An Evaluation of Selected Literature on The Measurement of Costs in Health Economic Evaluations.

By

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Health Economics Papers:3

Contents

Abstract

Objective: To evaluated a number of empirical studies to determine how economic evaluation studies in health care apply principles and practices of cost determination.

Methods: Important stages in the process of cost determination are discussed. Principles and practices with respect to which cost categories to consider as a consequence of choosing a specific study perspective, how to measure the physical resources used in a given project, and the correct valuation base to choose for resource valuation when measuring cost are considered. Using this knowledge 50 selected studies were chosen and evaluated.

Results: the results showed the following: a lack of detail when reporting cost; that many studies did not include the cost categories appropriate to the chosen study perspective; inadequate description of the valuation base; a lack of information on time frame used; and a lack of agreement on cost concepts across studies.

Conclusions: Although guidelines have been established for economic evaluations the results show that there is a need for more standardization in costing.

Key words: measurement of cost, economic evaluation, guidelines, empirical studies

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1. Introduction

Despite many years of experience in the context of economic evaluation the assessment, retrieval, measurement and valuation of costs continue to raise issues, both practical and methodological. Guidelines describing how to determine cost, i.e., which cost categories to include and which valuation bases to use when determining the costs of an intervention, are still needed even though some consensus about outlines has been established (5;7;8;14;15;66). The objective of this paper is to evaluate costing methods in the health economics literature in the context of economic evaluations in health care.

In order to do so the paper is structured in the following way. In section 2 the costing terms used are defined. Any study involving resource use must contain the following features: (i) an appropriate description of the project or intervention, its characteristics and the consequent cost categories which are to be considered; (ii) the measurement of resources used in the project such as time worked by different health professionals, beds used, drugs prescribed, etc.; (iii) the valuation of all resources used in the project. Each of these features is considered in turn in the subsequent parts of section 2. The principles enunciated in this section are then applied in an empirical study of fifty papers. Finally commentary is provided in the light of this empirical work.

2. Analysis

The ideal economic evaluation starts by identifying all the implications of applying one intervention or another, including the use of resources. The resource changes are measured and then valued. Cost categories which in principle should be included in the analysis are costs associated with the change in use of health care resources, the change in use of non-health care resources, the change in use of informal caregiver time and the change in use of patient time (23), i.e., direct medical costs, direct non-medical costs and production losses. In practice, however, cost categories included will depend on the objectives and context of the evaluation.

2.1 Definition of Costing Terms

At the outset we define a number of terms that will henceforth be used. These are shown in Table 1.

Direct costs are characterised as costs which can be directly connected to the use of one or more resources needed to be able to carry out an intervention. The term *indirect cost* is used in economics to refer to productivity losses related to illness or death (23). However, another interpretation of the term is found in accounting where it is used to specify overheads or fixed costs of production, e.g., utilities, custodial services or administration. In this paper both these definitions of indirect cost will be included. For clarity of presentation the economic indirect costs will be referred to as *productivity costs*, and the accounting indirect costs as *overheads*.

Another distinction in economics is found between *variable* and *fixed costs*. *Variable costs* are those cost elements that might change because of an intervention. *Fixed costs* are in contrast defined at those costs that are independent of the level of production. The distinction between these two cost terms depends on the time frame chosen. In the case of calculating incremental cost differences between two projects

any common fixed costs would be cancelled out. Intangible costs, e.g., pain and anxiety, are not defined in Table 1, since in economic evaluations of health, reductions in such costs are usually included on the benefit side (23;59).

Table 1 Definition of various types of cost and other economic terms

Cost term	Definition	Other economic terms	Definition
Average costs	the cost per unit of output (assuming that only one type of output is produced, i.e., no joint production)	Bill	an amount of money owed for services rendered set out in a printed or written statement of charges
Direct costs	costs which can be directly connected to the use of one or more resources needed to be able to carry out an intervention	Charge	a price for a good or service supplied
Fixed costs	costs that are independent of the level of production (in the short run)	Expense	the cost incurred in or required for something
Friction costs	the cost of the production loss confined to the period needed to replace a sick worker	Fee	a payment made to a professional or to a professional or public body for advice or services
Incremental costs	the change in total cost associated with some change in output quantity	Unit price	a price chosen as a standard in terms of which other prices may be expressed
Marginal costs	the change in costs for a given change in output (Technically, the derivative of total cost evaluated at output level q* is the marginal cost at output level q*)		
Opportunity costs	the value of the resources' best alternative uses		
Overheads	a cost incurred in the upkeep or running of a plant, premises, or business and not attributable to individual products or items		
Productivity loss	costs appearing from loss of productivity related to illness or death		.
Standard costs	costs that are listed in public data bases, and not specific to the project being evaluated		
Unit costs	a cost chosen as a standard in terms of which other costs may be expressed		
Variable costs	the costs that might change because of the intervention (depending on the time period)		

2.2 Cost Categories to Include

When discussing which costs should be considered, the norm is to include all resources consumed that are large enough to have an impact on a decision. As described in Drummond *et al* (16), the costs included in a given study are likely to be decided upon as a result of considering: (i) the viewpoint of the analysis, (ii) if the comparison is restricted to two or more programmes immediately under study, (iii) if some costs are merely likely to confirm a result that would be obtained by consideration of a narrower range of costs, and finally, (iv) what the relative order or magnitude of costs is.

