

IMPLICATIONS OF BASING HEALTH CARE RESOURCE  
ALLOCATIONS ON COST-UTILITY ANALYSIS  
IN THE PRESENCE OF EXTERNALITIES

Roberta J. Labelle

Centre for Health Economics and Policy Analysis,  
Department of Clinical Epidemiology and Biostatistics,  
McMaster University, Hamilton, Ontario, Canada

Jeremiah E. Hurley

Centre for Health Economics and Policy Analysis,  
Department of Clinical Epidemiology and Biostatistics,  
McMaster University, Hamilton, Ontario, Canada  
Associate Member, Department of Economics, McMaster University

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## **ABSTRACT**

The application of economic evaluation methods to the analysis of health care services and programs has grown steadily over the past two decades. One form of economic analysis in particular - cost utility analysis (CUA) - is receiving considerable attention from researchers and policy makers. Although CUA was originally applied primarily as a technique for choosing among treatment options for a defined disease or patient population, it is now increasingly being advocated as a tool for helping to establish funding priorities across a wide variety of health care programs and potential beneficiaries. In this paper we argue that CUA, as currently applied, is insufficient for providing information on allocative efficiency because it excludes externalities, a potentially significant source of societal utility (and disutility). The exclusion of externalities may bias the priority ranking of programs in unpredictable ways and ultimately lead to a systematic non-optimal allocation of health care resources.

## 1. INTRODUCTION

Economists have long recognized that utility derives, at least in theory, from a variety of sources and that the benefits and costs of a program or service can accrue to more than just the users [for example, Mishan (1971a), Sugden and Williams (1978), Boadway and Bruce (1984)]. A comprehensive program evaluation therefore requires that, in addition to user-specific costs and benefits, external costs and benefits should be included. As Mishan (1971a) points out, "A conscientious cost-benefit study, it is hardly necessary to remark, cannot ignore any spillover effect, positive or negative, that is of social concern." (p.128) The practical problems, however, of identifying and measuring externalities for program evaluation have challenged economists for decades. In response to the challenge, a number of methods have been devised for measuring peoples' willingness-to-pay for external benefits, including travel costing models, hedonic price equations and, more recently, contingent valuation methods. The context for these methodological developments has been almost exclusively cost-benefit analysis (CBA), rather than cost-utility analysis (CUA) or cost-effectiveness analysis (CEA).

The importance of externalities in the health sector (particularly external benefits) has been acknowledged by a number of economists [Mishan (1971b), Culyer (1976), Evans and Wolfson (1980)]. Culyer (1976), for example, points out that the "humanitarian spillovers" from health care are sufficiently large to provide a case for subsidizing health care consumption, and have been used as a justification for the publicly-financed National Health Service in the U.K.

In health care applications, however, the difficulties (and some would argue the inappropriateness) of quantifying health-related benefits within a willingness-to-pay paradigm have led to a shift from CBA to CEA and CUA. Currently, applications of CEA and CUA to health care programs and interventions dominate the relatively infrequent uses of CBA. In the case of CEA, although the information required is less demanding than that required for a comprehensive CBA, there are also stricter limitations on the uses of the results. The limitations arise because the objectives, and hence the scope of inquiry, of CEA are more narrow than those of CBA. In particular, CEA is a useful analytic approach for evaluating technical efficiency, but it cannot be

used for determining allocative efficiency. Accordingly, it can only provide part of the information for health policy decision-making [Cullis and West, 1979]. As early as 1971, Klarman cautioned that "One must recognize that CEA cannot provide rankings or priorities across diverse avenues of public expenditure" [Klarman (1982, p.598)].

Although these limitations of CEA have generally been acknowledged and accepted, there has been some debate about whether they apply to CUA. Because CUA, by definition, attempts to incorporate individuals' valuations of health outcomes, it shifts the focus of the evaluation from issues of purely technical efficiency to those of allocative efficiency. As noted above, CUA emerged in part as a response to the difficulty of quantifying benefits in monetary terms, as is required by a CBA, and the conceptual underpinnings of CBA have been held to apply to CUA [Feeny and Torrance (1989), Drummond, Stoddart and Torrance (1987)].<sup>1</sup> But what was recognized in the CBA context - the notion that externalities are potentially important and hence should be included - has not been pursued in the development and application of CUA. Cost-utility ratios, as currently constructed, do not include external benefits or costs. Although the same is true for cost-effectiveness ratios, we focus on CUA because there are few examples of CEA being used to determine efficiency across a broad range of services and programs within the health care sector. Its application has been restricted primarily to assessments of technical efficiency. Second, CUA, in contrast, is increasingly being advocated as a means of providing information for setting priorities and allocating resources within (and to), the health care sector.

