costs and the outcome measures used including, where relevant, the source of the health state values used to provide the weighting factors in calculating QALYs. This information is of interest since, according to the US Panel, the way in which the health state valuation questions are framed is crucial in determining whether or not it can be assumed that QALYs incorporate productivity costs due to morbidity. Finally, we report whether the results of the study have been presented with and without the impact of productivity effects included and, if so, what impact these have on the results. The appendix contains this information for each of the 40 studies in the review. The main purpose of this chapter, however, is to give an overall idea of the characteristics of these studies and to judge the extent to which they comply with our ten-point checklist of criteria for studies which include productivity costs, as summarised in Table 9.

3.3 How important are productivity costs in economic evaluation?

In the sample of studies taken from the HEED database, there was a wide variation in the impact which productivity costs had on the results of the analysis. In some cases, a net cost excluding productivity costs turned into a net saving when they were included. For example, the study by Tao and Remafedi (1998) of a behavioural intervention to prevent HIV reported direct costs of $1.1 million among around 500 volunteers over a ten-year period but total cost savings of $10 million when human capital gains were included. In the study by Krahn et al. (1998) of hepatitis B vaccination in Canada, lifetime direct costs were estimated to be $477,000 more with vaccination than without for a cohort of 46,000 students. This was accompanied by a reduction of almost $3.5 million in productivity costs with vaccination. In the study of varicella vaccination relative to no vaccination by Beutels et al. (1996), direct costs over 70 years of vaccinating annual birth cohorts of 800,000 neonates, at around DM 8 million, were relatively insignificant compared with productivity savings of nearly DM 170 million.

In other cases, the inclusion of productivity costs had a negligible effect on the results of the study, making either a small positive or negative contribution to overall costs. For example, Liberato et al. (1997)

Table 9 **Summary of study characteristics**

Reference	Country/ countries	Method	(i) Statement of method?	(ii) Mortality and morbidity?	(iii) Non-paid work time?	(iv) Quantities and unit costs?	(v) Productivity costs separated?	(vi) Health state values justified?	(vii) Medium term effects?	(viii) Consumption externalities?	(ix) Employers' friction costs?	(x) Sensitivity analysis?
Beutels et al. (1999)	Italy	HCA	Yes	Yes	No	Yes	Yes	N/A	N/A	N/A	N/A	No
Ford et al. (1999)	USA	HCA	No	Yes	No	No	Yes	N/A	N/A	N/A	N/A	No
Kobelt et al. (1999)	Sweden	HCA	No	N/A	Yes	Yes	No	No	N/A	N/A	N/A	No
Lord et al. (1999)	UK	HCA	No	No	No	Yes	Yes	N/A	N/A	N/A	N/A	Yes
Rosen et al. (1999)	USA	US Panel	Yes	Yes	No	No	No	No	N/A	No	No	No[2]
Alterman and Drucker (1998)	USA	HCA	No	Yes	No	No	Yes	N/A	N/A	N/A	N/A	No
Bosch et al. (1998)	Netherlands	US Panel	Yes	N/A	No	N/A	No	No	N/A	No	N/A	No[2]
Chung et al. (1998)	USA	US Panel	Yes	N/A	No	N/A	No	Yes	N/A	No	N/A	No
Durand-Zaleski et al. (1998)	UK	HCA	No	No	No	Yes	Yes	N/A	N/A	N/A	N/A	No
Glick et al. (1998)	USA	FCA	No	No	No	No	Yes	N/A	No	N/A	No	No
Hayman et al. (1998)	USA	US Panel	Yes	N/A	No	No	Yes	No	N/A	No	N/A	Yes
Hoerger et al. (1998)	USA	HCA	No	No	No	No	Yes	N/A	N/A	N/A	N/A	No
Jonsson (1998)	Sweden	HCA	No	No	No	No	Yes	N/A	N/A	N/A	N/A	No
Krahn et al. (1998)	Canada	HCA	No	Yes	Yes	No	Yes	N/A	N/A	N/A	N/A	No
Rosner et al. (1998)	Canada	HCA	No	No	No	No	No	N/A	N/A	N/A	N/A	No
Smith et al. (1998)	USA	HCA	Yes	Yes	No	No	Yes	N/A	N/A	N/A	N/A	Yes[1]
Smith and Roberts (1998)	USA	HCA	No	N/A	No	No	Yes	N/A	N/A	N/A	N/A	No
Tao and Remafedi (1998)	USA	HCA	Yes	Yes	No	No	Yes	N/A	N/A	N/A	N/A	No
Van Enckevort et al. (1998)	Netherlands	FCA	Yes	No	No	No	No	N/A	No	N/A	No	No
Evans et al. (1997)	Canada	HCA	Yes	N/A	No	No	Yes	N/A	N/A	N/A	N/A	Yes

Table 9 **Summary of study characteristics *(continued)***

Reference	Country/ countries	Method	(i) Statement of method?	(ii) Mortality and morbidity?	(iii) Non-paid work time?	(iv) Quantities and unit costs?	(v) Productivity costs separated?	(vi) Health state values justified?	(vii) Medium term effects?	(viii) Consumption externalities?	(ix) Employers' friction costs?	(x) Sensitivity analysis?
Ginsberg and Lev (1997)	Israel	HCA	No	No	No	Yes	Yes	N/A	N/A	N/A	N/A	No
Johannesson et al. (1997a)	Sweden	HCA	No	Yes1	Yes	No	Yes	No	N/A	N/A	N/A	Yes
Johannesson et al. (1997b)	Scandinavia	HCA	No	No	No	Yes	Yes	N/A	N/A	N/A	N/A	Yes
Liberato et al. (1997)	Italy	HCA	No	No	No	Yes	Yes	N/A	N/A	N/A	N/A	No
Liljegren et al. (1997)	Sweden	FCA	No	N/A	No	No	Yes	N/A	No	N/A	N/A	No
Nord et al. (1997)	Norway	FCA	Yes	No	No	Yes	Yes	N/A	No	N/A	No	Yes
Porter et al. (1997)	Canada	HCA	No	Yes	No	Yes	No	N/A	N/A	N/A	N/A	Yes
Salkeld et al. (1997)	Australia	HCA	No	Yes	No	No	Yes	N/A	N/A	N/A	N/A	No
Smith et al. (1997)	USA	FCA	No	No	No	No	No	N/A	No	N/A	N/A	No
Beutels et al. (1996)	Germany	US Panel	No	No	No	Yes	Yes	No	N/A	No	No	Yes
Goossens et al. (1996)	Netherlands	HCA	Yes	N/A	No	Yes	Yes	N/A	N/A	N/A	N/A	No
Johannesson (1996)	Sweden	HCA	No	No	No	No	No	N/A	N/A	N/A	N/A	No
Johannesson et al. (1996)	Sweden	HCA	No	No	Yes	No	Yes	N/A	N/A	N/A	N/A	Yes
Jordan et al. (1996)	USA	HCA	No	No	No	Yes	No	N/A	N/A	N/A	N/A	No
Kelly et al. (1996)	USA	US Panel	Yes	No	No	Yes	No	No	N/A	No	No	No[2]
Lindholm et al. (1996)	Sweden	HCA	No	No	No	No	Yes	N/A	N/A	N/A	N/A	Yes
Norum et al. (1996)	Norway	FCA	Yes	Yes	No	Yes	Yes	N/A	No	N/A	No	Yes
Rodby et al. (1996)	USA	HCA	Yes	Yes	Yes	Yes	Yes	N/A	N/A	N/A	N/A	No
Stinnett et al. (1996)	USA	US Panel	Yes	No	No	Yes	No	No	N/A	No	No	No[2]
Warner et al. (1996)	USA	FCA	No	Yes	No	Yes	Yes	N/A	No	N/A	No	Yes

Table 9 **Summary of study characteristics *(continued)***

HCA = Human capital approach, FCA = Friction cost approach, N/A = not applicable

i) Does it state which of the three recognised methods – the human capital approach the friction cost approach or the US Panel – is being used to estimate productivity costs?
ii) Does it give explicit consideration, where appropriate, to both mortality and morbidity costs?
iii) Does it give consideration to elements of time other than paid work time for those whose illness is being treated (e.g. leisure time)?
iv) Does it allow the separate identification of the quantity of resources (time) and the valuation of productivity costs?
v) Does it allow the identification of productivity costs separately from direct costs?
vi) Does it justify the source of health state values when productivity costs are incorporated as part of QALYs?
vii) Do studies which use the friction cost approach consider the medium term macroeconomic effects?
viii) Do studies which use the US Panel approach apply a monetary value to the difference between the gross and net wage for those at whom the intervention is targeted?
ix) Do studies which estimate mortality costs using the friction cost or US Panel approach give an estimate of friction costs to the employer for replacing deceased workers?
x) Are estimates of productivity costs subjected to sensitivity analysis?

Notes:

1. Morbidity and mortality costs are reported separately.
2. Sensitivity of the results to changes in productivity costs is not explicitly considered but QALYs are estimated using a variety of health state valuation adjustments.

estimated, under a 'current protocol' scenario, that interferon alpha in the treatment of chronic myelogenous leukaemia has an additional lifetime cost of $115,600 per patient relative to hydroxyurea, of which productivity costs account for $1,900. In an alternative scenario, whereby ineffective drug use is prevented, interferon had a total incremental cost of $75,600, with productivity costs reduced by $600. Goossens et al. (1996) estimated there was no significant difference in productivity costs between an educational/cognitive intervention and an educational discussion intervention in fibromyalgia. Neither did productivity costs have a sizeable impact on the cost effectiveness of surgery versus stereotactic radiosurgery for small operable cerebral arteriovenous malformations in the study by Porter et al. (1997). Varying the range of annual income for those with income from Can$0 to Can$40,000 gave a range of cost per QALY ratios between Can$8,600 and Can$6,400.

In general, the inclusion of productivity costs tended to improve the cost effectiveness of the new or experimental intervention, indicating a potential bias in the choice of methods. That is, productivity costs may be reported more frequently when the cost-effectiveness ratio becomes more rather than less favourable. Nevertheless, from a policy perspective, the relative value for money of different interventions can alter substantially depending on whether or not productivity costs are included in the analysis. In particular, when using the human capital approach, we would expect interventions which prolong healthy life expectancy at relatively young ages to have much improved cost-effectiveness relative to interventions which improve quality of life alone, once productivity costs have been taken into account. We saw earlier that most of the difference between the human capital and friction cost approaches is accounted for by the costs associated with mortality and long term disability. As with other aspects of economic evaluation methodology, differences in results may be due to differences in methods as much as to genuine differences between treatments. We have, therefore, identified the key elements of the methods used and the presentation of results, beginning with our attempt to classify each study according to whether it employed human capital, friction cost or US Panel approaches.

