COST-BENEFIT STUDIES OF HEALTH CARE PROGRAMS
Choosing Methods for Desired Results

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This article summarizes the results of a critical review of several cost-benefit analyses (CBA) of health care programs. With pertinent examples, it is demonstrated that the results and conclusions of a study depend upon the assumptions and methods underlying the measurement of costs and benefits in a CBA. Given the incentives for an analyst to comply with desires of his sponsor, and given the scope of the choice available to an analyst among alternative assumptions and methods, it seems quite possible that desired results often dictate the assumptions and methods chosen. It is recommended that a policy maker should suspect an advocacy in the results and conclusions of every CBA. If CBAs are to be a true decision aid, a policy maker ought to obtain several of them, each of which assesses the costs and benefits of a given action plan using assumptions and methods substantially different from the other.

AUTHOR'S NOTE: This study was partially funded by the SmithKline Corporation. The author is indebted to Dr. Morton L. Paterson, Manager of Cost-Benefit Studies at SmithKline for his encouragement and guidance. An earlier version of this paper was presented at the ORSA/TIMS meeting in Washington, D.C., May 1980.

EVALUATION & THE HEALTH PROFESSIONS, Vol. 7 No. 3, September 1984 285-303
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The need for prudent use of scarce national resources in health care dictates that social costs and social benefits of alternative programs be measured carefully. It is encouraging, therefore, that recent years have seen a growing number of such cost-benefit or cost-effectiveness analyses (CBA).[1] Analysts have attempted to answer a wide variety of questions pertaining to prudent allocation of resources to and among health care programs. For example, what is the best age for administering rubella vaccination (Schoenbaum et al., 1976)? Do the benefits of BCG vaccinations in school justify their costs (Stilwell, 1976)? What are the social costs and benefits of surgeries (Bunker et al., 1977)? Do the benefits of methadone maintenance programs outweigh their costs (Hannan, 1976)? Can we evaluate the cost-effectiveness of drugs such as antidepressants (Brand et al., 1975), l-dopa (Brungger, 1972), cimetidine (Robinson Associates, 1978)? Do benefits of medical research justify their costs (Weisbrod, 1971)? What are the benefits and costs of certain government regulations (Peltzmen, 1974; Dworkin, 1980) and restrictive formularies (Hefner, 1979)?

Such efforts in conscious and explicit accounting of social costs and benefits of various programs are commendable and represent the first step towards improved societal decision making. However, detailed examination of these and other CBAs *fails to prove* that CBAs are worth their costs. This article argues that, although the theoretical concepts underlying CBA are rich and insightful, their practical application depends upon a series of assumptions an analyst must make. There is no universally acceptable set of assumptions. Often there are many equally reasonable sets of assumptions. The results and recommendations of an analysis could be diametrically opposite when different sets of equally reasonable assumptions are employed. Often methods and assumptions chosen by an analyst may be determined by the vested interests and/or the foregone conclusions of the analyst and his clients.

THE PROMISE OF CBA

Theoretically, one cannot but applaud the basic approach of CBA, which is to account for *all* social costs and social benefits of a proposed program. The conceptual foundations of CBA[2] are indeed very rich as can be seen from their partial enumeration below:

1. The CBA approach recognizes that resources are scarce and they deserve to be allocated prudently among alternative social programs in order to maximize their benefits for the society. On the other hand, many other types of analyses, particularly in the health care sector, often ignore the scarcity of resources. For example, a typical so-called medical evaluation of alternative therapies may concentrate only on the *health outcomes* of *alternative therapies and may ignore the resource inputs required* for the alternative therapies.
2. CBA has taught us to account for *indirect* as well as direct costs. For example, CBA tells us to account for the different time commitments imposed upon a patient and his family by the different therapeutic modes. Such costs are called indirect costs because the provider of care does not incur them. Economic analyses of profit-motivated providers are likely to ignore such indirect costs, although they are, in fact, costs to the society as a whole.
3. CBA also tells us to account for the externalities of a program, that is, to account for the benefits and costs of a program accruing to persons other than the doctor (or medical team/hospital), the patient, and the insurance agency. For example, when a communicable disease is prevented in a specific patient, the beneficiaries may include his neighbors and colleagues.
4. CBA methodology emphasizes that one must account for the incremental costs and benefits of a program, or its components, rather than using the current average costs to estimate the realizable benefits of a program. For example, an ulcer patient who abstained from work for ten days per year because of ulcers may not report any work loss owing to ulcers once they are healed by surgery. However, the worker may continue to abstain from