## **2. ROLES FOR CUA**

Cost-utility analysis, which is a comparison of the costs of two or more alternatives and the associated health-related quality of life, has had two primary applications: to guide clinical decision making and to provide information relevant to health (care) policy decisions<sup>2</sup> [Drummond (1989)]. The first refers to decision making regarding optimal treatment, in a technical sense, for a given disease (e.g., what is the most efficient treatment for chronic renal failure?) or a particular patient population (e.g., what is the

most efficient approach to improving the quality of life of nursing home residents?). The analysis is used to aid clinical decisions that focus exclusively on the costs and outcomes incurred by a defined set of patients and hence it does not take into account the effects (either positive or negative) of an intervention on other individuals. Examples include CUA conducted as part of clinical trials [e.g., Bombardier et al. (1986)], or studies of the effects of the introduction of a new program [e.g., Boyle et al. (1983)]. When applied in this context, CUA provides essential information on patients' quality of life - an outcome dimension that historically has been largely ignored because of the emphasis on purely clinical outcomes.

The second application, the use of CUA to guide health (care) policy decisions, is increasingly evident. Applied in this context, CUA is used to inform the process of resource allocation, both within the health care sector and between the health care sector and other sectors. Because the focus is on system-level decisions, the potential beneficiaries and diseases (either to be treated or prevented) are diverse; for example, requests for funding of prenatal care programs may compete with requests for programs to reduce the incidence of stroke, or with calls for increased funding for long term care institutions. In an even broader sense, if the objective of public sector resource allocations is the maximization of societal wellbeing, it is possible that demands for higher levels of income assistance or improved housing might be assessed against demands for more health care.

Several of the advocates of CUA argue that the results can be used to assist decision makers in allocating health care resources [Sackett and Torrance (1978), Williams (1985), Gudex and Kind (n.d.), Drummond (1989), Cairns and Johnston (1990)]. Cost-utility analyses commissioned by public health authorities actually have contributed, in varying degrees, to health care resource allocation decisions [Gudex (1986), Dept. of Health and Social Security (UK) (1986), Allen, Lee and Lawson (1989)]. Perhaps the most visible evidence of the expanded role given to CUA is the emergence and proliferation of "league tables". A league table provides a cardinal ranking of the cost/QALY of various health care interventions, with the intervention yielding the lowest cost/QALY seen to be the "best", that is, the most (technically) efficient means of producing QALYs.

An example of a league table is provided in Table 1. It provides a ranking of the cost/QALY results from various studies, in ascending order. These summary tables are increasingly included when interpreting the results of specific studies. (See, for example, Torrance and Zipursky (1984), Williams (1985), Drummond, Teeling Smith and Wells (1988), Torrance and Feeny (1989), Goel, Detsky and Deber (1989).] Although several criticisms and caveats have been raised with regard to the compilation and interpretation of league tables [Drummond, Teeling Smith and Wells (1988), Drummond (1987), Loomes and McKenzie (1989)], the tables continue to be proffered as a means of directly comparing the value of various programs.

Practitioners of economic evaluations have argued convincingly that if the evaluations are to be used for setting resource allocation priorities, the analysis should be conducted from the "societal perspective", which requires that all costs and benefits be included, regardless of to whom they accrue [Drummond, Stoddart and Torrance (1987), Mulley (1989)]. In the case of CUA, whilst great effort has been taken to identify, measure and value all social costs [see, for example, Boyle et al. (1983)], there has been less emphasis on identifying, measuring and valuing all sources of society's utility.

As currently measured, the utility included in a CUA pertains to the utility of health states associated with the programs or services being evaluated. These health state utility values are obtained from a variety of sources, often raising the question of whose values should count [Mooney (1986), Mulley (1989)]. Patients are typically the source of utility values [McNeil, Weichselbaum and Pauker (1981), Bombardier et al. (1986), Churchill et al. (1987)], although caregivers [Mohide et al. (1988)], researchers [Goel, Deber and Detsky (1989)], health care providers [Williams (1985)], the general public [Ciampi, Silberfeld and Till (1982)], or a combination of the above [Rosser and Kind (1978)] have also been used. When the values are elicited from non-patients, in most if not all cases, respondents are asked to reply as if they were a patient with the condition of interest.<sup>3</sup> They are often asked explicitly to "put yourself in the patient's position" and respond accordingly, regardless of whether the choice is posed in the first person (e.g., "I prefer health state A to health state B"), the third person ("Mrs. Smith's health state (A) is preferable to Mrs. Jones' health state (B)"), or without explicit reference to a specific individual ("Health state A is preferred to health state B"). As a result, when utility

Table 1: Example of a League Table

Program	Cost-utility ratio, \$/QALY gained*
Screening for phenylketonuria	< 0
Postpartum anti-D therapy	< 0
Antepartum anti-D therapy	1 480
Coronary artery bypass surgery for left main coronary artery disease	5 100
Neonatal intensive care for infants weighing 1000 to 1499 g	5 460
Screening for thyroxine deficiency	7 650
Treatment of severe hypertension (diastolic pressure $\geq$ 105 mm Hg) in men aged 40 yr	11 400
Administration of new contrast media to 30% of population at highest risk, with 10-fold reduction in relative risk	23 000
Treatment of mild hypertension (diastolic pressure 95 to 104 mm Hg) in men aged 40 yr	23 175
Estrogen therapy among postmenopausal women who have not had hysterectomy	32 760
Neonatal intensive care for infants weighing 500 to 999 g	38 580
Coronary artery bypass surgery for single-vessel disease in patients with moderate angina	44 400
Tuberculin testing in school	53 000
Continuous ambulatory peritoneal dialysis	57 100
Complete conversion to new contrast media, with 10-fold reduction in relative risk	64 000
Hemodialysis in hospital	65 500
Administration of new contrast media to low-risk patients, with 10-fold reduction in relative risk	220 000

\*Values adjusted to 1986 US dollars.

assessments have been conducted on the general public, often for the purpose of increasing sample size, the responses have been used as proxies for patient responses [Torrance and Feeny (1989)]. Utility to non-patients, in the form of external benefits and costs, is omitted.

