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Cost-utility analysis (CUA) is a type of economic evaluation that is commonly employed by health care researchers for evaluating alternative medical treatments and interventions both within and across different disease categories. CUA provides a means for comparing alternative interventions on the basis of their cost and outcomes valued in utility terms. CUA could be used to decide whether a given treatment is justified in terms of its effectiveness per dollar cost or to rationalize the allocation of public health resources across different health programs such as screening for particular diseases, prevention programs, and levels of treatment for various diseases. The purpose of this paper is to assess the potential of cost-utility analysis as a guide to regulatory and non-regulatory decision making in health policy (environmental health and consumer safety).

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ECONOMIC ISSUES NOTE

(EIN 0702 1)

ON COST-UTILITY ANALYSIS

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I. Summary

Cost-utility analysis (CUA) is a type of economic evaluation that is commonly employed by health care researchers for evaluating alternative medical treatments and interventions both within and across different disease categories. CUA provides a means for comparing alternative interventions on the basis of their cost and outcomes valued in utility terms. Cost-utility analysis could be used to decide whether a given treatment is justified in terms of its effectiveness per dollar cost or to rationalize the allocation of public health resources across different health programs such as screening for particular diseases, prevention programs, and levels of treatment for various diseases'.

The utility measure most commonly used is the quality adjusted life year (QALYs).[2] A

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[1] See Drummond et al. (1996) for a detailed description of cost utility analysis.

[2] See Freeman et al. (2002) for a brief description of QALYs and a critical discussion and evaluation of their use as a representation of utilities or preferences over outcomes.

QALY is a measure of the performance of medical treatments and interventions that captures in a single value both the degree of improvement of health and the time interval over which the improvement occurs. One QALY represents one year of life in perfect health.

The purpose of this paper is to assess the potential of cost-utility analysis as a guide to regulatory and non-regulatory decision making in health policy (environmental health and consumer safety). After a brief description of the steps that are involved in conducting a cost-utility analysis, the kinds of questions that cost-utility analysis can address will be discussed. Then the advantages and disadvantages of cost-utility analysis will be discussed and compared with another form of economic evaluation-benefit-cost-analysis.

II. Introduction (Conducting Cost-Utility Analysis)

A cost-utility analysis involves three steps. The first step is to define a scalar measure of the effectiveness or utility of outcomes. Most cost-utility analyses use QALYs as the outcome or utility measure.

The second step is to calculate the cost of each option in monetary terms. While cost estimation may appear to be straightforward, there are several issues that must be addressed. Costs obviously include the monetary outlays for medicines, payment of time for health professionals, etc. For capital equipment and buildings, there are both operating costs and the amortization of investment costs. There may be questions of the allocation of joint costs, for which there are no unambiguous answers. There are issues of how to value nonmonetary costs such as the cost of the patient's time. And finally, there are questions of which costs to count. If the purpose of the cost-utility analysis is to determine the allocation of the fixed budget of a medical program, then the only costs that are relevant are those that come out of the fixed budget. But if the purpose is to optimize the allocation of all of society's resources, then all social costs must be included in the cost measure. For further discussion of some of these issues, see Dranove (1996), Garber, *et* al. (1996), Luce, et al. (1996), and Weinstein (1995).

The third step is to calculate the ratio of the cost to the selected measure of effectiveness for each option. So, for example, if a mode of treatment has a cost of $100,000 and produces a health improvement of 5 QALYs, it has a cost-utility index of $20,000 per QALY.

III. Uses of Cost-Utility Measures

The most common, and Straightforward, application of cost-utility analysis is in the selection of the appropriate strategy, or intervention, for dealing with a specific disease. Various strategies may consist of different combinations of such things as screening for early detection, specific diagnostic tests, surgery, medication, etc. Each strategy might yield a different degree of health status improvement and magnitude of life extension or duration of improvement. An incremental cost utility ratio can be

calculated for each of the competing interventions. In an incremental CUA the additional QALYS obtained are compared to the additional costs of each intervention. The strategy that yields a cost per QALY that is below a predetermined threshold value would be considered cost effective and would be selected.[3]

The second possible use of cost-utility analysis is to guide the allocation of a fixed medical budget across a range of programs for different diseases and health problems, for example, screening for childhood diseases versus treatment of prostrate cancer in males over age 60. In a simple model of optimization, the appropriate strategy is to rank all of the programs by their cost-utility index and to fund those with the lowest cost per utility, continuing until the budget is exhausted.[4]

Cost-utility analysis could also be used to establish a desired level of funding for medical programs in general. For example, a social choice could be made that the value of a QALY is $X. Then, all programs that have costs per QALY less than that threshold value are worth undertaking. And the budget should be adjusted so that all such programs can be undertaken.

IV. Advantages of Cost-Utility Analysis

The principle advantage and the basis for the attractiveness of cost-utility analysis is that it provides an apparently rational basis for evaluation of alternative health policies without requiring the monetary valuation of outcomes. CUA implies acceptance of the principle that costs do matter in medical decision-making; but allows for consideration of costs without the controversial practice of attaching monetary values to health outcomes, as would be the case with benefit-cost analysis. More specifically:

- cost-utility analysis captures in a single measure improvements in health status and increases in life expectancy;
- since the measure of effectiveness or utility usually comes from responses of people to rating or choice questions, it reflects the values that people place on different health outcomes; and
- it provides a convenient way of comparing the outcomes of different medical interventions and policies (Chapman and Neumann, 2000).

V. Disadvantages of Cost-Utility Analysis

[3]The threshold value employed may arise from a resource allocation exercise (See Weinstein 1995) or from a generally agreed upon value such as that of $50,000 per QALY which is commonly employed.