The study perspective is important because in one situation items may be considered as costs but in other cases not. For example, patient expenditures are considered as a cost when the societal perspective is used, but not when the focus is the hospital. When considering a situation where a comparison is restricted to two or more programmes presently being analysed, it would not be necessary to include costs that are common to the programmes, since such costs cancel out. Situation (iii) refers to a case where there happens to be some kind of overlap, i.e., inclusion of a cost category may simply confirm a result that has already been obtained when another cost category was determined. Hence, it might not be worthwhile to complicate the analysis further by including the latter category. However, ease of measurement should not be the key criterion for identification. This should also be borne in mind when considering (iv), where some justification should be given before excluding a cost category. In some situations the extra effort in measuring a cost category might not be worth the trouble, since inclusion of these specific costs might have such a minor effect that it would not influence the choice of programme.

There has been a considerable discussion in recent literature about the inclusion of future unrelated costs, i.e., consumption costs and costs for diseases that are unrelated to the intervention that is being evaluated, and which occur during added

years of life (6;13;20;26;43;60;73). It might not be possible, however, to include these types of costs because the existing data may not be adequate enough to capture future resource use of all unrelated diseases. Therefore, two questions arise: first, should future unrelated costs be included in an economic evaluation and second, what are the practical implications of obtaining the appropriate data?

An argument against the inclusion of future unrelated costs has been that health care is only one of many other costs incurred because of a prolonged life (60). Also, the decision concerning whether or not to treat a future condition may be a separate decision from the one being taken now, and should be based on the costs of alternative ways of treating the future disease (13). Finally, discounting future costs to present values often reduces their significance in an analysis to a minimum, which makes it safe to ignore them in many cases (6). On the other hand, one argument for including future unrelated costs is that if future benefits are included then future costs should also be considered (43). Further, under the assumption that the future stream of health costs meets some optimality conditions some authors conclude that including unrelated future health care costs does not affect the overall ranking of health care interventions (20), i.e., it would simply be adding a constant to a ratio. However, this implies a quite restrictive assumption, that the interventions being compared are for individuals of the same age. As an implication of including future cost, it has been argued that non-health care costs in added years of life should also be included (23). In addition, Meltzer (43) found that future earnings should be included in an economic evaluation, which was further elaborated on by Weinstein & Manning (73). Finally, including future unrelated costs if an intervention is undertaken subject to a budget constraint might affect prioritisation (26); however, this again depends on the restrictiveness of the budget constraint.

Which cost to include will depend on the objectives and context of the evaluation. A number of cost items under alternative perspectives are listed in Table 2. However, this comprehensive Table does not fully cover all perspectives, since it

does not explicitly refer to the governmental and institutional perspective used in the present paper.

Table 2

Costs to be included in economic evaluation using different study perspectives

Cost Element	Societal	Patient and Patient Family	Self-Insured Employer	Public or Private Insurer	Managed-Care Plans
Medical care (aggregate)	All medical care costs	Out-of-pocket expenses	Covered payments	Covered payments	Covered services
"Units"	All units	Those paid out-of pocket	Those covered	Those covered	Those covered
"Price"	Opportunity cost (incl. admin. cost)	Amount paid out-of pocket	Amount paid + admin. cost	Amount paid + admin. cost	Marginal cost
Patient time cost for treatment or intervention	Cost of all time used	Opportunity cost to patient	Only if it affects productivity, paid sick time, admin. cost	None	None
Marketed care giving	All costs	Out-of-pocket expenses	Covered payments	Covered payments	Covered payments
Unmarketed, informal care giving	All costs	Opportunity cost to caregiver	None	None	None
Transportation and other non-medical services	All costs	All costs	None	None	None
Sick leave, disability, other transfers	Admin. costs only	Amount received	Amount paid by employer + own admin.	Amount paid by insurer + own admin.	If any paid

Source: Gold *et al* (1996).

2.3 Measurement of Resources and Cost

To calculate the cost in an economic evaluation it is first of all necessary to measure the physical resources used in a given project, e.g., time worked by different health professionals, beds used, different drugs prescribed, etc. Then, having measured the resources used, these have to be valued, resulting in cost estimates. In this section we

first consider which method to use when measuring the use of physical resources and second, we focus on how to measure cost.