### **3. EXTERNALITIES**

We focus on two types of external benefits that may be particularly important in the health sector: benefits derived from interdependent utility with respect to health and health care and benefits associated with option demand. Other types of externalities undoubtedly exist, but the two analyzed herein have been the types most frequently associated with health care provision.

#### **3.1 Interdependent Utility as a Source of Benefits**

An interdependence of utility functions creates external effects because one person's consumption of health care affects another person's utility. This type of external benefit of health care interventions has been recognized at least since the late 1950's and was initially associated with immunization against communicable diseases [e.g., Weisbrod (1961)]. In the last 30 years, however, the conceptualization of the nature of the interdependence has expanded [Culyer and Simpson (1980), Evans and Wolfson (1980)]. Evans and Wolfson (1980) identify three main types of interdependence: selfish, paternalistic, and altruistic. Selfish interdependence exists when individual A cares about individual B's consumption of health services because B's consumption directly affects A's health status. An example is treatment for a communicable disease: when B is treated for hepatitis, thereby decreasing the probability that A will get the disease, A's utility increases for purely selfish reasons. Paternalistic interdependence exists when B's consumption of health care, B's level of health status, or both, directly enter A's utility function. That is, A cares about B's consumption of health care not because of its effects on A's health but because of its effects on B's health. Finally, altruistic interdependence exists when B's level of utility (as opposed to health status) enters A's



utility function. How B obtains this utility does not matter to A; the only thing that matters to A is B's level of utility, which is determined only in part by B's health status. Although the exact nature of the interdependence has important implications for the role of the government in the health care sector [see Evans and Wolfson (1980)], it is less important for our purposes. If only selfish interdependencies exist, the class of programs for which external benefits exist is limited. But if one admits of either paternalistic or altruistic interdependencies, then external effects exist for a broad array of health care interventions, and economic evaluations conducted from the societal viewpoint should include these benefits (or costs)<sup>4</sup>.

There is considerable empirical support for the proposition that interdependent utilities exist for many goods, and for health care in particular. In the U.S., for example, the charitable sector accounts for over 2% of GNP, over 85% of all households make donations to charities, and, in 1981, health organizations and hospitals raised over \$7 billion in contributions [Andreoni (1988)]. The amount of voluntary labour in the health sector is substantial and a large portion of blood products is provided through voluntary donations. Paternalistic and altruistic interdependencies are perhaps best evidenced by the fact that every industrialized nation has some form of public financing of health services in an attempt to remove barriers to care. Undoubtedly all these actions could be explained by a sufficiently ingenious model of purely self-interested utility maximizing individuals, but such elegant models should not obscure the motivation for giving: people care about others. The importance of this observation has been noted by a number of economists [Collard (1978), Margolis (1982), Etzioni (1989), Sugden (1985), Phelps (1975)]. Indeed, it is ironic that the benefits accruing from one of the primary motives for public intervention in the health sector have been excluded from evaluations of services provided through such systems.

### **3.2 Option Value as a Source of Benefits**

In his seminal paper, Arrow (1963) identified two types of uncertainty associated with health care: (1) uncertainty regarding illness and the need for care; and (2) uncertainty regarding the effectiveness of care. Whenever uncertainty is present, there is potential to improve welfare by reducing or eliminating the uncertainty. The second source of

non-user benefit, termed option value when first discussed by Weisbrod (1964), is present because of the uncertainty regarding future need for health care. When future need, and hence demand, is uncertain, there exist current non-users who, given the uncertainty regarding their future demand, are willing to pay an amount in the current period (an option value) to ensure that the service will be available at a later time. Option demand thus exists even though some (or possibly even most) individuals may never actually need or utilize the service. Conventional evaluation methods that count only the benefits to users, even if the entire future stream of user benefits are incorporated, will exclude this option value. Option value theoretically may exist for almost any good, but the benefits associated with it are likely to be significant compared to user benefits only for goods for which use is infrequent and for which there is considerable uncertainty regarding future demand. National parks and hospitals (or specific health services) are two examples that have been cited [Weisbrod (1964), Culyer (1971)].

Since Weisbrod's original paper on option value there has been considerable development and clarification of the concept, particularly its relationship to conventional benefit measures used in cost-benefit analysis [Cicchetti and Freeman (1971), Schmalensee (1972), Graham (1981), Bishop (1982), (1986), Smith (1983)]. Of particular interest is the relationship between option price, defined as the total amount a current non-user is willing to pay today to ensure the future supply of a good at a specified price (Weisbrod's original option value), and expected consumer surplus, defined as the expected value of the consumer surplus obtained in alternative future states of the world. The difference between option price and expected consumer surplus is termed option value. Option value is analogous to the difference between an actuarially fair premium (expected value of a loss) and the maximum premium an individual is willing to pay to purchase insurance and thereby eliminate uncertainty.

