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2.

## Methodological Issues

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## INTRODUCTION

Applications of cost-effectiveness analysis/cost-benefit analysis (CEA/CBA) can be quite complex, especially in the field of health care. The effort to apply CEA/CBA, therefore, *requires* a systematic and often rigorous approach. The problem to be solved may not be obvious, nor may its objectives. Is the problem one of health? If so, what is its scope? Is the objective to reduce deaths? Or deaths due to cardiovascular disease? Or is the problem one of efficiency? Is it to determine the best way to find a cancerous lesion? Or to lose weight? The answers to questions such as these help to determine the scope and nature of the analysis.

The framework for the analysis is also partially determined by the perspective of the evaluator. In reviewing an insurance package to evaluate a preventive service for a client, for example, a private health insurer probably would limit his or her concern to a comparison of the costs of providing the preventive service with the projected decrease in costs due to a decrease in future medical care utilization. From the perspective of the private health insurer, therefore, the problem has to do with the efficiency of the preventive program. The perspective of society as a whole is a broader one. Society's concerns would necessitate measuring not only the direct medical cost savings (if any), but also the indirect costs (such as lost (or saved) time associated with treatment, recovery, illness, or death) and the amount and value of life, limb, and misery involved. The benefits derived by the private sector, therefore, may be a subset of or different from the benefits derived by society as a whole.

In this chapter, the methodologies of both CEA and CBA are presented. First, the theoretically preferred orientation that a CEA/CBA should have is presented. Ordinarily, for example, a health problem rather than a given technology or procedure would be an "ideal" focus of an analysis, because this orientation will

allow the analyst to study alternative means to achieve some specified health objective. Following a discussion of identifying, measuring, and valuing benefits/effectiveness and costs, the implications of—and approaches to—special problems that confront the analyst are discussed. These problems include valuing costs and benefits that occur over time, reducing uncertainty or making estimates in the face of uncertainty, and taking into account the concept of equity. Also discussed are alternative methods for presenting findings and interpreting the results of a CEA/CBA. Finally, the inherent limitations of the technique are identified.

Throughout this chapter, CEA and CBA are assumed to be fundamentally the same technique, in that both are structured methods that are designed to assist a decisionmaker in the allocation of resources. In actual practice, however, CBA attempts to measure all costs and benefits of a given process/technology and to value them in monetary terms, whereas CEA ordinarily attempts to measure and value the resources expended and to compare them to only health status changes. In CEA, therefore, the final product is usually presented in terms such as cost per life or cost per year of life saved, or cost per degree of blood pressure lowered, and so forth. Although this more limited approach to assessing the worth of a technology is often practical, especially when the decisionmaking setting is limited in scope, a broader approach to assessing the worth of a technology may be more applicable for general public policy. For instance, in the case of a county health department seeking to know the most cost-effective method of controlling alcoholism, measures such as the cost per cured/prevented alcoholic may be sufficient information on which to base a decision. However, at a higher public policy level, a local health systems agency, for example, may need to set priorities among such diverse projects as an alcoholism program, a

health education program, an immunization program, and a mobile coronary care program. Its decision process will require more as well as different types of information, such as the specific populations affected in each case, the relative changes in health status, future health care expenditures, reimbursement possibilities, and political acceptability. At the national level, even more diverse programs compete with one another, requiring more diverse information such as changes in productivity (e.g., for alcoholism programs), criminal activity (e.g., for drug programs), property loss, social security payments, health care expenditures as well as health status. Therefore, as the policy perspective broadens, the information requirements for resource allocation decisions also broaden.

This chapter describes the methods of CEA/CBA from a broad policy perspective, a perspective which Congress will ordinarily have. The principal departure from conventional wisdom is that OTA assumes that the use of CEA in public policy decisions—like that of CBA—ordinarily requires a comprehensive examination of *all* relevant costs and benefits. In addition, since CEA does not value all variables in a common (monetary) metric the way CBA does, it

will be argued that the benefit/effectiveness part of a CEA can be analyzed in unlike terms (e.g., money saved, population groups treated, and disability days avoided). This approach has inherent limitations. First of all, CEA so broadly construed is contrary to what many analysts consider CEA to be. Second, with the results of a CEA presented as the cost per “array” of health and nonhealth benefits/effectiveness, such analysis will not permit easy comparisons between programs. As stated in chapter 1, however, the position taken by this report is that CEA and CBA are not decisionmaking techniques, but rather systematic methods to compare the costs and significant effects of a given course of action.

This expanded concept of CEA/CBA is not meant to imply that other more limited studies are not useful or valid, especially in resource allocation decisions of a more limited scope. As chapter 3 shows, many technically excellent analyses examine only the more important benefits/effectiveness. The purpose of the expanded definition of CEA is simply to place this analytical technique in a more general perspective, especially in light of its use in the public policy arena.

## DEFINING THE PROBLEM, OBJECTIVES, AND ALTERNATIVES

Ideally, a health care CEA/CBA should start with a broadly defined health problem such as premature death, excessive disability, or unnecessary pain and suffering. A broad problem definition would lead to equally broad objectives—to reduce premature deaths, excessive disability, or unnecessary pain and suffering. Alternative means of achieving such broadly defined objectives are numerous, encompassing a wide scope of possible programs. In theory, the programs need not be limited to the field of health care per se; alternative means of enhancing health include airport safety procedures and environmental pollution control, as well as immunization programs and surgical interventions.

In fact, the ultimate health care CEA/CBA would provide guidance for society's allocation

of money in order to maximize the society's health status. An approach this broad, however, would require not only technical sophistication beyond that of the current methods, but also the ability to shift funding among widely divergent programs, such as immunization activities, cancer research, emergency treatment systems, automobile safety, and fire and police protection.

Many public and private health-related programs in our pluralistic society are, in effect, fairly autonomous, however, and shifting funds from one program to another is difficult. In the real world, therefore, the identifiable health problem addressed through analysis may be more realistically limited to deaths or disability due to a given disease. Limiting the scope of the problem, in turn, limits the objectives and nar-

rows the alternatives. For instance, the problem that is defined may be confined to a given disease and the objective to that of reducing the resulting deaths and disability. Possible alternate actions include preventing the disease as well as curing or ameliorating it, but a still narrower definition of the problem—such as that of curing existing disease—would preclude prevention. However, as the scope narrows, the alternative possibilities can often be examined in greater depth, a counterbalancing advantage.

As a general rule, when an analyst examines a variety of alternatives, time and other limited resources preclude consideration of all or even many viable specific programmatic alternatives. In such cases, a possible strategy is to select representatives of diverse programs (e. g., treatment, screening, medical prevention, nonmedical prevention). Needless to say, the analyst should select programs not clearly dominated by others of the same type. Thus, a comparison of kidney disease treatment with prevention programs would not fairly represent the treatment end of the spectrum by selecting only inpatient dialysis, since both outpatient dialysis and home dialysis are viable options.