***Measurement method**:* An important part of determining cost is the choice of method to collect data, i.e., how to measure the physical resources used. There are two possible methods of measurement, the top-down method or the bottom-up method. Applying the *top-down method*, a procedure is used to allocate total resources (costs) to lower levels of resource (cost) objects, allowing total costs to be allocated to cost pools which are further allocated down to products or services. In contrast, the *bottom-up method* measures units of resources used (recognized at the cost object level) and multiplies these resource units by unit costs (16). As the top-down method often uses information from final accounts this type of method has to be retrospective, whereas the bottom-up method can be used both prospectively and retrospectively.

Having obtained the use of resources through the bottom-up method, the amount of each service consumed is multiplied by a unit cost and afterwards aggregated to give total costs. The data on the use of health care may be taken from encounter or billing systems if these exist. If such data are not available, the data are specially retrieved by the investigator. Where fee-for-service is practised this enables bills that can give information to be included in the database. However, the use of bills or charges as primary data sources may not be appropriate since these measures are often not the best estimates of costs and may need to be adjusted in some way (see section 2.4).

In many ways the bottom-up method is to be preferred since a more precise estimate of the actual cost is obtained through this detailed method. Detailed compilation is also one of the problems associated with the bottom-up approach, since data compilation might sometimes become very demanding. Another problem with this method is the use of unit prices. These are not always available, and where available they may not always represent the actual use of resources. Finally, the use of the bottom-up method makes it necessary to determine fixed cost and overheads

separately, otherwise only variable costs would be considered.

Study time frame: In the data collection process an important issue is the time frame of the study being evaluated. The time frame should be chosen in a way that makes it possible to encompass all important cost differences between the options being evaluated. Hence, the distinction between the short run and the long run has to be considered. In the short run some factors of production are fixed; in the long run, however, all factors can vary. This affects the collection of data, since in studies that have a long time frame all factors of production are variable. The time frame of the study is thus of importance when considering limits in production capacity, since the amount of a factor of production, for example doctors' hours, may be regarded as fixed in the short run. Over time, however, more doctors might be employed, and therefore the capacity level is increased.

The study time frame and the use of average vs. marginal cost: The distinction between average cost and marginal cost also comes into perspective when discussing a study's time horizon. Average variable cost will eventually rise, as long as there are fixed factors that constrain production, which is the case in the short run. Average cost will initially fall due to declining fixed costs but then rise due to the increasing average variable costs (69). If, on the other hand, average costs are falling, then marginal costs are less than average cost.

Economic theory dictates that marginal rather than average costs be used. What is relevant is the cost of treating those whose health will be affected by the health care services. These costs will therefore be marginal, for example, when considering treating more or when using a more intense therapy on patients already in treatment. In the case where the effect of an intervention is temporary, short run marginal cost should be used to measure cost. Where the effect is expected to endure, long run marginal cost should be used instead. However, in the long run or when few or no economies of scale exist, marginal cost and average cost might be more close in value, making the use of average cost more acceptable. In practice it is often assumed that average costs equal marginal

costs even in the short run, i.e., marginal costs are assumed constant over the relevant range. An implication of such an assumption would be that the true marginal cost could be over- or under-estimated since scale bias (34) might exist. As an example, in an overcrowded clinic where capacity is limited, the treatment of an extra patient might require an extension of capacity, e.g., another doctor has to be employed. This means that the use of average costs would underestimate marginal cost. However, if a clinic had a spare capacity, the use of average costs may overestimate the marginal costs of treating an additional patient.

Measurement of resource unit costs: Having decided upon the method of measurement, and subsequently measured the physical resources used, the next step is to determine the unit cost. In general, there are three ways to compute unit costs: 1) direct measurement of costs, 2) using the fees or charges for the services utilized (in some cases followed by adjustments), 3) estimates based on information from the literature (33). The use of fees, charges or estimates from the literature is straightforward. However, the direct measurement of costs needs more elaboration.

Direct measurement: This method requires the total cost of the cost centres providing the services of interest to be divided by the total amount of output. This first requires that the appropriate cost centres are determined. Second, it must be decided which components should be included in the measure of total cost (e.g., direct operating costs, overheads), and third, the level of detail and sample size, where appropriate, should be considered. An important component in this process is to choose the relevant valuation base when valuing the resources used. This is discussed in the following section.

2.4 Valuation Base

When discussing which valuation base to use, the theoretically correct value to use is the opportunity cost (35). As a result of scarcity, choices have to be made about what activities society should undertake and what activities should not be undertaken. Hence, opportunities to use resources in some activities will be given up (13), and the benefits which would have been accomplished from these forgone opportunities are opportunity costs.