There has been much debate in the cost-benefit literature regarding the most appropriate measure of benefits in the presence of uncertainty, but a consensus is emerging that option price is the best measure because it incorporates both expected consumer surplus and the benefits associated with risk reduction. Graham (1981) concluded that, given the constraints of actually measuring benefits, option price is the best measure of welfare under uncertainty. Bishop (1986) also supports the use of option

price.

Attempts to measure option prices in other applied fields indicate that the contribution of such benefits can be large relative to user benefits. Greenley et al. (1981) concluded that non-user benefits of preserved water quality were approximately 40% of user benefits; Walsh et al. (1984) estimated that the non-user preservation value of wilderness in the state of Colorado was 60% of recreational-use value; and Brookshire et al. (1983) obtained positive non-user option prices for the preservation of grizzly bear and bighorn sheep in the Wyoming wilderness.

Most of the development of this concept, both theoretical and empirical, has occurred in natural resource economics. But clearly, as Weisbrod noted, such non-user benefits may also be quite large for health services. There is considerable uncertainty regarding the future need (and demand) for many health services and, given the consequences of not receiving needed care, the option value associated with service availability may be considerable relative to user benefits. In the case of emergency room services, for example, at any given time only a small fraction of the population is in need of, and uses, the services, but most people are at some risk for future use.

#### **4. MODELLING THE EFFECTS OF OMITTING NON-USER UTILITY**

The omission of non-user benefits does not necessarily invalidate program rankings based on economic evaluations, as currently reported in league tables. If, for example, non-user benefits are always proportional in size to user benefits, then the inclusion of externalities would not alter the ordinal rankings. Even when this is not the case, it is possible to correct for the omission if it can be determined, a priori, that the underestimate varies consistently with certain characteristics of the program (e.g., the size of the target population). If it is not possible, however, to predict the effect of the omission on the cost-utility ratio, it becomes necessary to measure the externalities directly, in order to incorporate their impact on both users and non-users.

To explore the effect of the omission of non-user benefits on measures of economic efficiency, we develop a simple model for calculating the incremental total societal utility

and the incremental cost-per-util-gained associated with a hypothetical program. We employ cost-per-util rather than the more common outcome measure, cost-per-quality-adjusted life year (QALY), for several reasons. First, utility measures must be based on a valid and accurate representation of individual preferences, and there is concern that the QALY fails in this regard [Mehrez and Gafni (1989), Loomes and McKenzie (1989)]. An alternative utility-based measure, Healthy Years Equivalent (HYE), overcomes some of the methodologic difficulties with QALYs [Mehrez and Gafni (1989)]. Although, as a preference measure, the HYE has an intuitive appeal and interpretation when applied to patients, it makes less sense when applied to non-patients. Therefore, in the context of both user and non-user utility, we represent utility in units of "utils". We do not propose the cost-per-util as an alternative outcome measure for cost-utility analysis, but use it merely to illustrate the main points of the model.

Using the model, we then compare the incremental cost-per-util-gained when external benefits are excluded versus when they are included. Of particular interest in this comparison is the relationship between the prevalence of a disease and the magnitude of the discrepancy between the cost-per-util-gained with and without the inclusion of non-user benefits. The impact of prevalence is important because one characteristic of league tables is that they compare interventions aimed at diseases with dissimilar prevalence rates. This can be seen, for example, in Table 1. Treatment of severe hypertension, which has a prevalence of approximately 4.0% in adult males, is compared directly with treatment for mild hypertension, which has a prevalence of approximately 12.2% in the same population [Gunning-Schepers (1989)]. Thus the construction of ratios to report results means that issues such as cost-of-illness, burden of illness and total impact of treatment, which are all functions of prevalence, are ignored.<sup>5</sup>

#### 4.1 The Model

To construct the model we assume that a program has been proposed for the treatment of a specific condition and that it is to be evaluated from the societal viewpoint. The baseline for the comparison is the "no program" (i.e., no treatment) alternative and we assume that all individuals with the condition receive treatment. The standard assumptions found either implicitly or explicitly in CUA studies are made: that

individuals have measurable cardinal utility functions and that societal utility is additive in each individual's utility. In addition, we assume that the utility function is additively separable in each of its components.

The following notation is used to represent the variables that enter the analysis:

$N$  = total population (assumed to be constant during the period under analysis);

$P$  = prevalence rate<sup>6</sup> of the condition/disease being treated;

$NP$  = number of people in society who have the condition;

$U_p$  = mean increment in **patient** utility resulting from treatment;

$$\frac{\sum_{i=1}^{NP} U_{p,i}}{NP}, \quad \text{where } U_{p,i} \text{ is the incremental utility for the } i^{\text{th}} \text{ patient;}$$

$U_{PID}$  = mean increment in **patient** utility per **other patient** treated (resulting from the treatment of other patients);

$$\frac{\sum_{i=1}^{NP} \sum_{\substack{k=1 \\ k \neq i}}^{NP} U_{PID,i,k}}{NP(NP-1)} \quad \text{where } U_{PID,i,k} \text{ is the incremental interdependent utility for the } i^{\text{th}} \text{ patient from the treatment of the } k^{\text{th}} \text{ patient;}$$