A CEA/CBA can also start from an entirely different focus. For instance, instead of examining alternative means of ameliorating a societal health problem, the analysis may consider the ability of a given technology to accomplish specific objectives. That is, rather than addressing the general problems of excess mortality or even mortality due to heart attacks, either of which could include solutions outside the scope of the health care system, the analysis may examine the cost of a mobile coronary care unit relative to its ability to reduce mortality. This reduction in scope may have the advantage of allowing more detail, and possibly more rigor in the analysis, but it sacrifices the ability to consider relevant alternatives in solving the overall health problem.

A particularly perplexing problem for CEA/CBAs concerns technologies in which a cause-and-effect relationship to health status is not established, although an association is widely believed. An obvious example is a diagnostic procedure (e.g., an X-ray). In the case of such

technologies, objectives must often be defined in terms of intermediate outcomes (e.g., number of blood tests per minute or amount or quality of information produced). Analyses in which the objectives are so defined beg the question of the ultimate value of the diagnostic procedure, and may thereby call into question the value of the CEA/CBA itself.

For a CEA/CBA to be technically possible, the principal objectives should be quantifiable; when that is not possible, reasonable proxies should be available. This requirement places a severe constraint on the evaluation of health care procedures, the reason being that key objectives are often intangible. Unfortunately, such a constraint tends to place analysts and policymakers in a double bind, because health resource allocation decisions are often required irrespective of the ability to quantify objectives. When key objectives cannot be adequately measured, the temptation is to measure only the quantifiable objectives, relegating the intangibles to inconspicuous footnotes or ignoring them altogether. Thus, a hospice program which may be adopted in the absence of formal analysis, on the basis of the intangible benefits of dying with dignity and without pain, may be rejected under the scrutiny of a formal, rigorous CEA/CBA, based solely on economics—since the only quantifiable objective may be the reduction of health care cost.

The principal danger of performing a CEA/CBA when the important objectives are not quantifiable is that the results may be misrepresented or misinterpreted: That which is quantified may take on undue importance; that which is not, regardless of its importance, may be ignored. Thus, not only is it advantageous for an analysis to be premised originally on a health problem, but the important objectives or reasonable proxies should also be quantifiable. In structuring the analysis, therefore, it is important to array the objectives in priority at the outset, and then to analyze the quantifiability of each one.

There are at least two exceptions to the above statements. First, sometimes a minor objective by itself may indicate the desirability of a program even when the major objectives are not

quantifiable. In the case of the hospice program cited above, for example, although the principal purpose may be humanitarian in nature and thus impossible to quantify adequately, medical cost savings, although a much lesser consideration, may be sufficient to indicate adoption. Notice that this exception to the decision rule applies in only one direction: In the aforementioned case, the lack of medical cost savings would ordinarily not be sufficient in itself to indicate rejection. The second exception arises in the case of a CEA/CBA being performed from a nonsocial perspective. Often, this type of analysis has an orientation strictly toward minimizing health care costs; hence, the broader societal health objectives can be subordinated by a more narrow economic concern.

A final note concerns the overall responsibility of the analyst with respect to the scope of the study. On the one hand, it is helpful if the anal-

ysis provides information regarding the marshalling of resources in the most efficient manner conceivable, within the context of society's overall principles, regardless of artificial constraints, whether they be legal, political, or customary in nature. Although some alternatives may not be feasible under the present legal structure, or may be politically or economically unacceptable, a thorough analysis might identify them (e.g., see reference 335). On the other hand, in the interest of realism, the analyst should (when feasible, and to the extent of the analyst's knowledge) identify those alternatives that are politically, legally, and economically feasible at the present time. The broader scope is important for stressing what could be accomplished in the long term, but often only if society is willing to challenge some of its more established institutions. The narrower scope is important for stressing what can be accomplished in the short run, given the existing system.

## ASSESSING PRODUCTION RELATIONSHIPS

Just as defining the problem, objectives, and alternatives is essential in establishing the overall conceptual framework for the analysis, defining the process of health care is essential in establishing the technical framework for the analysis. That is, in order to evaluate the worth of a health care technology, we must know the resources (people, money, equipment, supplies) which are used, the manner in which they are combined, and the outcome (the saving of life/limb, the increase in happiness, the decrease of pain or of number of hospital days) which is produced. Health outcome is ideally measured in terms of net changes in health status.

Often, there is more than one way to produce a given product. Take the relief of a headache as an example. The input might be a head and shoulder massage, an aspirin, or acupuncture. As evidenced by the last example (acupuncture), sometimes we know how to produce an output without actually understanding the precise manner in which it is produced. In most cases, different inputs and varying amounts and combinations of the inputs result in varying quantities

and qualities of the output. Therefore, comparing one production process with another can be very complex.

In health care CEAs/CBAs, production relationships are related to the problem which is defined. Narrowly defined problems with intermediate outcomes are the most easily characterized: The production of an X-ray or a blood test, for example, is reasonably well understood; the production of a change in health status is not. Efforts to assess the effectiveness of health care, therefore, have often avoided measuring changes in health status. Early efforts to evaluate health care measured the amount and quality of the inputs, implicitly assuming that more doctors and more nurses were better than fewer, that board-certified specialists were better than general practitioners, newer facilities were better than older, and that the latest technology was better than the existing technology. In 1969, Donabedian suggested that quality of care be measured in terms of structure, process, and outcome (723). Structure refers to the inputs, process refers to the manner in which health

care is practiced as defined by *some* norm (i. e., the manner in which inputs are combined), and outcome refers to the success of health care in terms of health status. Most of the subsequent success in evaluating health care has been in the area of “process” evaluation and has taken the form of peer review and medical audit, such as is employed by the Professional Standards Review Organizations. More recently, there has been encouraging work in measuring outcome in terms of health status changes (406,78,79, 516) which has been made possible by the pioneering work of several groups of researchers who are developing techniques that measure health status (708,726,741).

Part of the *reason* that the results of health care are so difficult to understand is that there are numerous intervening, or exogenous, variables which complicate the analysis—variables such as age of patient, degree of patient compliance, environmental changes, and genetics. As a result of these variables, analysts sometimes use elaborate mathematical models to try to simulate both the disease process and the production process (e.g., see reference 335). One of the more basic techniques currently in use is decision theory, a diagrammatical expression of probable outcomes. In some instances, when outputs of a process are known but the process by which they are produced is not well understood, analysts can make use of operations research techniques which mathematically manipulate the quantity of inputs and the manner in which they are combined to “simulate” the production and/or disease process. These methods are known generically as simulation techniques. Despite the technical aura of much of the terminology, simulation methods can be helpful in simplifying a complex process into what are believed to be the essential relationships. They can be used to examine the changing nature of the outputs as both inputs and the manner in which they are combined are varied.