3.4 Was it clear which method was used?

In a number of studies, the method used to estimate productivity costs was not clearly defined. In only 15 studies was there an explicit statement of the method used or a reference to one of the three recognised techniques, including the two studies reported as part of the US Panel report (Kelly et al. (1996), Stinnett et al. (1996)). However, it was possible immediately to classify a further 18 studies as using the human capital approach because it was clear that long term productivity costs (in monetary terms) – beyond what might reasonably be thought of as the friction period – were being considered. For example, the authors might distinguish between morbidity costs incurred in the first year and in subsequent years or give the difference between patients' ages at death and retirement age (usually of 65) as the relevant period for estimating mortality costs. Two additional studies were categorised as using the human capital approach but were consistent with the friction cost approach because productivity costs were incurred over a short period of time.

In five cases, interpretation was required to classify the study. One of these studies was placed in the US Panel category, principally because it attributed a monetary value to productivity costs which the US Panel argue should be included in the numerator rather than the denominator of the cost effectiveness ratio (caregiver time and time spent seeking treatment). In this case, the US Panel's interpretation of the outcome measure (life years) as a vehicle for capturing productivity costs could be applied. In the other four studies for which judgement was required, the estimation of productivity costs was given a friction cost interpretation. In three studies, this was because the consideration of patients' productivity was not explicitly restricted to time undergoing treatment and these costs were limited to a period of months. In another study, reduced productivity while at work (a feature of productivity costs frequently discussed in the friction cost literature) was valued in monetary terms and replacement of deceased workers was assumed.

Overall, the human capital approach was the most popular method used, with 26 of 40 studies employing this approach. Of the other 14 studies, seven used the US Panel approach and seven the friction cost approach. These classifications were, in part, due to our interpretation rather than those explicitly described by the authors of the studies. One of the seven studies using the US Panel methods was classified in this way and four of the seven studies using the friction cost approach.

We did not seek an opinion from the authors of the original studies to confirm or refute our classification of the sample of studies. It is thus open to question whether the authors of those studies which, according to our definitions, used the friction cost or US Panel approaches, had these methods in mind when including productivity costs. The extent to which these methods have been adopted may, therefore, be overstated. On the other hand, the US Panel would probably contend that any study using life years or QALYs as the measure of effects implicitly allows for mortality costs. In addition, any study using QALYs would, in the US Panel's view, implicitly allow for morbidity costs unless it can be assumed that health state valuation takes place under the assumption of full compensation for illness.

For the purposes of this review, in studies classified according to the US Panel approach using our interpretation, some productivity costs have been valued in monetary terms. It is worth noting that 29 of the 33 studies not categorised as using the US Panel approach would be viewed as double counting productivity costs from a US Panel perspective. The other four studies assessed morbidity costs only and used life years gained rather than QALYs as the measure of outcomes; in these cases, morbidity costs would not be viewed as part of the outcomes.

3.5 Inclusion of time other than paid work time for patients receiving the intervention

As we have seen, the three approaches to the valuation of productivity costs focus primarily on the productivity costs associated with lost (paid) working time but do allow for other aspects of time. Therefore, it is of interest to ascertain the extent to which studies incorporated these other costs to the sick individual, namely the value of forgone leisure time and of unpaid work time. Of most interest were those studies which explicitly considered other sources of productivity costs, rather than those which could be interpreted as implicitly allowing for, say, leisure time by the use of QALYs (according to a friction cost or US Panel perspective). Only five of the 40 studies in this review made explicit reference to costs other than paid work time for sick individuals. In three studies, a monetary valuation was applied. The other two studies explicitly stated that leisure time was at least partly reflected in the QALY, one of which considered non market production to be leisure time. Of the three studies which used monetary valuations, two valued unwaged time/housekeeping and one valued leisure time. Four studies allowed for non-productivity time costs (caregivers' time or time undergoing treatment).

3.6 Estimation of resource quantities and unit costs

Guidelines for economic evaluation generally recommend that direct costs be broken down into quantities of resources used and the unit costs of those resources. Different sets of unit costs can then potentially be applied by other researchers to the items of resource use. In principle, therefore, it would be desirable for productivity costs to be treated in the same way. Although almost all studies described how productivity costs were estimated, with paid work being valued according to average earnings or wages in most cases, authors did not always present separate unit costs and lost time estimates. However, 16 of the 34 studies which included a monetary valuation of productivity costs did so or presented the results in such a way that it was possible to calculate the resource use and unit cost elements of the cost estimate.

3.7 Separate reporting of productivity costs and sensitivity analysis

Guidelines for economic evaluation, while not generally prescribing a particular approach for the estimation of productivity/time costs, often recommend that these be presented separately from direct costs.

Decision makers may then decide whether these costs are relevant to their own circumstances. 29 of the 40 studies considered here either presented estimates of productivity/time costs separately or reported results with and without their inclusion. However, only 13 studies reported the impact of altering productivity costs on the overall results. The one study which used two methods of allowing for productivity costs (the human capital approach and the friction cost approach) only reported the human capital estimates. Although productivity costs were lower under the friction cost approach than the human capital approach, in neither case were productivity costs significantly different between the two treatment groups as the numbers absent for longer than the friction period were roughly the same in both groups. In this example, therefore, the choice of method did not affect the conclusions of the study. In one study, a zero value and a rate equal to the rate of hourly compensation were applied to the time spent undergoing the intervention. None of the studies using US Panel methods estimated QALYs with and without the inclusion of productivity costs.

3.8 Features specific to the friction cost approach or US Panel approach

In the case of the US Panel approach, one study made an explicit justification of the way in which the health state valuation exercise was designed to incorporate productivity costs (Chung et al., 1998). The justification used was that respondents to the valuation exercise were asked to 'consider the full range of impacts of the health status change' (page 1095). Neither of the two studies which appeared in the US Panel report as examples of the method explicitly justified their choice of health state valuation methods. One of the studies in the report used the Health Utilities Index, the Quality of Well Being Index, the EuroQol scale and the National Center for Health Statistics Years of Health Life measure. It is worth noting, however, that the Health Utilities Index rules out income effects, and the EuroQol scale (used by one other study which declared that the US Panel approach was being adopted) and the Quality of Well Being scale neither rule in nor rule out income effects (Sculpher and O'Brien, 2000). Of the two studies which elicited values for study-specific health status scenarios, one was the Chung et al. (1998) study noted above; the other gave insufficient detail concerning the standard gamble exercise used to assess whether productivity costs would have been adequately accounted for.

A second element of the estimation of productivity costs which is particularly relevant to the US Panel approach is the treatment of the difference between gross and net wages. While the US Panel argues that the impact of illness and treatment on an individual's net wages is incorporated in the QALY, Weinstein et al. (1997) recommend that 'the consumption externalities which reflect the difference between an individual's productivity and own consumption … should be included in the numerator among the costs' (p. 508). However, none of the studies following the US Panel approach considered here did so.

A component of productivity costs specific to the friction cost approach is the medium term macroeconomic effect of illness and treatment. None of the studies using the friction cost approach in our sample explicitly estimated a medium term impact, no mention being made of the type of macroeconomic model recommended by Koopmanschap et al. (1995).

Finally, productivity costs which are relevant to both the friction cost approach and the US Panel approach are those incurred by the employer when replacing a deceased worker. In the studies reviewed here, none of those using the US Panel approach or the friction cost approach and which also estimated mortality costs provided an estimate of the employer's friction costs.

It is clear from this review, therefore, that while some researchers consider the friction cost approach or the US Panel approach to be superior to the traditional human capital approach, the theory and the practice are at odds with one another. In particular, the subtleties of these newer approaches have not been fully incorporated into the analyses in those studies which claim to have used them. In the concluding chapter, we will draw some lessons from this review concerning ways in which the assessment and reporting of productivity costs in economic evaluations may be improved.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 Introduction

This paper has attempted to set out the debate surrounding the three main methods of valuing productivity costs for the purposes of economic evaluation, and to illustrate this discussion with examples of how these costs have been estimated in practice. This chapter attempts to make some suggestions about which might be a preferred method and to draw some lessons from the practical application of the human capital approach, the friction cost approach and the US Panel approach.

4.2 Should productivity costs be considered?

Since the impact of illness and mortality on time at work or engaging in leisure activities represents a real opportunity cost to the individual and society, there is a persuasive case for including productivity costs in economic evaluations of health care interventions. In principle, productivity costs can be viewed in the same way as direct costs, which analysts are encouraged to estimate as comprehensively as possible. Public policy makers should certainly be aware of the differential impact of alternative treatments on patients' time, if significant. Failing to take account of productivity costs is implicitly to give no value to patients' time and may give a misleading impression of the relative efficiency with which society's resources are being used. As was seen in the previous chapter, productivity costs can have a large impact on the results of an evaluation.

Decision makers will be concerned not only with efficiency but also with equity issues. Taking account of productivity costs does not imply that equity is disregarded. Rather, any equity adjustments must be made explicitly through the valuation of time; for example, it may be decided to apply the same unit value to everybody's work or leisure time, regardless of their individual positions in the labour market. Alternatively, different values may be accepted but a compensating equity adjustment made to outcomes. An economic evaluation intended to capture the societal perspective will be incomplete if it does not take account of productivity costs. The decision maker must then decide how the results of the analysis are interpreted and implemented.

4.3 Is one method to be preferred?

In order to decide whether one method of estimating productivity costs can be recommended over the others, a useful starting point is to highlight the principal differences between them. In terms of short term absence from work, there is little practical difference between the human capital and friction cost approaches as they yield similar results. Although adjustments within the firm in the friction cost approach may result in no reduction in output for short term absence, this will involve costs such as the use of overtime, others working harder, or the sick worker sacrificing leisure time when returning to work to compensate for sickness absence. Lost productivity, or the effort required to prevent it, involves costs broadly equivalent to the human capital estimate.

In terms of valuing time, the human capital approach has been defended on the grounds that it uses the theoretically correct method of valuing a worker's production by the gross wage. However, diminishing returns for additional labour use and evidence that a fall in labour input leads to a less than proportionate fall in output suggest that using 80% of average value added may provide a more accurate estimate. The US Panel approach is different in the sense that a large part of productivity costs is assumed to be captured by QALYs. However, since the US Panel are not dogmatic about using this approach (Russell (1999), Weinstein (1999)) and given that most economic evaluations do not use QALYs, a monetary valuation seems preferable. It should be noted that the impact on leisure time for the sick worker should also be valued in monetary terms where QALYs are not used. When QALYs are used, there is an argument for using a health state valuation instrument which positively excludes changes in income rather than an alternative which rules them neither definitely in nor out. This will, in principle, address the US Panel concerns. Costs of absence from work can be supplemented with costs of reduced productivity at work, if these are significant, using one of the range of available survey instruments.