$U_{NPID}$  = mean increment in **non-patient** utility per **patient** treated (resulting from the treatment of patients);

$$\frac{\sum_{j=1}^{N-NP} \sum_{i=1}^{NP} U_{NPID,j,i}}{(N-NP)NP} \quad \text{where } U_{NPID,j,i} \text{ is the incremental interdependent utility for the } j^{\text{th}} \text{ non-patient from the treatment of the } i^{\text{th}} \text{ patient;}$$

$U_{OV} (P-P^2)$  = mean increment in option value for a **non-patient**;

$$\frac{\sum_{j=1}^{N-NP} U_{OV,j} (P-P^2)}{N-NP} \quad \text{where } U_{OV,j} \text{ is the incremental option value for the } j^{\text{th}} \text{ non-patient.}$$

$b$  = incremental cost of treatment per patient (constant);

$TC$  = total incremental cost =  $b \cdot NP$ .

The utility variables are specified as means because the analysis is not affected by the distribution of utility values across individuals. The use of means also simplifies the algebra. We make a distinction between the interdependent utilities of patients ( $U_{PID}$ ) and non-patients ( $U_{NPID}$ ) because it is possible that the mean values of the interdependencies may differ. On average, an individual with the condition who receives treatment may get a different level of utility from the treatment of others with the same condition than would an individual who does not have the condition.

Prevalence enters directly into the model. Option value is explicitly made a function of prevalence ( $P$ ) because, for a given degree of risk aversion, option value varies systematically with the degree of uncertainty regarding future demand. ( $U_{ov}$  is simply a scaling factor.) As such, prevalence can be interpreted as a proxy measure of the probability of needing the program.<sup>7</sup> The functional form for option value,  $U_{ov}(p-p^2)$ , was chosen to reflect the fact that when there is no uncertainty ( $P = 0$  or  $P = 1.0$ ), option value is zero; when  $P = 0.5$  an individual's uncertainty is greatest and, other things equal, option value is at its maximum. Option value accrues only to non-patients since patients with the disease do not face uncertainty about acquiring the illness. Constant marginal cost is assumed for simplicity.

#### 4.2 Total Benefits

Because it is assumed that total societal utility is additive in each individual's utility, and that each individual's utility is additive in its components, the total societal utility associated with the program is the sum of utilities across individuals and utility components. If non-users are excluded and only the utility accruing directly to patients is measured, the increment to total utility associated with the program is:

$$U_{NE} = NP \cdot U_p \quad (1)$$

where the subscript  $NE$  denotes that only user utility is measured (i.e., there are no externalities).

If non-user utility is also measured (i.e., when externalities are included), the increment to total utility is<sup>8</sup>:

$$U_E = NP \cdot U_p + NP(N-NP)U_{NPID} + NP(NP-1)U_{PID} + (N-NP)U_{OV}(P-P^2) \quad (2)$$

Equations (1) and (2) demonstrate that the difference between the two benefit measures,  $U_E - U_{NE}$ , varies systematically with prevalence. For  $U_{NPID} > 0$ ,  $U_{PID} > 0$ , and  $U_{OV} > 0$ , this difference is greater than zero and increases over the interval  $0 < P \leq 0.33$ ; for  $P > 0.33$  the difference is still positive ( $U_E - U_{NE} > 0$ ), but depending on the relative values of  $U_p$ ,  $U_{PID}$ ,  $U_{NPID}$ , and  $U_{OV}$ , it may increase or decrease as  $P$  increases.

### 4.3 Cost-Per-Util

The incremental cost-per-util-gained when non-user utility is excluded is:

$$\begin{aligned} C/U_{NE} &= \frac{C}{U_{NE}} = \frac{bNP}{NP \cdot U_p} \\ &= \frac{b}{U_p} \end{aligned} \quad (3)$$

With no externalities, the cost-per-util-gained does not vary with the prevalence of a disease because prevalence cancels out of the  $C/U$  ratio. Consequently, two programs for which the cost-per-util-gained is the same would be ranked as equal, regardless of whether or not the prevalence rates of the underlying diseases differed markedly.

When non-user utility is included, the incremental cost-per-util-gained becomes:

$$\begin{aligned} C/U_E &= \frac{b \cdot NP}{NP \cdot U_p + NP(N-NP)U_{NPID} + NP(NP-1)U_{PID} + U_{OV}(P-P^2)(N-NP)} \\ &= \frac{b}{U_p + N(1-P)U_{NPID} + (NP-1)U_{PID} + (1-2P + P^2)U_{OV}} \end{aligned} \quad (4)$$

and the cost-per-util-gained varies systematically with the prevalence of the disease.

The primary concern that motivated this paper is that using CUA to allocate resources when non-user utility is excluded may unknowingly lead to recommending a non-optimal allocation of resources. This possibility is addressed by using the model to examine possible biases. Specifically, we attempt to identify situations in which the omission of externalities has the greatest likelihood of changing program rankings. The

analysis focuses in particular on the relationship between prevalence and the amount by which cost-per-util-gained for a program is overestimated by the exclusion of externalities.