To assist in public policy decisions, analysts may perform a CEA/CBA by studying a process retrospectively, and then extrapolating the results into the future. In such cases, certain potential complications should be noted. For example, many studies are done on a small scale,

and the observed input-output relationships cannot necessarily be assumed to be the same on a large scale (as any baker knows, quadrupling the ingredients does not successfully produce a loaf of bread which is four times the normal size). An even more complex problem is that of the rate of technological change. To assume that a complex technological process will not change over time is obviously foolish, but to predict how it will change is fraught with uncertainty (e.g., see reference 559). Other problems include predicting the efficiency gained by learning better how to use a new technology, and predicting relative changes in future costs of inputs (e. g., labor v. capital). Finally, what works in one setting may not work in another. A technology applied in an urban setting may not work in a rural one; a carefully controlled study in a teaching hospital may demonstrate a technology’s efficacy—or potential effectiveness—but may not be useful in predicting its actual effectiveness outside that special setting (405).

### Marginal Valuations

The worth of a technology should be assessed at what economists term “the margin.” That is, the analysis should seek to compare the added, or marginal, cost of producing the next unit of benefit (see reference 559). In an evaluation of computed tomography (CT) scanning, the issue is not any longer whether the technology itself is cost effective, but, rather, whether the various applications of the technology are cost effective. Should CT be used for confirming suspected brain disease/trauma, or for ruling out brain disease/trauma when persistent headaches are presented? In what instances are body scans indicated—or cost effective? In general, the relevant inputs or costs which must be considered in a CEA/CBA of a health care technology will be tied to whether the technology is already in place or whether it has yet to be adopted/purchased.

### Joint Production Considerations

Finally, many technologies have multiple applications, and the technological process being studied is seldom applied in isolation. These two

considerations can have **enormous effects on cost and benefit calculations**. For instance, since a single blood test can be and is often used as a source of information for numerous diseases and bodily functions, analyzing the cost effectiveness of drawing blood for only one purpose is inadequate if the total cost is used; it either overstates the associated costs, understates the potential benefits, or both. Likewise, a CEA of a Pap smear program should be done in recognition of the fact that many other health evaluations are not only possible but are ordinarily performed during the examination, whether formally or informally. That is, the woman who is given a Pap test may be screened for other pelvic disorders, high blood pressure, fever, skin rashes, weight problems, wife battering, and many other conditions, all of which carry certain potential benefits and all of which should be assigned some of the cost (or, conversely, less cost should be assigned to the Pap test); or the CEA should be evaluating the complete ob-gyn examination rather than just a Pap test (335). Of course, including the effects of joint production adds greatly to the problems of measurement and valuation, but these difficulties in no way

diminish the conceptual importance of their full consideration in a complete analysis. Often, for instance, a very small incremental, or marginal, increase in cost to an existing production process, can have large benefits—other times, the reverse is true.

Thus, in order for the health care production process to be adequately described, a causal relationship of inputs to outputs should be demonstrated, joint production effects should be considered, and the effects of exogenous variables should be examined. In addition, the analysis of the use of an existing technology should include marginal changes of costs and benefits. Unfortunately, many variables are much easier to describe conceptually than they are to measure empirically.

As mentioned earlier, however, since many diagnostic procedures have intermediate outcomes as their objectives, a direct association with health status change may not be known. In such cases, if inputs and outputs cannot be shown to be causally related, at least an associative relationship (however distant) to some health problem should be noted.

## IDENTIFYING, MEASURING, AND VALUING BENEFITS/EFFECTIVENESS AND COSTS

At the heart of every CEA/CBA is the identification, measurement, and valuation of relevant costs and benefits/effectiveness associated with the production process. The identification and measurement procedures for both techniques are essentially the same; it is in the valuation process that the two techniques differ. The reader will recall that CBA ordinarily requires that all costs, effects, and benefits be valued in monetary terms, whereas CEA requires that only nonhealth status changes be so valued. But there are other differences between the two techniques.

One of the inherent difficulties in describing the elements of both CBA and CEA simultaneously—as is done in this report—is that, despite conceptual similarities of the two methodologies, details sometimes differ for technical rea-

sons. The classification of costs and benefits/effectiveness is one example. It is convenient to look on “costs” as those resources which one must give up in order to **gain some benefit or desired effect. Conversely, benefits are those resources which are gained from the expenditure of other resources** used to produce them. These definitions hold for the “costs” of buying or implementing the technology being assessed and for the health “benefits” attributable to the technology. But what about the medical cost savings which may result? Are they benefits, or are they negative costs (i. e., to be subtracted from the technology’s cost)? The answer is either. In CBA, costs are generally considered to be only those costs directly associated with the technology being assessed (which includes the expenditure of “indirect” costs such as time and lost productivity). All changes in resources resulting

from those costs, including medical cost savings, are considered to be benefits, some of which are positive, some are negative. In CEA, on the other hand, generally all net medical/health resource changes are compared with all net health status changes (516), which requires that medical cost savings be treated as negative costs, rather than as benefits. In this report, for the convenience of exposition, medical cost reductions will be considered under the discussion of benefits.

In the following two sections, both benefits and costs will be discussed in terms of their identification, measurement, and valuation.

## Benefits/Effectiveness

### Identification

**One primary advantage** of a CEA/CBA is the requirement that all relevant aspects of the use of technology be considered explicitly. With respect to the identification of benefits, this implies that the analyst may look beyond the obvious, beyond that which is intended, sometimes so far beyond that the effects are several orders or generations away. The analyst should look for effects through not only his/her own eyes, but perhaps also from the perspectives of society, private individuals, and private institutions as well. That which one person perceives as a benefit or cost may be perceived by another in an entirely different light. Consider elective hysterectomy, for example. The patient weighs as costs the financial costs plus the psychological/physical trauma against the benefits of preventing pregnancy, uterine cancer, or both; whereas the health insurer may weigh only the cost of the operation with expected reduction in future maternity or gynecological care costs (see reference 304).

The effects of technology in the health field can be far reaching and varied; they can also be obvious as well as obscure. They often follow directly from the problem under consideration, the objectives specified, and the framework in which the problem is approached. Not all benefits or effects are positive—some may be negative (e. g., deaths due to surgery) and some may be indeterminant (e.g., incurable disease maybe

discovered). Regardless, all effects should be identified and enumerated. To identify all benefits/effectiveness, each of the following categories should be considered: 1) personal benefits/effectiveness, 2) health resource benefits/effectiveness, 3) other economic benefits/effectiveness, and 4) social benefits/effectiveness.

**Personal benefits/effectiveness.—The primary purpose of health care technology is to enhance the health and well being of individuals;** consequently, the expected benefits/effectiveness should be examined in light of individuals' personal health objectives such as lowered anxiety, alleviated pain, reduced risk of sickness or death, enhanced quality of life, and so forth. Seldom will the analyst come to the conclusion that an individual has seen the doctor for a checkup or given up smoking in order to save future medical bills, which is not to say that medical expenses are unimportant. However, CEA/CBAs frequently attach great significance to medical cost reduction, while often ignoring patients' personal motives (see reference 304).