Where the three methods differ most is in relation to long term disability or mortality. In both the human capital and US Panel approaches, productivity losses persist over the long term as a straightforward extension of those observed over the friction period. In the friction cost approach, the impact of death or disability beyond the friction period is limited to medium term macroeconomic effects. The differences between the friction cost approach and the two other approaches are, however, for different reasons. The human capital approach has long term productivity losses because it implicitly assumes permanent full employment with no possibility of replacement from a pool of involuntary unemployed. Whether the human capital approach is to be preferred therefore depends upon the level of unemployment and the willingness of employers to recruit from the unemployed.

Although the US Panel accept that a deceased worker can be replaced from the unemployed, they argue that the consequent replacement of production is not the whole story since it ignores the impact on leisure time for the previously unemployed. In the US Panel account, the value of lost leisure is such as to be just compensated for by the wage, whereas the Erasmus group recommend a much lower value. Unlike the leisure time for the long term sick or disabled worker, it is not clear how leisure time for the unemployed can be incorporated into the QALY as Brouwer et al. (1997b) seem to suggest.

For treatments which have an impact beyond the friction period, the choice of method for estimating productivity costs will therefore depend upon a view about the state of the labour market and, if replacement from the involuntarily unemployed is assumed, about the value of their forgone leisure time.

A further issue is that, if life years gained are used as the measure of effectiveness, an important decision is whether life years can be assumed to take account of productivity costs, as the US Panel propose (Luce et al., 1996). The use of life years as a means of allowing for mortality costs appears in neither of the other approaches but it would imply that no monetary value was required for these costs under the human capital approach when life years or QALYs are used. In this case, the mortality-related monetary productivity savings estimated by, for example, Beutels et al. (1999) would 'disappear' and the human capital estimate would be much closer to the friction cost estimate. Since a life year is normally given equal weight no matter who receives it, this assumption also implies a degree of egalitarianism in the assessment of productivity. The same distributional considerations will influence the choice of whether or not to use QALYs to capture productivity costs, when the US Panel recommendation for the Reference Case of using community values (Gold et al., 1996) is adopted. This is in addition to the practical consideration of whether or not QALYs can reliably incorporate productivity costs. In the case of long term disability, where QALYs are not used, consideration should be given to the value of leisure for the sick individual.

4.4 A research agenda

The discussion of the three approaches to the estimation of productivity costs suggests that not all disagreements can be resolved by empirical investigation. For example, some of the criticisms of the friction cost approach are based on fundamental differences of opinion concerning the theory of how labour markets operate. Until theoretical foundations for the friction cost approach have been established, critics will argue that the human capital approach is a superior method as it is based on economic theory, even if that theory does not fully describe actual behaviour.

However, there are areas where empirical research could help to refine the estimates generated by the different methods. For example, it would be desirable to have improved estimates of the impact of morbidity on time at work and productivity at work. The Work Productivity and Activity Impairment (WPAI) measure (Reilly et al., 1993), the Health and Labor Questionnaire (HLQ) (van Roijen et al., 1996) and the Work Limitations Questionnaire (WLQ) (Lerner et al., 1998) have been developed for this purpose and could usefully be tested in applied economic evaluations. Further research could also be undertaken into the organisational impact of short term morbidity, including firms' ability to adjust to absence from work, the existence of internal reserves of labour, the responsiveness of production to changes in hours worked and the impact on other employees of an individual's absence.

As far as the sick individual is concerned, the US Panel's recommendations raise the issue of whether individuals do take account of lost income when considering a health state for valuation. While the description of health states in some generic utility instruments refer to the individual's ability to undertake usual activities such as work, it is not clear whether individuals would fully allow for lost income as a result of morbidity. Nor is the issue solely to do with the impact of morbidity on income, since both the US Panel approach and the friction cost approach advocate the inclusion of other elements of time in the health state valuation exercise, particularly leisure time. Research could be undertaken to separate the impact of illness on income and leisure from the overall QALY calculation. The results of cost effectiveness analysis with these items included in the QALY calculation could be compared with those obtained applying monetary values to the equivalent productivity costs.

Finally, as we saw earlier, the Erasmus group and the US Panel make different assumptions, either implicitly or explicitly, concerning the value of leisure for the unemployed. In principle, empirical research could help to determine how leisure time for this group should be valued. There are a number of ways, therefore, in which research may assist in resolving disagreements between methods. However, while this research is continuing, there is a need for guidance for analysts and appraisers of economic evaluations in how productivity costs should be estimated, taking account of the different approaches.

4.5 Can the reporting of productivity costs be improved?

Due to the lack of agreement between the three different methods for measuring productivity costs and the potential importance of these costs to the cost effectiveness of the intervention under investigation, it is important for users of economic evaluations to have clear information on how studies have approached the problem. As was seen from the last chapter, this information is often lacking, with many studies not clearly identifying the approach used to measure productivity costs. In a number of cases, judgement was required to categorise studies according to one of the three productivity valuation approaches. Moreover, for those studies which claimed to have used the friction cost or US Panel methods, it was apparent that only some elements of the method had been incorporated into the study.

Although studies did generally present their results in such a way as to allow productivity costs to be separately identified, it was unclear in cost utility studies using the US Panel approach how much of the productivity costs was accounted for in the quality adjustment in the QALY estimates. Moreover, the sensitivity of results to changes in assumptions concerning productivity costs was rarely explored. In particular, only one study used more than one method to estimate productivity costs and only the estimates derived from the human capital approach were presented, the other method used being the friction cost approach.

4.6 Recommendations for the estimation and reporting of productivity costs

Rather than prescribe one particular approach which should be adopted when estimating productivity costs, the following recommendations relate, firstly, to the way in which information on productivity costs is presented and, secondly, possibilities for making the analysis more useful. In the first category, analysts should be clear about the method they are intending to use to measure productivity costs and explain any departures from the method. The productivity costs being measured should relate to the impact of the intervention being evaluated using the morbidity/mortality distinction so that, where an intervention has an effect on both, the potential morbidity and mortality costs can each be discussed.

Analysts should make explicit what productivity costs are included in the analysis and how they are being treated, whether in monetary terms or incorporated into the outcome measure. As with most studies in our review, all analyses should either present the estimates of productivity costs separately or report the overall results with and without the inclusion of productivity costs. A criterion satisfied by only about half the studies was the separation of estimates of quantities of time from the unit costs or prices used to value them; it seems reasonable to expect all studies to observe this principle for productivity costs as well as for direct costs.

Although it may not be worthwhile, in terms of the cost of data collection, estimating the impact of an intervention on all potential aspects of productivity costs, thought should be given to the range of productivity costs which may be affected. In particular, some consideration should be given to time other than paid work time i.e. leisure or unpaid work such as household production. If it is decided to exclude some productivity effects from the analysis, then a justification for their exclusion should be given. Where productivity costs have been estimated for a number of different groups, then it would be helpful to show the distributional impact of the intervention on productivity costs.

The points noted so far relate primarily to the framework for reporting of information which analysts would need to collect in order to estimate productivity costs. However, in some respects, the estimation of productivity costs can only become more informative by greater analytical effort. For example, although most studies allow the separation of direct costs and productivity costs valued in monetary terms, it may also be desirable to separate out the impact of productivity costs when they are included in the outcome measure. Researchers using the US Panel approach would need to develop the analysis further if that element of health outcomes accounting for productivity costs were to be separately identified. As was noted in the previous chapter, none of the studies using the US Panel approach presented the results for health outcomes with and without productivity costs.

It would also be helpful to the user of analyses employing the US Panel approach for productivity costs to be valued in monetary terms as well as in terms of life years or QALYs. Indeed, analysts could usefully apply more than one approach to the estimation of productivity costs in order that users of the analysis can assess the impact of using different approaches. In the sample of studies reviewed in the last chapter, only one study used alternative methods and results were presented only for the human capital approach. Moreover, a minority of studies used sensitivity analysis which may be recommended for all studies even if no more than one of the three approaches towards productivity costs is used.

The final recommendation is that all studies which use the friction cost approach or the US Panel approach pay particular attention to the detail of the methods. In the case of the US Panel approach, studies did not provide a monetary estimate for the consumption externalities (the difference between gross and net wages). Neither did these studies take account of friction costs to the employer for recruiting and training replacement workers in the event of mortality of permanent disability. The absence of friction costs to the employer was not only a characteristic of US Panel studies; studies using the friction cost approach also failed to make explicit allowance for these costs. In addition, the estimation of medium term macroeconomic effects is an important aspect of the friction cost approach which has not been given due consideration in the studies reviewed here.

In summary, given the theoretical uncertainties surrounding the three approaches to estimating productivity costs, studies would benefit from improved clarity in terms of the method used, the costs included and excluded and the implications of using different approaches. Greater attention should also be paid to the nuances of these approaches, particularly the US Panel approach and the friction cost approach. Some of the insights of the friction cost approach, which have also been recognised by the US Panel, could be incorporated into economic evaluations in a more formal way using existing instruments. It is anticipated that analysts wishing to include productivity costs in their evaluations will, in future, make greater use of instruments developed to measured lost work time. Such approaches will be important in improving the transparency and the quality of productivity cost estimates presented in economic evaluations.

The purpose of the following guidelines is not to suggest that one

Box 8

We recommend that, when estimating and presenting productivity costs, analysts should:

i) State which of the three recognised methods, the human capital approach, the friction cost approach or the US Panel, they are using to estimate productivity costs.
ii) Be clear about what components of time costs are being included. For example, it seems reasonable to adhere to the US Panel's suggestion that time costs whilst consuming care and informal caregiver time costs should be considered part of direct costs.
iii) Discuss, where appropriate, the impact of illness and treatment on productivity costs relating to both morbidity and mortality.
iv) Incorporate (or at least discuss) the treatment of elements of productivity costs other than paid work time for those individuals receiving the intervention under investigation.
v) Present the results for productivity costs in such a way as to allow the separation of quantities of resource use and unit costs.
vi) Present the results for costs in such a way as to allow the separate identification of productivity costs.
vii) Provide a justification for the source of health state valuation data when productivity costs are incorporated into the measurement of QALYs.
viii) Consider medium term macroeconomic effects for their own context when the friction cost approach is used.
ix) Apply a monetary valuation to the difference between the gross and net wage for those receiving the intervention when the US Panel approach is used.
x) Provide an estimate of the friction costs to employers for replacing deceased workers when mortality costs are estimated using the friction cost approach or the US Panel approach.
xi) Subject estimates of productivity costs to sensitivity analysis.

of the three methods of estimating productivity costs is to be preferred over the others. Rather it is to provide some general reporting guidance for analysts who wish to include productivity costs in an evaluation, irrespective of their own preferred method. The recommendations are summarised in Box 8.