In many cases market prices - if they are available - are used for valuation, even though this, as a consequence, may result in biased cost estimates since prices do not always reflect the value of the best alternative uses of resources (the opportunity cost). For most purposes, however, the market price would be a possible estimate of opportunity cost, and sometimes when market prices might not seem totally correct they could still be used. However, this would only be satisfactory if an appropriate adjustment has been made. For example, the use of bills or charges as primary data sources may not be appropriate since these measures are often not the best estimates of costs and may need to be adjusted in some way, e.g., the time consumed in treatment may not be routinely tracked by an administrative system (23). Within different departments of a hospital, charges may or may not exceed cost (48), which usually is determined by its service mix and, further, as noted by Eisenberg (17), because of the fact that charges often are set by the marketplace or through regulation, they might not reflect the true costs of providing a service. In addition, should charges be used, one should be aware that no differentiation between fixed and variable cost is undertaken. In those cases where the conclusions of the analysis are sensitive to small changes in price, a more thorough consideration of the value of the resources in question would be required. Again, in other cases adequate adjustment would not be feasible, and alternatives to the use of market prices have to be investigated.

Shadow pricing is an approach that is applied where observed prices need to

be adjusted or when values have to be determined and assigned in cases where no observed prices exist. An adjustment of prices would be necessary if the prices observed in the market do not reflect the social marginal value of a good in a competing market, e.g., in a monopoly situation where the price of a good or service being provided exceeds its marginal costs, implying that the price is an overestimate of the social value of the good. Other situations where estimation of shadow prices would be relevant would be where a positive externality makes it necessary to adjust the price downward or in cases where value-added tax (VAT) is imposed on commodities thereby distorting the true costs of the commodities.

Another difficulty arises when the societal view is taken. Here patient costs would be included with all the attendant measurement problems, e.g., those related to the use of the correct valuation base when valuing the time spent receiving a treatment or when determining productivity costs. The problem is how to value time costs in monetary terms. The solution is that the value of time in its best alternative use should be used for this purpose. When individuals allocate their time, it is assumed that they will consider their opportunity cost when choosing between activities, e.g., leisure and work. Often wages are used as estimates of the opportunity cost of time, however, this may rise problems because wages vary between individuals, in accordance with for example gender, education and working status. As an implication, the use of wages would result in the assignment of zero costs to inputs of care provided by homemakers, despite the fact that these resources have opportunity costs (13). Hence, it might be a difficult task for the investigator to consider which estimate to use, for example, should the average wage of the homemakers age categories be used as an estimate or maybe instead some percentage of an average wage?

Having gone through the important stages in the process of cost determination, i.e., which cost categories should be considered as a consequence of choosing a specific study perspective, how to measure the physical resources used in a given project, and the correct valuation base to choose for resource valuation when

measuring cost, we now consider a number of empirical studies to see how economic evaluation studies in health care apply these principles and practices.

3. Methods

The MEDLINE database was used to search the literature from January 1997 to May 1998, and a sample of 50 studies published within these years was selected. The studies were found using the search terms: *cost, cost analysis* and *cost-effectiveness analysis*. The articles chosen for the review were selected by including the first 50 studies appearing from the search. Only studies published in English, German or Scandinavian languages were considered. There were no limitations as to the type of journal in which the studies were published. The following elements were abstracted from the studies selected:

Table 3 Elements abstracted from the studies selected

Perspective of the studies (e.g., health care institution - hospital or clinic, government payer, societal etc.)
Types of services included in the study (e.g., inpatient care, outpatient care, medication)
Which costs for each service were included (direct costs, indirect costs, overheads).
Standard or actual costs (where standard costs are cost measures that are taken from a catalogue and actual costs are costs measured in the study being evaluated).
How data were obtained (e.g., primary data, where the data are collected especially for the project being evaluated or secondary data, where data are based on existing data collections).
Were estimates, cost data or fees used as the basis for determining the cost measure?
Discount rate(s) (e.g., which discount rate was used; if future benefits and future costs were included in the study, were they then discounted).
Sensitivity analysis (was one or more sensitivity analysis conducted, and if so, was any effort made to measure the variation in costs).

4. Results

Perspective

It is necessary to have knowledge about the perspective of the analysis to make judgements about whether proper type of resources have been identified and measured.

As shown in Table 4, the studies reviewed used different perspectives. The perspective taken was most commonly the health care institution, followed by the government. The most comprehensive perspective, the societal perspective, where all costs are included in the analysis, appeared only four times.

In the following sections, the costing methods are reviewed according to type of "service". The choice of services to be evaluate are inspired by Jacobs & Bachynsky (33).