**Health resource benefits/effectiveness.—A direct result of the use of health care technology is the change in use of other health care resources.** For instance, preventive programs are often advocated because they are thought to enhance health and thus decrease future medical expenses. However, procedures such as screening may discover disease to such an extent that direct medical costs are, in the short run, actually increased. This phenomenon is likely to be observed when asymptomatic individuals are screened for socially latent problems such as venereal disease, mental illness, and drug abuse and for chronic conditions such as hypertension. Regardless of whether future medical costs are decreased or increased in the aggregate, shifts in medical resources will almost certainly occur and these shifts should be identified.

**Other economic benefits/effectiveness.—Secondary effects resulting from changes** in health status are often strictly economic: Healthy people are more productive than are sick people. These effects should also be identified. From certain points of view, such as the family's, society's, or the firms', they may be very important, whereas from the health insurer's point of view,

they may be **totally irrelevant. Consequently, an efficiency study performed by a health care provider for an insurance firm may ignore** such economic considerations; a socially oriented CBA/CEA should not.

**Social benefits/effectiveness.—Finally, society has collective objectives which stem from its underlying values and traditions—objectives which are not strictly economic and not directly related to health status.** These objectives may be concerned with the equitable distribution of medical care—ensuring that the poor have adequate access to health services—or with protecting the rights of the unborn, the mentally ill, or the comatose patient. Also, health and medical care resources may be employed to compensate certain of the Nation's citizens for the lack of adequate housing, nutrition, employment, or parental care. All of these effects, intended or not, should be explicitly identified.

The special case of intermediate outcomes.—Notwithstanding the ultimate goal of improving health and welfare, many technologies, particularly diagnostic ones, can best be evaluated only in terms of intermediate outcomes such as blood counts per minute, clarity of X-ray film, or number of pounds lost per week. This methodological limitation is an especially disturbing one, since diagnostic information often leads to increased use of other diagnostic and therapeutic resources, resulting in higher expenditures (569). There are, however, certain benefits from diagnostic technologies which can easily be overlooked: Such technologies often provide for patient reassurance; they may avoid therapeutic interventions; and they may assist in furthering medical knowledge. Health promotion programs also are often difficult to assess in terms of improved health status, resulting in the necessity of measuring intermediate outcomes. Examples are weight control and antismoking programs.

Therefore, when final outcomes resulting from a health care process cannot be adequately identified, intermediate outcomes should be identified and the uncertainty of the link with final health status ought to be noted.

## Measurement

Benefits/effectiveness initially should be counted in whatever units are most appropriate: Medical cost savings/expenditures are counted in dollars; reduced disability in days (or weeks, months, years); reduced mortality in years; changes in health status in well-years. Likewise, intermediate outcomes are counted as number of blood tests taken, number of persons examined, and so forth.

Some benefits/effectiveness are difficult to measure because they may be only partially, known, or not known at all. As was discussed in the section regarding the production of health, the efficacy and/or effectiveness of many interventions has not been demonstrated, and in those cases where it has, the technique seldom is efficacious and/or effective 100 percent of the time. In an earlier report (405), OTA found little evidence that health care technologies have been adequately and systematically evaluated. Without valid efficacy/effectiveness and safety information, the value of CBA/CEAs may be greatly diminished. Furthermore, even when there is good evaluative research on the technology in question, the information may not be directly applicable to the setting in which the technology will be used. Much of the good research is done under nearly ideal conditions such as in a controlled or partially controlled environment with the best data by the best researchers and clinicians; since applications of the technology will not normally have the benefit of such conditions, the projected "benefits" may be significantly overestimated. In any case, probability theory and sensitivity analysis can be used to embrace the concept of uncertainty, a subject which is explored more thoroughly in another section below.

Unfortunately, the intangible benefits/effectiveness are difficult to measure, although they are often the more important ones. The personal and societal benefits/effectiveness listed above, such as relief from anxiety and pain, for example, can often be estimated only by indirect methods such as patient satisfaction questionnaires, or by techniques which simulate an indi-

vidual's willingness to pay for the result. In the main, however, intangible benefits/effectiveness cannot be adequately measured—and consequently must remain only "identified." This should not eliminate the desirability of the analyst's including a statement of their probable importance.

### Valuation

Valuing benefits/effectiveness is the next step of the process. Basically, the objective at this stage is to determine their worth. Sometimes the value is self-evident, such as when the benefit is money saved. Since the techniques of CBA and CEA are designed to compare cost with benefit or effectiveness, the analysis is much easier when both sides are measured in money—for instance, spending \$100 in order to save \$350 is easily understood. Many of the applications of health care CEA/CBAs concern benefits/effectiveness which are not easily translated into money, however, and there is disagreement concerning their worth. Some health care technologies save lives, limbs, days of disability, and discomfort; other technologies produce information (e. g., X-rays and laboratory procedures). What are these benefits/effectiveness worth? The answers seldom are obvious.

Valuation of benefits is further complicated by the problems of risk-averseness associated with individual preferences. For instance, McNeil, et al. (736) demonstrated that patients preferred radiation treatment over surgery for lung cancer even though surgery provided the better chances for survival. The explanation given was that the surgery itself carried with it a risk of immediate death, and, consequently, patients preferred the assurance of a certain, but perhaps shorter, life to facing the risk of immediate death. In addition, patients were willing to trade off a perceived increased quality of life with longevity. Valuing such individual preference is difficult and, even more important, recognizing that they even exist is easily overlooked. (For a more thorough discussion of risk preference and risk behavior, see reference 755.)

The attempt to value benefits/effectiveness often poses serious problems, perhaps even more extreme than the problems their measure-

ment poses. In those cases where measurement is deemed impossible, impractical, or unreliable, attempts to value may not only provide no further useful information, but may actually mislead the reader by implying that the results are more valid than they actually are. An example of this may be the value of bereavement support in a hospice program. This benefit can certainly be identified, but it is not easily measured. Attempting to place a dollar value on it would probably be misleading.

Much of the controversy surrounding the valuation of health outcomes centers around the value of life, an issue which is directly pertinent only to CBA, since CBA alone expresses all costs and benefits in dollars. The oldest and most common method of valuing life is the so-called "human capital" approach, which values life in terms of earnings potential. The value is computed by summing the earnings lost due to premature death or to disability; conversely, it is done by summing the expected future earnings saved by postponing death or avoiding disability. All future moneys are discounted to a present value at some specified rate. (Discounting is discussed in another section below.)