The relationship can be examined by subtracting equations (4) from (3) and taking the derivative with respect to P. This yields the following conditions:

$$\begin{array}{l}
 \text{i) if } P > \\
 \text{ii) if } P = \\
 \text{iii) if } P <
 \end{array}
 \left. \vphantom{\begin{array}{l} \text{i) if } P > \\ \text{ii) if } P = \\ \text{iii) if } P < \end{array}} \right\} 1 + \frac{N(U_{NPID} - U_{PID})}{2U_{OV}}, \text{ then } (C/U_{NE} - C/U_E) \left\{ \begin{array}{l} \text{increases with } P; \\ \text{is constant with} \\ \text{respect to } P; \\ \text{decreases with } P. \end{array} \right.$$

The expressions indicate that the critical determinant of the relationship is the relative values of  $U_{PID}$ ,  $U_{NPID}$ , and  $U_{OV}$ . Theoretically, each of  $U_{PID}$ ,  $U_{NPID}$ , and  $U_{OV}$  could be positive, negative or zero for any given disease. Because the purpose of this paper is to examine the impact of excluding externalities, when they in fact exist, we restrict our attention to the situation in which  $U_{PID}$ ,  $U_{NPID}$  and  $U_{OV}$  are each positive (on net). In this case, the relative values of  $U_{PID}$  and  $U_{NPID}$  alone determine which of the above conditions hold. Three relationships are possible:

- a)  $U_{PID} > U_{NPID}$ ; this assumes that an individual with the condition derives more interdependent utility from the treatment of others with the same condition than does an individual who does not have the condition. In this case,  $(U_{NPID} - U_{PID})$  is less than zero, and the gap between  $C/U_E$  and  $C/U_{NE}$  becomes a function of the size of the term  $\frac{N(U_{NPID} - U_{PID})}{2U_{OV}}$ , hereafter referred to as  $Z^*$ . If  $Z^* < -1$ , then  $(C/U_{NE} - C/U_E)$  increases with P over the whole range of P  $[0 \leq P \leq 1]$ . This situation is depicted in Figure 1A, where the gap between the two cost-utility ratios widens as prevalence increases. If, however,  $-1 < Z^* < 0$ , then  $(C/U_{NE} - C/U_E)$  is decreasing in P over the interval  $[0, P^*]$  and increasing over the interval  $[P^*, 1]$ . This case is shown in Figure 1B.



- b)  $U_{PID} = U_{NPID}$ ; this is a situation in which the amount of interdependent utility received is the same for patients and non-patients. In this case,  $Z^*$  is zero and  $(C/U_{NE} - C/U_E)$  decreases with  $P$  over the whole range of  $P$ . This is illustrated in Figure 1C, where the gap narrows as prevalence increases.
- c)  $U_{PID} < U_{NPID}$ ; in this final scenario, non-patients receive greater interdependent utility from the treatment of a disease than do the patients with the disease. Here,  $Z^*$  is positive and hence  $(C/U_{NE} - C/U_E)$  again decreases with  $P$ , as in Figure 1C.

The above conditions demonstrate that it is not possible to determine, a priori, either the magnitude or the direction of the bias introduced by omitting externalities from a cost-utility analysis. To do this requires knowing the relative values of  $U_{PID}$  and  $U_{NPID}$ . But does this imply that, even under certain assumptions, it is not possible to estimate the impact of the omission? This question is important because it may be that there are assumptions that could be made which would preserve the relative rankings of programs, even if externalities were included. Consider, for instance, the simplest case, in which the values of  $U_{PID}$ ,  $U_{NPID}$ , and  $U_{OV}$  are identical across two programs. Even with this restrictive (and unrealistic) assumption, it is impossible to predict in advance the direction of the bias introduced by the omission of non-user utilities without knowledge of the specific values of the  $U_{NPID}$  and  $U_{PID}$ . That is, any of the relationships in Figure 1 could hold. If, for example, a disease with high prevalence was compared with one of lower prevalence, and the situation as in Figure 1A prevailed, then the inclusion of externalities would result in a smaller  $C/U$  ratio for the higher prevalence disease. If, however, the situation was as in Figure 1C the inclusion of externalities would favour the low prevalence program, and the rankings would be reversed. Thus, there is no way of knowing if, and how, the relative rankings in a league table would be affected.

## 5. DISCUSSION

The significance of omitting externalities depends crucially upon what one believes to be the appropriate theoretical basis for allocating society's resources and what one believes the theoretical foundations of CUA to be. If the common economic view of allocating resources in a manner that maximizes technical and allocative efficiency (as defined within the welfare theoretic tradition) is accepted, then externalities should be included in the evaluation of health care programs. The methods employed to conduct the evaluation should conform to the principles of welfare theory, with respect to both what is measured and how the values are obtained. Currently there are differing views in the CUA literature regarding whether welfare theory does, or even should, form the basis of CUA [Williams (1981), Feeny and Torrance (1989)]. Yet most CUA studies are conducted and interpreted as if the technique was capable of evaluating allocative efficiency. If the theoretic foundations of welfare economics are germane, then the deficiencies of CUA in this regard are an issue. Omitting externalities is a shortcoming of the technique and the validity of CUA is compromised because it does not, at least as currently structured, measure the theoretical constructs that are held to underlie it.