work for as many sick days as are allowed by the union contract, attributing that work loss to other real or fictitious diseases. In such a case, the incremental saving in work loss may be negligible, if any. CBA correctly tells us not to account for such hypothetical savings to that surgery.

5. CBA emphasizes that resources should be valued at their *opportunity cost*, that is, at the value of the benefits foregone by not being able to use the resources required by a program in their best possible alternative use. Thus, a surgery scheduled in an otherwise idle operating room may be valued at only the incremental cost of the surgical procedure, whereas a surgery scheduled in an overbooked surgical ward must be valued at the price another patient (or the insurance company) may be willing to pay if he or she did not have to forego surgery because this one was scheduled.
6. CBA recognizes that costs and benefits accruing in different years are not comparable unless they are *discounted to their equivalent values in a specific reference year*. Thus, avoiding $1000 in medical treatment costs five years from now may be worth saving only $621 in today's treatment costs, assuming a discount rate of 10% per year.

It is clear that CBA promises important insights for rational resource allocation and cost control in the health care sector. Furthermore, insofar as CBA requires the measurement of *all* costs and benefits of a program, it has the potential to encourage the systematic recordkeeping and tracing of the primary, secondary, and tertiary, direct and indirect, internal and external, as well as medical and nonmedical effects of a program. Of course, any analysis is based on some axioms or assumptions. CBA methodology requires that these assumptions be made explicit so that they can be critically examined and the effects of alternative assumptions can be assessed. Such an assessment is called sensitivity analysis. The potential for systematic recordkeeping, for detailed and explicit analysis, and for verification of results through sensitivity analysis accentuates the theoretical promise of CBA's value in rational decision-making.

Unfortunately, a review of available applications of the CBA methodology in the health care sector suggests that this promise actually has not been realized.

REASONS WHY THE PROMISE FAILED

There are many reasons why the promise of CBA approach is not adequately realized by available empirical studies. The most important of these reasons are detailed below:

1. Choosing among Societal Objectives. An attempt at measuring the social costs and benefits of a program assumes that societal objectives are known and defined precisely. Unless these objectives are known, one cannot determine as to what specific consequences constitute "costs" (because they are undesired), and what consequences constitute "benefits" (because they are desired). In democratic societies, societal objectives are plural, everchanging, and, often, mutually conflicting. A truly scientific analysis that recognizes the multiplicity, the dynamism, and the conflict among objectives can, at best, only *describe* the various consequences of a given program without attaching any values to these consequences. Such a description would leave it up to the policymakers to assign values to these consequences, aggregate the sum total of these values and arrive at the desired course of action. Yet, policy makers are not likely to accept such descriptions as "analyses." Policy makers often desire that the analyst should carry the process further and assist their decision making by imputing values to the various consequences, aggregating these values and providing definitive recommendations. Available CBA studies indicate that analysts are quite willing to comply with these desires of the policy maker, which is exactly where the process of choosing values, assumptions, and methods for desired conclusions may begin. Analysts who are willing so to comply, may be inclined particularly to arrive at conclusions that the policy maker (i.e., their client) may want to hear. Consciously or unconsciously, these analysts may choose among alternative societal objectives such that the chosen objectives are best fulfilled by the program the client favors. In specific cases, it is difficult to prove such a bias in the choice of societal objectives. But, certainly there is considerable scope for such a bias. In the health care sector an analyst may choose among a number of