4.7 Conclusions

Given the lack of consensus on a preferred method for including productivity costs into economic evaluations, we have attempted to highlight the main factors which should be considered when choosing between the different approaches described in chapter 2. One difficulty when making comparisons between them is that the methods are not necessarily fully developed. For example, Russell (1999) suggests that the US Panel's recommendations with respect to productivity costs may be revised. With respect to the friction cost approach, Brouwer and Koopmanschap (1998) point out that earlier estimates of the effect of short term absence from work did not make adjustment for possible compensating factors which ongoing research may indicate cannot be ignored.

When selecting a method to estimate productivity costs, it is important to be clear about areas of agreement and fundamental differences between the three approaches. An aspect of time on which the human capital approach, the Erasmus group and the US Panel are agreed is the individual worker's leisure time which all three suggest can be captured by QALYs. The only question for the analyst is how to value this time when QALYs are not used. This is a general problem with the US Panel approach since, despite their recommendations, it is likely that cost utility analyses will remain a small minority of all economic evaluations.

Given that the friction cost and human capital approaches produce similar estimates for short term morbidity, the most important choice in practice will be the treatment of long term disability and mortality. The choice of method here will be influenced by the circumstances of the evaluation. Depending on the state of the economy and the skills of the affected worker, a straightforward replacement by an unemployed person who would not otherwise have found employment may be possible. In this case, the friction cost approach can be applied, with thought given to the short term costs of replacing the deceased or disabled worker and the value of leisure for the formerly unemployed. The higher the value of their leisure, the closer the friction cost estimates will be to the human capital estimates.

In other cases, particularly for more highly skilled occupations, direct replacement from the unemployed may not be possible. An unemployed individual may be taken on only after a series of replacements (a 'replacement chain'), potentially involving substantial training costs. The higher these friction costs, which are also a feature of the US Panel approach, the closer will be the estimates of productivity costs given by the human capital and friction cost approaches. In some cases, replacement of a worker from the unemployed may not be feasible even at the end of a replacement chain, such that the human capital approach provides the most appropriate estimate of productivity costs. In summary, the context of each particular study will dictate which approach offers the most promise. Factors to be taken into account are the existence or otherwise of a pool of the involuntarily unemployed, their ability to replace current workers, their value of leisure and whether quality of life assessments can be relied upon to incorporate changes in productivity for individual workers.

Given doubts about the theory underlying the different methods and the practical problems of measuring the impact of illness and treatment on different elements of time, it is perhaps unsurprising that the human capital approach remains the predominant method of estimating productivity costs in economic evaluation. Nevertheless, applications of the friction cost and the US Panel approaches have appeared in the literature. This paper has argued that, with the three competing approaches being available to analysts, consumers of economic evaluations would benefit from greater clarity in terms of authors' preferred choice of approach and explanation of how it has been applied. Even where an explicit preference for one method has been stated, some improvements to the reporting of the methods and the investigation of the impact which productivity costs have on the overall results would be desirable. We hope that the recommendations made here can provide some useful guidance to authors of economic evaluations but we would also encourage the proponents of the different methods to provide more detailed guidelines for analysts interested in estimating productivity costs.

REFERENCES

Belgian Society of Pharmacoepidemiology (1995). A proposal for methodological guidelines for economic evaluation of pharmaceuticals – Belgium. Brussels: Belgian Society of Pharmacopeidemiology.

Brouwer W B F, Koopmanschap M A (1998). How to calculate indirect costs in economic evaluations. PharmacoEconomics 13(5Part1):563-566.

Brouwer W B F, Koopmanschap M A, Rutten F F H (1997a). Productivity costs measurement through quality of life? A response to the recommendation of the Washington panel. Health Economics 6:253-259.

Brouwer W B F, Koopmanschap M A, Rutten F F H (1997b). Productivity costs in cost-effectiveness analysis: numerator or denominator: a further discussion. Health Economics 6:511-514.

Brouwer W B F, Koopmanschap M A, Rutten F F H (1998). Patient and informal caregiver time in cost-effectiveness analysis. International Journal of Technology Assessment in Health Care 14(3):505-513.

Brouwer W B F, Koopmanschap M A, Rutten F F H (1999). Productivity losses without absence: measurement validation and empirical evidence. Health Policy 48:13-27.

Cady R C, Ryan R, Jhingran P, O'Quinn S, Pait D G (1998). Sumatriptan injection reduces productivity loss during a migraine attack: results of a double-blind, placebo-controlled trial. Archives of Internal Medicine 158:1013-1018.

Canadian Coordinating Office for Health Technology Assessment (1997). Guidelines for economic evaluation of pharmaceuticals: Canada. 2nd ed. Ottawa: Canadian Coordinating Office for Health Technology Assessment (CCOHTA).

Collège des Economistes de la Santé (1997). Guidelines and recommendations for French pharmaco-economic studies. La lettre du collège, numero spècial: evaluation for French pharmaco-economic studies.

Commonwealth of Australia (1995). Guidelines for the pharmaceutical industry on preparation of submissions to the Pharmaceutical Benefits Advisory Committee: including submissions involving economic analyses. Canberra: Australian Government Printing Office.

Davies G M, Santanello N, Gerth W, Lerner D, Block G A (1999). Validation of a migraine work and productivity loss questionnaire for use in migraine studies. Cephalalgia 19:498-502.

Department of Health/ABPI (1994). UK guidance on good practice in the conduct of economic evaluations of medicines. British Journal of Medical Economics 7:63-64.

Drummond (1992). Cost-of-illness studies: a major headache? PharmacoEconomics 2(1):1-4.

Drummond M F, O'Brien B, Stoddart G L, Torrance G W (1997). Methods for the economic evaluation of health care programmes. New York: Oxford University Press, 2nd edition.

Garber A M, Weinstein M C, Torrance G W, Kamlet M S (1996). Theoretical foundations of cost-effectiveness analysis. In Gold M R, Siegel J E, Russell L B, Weinstein M C (eds). Cost-effectiveness in health and medicine. New York: Oxford University Press.

Gerard K, Mooney G (1993). QALY league tables: handle with care. Health Economics 2:59-64.

Gold M R, Patrick D L, Torrance G W, Fryback D G, Hadorn D C, Kamlet M S, Daniels N, Weinstein M C (1996). Identifying and valuing outcomes. In Gold M R, Siegel J E, Russell L B, Weinstein M C (eds). Cost-effectiveness in health and medicine. New York: Oxford University Press.

Greenberg P E, Stiglin L E, Finkelstein S N, Berndt E R (1993). The economic burden of depression in 1990. Journal of Clinical Psychiatry 54:405-418.

Hannoveraner Konsensus Gruppe (1999). Deutsche Empfehlungen zur gesundheitsoekonomischen Evaluation – Revidierte Fassung des Hannoveraner Konsens. Gesundheitsoekonomie und Qualitaetsmanagement 4 A62 – A65.

Hu X H, Markson L E, Lipton R B, Stewart W F, Berger M L (1999). Burden of migraine in the United States: disability and economic costs. Archives of Internal Medicine 159:813-818.

Italian Group for Pharmacoeconomic Studies (1997). Pharmecoeconomic studies: Italian proposal for guidelines. Pavia: University of Pavia.

Johannesson M (1995). The relationship between cost-effectiveness analysis and cost-benefit analysis. Social Science and Medicine 41:483-489.

Johannesson M (1996). The willingness to pay for health changes, the human-capital approach and the external costs. Health Policy 36:231-244.

Johannesson M (1997). Avoiding double-counting in pharmacoeconomic studies. PharmacoEconomics 11(5):385-388.

Johannesson M, Karlsson G (1997). The friction cost method: a comment. Journal of Health Economics 6:249-255.

Johannesson M, Meltzer D (1998). Some reflections on cost-effectiveness analysis. Health Economics 7:1-7.

Johannesson M, O'Conor R M (1997). Cost-utility analysis from a societal perspective. Health Policy 1997 39:241-253.

Johns G (1994). How often were you absent? A review of the use of self-reported absence data. Journal of Applied Psychology 79(4):574-591.

Kessler R C, Frank R G (1997). The impact of psychiatric disorders on work loss days. Psychological Medicine 27:861-873.

Koopmanschap M A, Rutten F F H (1993). Indirect costs in economic studies: confronting the confusion. PharmacoEconomics 4(6):446-454.

Koopmanschap M A, Rutten F F H (1996a). A practical guide for calculating indirect costs of disease. PharmacoEconomics 10(5):460-466.

Koopmanschap M A, Rutten F F H (1996b). Indirect costs: the consequence of production loss or increased costs of production. Medical Care 34(12,suppl):DS59-DS68.

Koopmanschap M A, Rutten F F H, van Ineveld B M, van Roijen L (1995). The friction cost method for measuring indirect costs of disease. Journal of Health Economics 14:171-189.

Koopmanschap M A, Rutten F F H, van Ineveld B M, van Roijen L (1997). Reply to Johannesson's and Karlsson's comment. Journal of Health Economics 16:257-259.

Koopmanschap M A, van Ineveld B M (1992). Towards a new approach for estimating indirect costs of disease. Social Science and Medicine 34(9):1005-1010.

Langley P C (1998). Guidelines for formulary submissions for pharmaceutical product evaluation. Blue Cross Blue Shield of Colorado, Blue Cross Blue Shield of Nevada.

Lerner D, Amick B, GlaxoWellcome (1998). Work Limitations Questionnaire. The Health Institute.

Lerner D (2000). Personal communication.

Liljas B (1998). How to calculate indirect costs in economic evaluations. PharmacoEconomics 13(1Part1):1-7.

Luce B R, Manning W G, Siegel J E, Lipscomb J (1996). Estimating costs in cost-effectiveness analysis. In Gold M R, Siegel J E, Russell L B, Weinstein M C (eds). Cost-effectiveness in health and medicine. New York: Oxford University Press.

Meltzer D, Johannesson M (1999). Inconsistencies in the 'societal perspective' on costs of the Panel on Cost-Effectiveness in Health and Medicine. Medical Decision Making 19(4):371-377.

Milburn A (2000). A healthier nation and a healthier economy: the contribution of a modern NHS. LSE annual lecture.

Ministry of Health (1994). Ontario guidelines for economic analysis of pharmaceutical products. Toronto: Ministry of Health.

Ministry of Social Affairs and Health (1999). Guidelines for preparation of an account of health-economic aspects. Helsinki: Ministry of Social Affairs and Health.

National Institute for Clinical Excellence (2000). Appraisal of new and existing technologies: interim guidance for manufacturers and sponsors. http://www.nice.org.uk/nice-web/Embcat.asppage=oldsite/appraisals/apr_gide.htm.

Norwegian Medicines Control Authority (1999). Norwegian guidelines for pharmacoeconomic analysis in connection with application for reimbursement. Oslo: Norwegian Medicines Control Authority (SLK).