A second question then arises as to whether externalities are large enough (relative to user-specific costs and benefits) to affect allocation decisions. Evidence from studies outside the health sector strongly suggest that this might be the case, but there is little empirical information on the magnitude of health-care related externalities per se. The nature of the commodity health, however, coupled with the experiences from other sectors, indicate the need to explore these issues further.

Can the existing CUA methodology be adapted to measure externalities? It might be possible, but it will certainly not be a straightforward task; we outline some of the difficulties that are likely to be encountered. First, the respondent sample would have to be expanded from patients (users of care) to the community at large (non-users). Patients would be represented in this sample only in proportion to the prevalence of their disease in the population. The second modification would involve the information that would have to be conveyed to respondents. Typically, in a CUA, respondents are given information about the health outcomes, or states, (e.g., functional ability, mental

ability, pain, dependence, etc.) associated with the alternatives being evaluated. They are then asked to choose amongst options based on their preferences for the health outcomes. A much broader range of information is required, however, for capturing externalities. In addition to the information on health status improvements for those treated (including long term sequelae and prognosis), to evaluate the program, respondents would have to be provided with data on prevalence, incidence, and communicability of the disease and on the distribution of its impact across population sub-groups. Particularly important for assessing option demand might be information on risk factors and future patterns of illness. This list is not comprehensive, but it illustrates the types of information that respondents would require in order to estimate external benefits and costs. It appears that the greatest challenge for researchers who attempt to move from measuring individual utilities to societal utilities will be in obtaining and conveying the requisite information. Much of the information listed above is not known, or not known with precision. Nor will it be easy to present the information to respondents in a meaningful way. A second challenge will be to determine if the existing utility measurement tools of standard gamble, time-trade-off or category scaling could be modified to incorporate the information, if available.

Given the methodological obstacles to modifying CUA techniques for resource allocation purposes, it may be useful to reconsider cost-benefit analysis. There are several recent examples of CBAs in the health care field, and considerable work is being directed at revising traditional CBA methodology for health care-related applications. Contingent valuation methodology, which has been used to value externalities in other sectors, is an approach that has the potential to incorporate the information needed for a full evaluation, and which can be modified in light of the criticisms levied against standard CBA methods applied to the analysis of health care. Willingness-to-pay techniques can be replaced by more relevant approaches such as willingness to reallocate public funds and willingness to be taxed [Donaldson (1990)]. The advantage of moving (back) to a CBA approach is that the theoretic underpinnings, and hence the attendant value judgments, are well understood. Moreover, the approach would provide more comprehensive information on the sum total of benefits to society, not just to a sub-sample of patients. Much work needs to be done refining CBA measurement techniques

for the health care context, but such efforts may prove worthwhile if they help form a solid basis for resource allocation decisions. As Mishan (1971b) has emphasized,

In view of the existing quantomania, one may be forgiven for asserting that there is more to be said for rough estimates of the precise than precise estimates of economically irrelevant concepts. (p. 705)

## NOTES

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1. It should be acknowledged that the notion of using the Paretian Principle to identify socially optimum allocation does not necessarily imply the simultaneous objective of maximizing social utility, as measured by  $\Sigma U_i$ . As Mishan (1971a) emphasizes, "...the rationale of the conventional cost-benefit analysis is not to be interpreted as having an affinity with a social goal of maximizing or increasing aggregate utility. No interpersonal comparisons of utility are to be invoked." (p.190).
  2. A third application, that of guiding decisions at the individual patient level is advocated by some [Williams (n.d.)] while strongly discouraged by others [LaPuma and Lawlor (1990)]. Because the focus of the present paper is on decisions made at the health system level, we subsume the patient-level application in "clinical decision making".
  3. Detailed descriptions of procedures for measuring health state utilities can be found in Furlong et al. (1990), Gudex and Kind (n.d.) and Torrance (1986).
  4. In a recent paper Jones-Lee has argued that within a utilitarian framework externalities should only be measured if they are of the selfish or paternalistic type, i.e., if they are directly tied to a good and are not purely altruistic in the sense defined above (Jones-Lee 1991).
  5. The inherent limitations of basing allocation decisions on any ratio measures has been well documented in the CBA literature [Birch and Donaldson (1987)].
  6. More specifically, for purposes of this analysis, we employ the notion of "period prevalence" which is defined as the number of people known to have the disease over a specified time period, divided by the number of people at risk over that period.
  7. This is true in the sense that the prevalence rate for a specified population or sub-population is, in fact, the pre-test likelihood (of having a disease) for an individual (from that same population) undergoing a diagnostic test. But if, at any given time, an individual knows with certainty whether or not he/she has the disease, future demand is likely to be a function of the rate of new cases arising in the population. Accordingly, option demand will be determined by the incidence of a disease, or the rate of new cases arising in the population, rather than the prevalence rate. To simplify the model, however, and to avoid cumbersome notation, we have not distinguished between prevalence and incidence since this refinement does not affect the results in a qualitative way.