societal objectives including (a) maximization of equitable access to health care, (b) maximization of gross national produce of a nation state, (C) maximization of per capita income, (d) maximization of number of lives (or life-years) saved per dollar of health care expenditure, (e) the most beneficial allocation of a given health care budget, (f) the most beneficial allocation of the national budget, and so on. Depending upon the choice among these alternative objectives, the values attached to specific consequences of a program can be substantially different. For example, saving the life of an individual whose contribution to GNP is likely to be only marginal (i.e., below average) may be seen as a "cost" under objective (c), as a slight benefit under objective (b), as a substantial benefit under objective (d), and as an unavoidable activity in the pursuit of objective (a). Thus, if a client's health care program is aimed at saving the lives of the poor, the blacks, the women, or the elderly, the analyst could choose objectives (a) or (d) rather than (c) or (b). Perhaps this is why Riddiough (1979), whose study justifies pneumococcal vaccination for the elderly, uses objective (d); whereas, Barlow (1968), whose study questions the value of malaria eradication in underdeveloped countries, uses objective (c). Of course, one would never know if these analysts chose their objectives first and then arrived at their conclusions or vice versa. However, the existence of the potential for selective definition of societal objectives has been demonstrated by Joglekar (1982).

2. *Identifying "Significant" Costs and Benefits.* Although the foundation of CBA lies in the determination to account for *all* (meaning each and every) of the costs and benefits, in practice such a task is impossible considering the inevitable constraints on time and resources any study must face. Consequently, analysts must compromise and attempt to meaure only the most significant costs and benefts. Unfortunately, an analyst's judgment as to what consequences are "significant" and what are not, may be incorrect—deliberately or otherwise. For example, Steiner and Smith (1976), justify a program for administering PKU screening to each one of the 46,714 live-born babies each year in Mississippi

so that an expected number of 1.76 cases of PKU could be detected and cured. Steiner and Smith (1976) can do this primarily because they ignore one significant social cost associated with such a screening program. They ignore the expected cost of the time, the money spent, the work lost, and the anxiety experienced by parents of the 46,714 babies that must be screened. In another study, Stilwell (1976) concludes that British schools' BCG vaccination program will be uneconomical by the mid-1980's, primarily because he assumes that a BCG vaccination protects only the child vaccinated. Insofar as TB is a contagious disease, the externalities associated with the BCG vaccination may be significant and ought to be accounted for. To repeat, one cannot be sure whether these analysts ignored such significant costs only out of innocence or because ignoring them made it easier to arrive at the specific conclusions. It may be noted further that in their decisions about what to measure and what not to, analysts may be tempted to include what is conveniently measurable and exclude what is not—even when what is excluded may be socially significant. For example in health care-related CBA's, pain, human suffering, and quality of life considerations are invariably excluded. Stilwell's (1976) study may have resulted in a different conclusion had he considered such nonquantifiable costs for the TB cases caused by a discontinuation of the BCG program. In a sense, this inclination to consider only what is quantifiable, also influences the analyst's choice of societal objectives mentioned earlier. Most CBAs avoid objectives such as the "maximization of equitable access to health care," because a quantitative determination of what is equitable may be difficult. Thus, CBAs focus on economic efficiency questions (which can be analyzed quantitatively with relative ease), although the history of social decisions pertaining to health care suggests that concerns of equitable access and of patients' rights in and to health care are the more dominant considerations.[3] Consequently, most of the available cost-benefit studies can be challenged on the grounds that they violate the true objectives of the society. The controversy generated by Schoenbaum's (1976) analysis of rubella vaccination policy may be a case in point. His recommendation to

vaccinate all females at age 12 has been considered discriminatory because black females may be far more likely to be pregnant before being protected by this rubella vaccination policy than are white females (McBride et al., 1976).