[4]See, for example, Weinstein (19965). Weinstein also notes that this simple explanation is correct only under some simplifying assumptions, including that programs are divisible and that there are no competing choices. Competing choices arise when there are *two* or more different programs for dealing with the same problem and only one *of* the programs can be selected.

The major disadvantage of cost-utility analysis lies with the outcome measure typically used, QALYs. The QALY has serious limitations as a representation of the preferences of individuals. QALYs are consistent with economic preferences only if those preferences have quite restrictive and unpalatable (from an economic perspective) properties such as constant marginal valuations of health status and longevity and a marginal valuation of health status that is independent of longevity (Freeman, et al., 2002). These limitations are likely to be most serious when QALYs and cost-utility are compared across policies with quite different patterns of health status and longevity changes, as often would be the case in making budget allocations or determining "optimal" levels of spending on health care.

QALYs, by definition are only able to value morbidity and mortality (i.e. health) effects. However, it is possible that a health intervention or program may have non-health outcomes that may yield significant utility to the individuals affected. Arguments that process effects (e.g. waiting time, uncertainty) should be included along with health outcomes in economic evaluations of health interventions have been argued.

It is likely that one of the factors that makes cost-utility analysis attractive to some people is the perception that costs are easy to measure, at least compared to the economic benefits of improved health. It is true that counting up expenditures on medicines, treatments, medical services, etc. is straightforward. This may be sufficient if the user of cost-utility analysis is concerned only with budgetary costs. But, as noted above, from a social perspective, third party costs such as patients' time and other indirect costs are important. A ranking of alternatives by a "budgetary cost-utility" calculation could be quite different from a ranking by "social cost-utility.''

Suppose for the sake of argument that the problems with QALYs as a representation of preferences could be resolved and that the social costs of all options could be measured with reasonable precision. Then cost-utility analysis could be used to rank the options. And if it were found that some unfunded treatments or programs had costs per QALYs that were below options being funded, the reallocation of funds toward the lower cost per QALY options would lead to a Potential Pareto Improvement.

But cost-utility analysis can not answer the broader question of how far down the list of options we should go or what is the proper level of funding for medical programs. To answer that question, one needs to know the social value per QALY or in welfarist terms, people's willingness to pay (WTP) for a QALY. Unfortunately, since a QALY is an artificial construct and not an object of choice for people, we can not expect to obtain estimates of the WTP per QALY from revealed preference methods of valuation. Nor does asking people stated preference questions about QALYs seem feasible. Rather WTP estimates would have to come from observations of or questions about WTP for defined changes in health status that the researcher could convert to QALYs. But this involves estimating monetary values for changes in health impacts, something which cost-utility analysis seems to have been designed to avoid.

VI. The Value of a QALY

In a 1982 paper cited by Torrance (1986), Tolley and Fabian (1994), and Weinstein (1995) among others, Kaplan and Bush suggested that all options with a cost per QALY of $20 thousand or less (1982 dollars or $36 thousand in 2000 dollars) were "cost-effective by current standards" while options with costs per QALY greater than $100 thousand ($178 thousand in 2000 dollars) were "questionable in comparison with other health care expenditures (Torrance, 1986, p. 5; Weinstein, 1995, p. 95)." These values were apparently based on a review of spending decisions by public agencies in various contexts. We have not seen any more recent studies attempting to infer a public or social value per QALY from spending or treatment decisions by medical professionals.

Tolley and Fabian (1994, p. 313) have suggested an alternative approach to linking QALYs as a health status indicator to economic valuation. Estimates of the value of statistical life (VSL) based on the observed wagehisk tradeoff in labor markets can be combined with data on the life expectancy of the mean worker at risk and an assumption about individuals' discount rates to compute a value of statistical life year saved (VLY). For example at a zero discount rate and a 25 year life expectancy, a VSL of $5 million is equivalent to a VLY of $200 thousand. A positive discount rate would yield a higher VLY. On the further assumptions that workers expect to live in perfect health for their remaining life and that the value of a QALY is independent of the age at which it is lived, the value of a statistical life year is the same as the value of a QALY.

Using alternative assumptions about the VSL and discount rate, Tolley, Kenkel, and Fabian (1994, p. 329) provide estimates of a VLY and QALY of between $89 thousand and $221 thousand with a best estimate of $152 thousand (all in 2000 dollars). The U.S. EPA used a somewhat different life expectancy and discount rate and a substantially higher VSL in its retrospective analysis of the benefits and cost of the Clean Air Act to compute a VLY of $386 thousand (U.S. Environmental Protection Agency, 1997, p. 1-3). These values are 5-10 times higher than the cut off implied value per QALY from the cited paper by Kaplan and Bush. But there are a number of untested and untestable assumptions that lie behind the calculations described here.

VII. Conclusions

In this discussion of the advantages and disadvantages of cost-utility analysis, the basis of comparison has been with the economic approach based on the monetary valuation of changes in health status as a measure of effectiveness. The latter has two advantages. The first is that both costs and benefits are expressed in the same units, allowing the calculation of net benefits for each option. Cost-utility analysis based on QALYs avoids the controversial step of converting changes in health status into money. But as a consequence it leaves unanswered the important question of what level of funding for medical programs is appropriate. That question can only be answered by specifying a maximum cost per QALY that is acceptable. But this is functionally equivalent to specifying the monetary value of a QALY.

The second advantage of the economic approach is that its measure of effectiveness is derived directly from a very general representation of individuals' preferences. But cost-utility analysis is based on QALYs as the measure of effectiveness. And QALYs are a flawed measure in that they consistent with the theory of preferences only under restrictive assumptions about the nature of these preferences.

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