Table 4 Study Perspective

Perspective	Number of studies
Health care institution (hospital or clinic)	
(2;3;9;11;12;18;19;21;27;28;29;31;36;37;40;45;47;49;50;51;53;54;56;58;61;62;67;70;71;72;77)	31
Government	
(24;38;42;44;46;64;68;74;75;76)	10
Societal (productivity costs included)	
(30;41;55;65)	
4	
Private Insurer (third party payer)	
(32;52)	
2	
Patient and Patient family	
(1;10)	2
Managed Care	
(4)	1
Total	50

Inpatient Care

When costing inpatient care, most authors included total cost for each cost centre. None of the studies included the opportunity cost of resources such as property and equipment and only a few (11;27;41;54;55;74) allocated overhead or capital expenses, such as equipment, personnel or facilities, to the cost centres. Considering the way overheads were allocated, more often it was not clear which method (the direct-allocation -, the simultaneous equations -, or the step-down method) was used[2]. Only in one study (41) were overheads allocated directly.

The inclusion of types of costs differed in the studies. Several studies detailed

labour costs (1;2;4;11;29;30;38;41;47;50;54;55;58;61;74;77), equipment costs (24;29;30;37;41;49;50;54;58;77), costs of supplies (3;11;12;29;30;41;49;54;55;58;75), and the cost of diagnostic tests (1;4;31;38;42;44;54;56;58;62;68;72;77). In many cases, categories such as treatment costs were not described in detail. Talking about how detailed the cost categories were described, depends of cause on the chosen approach. In the case of a bottom-up approach the investigator should elaborate on which and how resources were measured; in addition, the valuation base chosen could be described. On the other hand, when applying the top-down method the different cost pools used and what they include should be described.

A common method for costing in-patient care was to apply an average cost per patient day for a single hospital or clinic to the number of hospitalized days (2;12;40;41;45;75;76). The description of what this average term included was not very detailed for any of these studies.

The units of output used when determining costs for surgical procedures were, for example, the time in the operating room (50), days spent in the intensive care unit or surgical ward (40;55), and the number of operations performed (40).

Considering the valuation base, institution (hospital/clinics) fees or charges (e.g., per diem base) were used in many cases for resource valuation (1;2;4;9;11;12;18;24;29;40;41;42;47;51;52;55;62;65;67;75;76). Some studies used the Medicare Fee schedule (9;28;38;50;54;61;64;77), others used diagnostic code charges, e.g., Diagnostic Related Groups (DRG) or Current Procedural Terminology (CPT) codes (32;61;64), or estimates from the literature (1;3;19;28;30;38;41;44;51;70;74;76). In many cases, however, the cost side was very briefly described and it was not possible in these cases to give a clear description of which valuation base was used for the different cost categories (21;27;31;36;37;45;46;47;49;53;56;58; 68;72).

Outpatient Care

Cost for outpatient care was measured in 22 out of the 50 studies reviewed (1;4;10;11;18;21;28;30;31;44;45;47;52;53;61;62;64;67;68;71;74;75). The outpatient or ambulatory costs included outpatient surgery, diagnostic services and follow-up visits. Hospital fees or charges were used by some studies for resource valuation (1;4;11;18;45;52;62;67;74). Some studies used the Medicare Fee schedule (28;64), others used diagnostic code charges, e.g., DRG or current procedural terminology (CPT), (61;71) or estimates from the literature (10;30). In one study (30) the cost of laboratory technician time was determined by measuring the time using time-and-motion studies and then afterwards multiplying the time used by the technician's salary. Six studies specified no valuation base (21;31;44;53;68;75).

Health Care Professionals

A total of 25 of the 50 studies mentioned the costs of different types of health professionals such as physician costs, nurse costs etc.(1;2;4;9;11;19;21;28;29;30; 32; 38;41;42;44;47;50;53;54;55;61;65;72;74;77) separately. Of the 25 studies, 16 reported which valuation scheme was used (CPT) codes or fees (e.g., Medicare) were the most common. Nine studies specified no method. In the 25 other studies only broader terms like the 'cost of treatment' were reported.

Home Care

Two studies (2;10) reported the cost of home care. One study (10) considered the family costs for care-giving which were measured by including pay for long-term services utilized, labour costs for care giving, out-of-pocket expenditures for miscellaneous materials, and the value of the time spent in traffic for collecting

medications, attending appointments and visiting patients. The labour cost of the family caring for patients was calculated as equivalent to the care-giving tasks carried out by health aides. The other study (2) measured the weekly cost attributable to the living costs of patients in private accommodation with help from estimates given by care providers.

Medication

A total of 22 of the 50 studies included drug costs. Ten studies listed no method for cost measurement (12;19;21;36;38;44;49;54;61;74). The remaining twelve studies measured the cost of drugs in a number of different ways, the reason being that the perspective of the studies differed and therefore the payer differed. Out-of-pocket costs, where the family or the patient was paying for the drug, were used in one study (11). Sometimes the government or a hospital/provider was responsible for the payment (29;52;64). Three studies used a price from the pharmacy (2;24;31). In other cases it was a wholesale price (4;28;32;47) or the retail price (41) that was used to measure the cost of medication. None of the studies reported the inclusion or exclusion of value-added tax, sales tax etc.