3. Quantifying the Nonquantifiable. Another issue of concern is the analyst's tendency to force quantification on what may not be basically quantifiable. The value of a human life may not be quantifiable unless one wishes to restrict oneself to such quantifiable aspects of that life as expected years of survival, expected earnings in the future, or expected health care expenditures in the future. An individual's innovative potential or ethical and moral contributions must be downplayed, for such are not quantifiable. Thus, forcing the valuation of a human life is to account for only a *few* of the attributes of human life. No matter which attributes are chosen, such an account is partial and subject to controversy. Proponents of cost-effectiveness analysis often question analyses that put a dollar value on human lives (typically using the human capital approach).[4] Instead, they recommend the measurement of the quality-adjusted life years (QALY) as the measure of the value of that life.[5] This "quality adjustment" is typically in terms of the physical health of the human being. The fact is that a healthy year of life in poverty and slavery may not be as socially desirable as a healthy year of life in freedom and prosperity. In sum, regardless of the attributes chosen for quantification, a forced quantification of what is basically nonquantifiable will be misleading. More importantly, insofar as there are alternative methods of quantification, there is a scope for choosing suitable methods for desired conclusions. As pointed out earlier, analysts who want to justify programs for the poor, the minorities, or the elderly may use the QALY method of valuing human life; whereas, analysts who want to justify health care programs that benefit primarily white, young, adult males may insist upon the use of the human capital approach.[6]

4. Choosing the Discount Rate. Although there is a general consensus among CBA analysts that costs and benefits accruing

in different years are not comparable unless they are adjusted to corresponding discounted values in a specific reference year, experts disagree on the proper numerical value of the discount rate to be used. Some argue for the social rate of time preference as the conceptual foundation for determining the appropriate discount rate. Such analysts use a rate that is lower than prevalent market rates of interest. Others espouse the social opportunity cost of capital as the conceptual basis and consequently use a higher discount. This controversy has manifested itself in the health care related CBAs in widely divergent choices of discount rates.[7] What is curious is that the chosen discount rates often seem to favor the conclusions of the studies. For example, Stilwell (1976) uses a 10% discount rate (which discounts future benefits heavily) in a study that concludes that BCG vaccinations may not be economical, whereas Brungger (1972) uses a -6% discount rate (which inflates future savings) in a study that concludes the l-dopa is a cost-beneficial treatment for Parkinson's disease insofar as it reduces future use of long-term hospitals and nursing homes. Of course, outsiders cannot tell whether an analyst chose a discount rate first and simply spelled out the consequent results, but clearly there is considerable scope for the analyst first to choose the results he or she desires and then the discount rate suitable for those results.

5. *Using Available Information Selectively.* In carrying out a cost-benefit analysis, information is required on a variety of pertinent factors, such as the current incidence rate, mortality rate, hospitalization rate, and medical care costs of a disease. Data on such factors are available through numerous sources. The methods employed by different data collection agencies are seldom consistent with each other. Consequently, estimates based on different sources vary widely, and an analyst can choose the source and the data he or she would use. Again, this situation presents an opportunity for the analyst to justify his or her desired conclusions by using sources and data which are most suitable for such a justification. For example, Robinson Associates (1978) projected substantial economic savings resulting from the intro-

duction of cimetidine for the treatment of duodenal ulcers. However, as Fineberg and Pearlman (1979) have pointed out, at the time Robinson Associates conducted their study, two independent estimates of the national costs of ulcer disease (in the absence of cimetidine) were available, the lower one prepared by the National Commission on Digestive Diseases (NCDD) and the higher one prepared by Stanford Research Institute (SRI). Robinson Associates based their study on the SRI estimate. Although the relative soundness of methods underlying the two studies may have justified the choice in this specific case, the fact is a higher estimate of costs without cimetidine enables one to attribute greater savings to cimetidine. Again, the purpose here is not to indict Robinson Associates. The purpose is to demonstrate the existence of the scope for CBA analysts to use available information, data, or estimates selectively.[8]

6. Interpreting Data and Analysis Conveniently. Perhaps the most fertile method of supporting desired conclusions is to interpret data and analysis conveniently. The literature on health care related CBAs is abundant with examples of such convenient interpretations, including:

(a) In his often quoted study of the costs and benefits of regulation of pharmaceutical innovation, Peltzman (1974) considers two distinct relationships between the prices of new drugs in a particular therapeutic category and the ratio of the number of new drug prescriptions to the number of all prescriptions in that category. In his equation E2, he considers the latter as a dependent variable and comes up with an R^2 value (i.e., the coefficient of correlation, which expresses the percent of variation explained by the assumed dependence) of 0.2885. In his equation E3, Peltzman (1974) entertains the hypothesis that the prices of new drugs are dependent on the quantity marketed. E3 results in an R^2 value of 0.8360. Given the R^2 values of the two dependencies hypothesized, a statistician would accept E3 as the "more explanatory" relationship. Yet, Peltzman (1974: 98) argues that "since E3 contains the implausible implicit assumption that sellers of new drugs predetermine output and then find a price which clears the

market of this output: E2 is probably closer to the truth than E3." The truth is that the relationship implied by E3 may not only be plausible but may be very realistic in the pharmaceutical context. For any new drug, the number of prospective users (probably a percentage of total number suffering from an illness) may, indeed, be predetermined—not necessarily by the seller of the drug but by the circumstances (i.e., the average incidence of the disease, the availability and effectiveness of alternative drugs—so that the only controllable variable for the producer of the new drug may be its price. Nevertheless, one would not mind it very much if Peltzman (1974) had instead used his equation E2 as the explanatory relationship, for R^2 values do not *prove* causalities, they only express a degree of association between two variables, and causality is a matter of one's belief. However, Peltzman (1974) transgresses fundamental principles of the theory of statistics when he attempts to construct a new equation (E4) that takes an average of the coefficients determined by E2 and E3. It can be shown that the use of E4 biases the results *in favor* of Peltzman's (1974) conclusions, contrary to his claim that he has deliberately biased them against his conclusions.

(b) Bickley et al. (1978), in a paper aimed at seeking the addition of the drug Keflex to Medi-Cal formulary, use an imaginative approach to claim that Keflex would provide a net saving to Medi-Cal. Their data show that the average episode costs using alternative anti-infective therapies are smaller than the episode costs using Keflex in almost every disease-code category. However, Bickley et al. (1978) argue that such a comparison (of average episode costs) would obscure the key therapeutic and economic basis for Keflex use: namely, that Keflex therapy may reduce episode costs for *some* patients in a specified diagnosis code. Consequently, Bickley et al. (1978) look at the distribution of episode costs under alternative anti-infective therapy and assume that all matched cases of episodes that involved a cost higher than the episode cost with Keflex could have saved these extra costs by using Keflex. Bickley et al. (1978) simply ignore the fact that, at present, physicians have no basis to identify specific patients whose episode costs with Keflex will be smaller. Consequently, once on the formulary, Keflex would be prescribed to any "average patient". It follows that average cost comparison is the only relevant comparison.

(c) In evaluating a multiemployer alcoholism treatment program, Schramm (1977) finds that the costs of treating a referred alcoholic in the first year are $2462, but the average savings from reduced absenteeism during the first year (calculated as the employee's hourly wage rate times the reduction in hours absent) are only $586.42. Although he points out that the second and third-year treatment costs will be almost one half of those for the first year, the data presented suggest that the program may not be cost-efficient even in the second or the third year. Yet, in his conclusion, Schramm claims that the program is cost-effective.

Although these types of convenient interpretations may be detected by a careful analyst, casual readers, and policy makers may be misled easily by them. It is this potential of CBA studies to mislead policy makers that makes one wonder whether CBA studies are worth their costs.

SOME POSITIVE TRENDS . . . WITH THEIR OWN LIMITATIONS

A number of analysts seem to have recognized the arbitrariness of the chosen objectives, assumptions, and methods in a CBA. Consequently, they have attempted to overcome the limitations of CBA through a series of steps. Unfortunately, these steps have their own limitations. For example:

1. An increasing number of analysts seem to warn their readers of the potential indecisiveness of their conclusions. For examples, see Brungger (1972), Bunker (1977), Haunalter (1977), Conley (1975), Robinson Associates (1978), Weinstein and Stason (1977), Weisbrod et al. (1978), among others. Unfortunately, these warnings are rarely repeated in the abstracts of the CBAs and hardly imprinted upon the policy makers.[9] As Fein (1977) points out, numbers have the danger of implying false precision. Although analysts are more careful about the use of their numbers and often point out the limitations of certain assumptions upon which their numbers are based, outsiders may

impute greater certainty and authority to these numbers. There is a danger that a study's conclusions will be remembered, but the fact that they are derived from a narrow perspective (e.g., the neglect of consideration of equity and distribution) will be forgotten.