One of the first problems encountered by human capital theorists was the problem of consumption: If, conceptually, life is valued in terms of its financial return to society, should not the individual's own consumption be excluded from the benefit calculation? However, this solution would require valuing life at zero for those who consume all they earn, and valuing life negatively for those who deficit spend. Regardless of whether earnings are considered net of consumption, though, the human capital method is really valuing livelihood—i.e., one's earning potential—not life.

The human capital approach also poses distasteful problems such as valuing men more highly than women, since males have traditionally earned more than females. Likewise, the working population is valued more than the very young or the very old, and whites more than nonwhites. In addition, this method fails to value other effects such as the psychic costs of death to friends and relatives.

Although the human capital approach has enjoyed wide application (owing principally to the absence of a better method), few people are satisfied that the value of life can truly be captured solely by estimating earnings potential. This has led to interest in other methodologies.

A conceptually more appealing approach is the “willingness-to-pay” technique (e.g., 470). The idea is to attempt to capture the value, to an individual, of reducing the risk of death or disability by small amounts, and using the information to imply the value of life itself. This method has its own conceptual problem in that the imputed values are still income related: A rich person will be willing and able to pay more to reduce the risk of death than will a poor person. Also, there is a question as to whether an individual can understand what a small reduction in statistical probability of death means. Nevertheless, the willingness-to-pay approach is the only technique that attempts to estimate individual perceptions as to one’s own worth, which, presumably, includes such diverse notions as personal values, risk averseness, family obligations, age, income, personal desires, and even a philosophical outlook on life. Despite its conceptual appeal, however, there is no indication that such a method can arrive at a consistent value for all human life. It also ignores the value of one’s life to others in society.

Other methods of valuing life have attempted to make use of imputed values from life insurance holdings and from jury verdicts. The former suffers from the same conceptual problem as the human capital method since “earnings” not “life” is insured; the latter suffers from gross inconsistencies (291). Neither method has found much acceptance.

Notwithstanding the unending criticism of the techniques to value life, the concept is an important one. Klarman writes (291):

As Mishan observes, a rough measure of a precise concept is superior to a precise measure of an erroneous concept. It is agreed that the notion of the value of human life, apart from livelihood, is sound. And a numerical estimate of this value would be useful in comparing how worthwhile alternative programs are. Comparisons of programs would gain in relevance and

aptness if all benefits were counted, including saving of human life or gains in life expectancy. This potential gain is much more likely to be realized if all benefits are entered into the model, rather than having some appear only in footnotes.

CEA attempts to avoid this valuation controversy by simply counting the lives or years of life saved (or lost) and not transforming the numbers into money. Once money is allocated to save lives, however, the value of life is implied—an important point which is easily overlooked. Notice that in CBA, the analyst must choose a value to complete the analysis; in CEA, the policy maker chooses the value, albeit indirectly. For instance, when analysts assess competing life-saving programs using CBA, they must choose a specific value (or range of values) for life. The most attractive program, in terms of the analysis, is that which computes to have the highest net benefit; if benefits exceed costs, adoption of the program would ordinarily be recommended. Analysts using CEA, however, compute the cost per life or year of life saved. Although the most attractive alternative is that which provides the most effectiveness for a given cost, the decision to adopt the “best” program depends on the implied value which the policymaker places on life, or on health status change. For instance, of several life-saving programs, the most attractive may cost \$100,000 per life saved. The decision to adopt that program depends on whether the policymaker thinks that \$100,000 per life saved is reasonable.

A common misconception regarding the two techniques is that CEA avoids value judgments. In fact, many value judgments are made, albeit often implicitly. These include judgments such as the equating of different lives—is a young life worth the same as an old one? Judgments such as the equating of years of life—is 1 year of life for 15 people equal to 15 years for 1 person? Judgments such as equating all days of disability—is the day lost due to the common cold equal to that lost due to surgery? Clearly, CEA is not value neutral.

Time-related distortions.—Since many benefits/effectiveness of health care technologies oc-

cur during widely varying intervals of time, analysts must somehow place them in perspective in order to allow comparisons to be made. That is, they must be able to compare the value of reducing \$1 of medical cost today with reducing it next year, with saving a life today with saving it next year, and so forth. The accepted practice is to transform each future effect to a present value by means of a discount rate, which is similar to an interest rate. Discounting has long been used for the valuation of financial resources, but in the health care field it has only recently been applied to the valuation of non-financial resources (78,79,406,572). (A more complete discussion on discounting is presented in a separate section below.)

**Valuing multiattributed outcomes.**—As noted previously, many individual processes in health and medical care produce widely divergent outcomes, ranging from diagnostic information to the relief of pain to the prolongation of life. Not only is each of these outcomes difficult to measure (if, indeed, the outcomes are ever identified) and to value in its own right, but the various outcomes are also difficult to compare with one another. For instance, how much pain is worth a life? That would be a difficult question even if pain could be accurately measured. Nevertheless, conceptually, the issue of comparing outcomes is important, and recently, considerable progress has been made in weighting outcomes so that health status changes can be combined. In a recent report, for instance, OTA used the concept of quality-adjusted life years to evaluate the cost effectiveness of pneumococcal vaccine (406). This technique attempts to weight differences in health status in relation to good health. Thus, a day of good health is assigned the value of "1," a day of death the value of "0," and days of sickness, depression, or disability values somewhere between these extremes. For instance, total disability may be assigned a value of 0.1, while a slight disruption of daily life due to the common cold may be assigned a value of 0.9.

**Valuing intermediate outcomes.**—Above it was suggested that in certain cases, often when evaluating preventive or diagnostic technologies, intermediate outcomes may be valid ob-

jectives, but their measurement begs their worth. What is the value of an X-ray? A blood test? Or a physical examination? Often, no value can be assigned to these outcomes. When this is the case, it is incumbent on the analyst to note that it is and to state the extent to which the technology is associated with final outcomes as well as their probable importance to the study's result.

## costs

### Identification

In this report, the term "costs" refers to the resources expended to produce an intended benefit or effectiveness. For instance, the costs of a screening program would include the amount of services provided (personnel time, supplies, capital expenditures), as well as the patients' time which is forgone in the use of the service. Care should be taken to identify all resources which are expended or which must be expended. In general, the concept of "opportunity cost" is the true cost of a program. That is, the cost is equal to the value of the opportunities which are lost as a result of the investment in the program. Initially, costs should be identified in terms of the actual resources used in the production process—person hours, supplies, and so forth. In structuring the analysis, it is helpful to consider costs as a broader concept than simply financial resources.

Identifying the proper financial costs is always easier conceptually than it is in actuality. In the health care field, this task is even more difficult because charges often do not reflect true costs, a fact which is sometimes due to unsophisticated accounting procedures and other times due to the deliberate subsidization of one service by another. Hospitals, for instance, are known to operate some services, such as maternity wards, at a loss while operating certain ancillary departments, such as diagnostic laboratories, at a profit. The same was found true for neonatal intensive care (see reference 71).