Out-of-pocket costs

Out-of-pocket expenditures for miscellaneous materials such as food, clothes, facilities, transportation, or the value of the time spent in traffic (for collecting medication, attending appointments etc.) were included in only a few studies (10;58;75). The value of time spent in traffic was measured in one study (10) by multiplying the number of hours per month spent in traffic by the market value of a health aide. The rest of the studies, however, listed no method for considering the valuation of out-of-pocket expenses. Of cause, for some studies there was no reason for including such costs,

because of the perspective chosen, however, other studies omission of this cost category must be considered as a mistake.

Productivity loss and Overheads

Distinguishing between the health economic definition of indirect costs (productivity losses) and the accounting definition (overheads), four studies (30;41;55;65) reported productivity losses related to illness. In one study (65) these costs were calculated on the basis of the number of days off work reported by the patient during the treatment and follow-up period combined with information about the mean income in different age and sex groups. Another study (41) calculated the cost of time off work using the friction cost method (39), and one study (30) listed no method.

Finally, one study (55) assumed that depending on the severity of the illness - in this particular case it was the distinction between a minor or major stroke - patients would return to work after a 6-month recovery period or in the worst case patients would never return to work and 25 years of productivity would be lost. These assumptions were combined with the assumption that the work of all individuals had the same economic value, whether they worked outside or inside the home. Again, as mentioned above when discussing out-of-pocket costs, the necessity of including productivity loss, depends on the because of the perspective chosen. In fact, when considering the selected studies it appeared, that the studies who used a societal perspective correctly were the ones determining productivity losses (Appendix I, Table A1).

Six studies (11;27;41;54;55;74) measured overheads in their calculation of costs. The content of these overheads varied between the studies, some of the costs included were administration, housekeeping, support from other service centres and equipment maintenance.

Discounting of costs

In 26 studies a discount rate was used to compute present values. Thirteen studies used a discount rate of 3%, and twenty studies used a rate of 5%. Eight studies used both 3% and 5% discount rates (4;9;11;41;46;54;62;64). In one study (49) 10% was used for the standard case. Several of the studies explicitly mentioned that they were discounting costs (42;44;49;51;62;70) and future unrelated costs (21;30;38;54;64).

Sensitivity Analysis

Thirty-four studies conducted one or more sensitivity analyses of different variables. With respect to costs two studies considered the variation of disease costs (21) and vaccine or immunization costs (21;74). One-, two- or multi-way sensitivity analyses were undertaken in three studies (28;38;62).

5. Assessing the Methods Used to Determine Costs

Overall assessment

50 studies were selected for the purpose of an evaluation of selected literature on the measurement of costs in health economic evaluations. The number of studies was chosen on the judgement that this number would be sufficient to give an indication as to how economic evaluation studies are handling costs.

In many of the studies evaluated insufficient information was provided to reach an informed judgement. It is clearly possible that this lack of detail in reporting costs is a result of space considerations in journals and thus not primarily the responsibility of the authors concerned.

Often more than one intervention was possible, and this in combination with the lack of detailed reporting made a generalisation about the application of costing methods almost meaningless. It was difficult to see which cost components were included in the estimate and thus to judge whether all relevant costs were taken into account. Subject to this, when comparing the study perspectives (Table 4) and the services actually being costed (section 4) the results show a failure to include and value all cost categories which according to Table 2 should be included in an economic evaluation when applying a particular perspective. More than half of the studies reviewed (52 percent) did not fulfil the recommended guidelines mentioned in Table 2, i.e., the proportions of cost categories included were not satisfactory compared with the study perspectives chosen.

In addition, when comparing the studies concerning their understanding of the cost concepts, there was no consistency between studies on this important issue. When considering the valuation base chosen, it appeared that in 74 percent of the cases there was a considerable lack of detail when describing which values actually were used and how these were measured. Thus, making any judgements about the validity of the cost estimates difficult. We would also have liked to look at the time frame of each study

to determine if fixed and/or variable costs were used appropriately; however, again the lack of information on the cost side prevented this.

Inpatient- , outpatient- , professional - and home care

Especially, American studies have used hospital charges as this costing method. However, since hospital charges do not necessarily reflect actual costs, many studies used a cost-to-charge ratio for adjustment. This resulted in most cases in an unclearly described estimate, which made it uncertain what was actually measured. Firstly, because it was not clear how the charge used was determined, and secondly, because no reason was given for the choice of the specific ratio. Technically, correction of a price should be based on the marginal cost of resources used. In cases with no diseconomies of scale or economies of scale average variable and marginal costs would be equal (69), and therefore a possible correction could be based on average cost. Where diseconomies of scale exist, marginal cost should be used, which in some cases might make an estimation of a cost function necessary. In addition, a time frame must be specified.