Office Health Economics (OHE) (2000). Health Economic Evaluations Database. London: OHE-IFPMA Database.

Olsen J A, Richardson J (1999). Production gains from health care: what should be included in cost-effectiveness analyses? Social Science and Medicine 49:17-26.

Pharmaceutical Management Agency Ltd (1998). A prescription for pharmacoeconomic analysis. Wellington: Pharmac.

Reilly M C, Zbrozek A S, Dukes E M (1993). The validity and reproducibility of a work productivity and activity impairment instrument. PharmacoEconomics 4(5):353-365.

Revicki D A, Irwin D, Reblando J, Simon G E (1994). The accuracy of self-reported disability days. Medical Care 32(4):401-404.

Russell L B (1986). Is prevention better than cure? Washington DC: The Brookings Institution.

Russell L B (1999). Improving the Panel's recommendations. Medical Decision Making 19(4):379-380.

Russell L B, Siegel J E, Daniels N, Gold M R, Luce B R, Mandelblatt J S (1996). Cost-effectiveness analysis as a guide to resource allocation in health: roles and limitations. In Gold M R, Siegel J E, Russell L B, Weinstein M C (eds). Cost-effectiveness in health and medicine. New York: Oxford University Press.

Sculpher M, O'Brien B (2000). Income effects of reduced health and health effects of reduced income: implications for health state valuation. Medical Decision Making 20:207-215.

Severens J L, Laheij R J F, Jansen J B M J, van der Lisdonk E H, Verbeek A L M (1998). Estimating the cost of lost productivity in dyspepsia. Alimentary Pharmacology and Therapeutics 12:919-923.

Severens J L, Mulder J, Laheij R J F, Verbeek A L M (2000). Precision and accuracy in measuring absence from work as a basis for calculating productivity costs in The Netherlands. Social Science and Medicine 51:243-249.

Sickness Funds Council (1999). Dutch guidelines for pharmacoeconomic research. Amstelveen: Ziekenfondsraad.

Testa M A, Simonson D C (1998). Health economic benefits and quality of life during improved glycemic control in patients with type 2 diabetes mellitus. Journal of the American Medical Association 280(17):1490-1496.

Van Roijen L, Essink-Bot M-L, Koopmanschap M A, Bonsel G, Rutten F F H (1996). Labor and health status in economic evaluation of health care: the Health and Labor Questionnaire. International Journal of Technology Assessment in Health Care 12(3):405-415.

Van Roijen L, Essink-Bot M-L, Koopmanschap M A, Michel B C, Rutten F F H (1995). Societal perspective on the burden of migraine in the Netherlands. PharmacoEconomics 7(2):170-179.

Weinstein M C (1999). Theoretically correct cost-effectiveness analysis. Medical Decision Making 19(4):381-382.

Weinstein M C, Siegel J E, Garber A M, Lipscomb J, Luce B R, Manning W G Jr, Torrance G W (1997). Productivity costs, time costs and health-related quality of life: a response to the Erasmus group. Health Economics 6:505-510.

Weisbrod B A (1961). The valuation of human capital. Journal of Political Economy 69:425-436.

Williams A (1992). Cost-effectiveness analysis: is it ethical? Journal of Medical Ethics 18:7-11.

STUDIES INCLUDED IN THE SAMPLE FROM HEED

Alterman R L, Drucker E (1998). Cost-effective screening for cerebral aneurysms. Neurosurgery Clinics of North America 9(3):497-507.

Beutels Ph. Bonanni P, Tormans G, Canale F, Crovari P C (1999). An economic evaluation of universal pertussis vaccination in Italy. Vaccine 17:2400-2409.

Beutels P, Clara R, Tormans G, Van Doorslaer E, Van Damme P (1996). Costs and benefits of routine varicella vaccination in German children. Journal of Infectious Diseases 174(Suppl3):S335-S341.

Bosch J L, Tetteroo E, Mali W P T M, Hunink M G M for the Dutch Iliac Stent Trial Study Group (1998). Iliac arterial occlusive disease: cost-effectiveness analsysis of stent placement versus percutaneous transluminal angioplasty. Radiology 208(3):641-648.

Chung K C, Walters M R, Greenfield M L V H, Chernew M E (1998). Endoscopic versus open carpal tunnel release: a cost-effectiveness analysis. Plastic and Reconstructive Surgery 102(4):1089-1099.

Durand-Zaleski I, Earlham S, Fordy C, Davies M, Allen-Mersh T G (1998). Cost-effectiveness of systemic and regional chemotherapy for the treatment of patients with unresectable colorectal liver metastases. Cancer 83:882-888.

Evans K W, Boan J A, Evans J L, Shuaib A (1997). Economic evaluation of oral sumatriptan compared with oral caffeine/ergotamine for migraine. PharmacoEconomics 12(5):565-577.

Ford E S, Kelly A E, Teutsch S M, Thacker S B, Garbe P L (1999). Radon and lung cancer: a cost-effectiveness analysis. American Journal of Public Health 89:351-357.

Ginsberg G M, Lev B (1997). Cost-benefit analysis of riluzole for the treatment of amyotrophic lateral sclerosis. PharmacoEconomics 12(5):578-584.

Glick H, Willke R, Polsky D, Llana T, Alves W M, Kassell N, Schulman K (1998). Economic analysis of tirilazad mesylate for aneurysmal subarachnoid hemorrhage. International Journal of Technology Assessment in Health Care 14:(1)145-160.

Goossens M E J B, Rutten-van-Molken M P M H, Leidl R M, Bos S G P M, Vlaeyen J W S, Teeken-Gruben N J G (1996). Cognitive-educational treatment of fibromyalgia: a randomized clinical trial. II. Economic evaluation. Journal of Rheumatology 23(6):1246-54.

Hayman J A, Hillner B E, Harris J R, Weeks J C (1998). Cost-effectiveness of routine radiation therapy following conservative surgery for early-stage breast cancer. Journal of Clinical Oncology 16(3):1022-1029.

Hoerger T J, Bala M V, Rowland C, Greer M, Chrischilles E A, Holloway R G (1998). Cost-effectiveness of pramipexole in Parkinson's disease in the US. PharmacoEconomics 14(5):541-557.

Johannesson M (1996). The cost-effectiveness of hypertension treatment in Sweden: an analysis of the criteria for intervention and the choice of drug treatment. Journal of Human Hypertension 10(Suppl2):S23-S26.

Johannesson M, Borgquist L, Jonsson B, Lindholm L (1996). The cost effectiveness of lipid lowering in Swedish primary health care. Journal of Internal Medicine 240:23-29.

Johannesson M, Jonsson B, Kjekshus J, Olsson A G, Pedersen T R, Wedel H (1997). Cost effectiveness of simvastatin treatment to lower cholesterol levels in patients with coronary heart disease. The New England Journal of Medicine 336(5):332-336.

Johannesson M, Meltzer D, O'Conor R M (1997). Incorporating future costs in medical cost-effectiveness analysis. Medical Decision Making 17:382-389.

Jonsson B (1998). Targeting high-risk populations. Osteoporosis International Suppl.1:S13-S16.

Jordan J E, Marks M P, Lane B, Steinberg G K (1996). Cost-effectiveness of endovascular therapy in the surgical management of cerebral arteriovenous malformations. American Journal of Neuroradiology 17:247-264.

Kelly A E, Haddix A C, Scanlon K S, Helmick C G, Mulinare J (1996). Cost-effectiveness of strategies to prevent neural tube defects. In Gold M R, Siegel J E, Russell L B, Weinstein M C (eds), Cost-Effectiveness in Health and Medicine, New York: Oxford University Press.

Kobelt G, Eberhardt K, Jonsson L, Jonsson B (1999). Economic consequences of the progression of rheumatoid arthritis in Sweden. Arthritis and Rheumatism 42(2):347-356.

Krahn M, Guasparini R, Sherman M, Detsky A S (1998). Costs and cost-effectiveness of a universal, schooled-based hepatitis B vaccination program. American Journal of Public Health 88(11):1638-1644.

Liberato N L, Quaglini S, Barosi G (1997). Cost-effectiveness of interferon alfa in chronic myelogenous leukemia. Journal of Clinical Oncology 15:2673-2682.

Liljegren G, Karlsson G, Bergh J, Holmberg L (1997). The cost-effectiveness of routine postoperative radiotherapy after sector resection and axillary dissection for breast cancer stage I. Results from a randomized trial. Annals of Urology 8:757-763.

Lindholm L, Rosen M, Weinehall L, Asplund K (1996). Cost effectiveness and equity of a community based cardiovascular disease prevention programme in Norsjo, Sweden. Journal of Epidemiology and Community Health 50:190-195.

Lord J, Thomason M J, Littlejohns P, Chalmers R A, Bain M D, Addison G M, Wilcox A H, Seymour C A (1999). Secondary analysis of economic data: a review of cost-benefit studies of neonatal screening for phenylketonuria. Journal of Epidemiology and Community Health 53:179-186.

Nord E, Wisloff F, Hjorth M, Westin J (1997). Cost utility analysis of melphalan plus prednisone with or without interferon-alpha 2b in newly diagnosed multiple myeloma: results from a randomised controlled trial. PharmacoEconomics 12(1):89-103.

Norum J, Angelsen V, Wist E, Olsen J A (1996). Treatment costs in Hodgkin's disease: a cost-utility analysis. European Journal of Cancer 32A(9):1510-1517.

Porter P J, Shin A Y, Detsky A S, Lefaive L, Wallace M C (1997). Surgery versus stereotactic radiosurgery for small, operable cerebral arteriovenous malformations: a clinical and cost comparison. Neurosurgery 41(4):757-766.

Rodby R A, Firth L M, Lewis E J, The Collaborative Study Group (1996). An economic analysis of captopril in the treatment of diabetic nephropathy. Diabetes Care 19(10):1051-1061.

Rosen A B, Fowler V G, Corey G R, Downs S M, Biddle A K, Li J, Jollis JG (1999). Cost-effectiveness of transesophageal echocardiography to determine the duration of therapy for intravascular catheter – associated staphylococcus aureus bacteremia. Annals of Internal Medicine 130(10):810-820.

Rosner A J, Grima D T, Torrance G W, Bradley C, Adachi J D, Sebaldt R J, Willison D J (1998). Cost effectiveness of multi-therapy treatment strategies in the prevention of vertebral fractures in postmenopausal women with osteoporosis. PharmacoEconomics 14(5):559-73.

Salkeld G, Phongsavan P, Oldenburg B, Johannesson M, Convery P, Graham-Clarke P, Walker S, Shaw J (1997). The cost-effectiveness of a cardiovascular risk reduction program in general practice. Health Policy 41:105-119.