Also, since many resources in the health field are often erroneously thought to be "free," some costs may be understated. A good example is

the cost of volunteer time, where, under the opportunity cost concept, volunteer time is worth that which is forgone by its use. For example, rather than working in a hospital ward, the volunteer may have worked for the heart association. Or the service rendered by a volunteer may ordinarily be one which the organization must otherwise buy.

In other instances, owing to market imperfections, inappropriate use of resources may be used which can lead to the overstating of costs. Physicians giving immunizations, registered nurses making beds, and dentists cleaning teeth are examples.

Next, the identification of the technological resource costs will depend on the stage of the technology's development. For a new technology, costs may be difficult to identify, but should include the R&D costs as well as the capital costs associated with purchasing and operating the equipment. For an established technological process, where the analysis concerns the level of use, marginal operating costs can dominate. One potential problem of using past performance to project future costs is that costs may change as a result of increased efficiency, technological change, or changes in scale.

Other reasons why costs are difficult to identify are: 1) some costs, such as overhead, are common to many products; 2) some technologies produce multiple outcomes—if the CEA/CBA study concerns only one, the analyst must somehow determine which costs must be included, which are to be ignored, or how they are to be shared; and 3) often, during the production process other tasks are or can be performed at minimal incremental cost.

### Measurement

Initially, measurement should consist of counting the minimum resources or units of

service required to produce the intended benefit or effectiveness. Generally, this step in the evaluation will follow naturally from the identification process. In cases where substitution of resources is possible, however, care must be taken to count the generic service required. Thus, the number of hours of immunizations, of making beds, and of cleaning teeth should be counted, not the number of physician, nurse, or dentist hours required to accomplish the respective tasks. The same argument can be used for measuring volunteer time.

Measuring costs when joint production factors must be considered is extremely difficult, often not very reliable, but may be critical to the validity of the analysis. Ignoring joint production effectiveness simply because it is hard to measure can lead to a considerable overstatement of costs.

### Valuation

Most analysts believe that valuation of costs poses substantially fewer problems than valuation of benefits, because many cost resources have a real or easily imputed market value. In cases where costs reflect opportunity costs and where they are measured in dollars, valuation is essentially complete, except when the costs occur during different periods of time, in which case discounting is required. When costs are measured in generic terms, such as type and amount of services provided, valuation can be relatively difficult and sometimes controversial. This is because the professions in the health field often successfully restrict others from performing tasks, which could otherwise be safely performed at a more economical level (749). Nevertheless, the analyst should critically evaluate the resources required to accomplish the job, taking note of political, legal, or technical constraints to providing the service at the most efficient level possible.

## VALUING BENEFITS AND COSTS OVER TIME: DISCOUNTING

Costs and benefits seldom occur at the same point in time. But in order for valid comparisons to be made, they can be treated as if they all occurred in the present, through the application of a method termed discounting.

The rationale for discounting future costs and benefits stems from the fact that resources can be productively invested for future gains, as well as from the observation that people expect to be rewarded for postponing gratification. For instance, in order to induce individuals to save, interest must be paid, even in the absence of inflation. The rate of interest determines the future value of the amount invested. Thus, \$100 invested at 5-percent interest will become \$105 in 1 year. Discounting is the reverse process: \$105 next year has a "present value" of \$100 when the discount rate is 5 percent.

Thus, just as an amount,  $p$ , invested at interest,  $i$ , has a future value of:

$$\begin{aligned} & p(1+i) \text{ in year 1} \\ & p(1+i)^2 \text{ in year 2} \end{aligned}$$

and

$$p(1+i)^n \text{ in year } n$$

an amount of money,  $p$ ,  $n$  years in the future at discount rate,  $i$ , has a present value of:

$$\frac{p}{(1+i)^n}$$

Likewise, a stream of future benefits or costs is the sum of each amount, discounted at rate,  $i$ , from whichever year the benefit/cost is incurred.

There is general agreement among economists and policy makers that discounting future monies is conceptually correct. However, there is no consensus as to the rate which should be used and there is still some confusion as to the proper

method of valuing future nonmonetary benefits/effectiveness. Fortunately, when benefits/effectiveness occur over a long time, almost any discount rate used makes them less and less important to the outcome of the analysis in a fairly short period of time (480). This phenomenon results in making the rate used and the uncertainty of future events less important than they otherwise would be.

### Setting the Discount Rate

The particular rate chosen can have a substantial impact on the outcome of the analysis, since investment in health programs often means spending present moneys, which are not discounted, for future benefits, which are. In such programs, the higher the discount rate, the less attractive the program appears. As an example, suppose we spend \$1,000 today, expecting to save \$2,000 in medical costs 10 years later. In order to compare the expected benefit (\$2,000 **savings**) with the costs of the program (\$1,000), we must discount the benefit to its estimated "present value." Consider the varied results using different discount rates:

cost ..... .. \$1,000 (present dollars)  
Benefit ..... .. \$2,000 (in year 10)

Discount rate (%)	Present value of benefit	Present value of net benefit (B - C)
0	\$2,000	\$1,000
5	1,228	228
7	1,017	17
10	771	- 228

And, if the benefit were not realized for 20 years, the results would be:

Discount rate (%)	Present value of benefit	Present value of net benefit (B - C)
0	\$2,000	\$1,000
5	754	- 246
7	517	- 483
10	297	- 709

Many programs in the health field have even longer benefit time horizons. Thirty years is not uncommon, especially for prevention or health promotion programs such as antismoking clinics and pap testing. Thus, we see the power of discounting and the resultant importance of the choice of rate.

Most economists believe that the correct rate is the opportunity cost of capital in the private sector, subject to certain adjustments (e. g., the adverse effect of pollution produced by private sector investments). That is, society could opt to invest the money in the private sector and earn “benefits” at a substantial rate (perhaps as high as 15 percent) which represents the opportunity that is lost by investing in the health program.

An alternative argument, also persuasive, is that the discount rate for social programs is considerably lower than the opportunity cost of capital since society’s objectives include the equitable distribution of benefits to future generations. Klarman (291) refers to this argument as reflecting society’s “social rate of time preference. ” Referring to the numerical examples in the text above, the reader will note that low discount rates result in future benefits’ appearing more attractive. That is, society would more readily invest money in the present to reap future health benefits if a low rate were used (706). In any case, whether the correct rate is the private cost of capital or a lower social rate, agreement would still not be reached on the precise number because of the fact that interest rates vary not only across time but also across investment opportunities in any single point in time. In the absence of agreement, the accepted method to treat this uncertainty is to present the results testing several rates—a technique generally referred to as sensitivity analysis. (Sensitivity analysis is discussed in a separate section below. )

### **Valuing Nonmonetary Benefits/Effectiveness Over Time**

How does one compare the value of a life or a day of disability which is saved in the future,

with the same benefit which is saved in the present? In CBA, all such benefits are transformed into monetary terms, a controversial process discussed earlier, and then discounted the same as any other future financial asset. In CEA, however, benefits are expressed in nonmonetary terms such as lives or years of life saved. Should these be discounted as well? Weinstein and Stason (575) presented a persuasive argument in the affirmative. One way to explain the need for discounting future nonmonetary benefits is to assume no discounting, and for the sake of clarity, to assume no inflation. Consider a life-saving program which costs \$1,000 and saves, immediately, 10 years of life (i. e., \$100 is spent per year of life saved). Assume also a linear relationship between costs and benefits, If that \$1,000 were invested at 5-percent interest instead of being spent on the life-saving program, in 1 year we would have \$1,050 which could be used to save approximately 10½ years of life; in 2 years there would be \$1,102 which could be used to save over 11 years of life; and so forth. Therefore, unless a year of life is valued more highly in the present than in the future, the rational decision will always be to put off spending the money for an additional year. Discounting all benefits/effectiveness to present values avoids this irrational incentive.