Other studies used an average price per bed day. Difficulties using this broad measure arise since it does not represent the use of resources that specifically follow the patient. In addition, when using this measure it is assumed that resource use is constant during the entire stay at the hospital. It is inappropriate, however, to assume a constant cost per day, since a hospital stay normally will have high initial costs that decrease by the end of the stay (25), e.g., in a hospital where a department treats many different types of diagnosis, the use of an average patient treatment cost calculated for the department as a whole might not reflect the true cost associated with treating a specific patient.

Studies that measured the use of patient specific resources often received their information from the hospital charging system. As mentioned above this is a problematic approach.

When costing inpatient care cost centres, total costs were mostly included. The cost categories included varied between studies with the same perspective, thus indicating that, overall, more standardization is needed. Cost categories included were, for example, cost of diagnostic tests, cost of equipment, labour and supply costs. Further, the lack of detail given in these studies concerning how costs were actually computed (e.g., which valuation base was used) makes it difficult to judge the quality of the studies performed.

Similar problems as those in costing inpatient care arise when discussing the measurement of costs related to outpatient care, professional care, and home care.

Medication

Measurement and valuation of medication costs were better documented. One study used out-of pocket expenses, occasionally wholesale prices or pharmacy prices were used, and in one study the use of retail prices was mentioned. The difficulty with regard to the valuation base is the usual problem when measuring costs: does the price which has been chosen to evaluate the drug cost actually reflect the true value of that drug? The consumer price (as stated by the consumer) might not include all the relevant costs because of the possible existence of some coverage arrangement from private insurance. The prices paid by the provider, the hospital, would in most cases consider all relevant costs, including purchasing costs, dispensing fees etc. (33). However, the problem with using a wholesale price would be that it does not include the transportation cost that the retail price incorporates, neither does it include the dispensing costs.

None of the studies reported the inclusion or exclusion of value-added tax, sales tax etc. The inclusion of such measures, however, depends upon the study perspective chosen, hence in some studies it would be appropriate not to include such a tax, e.g. if a societal perspective was chosen a tax would be considered as a transfer and would not be included.

Out-of-pocket costs

Only three studies incorporated patient out-of-pocket costs. No standardized way of costing these patient or family costs was used.

Productivity loss and Overheads

Only four studies reported productivity losses related to illness. As with out-of-pocket costs several different measurement methods were used, i.e., there was no standardization. Overheads were measured in six studies, where the content of these costs varied depending on the study objective.

Discount rate

It is necessary to discount all costs incurred beyond the base year to account for time preferences. This is accomplished by calculating the present value of future costs. Discount rates were used in several studies. In the literature there is wide agreement on the use of present values for all future costs and effects in cost-effectiveness analysis; making it possible to compare cost and effects at the same time level. This was done in five of the studies. If the costs and effects of an intervention are discounted at different rates. This may, however, result in a paradox if the intervention is carried through, since the cost-effectiveness of an intervention can be improved by delaying its start, for example, if the discount rate selected to convert future health benefits is lower than the discount rate used for future costs. There were no indications that different discount rates for costs and benefits had been used in the studies evaluated. A discount rate of 3%, was used in thirteen of the studies surveyed. Twenty studies used a 5% rate.

Sensitivity analysis

The rationale behind including a sensitivity analysis is to explore the important variables to the point that the researcher is convinced about how they affect the model

(23). Thirty-four studies conducted one or more sensitivity analyses of different variables. The types of sensitivity analyses performed and reported depended on the study. With respect to the variation of cost variables, only two studies explicitly mentioned the variables that were included.

6. Policy Implications

The rationale behind economic appraisal or evaluation is to identify the best use of resources, hence, be able to determine how the best possible outcome can be obtained for a given budget (the constraint set by available resources), i.e., allocative efficiency, or how an intervention can be carried through at minimum of costs, i.e., productive efficiency.

The overall picture for the papers reviewed was of major deficiencies in the measurement and valuation of costs. The lack of detail in cost reporting is of major importance since, it is possible that costs are considerably over- or under-estimated. This might bias the decisions when benefits and costs are evaluated against each other. Hence, as noted by Seigel *et al* (63), the impact and value of the analysis very much depends upon the way in which an economic evaluation is reported. Further, the more detailed the results that are reported the higher the probability that research can be reviewed and replicated if necessary in other research projects. Finally, without a detailed description of cost measurement and valuation, potential users of studies containing cost information, such as health authorities, patient groups, drug companies and so on, will be unable to make informed judgements.