Smith K J, Roberts M S (1998). Cost effectiveness of early treatment with oral aciclovir in adult chickenpox. PharmacoEconomics 13(5Pt2):645-651.

Smith S, Weber S, Wiblin T, Nettleman M (1997). Cost-effectiveness of hepatitis A vaccination in healthcare workers. Infection Control and Hospital Epidemiology 18(10):688-691.

Smith W J, Jackson L A, Watts D H, Koepsell T D (1998). Prevention of chickenpox in reproductive-age women: cost-effectiveness of routine prenatal screening with postpartum vaccination of susceptibles. Obstetrics & Gynecology 92(4):535-45.

Stinnett A A, Mittleman M A, Weinstein M C, Kuntz K M, Cohen D J, Williams L W, Goldman P A, Staiger D O (1996). The cost-effectiveness of dietary and pharmacologic therapy for cholesterol reduction in adults. In Gold M R, Siegel J E, Russell L B, Weinstein M C (eds), Cost-Effectiveness in Health and Medicine, New York: Oxford University Press.

Tao G, Remafedi G (1998). Economic evaluation of an HIV prevention intervention for gay and bisexual male adolescents. Journal of Acquired Immune Deficiency Syndromes and Human Retrovirology 17(1):83-90.

Van Enckevort P J, TenVergert E M, Bonsel G J, Geertsma A, van der Bij W, de Boer W J, Koopmanschap M A, Al M J, Rutten F F H (1998). Technology assessment of the Dutch lung transplantation program. International Journal of Technology Assessment in Health Care 14(2):344-356.

Warner K E, Smith R J, Smith D G, Fries B E (1996), Health and economic implications of a work-site smoking-cessation program: a simulation analysis. Journal of Occupational and Environmental Medicine 38(10):981-992.

APPENDIX
CHARACTERISTICS OF STUDIES IDENTIFIED FROM HEED

KEY

Reference/Type of analysis (e.g. CEA, CUA)/Intervention

1 Method used (Human capital, friction cost, or US Panel)
2 Morbidity or mortality costs
3 Components of time (paid/unpaid work, leisure etc.)
4 Outcome measure used
5 Results with and without inclusion of productivity costs

Beutels et al. (1999)/CEA/Pertussis vaccination

1 Human capital approach (authors' statement).
2 Mortality costs. Informal caregiving costs associated with morbidity were also included.
3 Paid work time.
4 Infections prevented, life years gained.
5 Routine vaccination at 50% coverage had an incremental direct cost of US$4.3 m (1996 prices) compared with no vaccination but mortality-related productivity savings of US$7.2 m. Caregiver savings were US$2.4 m.

Ford et al. (1999)/CEA/Radon screening in the home

1 Human capital approach.
2 Mortality and morbidity costs.
3 Paid work time.
4 Lung cancer deaths prevented, life years gained.
5 Relative to no screening, universal screening at a threshold of 2 pCi/L was estimated to cost $3.05 m per lung cancer death prevented including medical costs and productivity losses and $3.36 m excluding medical costs and productivity losses.

Kobelt et al. (1999)/CUA/Range of treatments for rheumatoid arthritis

1 Human capital approach.
2 Morbidity costs.
3 Paid work time. The cost per year of lost work capacity was calculated from the average labour cost. Leisure time was assumed to be captured at least partly by the QALY.
4 QALYs using the EuroQol scale.
5 Cost per QALY results did not give productivity costs separately.

Lord et al. (1999)/CUA/Screening and treatment for phenylketonuria (PKU)

1 Human capital approach.
2 Morbidity and mortality costs. The intervention both extends life and improves quality of life. Long term costs, including mortality costs, are implied by the reporting of patient's earnings by age group from 18-24 up to 60-64.
3 Paid work time for parents and those screened. In the base case, for cases of PKU not detected early, one parent loses all earnings in half the families whose disabled child is living at home. For untreated patients, those aged 18-24 lose 83% of earnings and those aged 25-65 lose 86% of earnings. Average hours and wages were obtained from the New Earnings Survey and adjusted for unemployment-employment rates from the General Household Survey.
4 Cases of PKU detected, QALYs based on an estimate from the literature of the QALYs gained per case of PKU detected.
5 In the 'price standardisation' analysis, median net direct cost savings were estimated at £143,400 (1995 prices) per case detected and treated, compared with productivity cost savings of £153,100. In the 'modelling' approach, the best estimate of net direct cost savings was £93,400 per case detected and treated compared with avoided productivity losses of £52,900.

Rosen et al. (1999)/CUA/Duration of therapy for intravascular-associated Staphylococcus aureus bacteraemia guided by transoesophageal echocardiography

1 US Panel approach (to which the authors refer).
2 Morbidity and mortality costs.
3 Paid work time (other elements of time were not discussed).
4 QALYs based on utilities from the published literature.
5 QALYs not presented with and without productivity costs – altering the utility of stroke had little impact on the results.

Alterman and Drucker (1998)/CEA/Screening for cerebral aneurysms

1 Human capital approach.
2 Mortality and morbidity costs (annual costs of death or disability are reported).
3 Previously published data on lost income.
4 Life years gained.

5 With screening, disability costs are around $200 million after 40 years in a population of 25,000, compared with over $250 million of medical costs. Without screening, costs of death and disability are around $1,250 million at 40 years and medical costs are negligible.

Bosch et al. (1998)/CUA/Stent placement versus angioplasty for iliac arterial occlusive disease

1 US Panel approach (to which the study refers).
2 Morbidity costs (authors' statement). Long term survival was not affected by the revascularization procedure carried out.
3 Lost paid work time over and above that captured by QALYs was deemed to be minimal as most patients were retired and mean convalescence time was less than a week.
4 QALYs based on valuations derived in a previous study using the SF-36, Health Utilities Index and EuroQol-5D. Patients also undertook the standard gamble.
5 Productivity costs were not separately identified from the overall QALY estimate.

Chung et al. (1998)/CUA/Endoscopic versus open carpal tunnel release

1 US Panel approach (authors' statement).
2 Morbidity costs; neither form of surgery is expected to have an impact on mortality.
3 The value of work time was incorporated into the estimation of QALYs by asking respondents to 'consider the full range of impacts of the health status change' when utilities were assessed.
4 QALYs based on the valuation of scenarios by subjects familiar with carpal tunnel syndrome.
5 Productivity costs were not separately identified from the overall QALY calculations.

Durand-Zaleski et al. (1998)/CEA/Chemotherapy for unresectable colorectal liver metastases

1 Human capital approach.
2 Morbidity and mortality costs. Survival and continuation of work after diagnosis varied by treatment.
3 Value of workdays lost relative to a full working life. Labour time was valued according to the average compensation per employee for an estimated 250 days worked annually in the UK.

4 Life years gained, survival with normal quality of life based on patient responses to Rotterdam Symptom Checklist, Sickness Impact Profile, and Hospital Anxiety and Depression Scale.
5 Total costs under hepatic arterial infusion, systemic chemotherapy and symptom control were £31,659, £15,232 and £10,226. Of these costs, the costs of lost work time were £9,814, £7,360 and £6,134 in the three groups, respectively.

Glick et al. (1998)/CEA, CUA/Tirilazad mesylate for aneurysmal subarachnoid haemorrhage
1 Friction cost approach (our interpretation).
2 Mortality and morbidity costs (both are reported as outcomes).
3 Impact of tirilazad versus vehicle on paid work time. Daily 'employment value' at three months was estimated as difference in earnings.
4 Deaths averted, life years gained, QALYs using quality adjustments from a previous exercise with the Health Utilities Index Mark II among patients with subarachnoid haemorrhage. Adjustments were applied according to Glasgow Outcome Scale score.
5 At three months, daily employment value was $US21.1 with vehicle and between $US21.3 and $US23.7 with tirilazad depending on the dose. Differences were not statistically significant.

Hayman et al. (1998)/CUA/Radiation therapy following conservative surgery for early-stage breast cancer
1 US Panel approach (authors' statement).
2 Morbidity costs; the addition of radiation therapy did not alter life expectancy.
3 Productivity costs associated with recovery from treatment were assumed to be incorporated into the assessment of QALYs. Time undergoing treatment was valued in monetary terms using average hourly wages.
4 QALYs based on interviews with a group of breast cancer patients treated with lumpectomy and radiation therapy, using the standard gamble.
5 QALYs were not calculated with and without productivity costs associated with recovery. Exclusion of costs of time undergoing treatment and of travel costs reduced the cost per QALY from $28,000 (1995 prices) to $25,800.

Hoerger et al. (1998)/CUA/Pramipexole for Parkinson's disease

1 Human capital approach.
2 Morbidity costs (long term). The impact of mortality was not discussed.
3 Lost work time, with the probability of working dependent on Unified Parkinson Disease Rating Scale (UPDRS) and retirement taken at 65. Work time was valued using median weekly earnings
4 QALYs using multivariate regression to estimate the EuroQol score as a function of UPDRS score.
5 In the base case, total costs were $US2,606 (1997 prices) higher with than without pramipexole for early stage patients but productivity costs were $US7,546 less. In advanced-stage patients, total costs were $US4,099 higher but productivity costs were $US6,413 lower with pramipexole.

Jonsson (1998)/CUA/Hormone replacement therapy or bisphosphonates for the prevention of hip fractures in osteoporosis

1 Human capital approach.
2 Mortality costs.
3 'difference between production and consumption' during extra survival due to a reduction in the number of fractures.
4 QALYs with quality of life adjustments based on author's judgement.
5 For a 70-year-old woman with a relative risk of 1 and an intervention costing SEK 5,000 per year, cost per QALY increases from SEK 23,400 at baseline to SEK 385,000 when costs in added years of life are included. When the relative risk is set to 2, cost per QALY increases from SEK 51,000 to SEK 170,000.

Krahn et al. (1998)/CEA/School-based hepatitis B vaccination

1 Human capital approach (the article refers to lifetime indirect costs).
2 Morbidity and mortality costs ('the loss of productive time incurred because of hospitalization, convalescence, physician visits, and premature death').
3 The value of paid work time using the industrial aggregate of average weekly earnings and the value of housekeeping services using average weekly earnings for those in full time domestic work, adjusting for differences in hours between domestic workers in and out of the labour force.
4 Acute infections prevented, chronic infections prevented, life years gained.

5 For a cohort of 46,000 grade six students, lifetime direct costs are $477,000 (1994 prices) greater with vaccination than without. Lifetime indirect costs are $3,491,000 less with vaccination than without.

Rosner et al. (1998)/CUA/Multi-drug therapy treatments for the prevention of vertebral fractures in postmenopausal women with osteoporosis

1 Human capital approach (but consistent with friction cost approach).
2 Morbidity costs (short term). The impact of mortality was not discussed.
3 Lost paid work time by patients with osteoporosis symptoms or vertebral fractures and resulting loss of work time for caregivers. Lost time was estimated by a Delphi panel and valued according to average weekly wage rates.
4 QALYs based on clinicians' judgement with regard to the impact of a vertebral fracture on the Health Utilities Index Mark 2.
5 Productivity costs not separately reported.