In conclusion, then, although the discounting of future benefits/effectiveness and costs is conceptually correct, there is not, nor is there soon likely to be, consensus regarding the rate for two general reasons. The first is technical in nature: Interest rates vary across both time and investment opportunities. The second is conceptual: The discount rate can reflect the private opportunity cost of capital, or a lower social rate of time preference. The results of CEA/CBAs should be presented using several discount rate estimates in order to examine the influence of the rate on the results—again, a technique referred to as sensitivity analysis, discussed immediately below.

## ADDRESSING PROBLEMS OF UNCERTAINTY: SENSITIVITY ANALYSIS

Discussions in the preceding sections have noted the uncertainty of knowledge regarding the etiology of disease and regarding diagnostic and curative techniques. Superimposed on these variables are changing personal habits, interactive environmental conditions and often unforeseeable future technological developments. In addition, there is lack of agreement as to the magnitude of health status changes and the value of the discount rate. How can we have confidence in predicting results in the face of all this uncertainty?

One possible answer is to place the results obtained from analysis in perspective, to examine closely the assumptions upon which the analysis rests, and to test the sensitivity of the results to reasonable changes in these assumptions.

Uncertainty can be classified into that which is due to random events and that which is due to ignorance. Unfortunately, many events in the health field suffer from both types. The first, random type, refers to events which occur according to a probability distribution. In general, these are events associated with large numbers. An example is the number of heart attacks occurring in a large population at any given time. This event is thought to be random and is statistically predictable. It is different from the chance of a heart attack occurring to an individual, which is dependent on nonrandom variables such as a person's living habits and genetic heritage. In some instances, events in the health field are thought to be random, but their probability distribution is not known, which makes prediction more difficult.

The second, and more troublesome, type of uncertainty is due to ignorance. Sometimes the problem is simply lack of information—we do not know what causes cancer, or what triggers certain allergic reactions—in which case we have the option of buying more information, either through more research, more time, or both. In other instances, the uncertainty is due

to future events over which we have no control—women may smoke more, or there may not be an influenza epidemic this year—in which case the best we may be able to do is to examine trends or use expert opinion.

When evaluating a health care technology or program in the face of the unknown, the analyst has a rather impressive sounding arsenal of techniques. For random events, probability theory can be used, often through the application of decision analysis, which is a diagramming of the possible courses of action, each branch accompanied by a known or imputed probability. When probabilities are not known, expert judgment can be substituted. Thus, without knowing the cause or even the dynamics of a given random process, the analyst can attempt to predict the likelihood of an outcome. But there are other techniques from the field of operations research such as Monte Carlo and Markov Chain methods which allow manipulation of a simulated process until the outcome mirrors empirical findings such as incidence rates of a disease (see reference 335). These analytical methods can provide valuable insight as to what process may be occurring. They may also provide a false sense of security to a policy maker, since the terminology and the technical sophistication which is required often mask the tenuous assumptions on which the methodologies rest.

Sensitivity analysis is the examination of an uncertain event under different assumptions. Earlier we discussed discounting, concluding that the precise discount rate was unknown, and that a consensus may never be reached. Under this uncertainty, one logical course for the analyst is to test the sensitivity of the results to several discount rates. For instance, one can test a low, high, and middle value—an approach which is most helpful when there is a wide range of reasonable estimates. Or one can incrementally change the rate about the suspected mean—an approach that is feasible when the range of

possibilities is relatively narrow. In either case, if the results of the study vary widely when the different values are used, one can have less confidence in any single set of results. Conversely, if the results change little, then the precise rate may be unimportant. In some CEA/CBAs, the decision criteria rest on the rank order of alternatives, not the absolute values involved, and the analyst need only determine whether the ranking itself is disturbed.

There are other approaches that increase the confidence one can place in analysis in the face of uncertainty (744). For instance, a technique known as “worst case analysis” can be done by assigning to the uncertain variables values that least help the program (i.e., which the analyst believes to be the preferred one). If the program still is preferred, one can have more confidence in recommending it. Another method is termed “break-even analysis,” in which assumptions are varied until some minimally acceptable result is obtained; one can then ask whether the assumptions are realistic. For example, a CBA requires a value to be placed on life, yet there is no generally accepted value. The value can be varied upward, starting from zero, however, until the analysis indicates that the program is acceptable; then the value for life can be examined. Perhaps it is so low (say \$1,000) that all would agree that life was worth at least that amount. In such a case, analysis can proceed

more confidently in the face of the extreme uncertainty of this critical variable. In other instances, the analysis will not indicate adoption of the program unless a very high value is placed on life. Here, the preferred course of action may not be so apparent. Techniques such as worst case and break-even analyses are often more helpful in identifying exceptionally good programs than in ruling out bad ones. Nevertheless, these and other similar techniques can be helpful in reducing uncertainty.

To summarize, sensitivity analysis can produce three important results:

1. It can demonstrate the substantial dependence of a conclusion on a particular assumption.
2. It can demonstrate that an assumption does not significantly affect a study's conclusion, and hence that the tenuousness of the assumption is not a source of concern.
3. It can establish a minimum or maximum value which a variable must have for a program to appear economically worthwhile.

Finally, uncertainty can often be reduced; it should never be ignored. Results of a CEA/CBA should be accompanied by statements regarding the confidence which the reader can place in them. A sensitivity analysis is most helpful in this regard.

## EXAMINING ETHICAL ISSUES

Ethical issues permeate both the process and the use of CEA/CBAs in health care. Some of these issues have already been touched on (e.g., valuing life), others have only been hinted at (e.g., using uncertain information). In general, there are powerful ethical arguments both for and against using CEA/CBA-type studies to help make decisions. The arguments for using CEA/CBA center around the concept that “some information is preferable to no information,” whereas the arguments against tend to be based on the actual or potential misuse of the technique. Here, we will present a brief discussion of the ethical issues involved. Readers who

are interested in a more detailed discussion of this topic are referred to appendix D of the main report of this OTA assessment. That appendix —“Values, Ethics, and CBA in Health Care”—was prepared for OTA by the Hastings Center.