8. A more general specification of the total utility function is:

$$U = N \bullet F(U_p, U_{PID}, U_{NPID}, U_{OV}, P).$$

This general specification allows for the interaction of utility components, and option value which has intuitive appeal. (Consider, for example, the potential relationship between  $U_{PID}$  and  $U_{NPID}$ .) To facilitate the mathematics, however, we made the simplifying assumptions listed on page 15.

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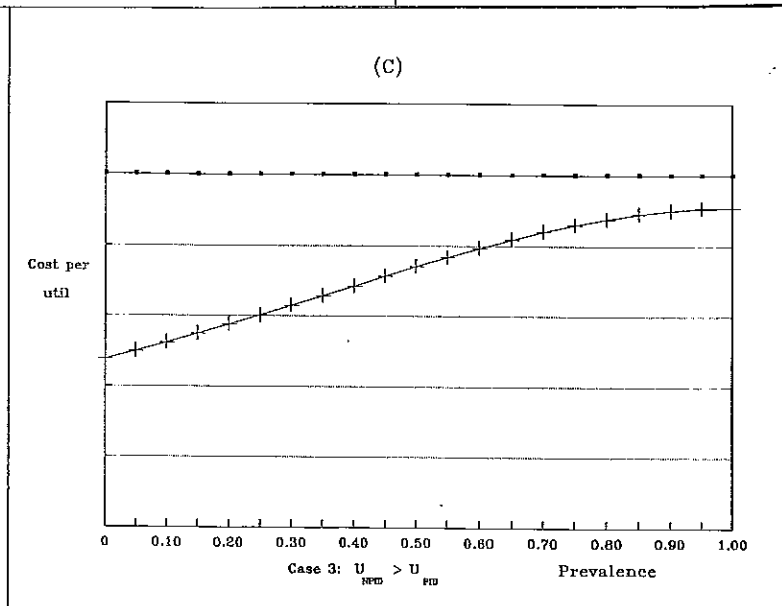
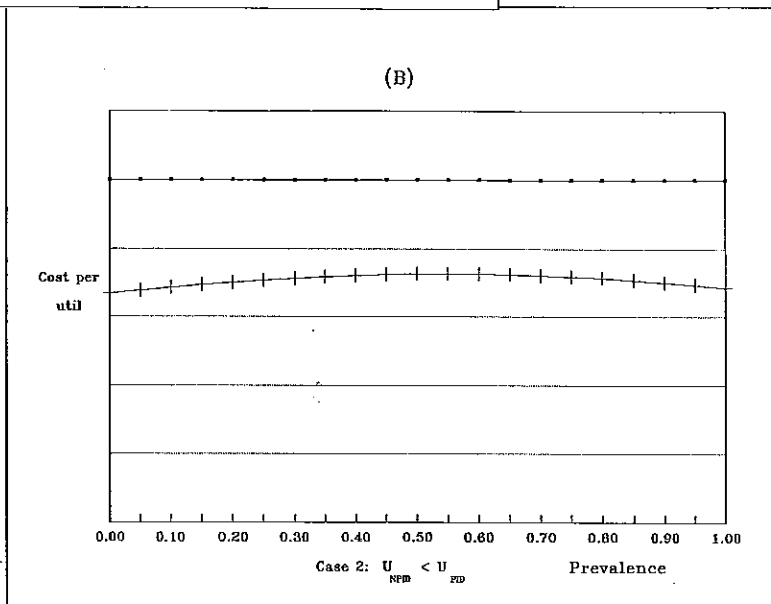
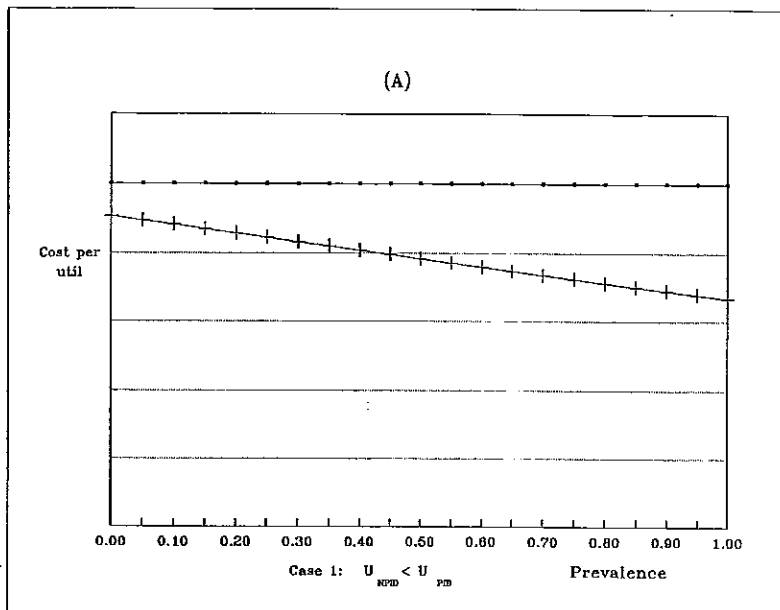
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# Figure 1: Relationship Between Cost per Util and Prevalence



- Externalities not included
- +— Externalities included