Smith et al. (1998)/CEA/Prenatal screening for varicella and postpartum vaccination

1 Human capital approach (authors' statement).
2 Morbidity and mortality costs.
3 Paid work time. Morbidity costs for women were based on age-specific annual mean earnings.
4 Cases of adult chickenpox prevented, cases of fetal/neonatal chickenpox-related disease prevented, chickenpox-related deaths prevented, adult deaths prevented, fetal/neonatal deaths prevented, life years gained.
5 In the base case, selective serotesting was estimated to have net medical costs of US$36.4 m (1995 prices) compared with no intervention but to yield a net medical and productivity cost saving of US$21.8 m. The medical costs for serotesting all pregnant women compared with no intervention of US$134.7 m compare with total (medical plus productivity) costs of US$57.7 m.

Smith and Roberts (1998)/CUA/Oral aciclovir for adult chickenpox

1 Human capital approach.
2 Morbidity costs; probability of death was the same with and without aciclovir. However, the sensitivity analysis tested the assumption of a reduction of one death in the US per year with aciclovir. The authors state that indirect costs of death were estimated as wages lost from time of death to age 65.
3 The value of paid work time was estimated by the average weekly wage rate (e.g. the time cost of hospitalisation was put at two weeks' wages).
4 QALYs based on utilities obtained in previous studies.
5 Taking account of direct costs only, aciclovir was $US123.98 per patient more costly than no antiviral treatment in the base case but, when productivity costs are included, aciclovir was $US13.20 less costly.

Tao and Remafedi (1998)/CUA/Behavioural intervention to prevent HIV

1 Human capital approach (authors' statement).
2 Morbidity costs.
3 Value of expected future earnings less productivity gains in the next ten years as most persons with HIV expected to work for ten years after becoming infected. The authors report that aging is modelled but not mortality.
4 QALYs based on an estimate from a previous study of the number of QALYs gained per HIV infection averted.
5 In the base case, the intervention was estimated to incur $1.1 m (1994 prices) in direct costs over a ten year period, including treatment costs averted, but to save $10 m when human capital gains are included.

Van Enckevort et al. (1998)/CUA/Lung transplantation

1 Friction cost approach (authors' statement).
2 Mortality and morbidity costs (both are among the outcomes).
3 Not stated.
4 Life years gained, QALYs using the EuroQol scale.
5 Productivity costs not separately reported.

Evans et al. (1997)/CEA, CUA/Sumatriptan versus caffeine/ergotamine for migraine

1 Human capital approach (authors' statement).

2 Morbidity costs. The authors assumed that a moderate or severe attack not relieved within two hours is associated with one day of work missed or the equivalent incapacity at work.
3 Paid work time was valued according to average earnings per day for Canadian patients with migraine.
4 Attacks aborted, QALYs based on the Quality of Well-Being Scale and authors' judgement concerning the experience of symptoms.
5 Sumatriptan had an incremental direct cost of $Can 17.34 (1995 prices) per patient in the base case but, including productivity costs, a saving of $Can 42 per year was estimated.

Ginsberg and Lev (1997)/CEA/Riluzole for amyotrophic lateral sclerosis (ALS)
1 Human capital approach (consistent with friction cost approach).
2 Mortality costs. Delay in cessation of work of three months corresponds with the three months increased life expectancy with riluzole.
3 Paid work time was valued using the average annual employment cost adjusting for the age and sex distribution of the ALS population and a 7% unemployment rate.
4 Life years gained.
5 Riluzole was associated with increased health service costs of $US757 (1996 prices) and increased productivity of $US3,641, giving a net saving of $US2,247.

Johannesson et al. (1997a)/CEA, CUA/Treatment for hypertension
1 Human capital approach.
2 Mortality and morbidity costs (authors' statement). Morbidity costs were drawn from the literature. The effect of mortality was estimated using the difference between consumption (using survey data) and production.
3 Paid work was valued according to the average gross income from labour plus payroll taxes and labour participation and unemployment rates. Non-market production was considered to be leisure time and therefore included in the quality adjustment weights.
4 Life years gained, QALYs using quality adjustment weights from the literature.
5 In the base case, with blood pressure in the range 90-94 mm Hg, the cost per QALY was $US107,000 (1995 prices) for men aged <45 and

$US176,000 for women aged <45. Varying the morbidity costs by +/- 50% gave ranges of $US96,000-118,000 for men and $US156,000-196,000 for women. Varying annual net consumption by +/- SEK 50k gave ranges of $US113,000-100,000 and $US181,000-171,000.

Johannesson et al. (1997b)/CEA/Simvastatin as secondary prevention in coronary heart disease

1 Human capital approach.
2 Morbidity costs affected by the occurrence of coronary events. Labour production before and after a coronary event was estimated for patients in the Scandinavian Simvastatin Survival Study placebo group suffering nonfatal events.
3 Paid full time work was valued according to the average annual cost for the labour of a Swedish worker.
4 Life years gained.
5 In the base case, direct costs per life year gained (LYG) were $6,700 for men aged 35 and $13,200 for women aged 35. Savings were recorded when productivity costs were included. At age 59, the ratios fell from $4,200 and $7,100 for men and women to $1,200 and $3,200 when productivity costs were included. At age 70, the ratios were unaffected.

Liberato et al. (1997)/CUA/Interferon alfa (IFNa) versus hydroxyurea in chronic myelogenous leukaemia

1 Human capital approach.
2 Morbidity costs (long term). It was assumed that every IFNa patient not discontinuing the drug due to side effects loses one week from work because of IFNa side effects in every Markov cycle. Patients entering blastic crisis are assumed to retire. The impact of improved survival under IFNa was not discussed.
3 Paid work time valued according to annual income. Production losses for those who retire are put at half the annual income.
4 QALYs based on utilities obtained from an expert panel.
5 In scenario A (current protocol), the incremental total cost of IFNa is $115,600 including an incremental productivity cost of $1,900. In scenario B (prevention of ineffective drug use), the incremental total cost of IFNa is $66,100 with a productivity cost saving of $600.

Liljegren et al. (1997)/CEA, CUA/Routine postoperative radiotherapy in breast cancer

1 Friction cost approach (our interpretation).

2 Morbidity costs; survival was not significantly different between radiotherapy and no radiotherapy groups. Production losses were limited to six months after primary treatment or local recurrence.

3 The value of paid work was estimated using the average income per day for working women.

4 Local recurrences avoided, QALYs based on utility values obtained in a previous study.

5 When medical costs only were included, the incremental cost per local recurrence avoided was SEK297,857 (1993 prices) with radiotherapy, increasing to SEK 337,727 when travel expenses and productivity costs were included.

Nord et al. (1997)/CUA/Melphalan-prednisone (MP) plus interferon-alpha2b versus MP alone

1 Friction cost approach (to which the authors' refer).

2 Mortality and morbidity costs. Interferon gives 3 months' increased survival but a quality of life loss lasting 12 months. The impact of improved survival was not explicitly considered but a 3 month difference is similar to short term morbidity with a friction period of about the same length (Koopmanscap et al., 1995).

3 The cost of paid work time, with some short term absenteeism compensated for by increased productivity in remaining workers and replacement by other workers. The daily cost of short term absenteeism is assumed to be half the average daily salary. This proportion was influenced by the unemployment rate, suggesting replacement of deceased workers.

4 QALYs based on converting QLQ-C30 into quality of life adjustments using the EuroQol scale, the Index of Health-Related Quality of Life and the 15D.

5 Indirect costs are reported as being NOK 12,600 (1995 prices) more in the interferon group than in the melphalan-prednisone group. The additional direct cost of interferon is estimated at NOK 75,000, giving a total incremental cost of NOK 87,600.

Porter et al. (1997)/CUA/Conventional versus stereotactic radiosurgery for small cerebral arteriovenous malformations (AVMs)

1 Human capital approach.
2 Mortality and morbidity costs ('lost productivity related to death or disability from the disease or its treatment'). No patient suffering a major stroke returns to work, resulting in a loss of 25 years' productivity (age at baseline of 40 to retirement age of 65). Patients suffering a minor stroke return to work after six months.
3 Work time was valued according to the national average annual income for those with income.
4 QALYs using authors' judgement concerning quality adjustments and a standard gamble exercise among patients with AVMs treated in a separate clinic.
5 Productivity costs are not separately reported, but the impact of varying productivity costs in the sensitivity analysis was to give a range for the cost per QALY of between $6,400 (1995 prices) and $8,600.

Salkeld et al. (1997)/CEA, CUA/Lifestyle intervention versus usual care for cardiovascular risk reduction

1 Human capital approach.
2 Morbidity costs (authors' statement) were long term caused by coronary heart disease (CHD) events. Survival gains were small.
3 Production losses based on the proportion of patients in paid work before and after a CHD event. Costs were calculated on an annual basis using weekly earnings.
4 Life years gained, QALYs gained based on previously published valuations.
5 Productivity costs are not reported separately but their exclusion adds around $11,000 per life year gained (LYG) or $9,000 per QALY gained. Incremental costs per LYG (per QALY) at baseline were around $190,000 ($150,000) for men and over $3 m (over $11m) for women.

Smith et al. (1997)/CEA, CUA/Hepatitis A vaccination in health care workers

1 Friction cost approach (our interpretation).
2 Morbidity costs. Each case of hepatitis A results in a worker spending one month off work. The impact of mortality on production was not explored.
3 Paid work was valued according to average lifetime salary rates.

4 Cases prevented, lives saved, life years gained, QALYs based on authors' judgement concerning quality adjustments.

5 Value of work time was not presented separately but the authors state that 'excluding the cost of time off work did not alter the overall conclusions of the study'.

Beutels et al. (1996)/CEA/Routine varicella vaccination in children

1 US Panel approach (our interpretation).

2 Mortality and morbidity costs. Caregivers' time was valued in monetary terms. A monetary value of production loss for the small number of adults contracting varicella is also estimated.

3 Value of paid production drawn from the literature.

4 Infections prevented, deaths prevented, life years gained.

5 The direct costs of vaccinating all healthy children aged 12-18 months were estimated at DM 7.9 m, with productivity savings of DM 169.2 m. In adolescents (all healthy 12-year-olds), direct cost savings of DM 3.9 m and productivity cost savings of DM 17.1 m (1995 prices) were estimated. For a combined strategy (all healthy children aged 12-18 months and, for 11 years, all healthy 12-year-olds with a negative history of varicella infection), direct costs were DM 4 million and productivity savings were DM 186.3 million.