2. An increasing number of analysts are also including sensitivity analysis (that is, a presentation of the effects of alternative assumptions upon the results of a study) in their reports. For examples, see Geiser and Menz (1976), Hannan (1976), NEI (1977), Riddiough (1979), Rufener et al. (1977), Stason and Weinstein (1977), Weisbrod (1978), among others. Unfortunately, this sensitivity analysis is invariably carried out on assumptions (about discount rates, incidence rates, drug penetration rates, etc.) that are of lesser importance than assumptions about the pertinent societal objectives, such as the choice between the human capital approach and the QALY method of valuing a life. Furthermore, sensitivity analysis cannot really be extended to anything more than a few parameters. This difficulty can be appreciated from the following quotation from Sassone and Schaffer (1978):

> For concreteness, let us suppose that the calculations for each of two alternative projects involve 10 parameters, each a candidate for sensitivity analysis. A selective sensitivity analysis on the 10 parameters would produce 20 NPVs (Net Present Values) for each project, in addition to the initial 'best' estimate. The analyst must present to the decision maker a total of 42 NPVs when comparing two alternative projects. Such a large number of figures may not aid the decision maker at all. In fact, the presentation of all NPV estimates might even violate the analyst's charge to present the decision maker with results in a format convenient for use (1978: 142).

3. This reviewer has come across at least one CBA that incorporates the concept that a purely economic view does not fully reveal the pros and cons of a therapy. Brand et al. (1972) present a multidimensional study (including a medical analysis and a social analysis, in addition to the economic analysis) of the benefits and costs of antidepressants in Switzerland. In principle, the multidimensional approach is very commendable. However, in this particular study, the use of the multidimensional approach has

left the economic analysis rather incomplete, if not biased. Some of the disadvantages of the antidepressant therapy mentioned in the medical and social analyses could have been quantified easily in economic terms (with about as much accuracy as that of the advantages and disadvantages that are quantified) but were not. In view of that omission, one wonders whether Brand's study may also represent one case of choosing suitable methods for desired conclusions.

4. Lastly, there is a growing number of critiques of empirical CBAs. For examples, see Conley (1975), Churchman (1971), Fein (1977), Feinberg and Pearlman (1979), Gross (1976), Hatry (1970), Hoos (1972), Joglekar (1979), Jonsson (1976), Levine (1975), Self (1975), among others.[10] Although one of the basic principles of CBA methodology is to make the study's assumptions explicit and open for criticism, it is only human on the part of proponents of CBA to be alienated by such critiques. Consequently, these critiques have received a cold shoulder from those whose admittedly courageous and perhaps well-intentioned works have been criticized. Instead of adding a value, available critiques seem to have generated only conflicting emotions among analysts. Clearly, there is an urgent need for an attitudinal change among analysts as well as their critics.

In short, although there are few positive trends in the practice of CBA, at present, these trends cannot realize their full potential because of several limitations mentioned above.

CONCLUSION

The need for prudent use of scarce national resources in health care dictates that social costs and social benefits of alternative programs be measured carefully. The literature on cost-benefit methodology provides a rich conceptual base for the conduct of such studies. Unfortunately, in practice, analysts have considerable leverage for choosing objectives, assumptions, data, analytical methods, and interpretations that would yield desired conclusions. Given the current state of the art and the actual practice,

CBA's value in rational allocation of societal resources seems dubious.

In all fairness to the CBA methodology, however, it must be recognized that if the value of CBA is dubious, so is the value of the profit and loss (P & L) statement of a company for an outsider. Time and again, analysts have pointed out the scope available to the comptroller of a company in choosing depreciation and inventory valuation methods (among other more subtle methods) so as to dramatically alter a company's profitability picture. The validity of such indices as the gross national product (GNP) in measuring national productivity or the consumer price index (CPI) in measuring inflation has also been frequently questioned. Yet, P & L statements or CPIs have proved to be valuable information sources in a majority of circumstances. The reason is, there is a degree of standardization and year-to-year consistency in the P & L statements or CPIs. More significantly, the preparation and use of such statements and indices have reached a level of maturity. It is hoped that CBA will also reach a level of maturity in the coming decade or two. This process of maturity would necessitate, among other things:

(a) some explicit or implicit agreement among policymakers and analysts on the appropriate societal objectives,
(b) some standardization in the use of alternative methods of valuing human life,
(c) standardization in the range of discount rates to be used,
(d) availability of more complete and consistent data,
(e) simultaneous conduct of several CBAs using alternative objectives, alternative assumptions and alternative methods,
(f) a recognition of the value of independent critiques of CBAs,
(g) an attitude of tolerance towards the critics,
(h) an education of the policymakers in the value and the limitations of CBAs,
and, above all,
(i) a code of ethics to guide the choice of societal objectives, data, assumptions, methods, and interpretations.

In the meantime, every available CBA ought to be approached with care and caution to detect any elements of the types of biases

suggested by this article. At present, CBAs are more likely to choose suitable methods to rationalize their desired conclusions than they are to be impartial aids for policy decisions.

NOTES

1. Available literature distinguishes between two basic types of studies. One type, called the cost-effectiveness (CE) study attempts to measure health consequences (e.g., morbidity, mortality) of a program in a stardardized but nonmonetary unit such as quality-adjusted-life years (QALY), but other consequences are measured in dollar terms. In CE studies, the objective is to minimize the cost per QALY. The other type, called the cost-benefit (CB) study attempts to measure all (health and nonhealth) consequences of a program in dollar terms. It aims at maximizing net benefits of a program, and at times net benefits per dollar of investment. In this article, both of these types are included in the general term cost-benefit analysis (CBA).

2. For a better understanding of the foundations of CBA, see Bunker et al. (1977), Churchman (1971), Drummond (1978), Gross (1976), Hatry (1970), Jonsson (1976), Levine (1975), Quade (1975), Rothenberg (1975), Sasson and Schaffer (1978).

3. For an elaboration of this point, see Churchman (1971), Drummond (1978), Fein (1977), Fried (1975), Hoos (1972), Self (1975).

4. For discussions of alternative approaches to valuing human lives in dollar terms, see Card and Mooney (1977), Gross (1976), Jonsson (1976), Mishan (1971), Mushkin (1962), Rothenberg (1975). The human capital approach uses lifetime earnings of an individual as the the basis for valuing his or her life. Other approaches include a measure of the willingness to pay to avoid a death on the part of the individual or the society (imputed by using expenditures per life saved resulting from past decisions). Card and Mooney (1977) discuss the limitations and controversies surrounding several approaches. Their discussion indicates that the estimated value of a life using one method may be as much as a thousandfold different than the estimated value using another method.

5. On the surface of it, the QALY method seems to circumvent the equity questions surrounding the human capital approach, which imputes considerably smaller dollar value to the life of a black or a woman compared to a white male. But, the QALY method is not really free of value judgments and questions of equity as some of its proponents have implied. For example, the QALY method places a substantially higher value on the life of a child than on the life of a sixty-year-old person. It also values the life of a female higher than the life of a male of the same age. In any case, the use of alternative quality adjustment methods and/or alternative discount rates can make one estimated QALY value of a life severalfold different than another estimated QALY value of the same life.

6. For example, a rough computation (using simple but reasonable assumptions) indicates that a user of the human capital approach would rather save one 20-year-old man than eight 65-year-old men, but a user of the QALY method would rather save two 65-year-old men than one 20-year-old man.

7. For a better understanding of the discount rate controversy, see Baumol (1968).

8. Boden (1979) has made a similar point in the context of CBAs in pollution control.

9. In fact, these warnings rarely are resounded even by the technical reviewers of these reports. For examples, see the review by Bootman et al. (1979), Jonsson (1976), Levine (1975), Rothenberg (1975), Sasson and Schaffer (1978).

10. Not many of these critiques treat a large number of studies in adequate depth. Except for Joglekar (1979), they do a marginal job by either being too specific to a few studies (e.g., Fineberg and Pearlman, 1979) or being too general (e.g., Hoos, 1972). Joglekar (1979) presents detailed reviews of approximately twenty CBAs along with an integrative structure for the review.

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