7. Discussion

In this paper we have reviewed a number of studies in order to evaluate the application of costing principles and practices in health economic evaluations. As a basis we used the recommendations by Gold *et al* (23) on which cost categories to consider given the study perspective chosen. The review in this paper did not consider methodological issues concerning how, for example, productivity losses should be determined but more whether such productivity costs should be included or not. The use of Gold's recommendations instead of those given e.g. by Drummond *et al* (16) for this purpose would not influence the results, since both sets of authors agree upon which cost categories to include.

The study results show that there is considerable cause for concern with regard to: (i) Lack of detail: it was often difficult to see which cost components were actually included and thus to judge whether all relevant costs were taken into account. (ii) Non-inclusion of relevant cost categories: only 48 percent of the studies included the cost categories appropriate to the chosen study perspective. (iii) Inadequate description of the valuation base: considerable lack of detail was exhibited when describing which values were actually used, making judgements about the validity of the cost estimates difficult. (iv) Lack of information on time frame used: it was thus not possible in many studies to make judgements about the appropriate use of fixed and/or variable costs. (v) Lack of agreement on cost concepts across studies as reflected in what is included in the different cost concepts.

The solution would not necessarily be a single set of cost guidelines, since this is not possible to establish, one of the reasons being that the inclusion of costs depends on the chosen perspective. Nevertheless it can be concluded that there is a need for more standardization in costing, since although guidelines have been established in this area, the results of this paper underline that this has not given the results expected. The need for more standardization has also earlier on been advocated by Reinhardt (57)

who argued that 'although such binding rules would somewhat limit the much cherished creativity of individual researchers, they would in return lend the products of CEA and CBA the respectability they now lack'.

The results of this study confirm the results reported in a very recent paper by Gerard *et al* (22) who updated an earlier review of cost-utility analyses to address whether previously identified gaps in reporting had diminished over time. To quote these authors: 'the measurement of costs appears to have shifted away from best practice'.

The choice of the fifty studies was essentially arbitrary. The evidence from these papers, concerning deficiencies in costing, however, is so strong that another choice of sample would be unlikely to produce substantially different results. Hence, it is incumbent upon the practitioners of economic evaluations to pay much more attention to the appropriate costing of resource use in health interventions than currently appears to be the case.

Notes

1. Generally, the opportunity cost of a resource is indicated by its market price. However, this is not always the case, for example when the use of an existing resource involves no payment. In a situation where the assets have an alternative use, the value in that alternative use should be included in the appraisal.

2. If a more detailed consideration of costs is required, various methods for allocating shared or overhead costs are available (16):

The direct-allocation method: each overhead cost is allocated directly to the final cost centres and interactions between overhead departments are ignored.

The step-down method: The overhead departments are allocated to the remaining overhead departments and to the final cost centres. In the iterative approach, the procedure is repeated a number of times to exclude residual amounts that otherwise would not have been allocated.

The simultaneous equation method: The same data is used as when using the step-down method, but simultaneous linear equations are used to give the allocations.

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Appendix 1

Table A1 Services being costed

Article number	Perspec-tive	Inpatient Care	Outpatient Care	Profession-al Care	Medication	Out-of-pocket	Productivity loss	Over-heads
1	PPF	x	x	x				
2	HCI	x	(x)					
3	HCI	x		x	x			
4	MC	x	x	x	x			
9	HCI			x				
10	PPF		x			x		
11	HCI	x	x	x	x			x
12	HCI	x			x			
18	HCI		x					
19	HCI	x		x	x			
21	HCI		x	x	x			
24	G	x			x			
27	HCI	x						x
28	HCI	x	x	x	x			
29	HCI		x	x	x			
30	S		x	x			x	
31	HCI		x		x			
32	PI	x		x	x			
36	HCI	x			x			
37	HCI	x						
38	G	x		x	x			
40	HCI	x						
41	S	x		x	x		x	x
42	G	x		x				
44	G	x	x	x	x			
45	HCI	x	x					
46	G	x						
47	HCI	x	x	x	x			
49	HCI				x			
50	HCI	x		x				
51	HCI	x						

52	PI	x	x		x			

Table A1 Services being costed (continued)

Article number	Perspective	Inpatient Care	Outpatient Care	Professional Care	Medication	Out-of-pocket	Productivity loss	Over-heads
53	HCI	x	x	x				
54	HCI	x		x	x			x
55	S	x		x			x	x
56	HCI	x						
58	HCI	x				x		
61	HCI	x	x	x	x			
62	HCI	x	x					
64	G	x	x		x			
65	S			x			x	
67	HCI	x	x					
68	G		x					
70	HCI	x						
71	HCI		x					
72	HCI	x		x				
74	G	x	x	x	x			x
75	G	x	x			x		
76	G	x						
77	HCI	x		x				
Total		38	22	25	20	3	4	6

Note: (x) the cost component is presumably included

HCI: Health care institution; G: Government; S: Societal; PI: Private Insurer; PPF: Patient and Patient family; MC: Managed Care