Goossens et al. (1996)/CUA/Educational/cognitive (ECO) versus educational discussion (EDI) intervention for fibromyalgia

1 Human capital approach (authors' statement). The friction cost approach is used in the sensitivity analysis but results are not separately reported.

2 Morbidity costs.

3 Costs associated with absence from work and inability to perform usual daily activities are reported using the national average gross hourly wage. Unpaid help by family or friends was valued using the price of professional help (treated in this study as direct non health care costs).

4 QALYs based on rating scale and standard gamble utilities.

5 Total direct costs per patient year were $US4,260 (1993 prices) in the ECO group and $US2,637 in the EDI group. Productivity costs using the human capital approach were $US6,379 and $US5,817. It is stated that these costs are lower using the friction cost approach but in neither case were they significantly different between groups.

Johannesson (1996)/CEA/Pharmacotherapy for hypertension

1. Human capital approach.
2. Morbidity costs (author's statement) are long term with indirect costs taken from another source for the first year and subsequent years after a coronary event (acute myocardial infarction (MI) and coronary insufficiency, silent MI, angina pectoris and stroke).
3. Paid work time. No indirect costs are attributed for those above the age of 65.
4. Life years gained.
5. Morbidity costs are not separately reported.

Johannesson et al. (1996)/CEA/Advice and pharmacotherapy for lipid lowering

1. Human capital approach.
2. Morbidity costs were valued as in a previous study for those below retirement age. Time of patients and relatives for attending the intervention was valued according to assumptions about the division between work and leisure time.
3. For those above retirement age, all time receiving the intervention was assumed to be leisure time, valued at 35% of the gross wage. For those below retirement age, half the time was assumed to be working time, valued at the average salary cost in Sweden.
4. Life years gained.
5. In the base case, estimate one (assuming the epidemiologically expected reduction in coronary heart disease (CHD)) gave a cost per life year gained of $US61,000 (1991 prices). In estimate two (half the epidemiologically expected reduction in CHD is assumed), the cost per LYG is $US142,000. Excluding morbidity costs, these ratios increased to £73,000 and £149,000.

Jordan et al. (1996)/CEA, CUA/Surgery plus endovascular therapy for cerebral arteriovenous malformations (AVMs)

1. Human capital approach.
2. Mortality and morbidity costs. Mortality costs were estimated taking the difference between patients' average age and an assumed retirement age of 65. Morbidity costs were calculated as a percentage of mortality costs based on morbidity and mortality ratios.
3. Paid work time was valued according to average annual income based on the non-farm industrial wage.

4 Angiographic cure, life years gained, QALYs using authors' judgement concerning quality weights.
5 Productivity costs are not separately reported.

Kelly et al. (1996)/CUA/Folic acid supplementation to prevent neural tube defects (NTBs)

1 US Panel approach.
2 Mortality and morbidity costs. Caregiver's lost paid work time and nonwage housekeeping were valued in monetary terms. Productivity costs of people with spina bifida were excluded (although productivity gains for those who are prevented from developing NTBs are presumably intended to be captured by QALYs).
3 Lost paid work time for caregivers was valued according to the weighted average annual mean earnings by age and sex for the proportion of population in the labour force and the imputed value of nonwage housekeeping, based on labour force wage rates for similar tasks.
4 Life years gained. QALYs estimated using the Health Utilities Index, the Quality of Well-Being Index, the EuroQol scale and the NCHS Years of Healthy Life.
5 Productivity costs not separately reported.

Lindholm et al. (1996)/CEA/Health promotion activities to prevent cardiovascular disease

1 Human capital approach.
2 Morbidity costs are long term (indirect costs for year 1 and year 2 and following are reported) for myocardial infarction and angina pectoris.
3 Paid work time valued according to the employer's cost for an industrial worker.
4 Life years gained.
5 With costs and life years discounted at 5%, the health care system costs range from £1,650 (1992 prices) to £4,050 depending on the scenario while societal costs range from net savings to £1,950.

Norum et al. (1996)/CUA/Chemotherapy for Hodgkin's disease

1 Friction cost approach (authors' statement).
2 Mortality costs. Deceased workers are assumed to be replaced from the unemployed. Production gains were estimated to be 10% of the human capital estimate.

3 Paid employment valued by gross income.
4 QALYs based on the EuroQol scale.
5 Health care costs per QALY range between £818 (1994 prices) and £1,803 as the discount rate is increased from 0% to 10%. Including production gains, these ratios fall to between £795 and £1,651.

Rodby et al. (1996)/CEA/Captopril versus control of blood pressure alone in diabetic nephropathy
1 Human capital approach (authors' statement).
2 Mortality and morbidity costs. Captopril delays the onset of end stage renal disease and improves survival.
3 Lost paid work time and household production was based on the relative labour force participation between patients with diabetes and end stage renal disease (ESRD) patients or transplant patients. The value of a death was computed to life expectancy for patients with diabetes and no ESRD.
4 Dialysis years saved, life years gained.
5 Over four years, direct cost savings with captopril in insulin dependent diabetes mellitus (IDDM) are $4,850 (1994 prices) per patient and $2,790 in non insulin dependent diabetes mellitus (NIDDM). Productivity cost savings are $25,650 and $41,270. Over 12 years, direct cost savings are $30,100 and $9,900 compared with productivity savings of $100,920 and 45,730. Over 31 years, direct cost savings for those with IDDM are $32,550 compared with productivity savings of $84,390.

Stinnett et al. (1996)/CEA, CUA/Diet and pharmacotherapy for cholesterol reduction
1 US Panel approach.
2 Morbidity and mortality costs. Patient travel, waiting and treatment time were valued in monetary terms.
3 Patient travel, waiting and treatment time valued using the average hourly earnings of employed persons reporting earnings.
4 QALYs based on valuations of quality of live provided by patients involved in the Acute Myocardial Infarction Patient Outcome Research Team and the Beaver Dam Health Outcomes Study which used the Quality of Well Being scale.
5 Productivity costs not separately reported.

Warner et al. (1996)/CEA/Worksite smoking cessation intervention

1 Friction cost approach (our interpretation).

2 Mortality and morbidity costs. Deceased workers are replaced by new employees in the 'full-firm' model (it is not stated whether these are previously unemployed). Absenteeism rates were drawn from the National Health Interview Survey, and reduced productive time while at work was based on authors' judgement.

3 Value of absenteeism and reduced productivity in paid work estimated using manufacturing workers' earnings.

4 Smoking cessation, deaths postponed, life years gained.

5 At year 50, total cost savings to the firm of 10,000 employees, including reduced medical expenditures, are $5.2 m (1995 prices). Reduced absenteeism and productivity gains at work consititute $1.2 m and $1.4 m of these savings.

GLOSSARY

Consumption externalities – that component of a worker's production which generates benefits other than to the specific worker. In particular, that component which accrues to the government in the form of tax revenue. The distribution of this tax revenue to others in society (those external to the original productive activity) provides them with the means to consume goods and services.

Cost benefit analysis – a form of economic evaluation in which the outcomes and costs are valued in the same units – invariably in monetary terms. In principle, it can give an unambiguous answer as to the desirability of a policy option; if there are positive net benefits for the programme, it should be implemented and, if there are net costs, it should not.

Cost effectiveness analysis – a form of economic evaluation in which the results are expressed as a ratio of cost per unit of health outcome. The outcomes can be specific to the therapeutic area under investigation (e.g. mm Hg change in blood pressure, change in cholesterol level) or more general (e.g. life years gained).

Cost utility analysis – a form of cost effectiveness analysis in which the outcomes combine life expectancy with the value attached to other aspects of health status, generally in the form of the quality adjusted life year (QALY).

Friction period – the period of time required by organisations to recruit new workers in response to death and disability in the existing workforce.

Frictional unemployment – those who are temporarily unemployed while moving from one job to another. Rather than accepting the first available job, individuals will prefer to spend time searching for more favourable opportunities.

Full employment – achieved when the only unemployment is frictional unemployment.

Generic health-related quality of life measures – measures which assess individuals' quality of life according to a general set of attributes or dimensions of health (physical, psychological, social etc.) rather than a set of attributes relevant to a particular disease. These measures are normally administered in questionnaire format.

Gross wage – the cost of labour to the employer which includes taxation and other on-costs such as national insurance.

Health state valuation – the process by which individuals are asked to weight the relative importance of different dimensions of health. These values are normally expressed on a scale with reference points of 0 for death and 1 perfect health. There are a number of methods for obtaining these values and respondents may be asked to value their own health or provide valuations for a general set of health states, for example as part of a general population survey.

Involuntary unemployment – the level of unemployment consisting of those who are prepared to work at the wage rate on offer in the labour market but who are unable to find employment.

Multiattribute utility measures (MAU) – standardised descriptions of health using a series of health states to which values (or utilities) are attached on a 0-1 scale. These are typically generic measures which are suitable for using as weights when calculating QALYs (see below). Examples are the EQ-5D scale, the Health Utilities Index and the Quality of Well Being scale.

Net national income – the value of all goods and services in society less depreciation.

Net wage – the gross wage less all employers' on-costs and income taxes, but including employers' and employees' contributions to a pension scheme.

Opportunity cost – the true value of a scarce resource: the benefit forgone from using a resource in a particular way rather than the best alternative use.

Present value – the total value of a series of future flows of money or health benefits (e.g. QALYs) discounted to the present. Discounting acts in the opposite way to compound interest and, by attaching a lower weight to current than future flows, reflects a preference to receive benefits in the present rather than the future and for costs to be incurred in the future rather than the present.

Quality adjusted life year (QALY) – a measure of benefits of health care interventions combining survival and the value (weight) attached to other aspects of health status. The QALY is conventionally expressed as life years multiplied by the quality weighting.

Reference Case – a 'base case' set of recommendations for the conduct and presentation of economic evaluation put forward by the US Panel on Cost-Effectiveness in Health and Medicine.

Replacement chain – a worker who dies or requires replacement through long term illness may be replaced from elsewhere in the employed workforce, creating a further vacancy. This may generate a series of replacements, or replacement chain, which ends when a member of the unemployed finds employment.

Societal perspective – the perspective normally recommended to be adopted in economic evaluation, whereby the analysis takes account of all costs no matter who in society incurs them and all benefits regardless of who in society receives them. The main implication is that productivity costs are included from the societal perspective.

Transfer payment – a transfer of money from one part of society to another which does not reflect the use of real resources. Compensation for lost income while an individual is absent from work is an example of a transfer and, in a publicly financed system of income replacement, is matched by tax payments from the rest of society.

Utility – a term widely used in economics with a variety of meanings. In economic evaluation it is typically used to mean a cardinal measure of the value individuals attach to different outcomes (usually health). These are often used in QALYs to weight periods of time in different health states (see QALY).

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