Some of the ethical arguments against using CEA/CBA stem from the fact that the delivery of health care itself has strong ethical overtones. For instance, many public policies are directed at eliminating or reducing financial and social barriers to health care. Because CEA/CBA is looked on by some as a rationing mechanism

based on costs, there is bound to be resistance to its use.

From a methodological standpoint, the ethical arguments against using CEA/CBA concern the difficulty in valuing that which is often most important: life, pain, happiness. They also concern the misuse of information. There is the fear that quantified variables will take on undue significance, and that assumptions will be treated as if they were fact. These arguments are particularly compelling since both the analyst and the decisionmaker may be responsible for such problems. For instance, this assessment finds that the process of CEA/CBA is subject to systematic methodological bias, whereby a given analysis can be “legitimately” performed in a variety of ways, each of which may affect the interpretation of the results. In addition, the policy maker may ignore the traditional caveats that are often, but not always, provided by the analyst.

There are also many other inherent problems that have ethical overtones, such as: 1) the value of a benefit may vary across individuals, or may

be perceived to be different between the individual, society, or the relevant program (e. g., third-party payer), 2) the value of the benefit may differ between generations, 3) the value of quality of life is difficult to assess in comparison with other effects such as increased longevity, thus making tradeoffs difficult to analyze.

The counterarguments—by those in favor of using CEA/CBA—acknowledge the ethical problems, but say that if used in the proper perspective such analyses can help by making explicit the assumptions on which decisions are based. The Hastings paper (app. D of the main report) concludes: “We are persuaded that, in an important sense, the defenders of cost-benefit analysis are correct when they argue that policy decisions in the health field are being made daily on shaky grounds anyway, and that cost-benefit analysis is at least an attempt—however imperfect—to ground those decisions in real needs and real possibilities. The problem is not that cost-benefit analysis is not objective and not value-free, but rather that objectivity and value-freedom are unjustifiably attributed to it.”

## PRESENTING AND INTERPRETING FINDINGS

We have mentioned the limitations to which most CEA/CBA studies are subject: the uncertainty of many key variables; the difficulty of identification and measurement of benefits and costs; the inability to value and incorporate many effects, such as ethical ones.

Implied throughout this chapter is the technical complexity of many studies. This type of study can lead to misinterpretation of results since: 1) the intended audience is often public officials or health care professionals, who may not be technically oriented, and 2) study findings are often reported in capsule form such as a news brief and are often introduced in the professional literature in abstract form. Consequently, the writers and analysts must be particularly careful in the way they present the results and interpret them for the reader. The presentation of the findings should identify the

important variables and should discuss the confidence that the reader can place in the values that were used. A review of the findings and the significance of the sensitivity analysis, if used, is ordinarily necessary to place the results of the study in proper perspective.

There are also certain technical considerations that can significantly alter the way in which a study is interpreted. The first is the use of net benefit (that is, benefit minus cost), rather than the cost-benefit ratio as a criterion to compare programs. The former (net benefit) approach is usually preferred, especially when the alternative programs are widely variant in scope. As an illustration, consider two programs:

Program A costs \$2,000 and reaps gross benefits of \$4,000; program B costs \$2 million and

reaps gross benefits of \$3 million. A net benefit approach yields the following results:

<i>Program A</i>	<i>Program B</i>
\$4,000 – \$2,000 = \$2,000	\$3 million – \$2 million = \$1 million

Clearly, program B is preferred, given the ability to finance the project and setting aside for the example all considerations of equity and distributional effects.

However, a benefit-cost ratio (B/C) would yield the following results:

<i>Program A</i>	<i>Program B</i>
\$4,000	\$3 million
\$2,000	\$2 million
	= 1.5

Now, program A is clearly preferred. Notice that the ratio gives the reader no indication of the size of the expected benefits, nor the size of the program. Also, although program A gives a better rate of return for the money invested, there is no reason to believe that it can be increased in scale and still maintain the high rate of return.

The B/C ratio is also sensitive to whether an effect of a health program is considered as a benefit or as a negative cost. In the discussion of costs and benefits, it was pointed out that medical cost savings, resulting from an investment in disease prevention/health promotion, are treated as negative costs in a CEA (i.e., the “savings” are subtracted from the costs) and as benefits in a CBA. This distinction is technically important only when a cost-benefit ratio is employed; when costs and benefits are netted, it makes no difference whether a particular item is considered a benefit or a negative cost.

The interpretation of an analysis can also be distorted as a result of problems of scale. For example, if it is impossible to compare equal cost or equal effectiveness alternatives in a CEA, cost-effectiveness ratios can be misleading. Consider the following hypothetical case presented in tabular form:

	<i>Lives saved</i>	
<i>cost</i>	<i>Program A</i>	<i>Program B</i>
\$100,000	10	—
\$200,000	—	15
C/E	\$10,000 per life saved	\$13,333.33 per life saved

According to the strict ratio rule, program A is preferred; it costs less per life saved. But if there is no possibility of replicating program A (i. e., saving another 10 lives for an additional expenditure of \$100,000), might we not prefer program B? For \$100,000 more than the cost of program A, it saves an additional five lives. Is that not a worthwhile expenditure? It is at this point that the question becomes largely a social or political one. CEA has contributed information which may inform and assist social decision-makers, but it has not produced an economically preferable conclusion. However, the CEA technique is usually used to compare alternative means to achieve some objective. In this case, the decision to invest has already been made, and the analysis is used to choose the most efficient method. Thus, if the decision has been made to reduce deaths due to heart disease, the cost per life saved may be compared between blood pressure screening programs, inpatient coronary care units, mobile coronary care units, and cardiopulmonary resuscitation classes for the general public. Alternatively, when operating under a budget constraint, the number of lives saved per dollar amount available is compared between programs.

A related point is that an analysis for an existing technology should be performed at the margin. That is, the additional cost of using one more unit should be compared to the additional benefit derived. In some instances, the additional cost is so small that one additional unit will be extremely cost effective even if the expected benefits are small. In other instances, the additional cost may not be large but the added benefit is infinitesimal. Neither of these subtle, but valuable, insights will necessarily be gained if the analysis uses only average (as opposed to marginal) costs and benefits. A marginal analysis will help to determine the optimal size of a program and the point at which a given technology is no longer cost effective (468,559).

## LINKING ANALYSIS TO POLICY IMPLEMENTATION

As noted at the outset, a CBA/CEA should consider all the relevant costs and benefits/effectiveness, regardless of to whom they may accrue or when they may occur. Also, although an analysis can take on a program or organizational perspective as well, a CEA/CBA is ordinarily performed from a societal point of view. In identifying the appropriate societal costs and benefits/effectiveness, these variables need to be viewed from perspectives other than that of society, in order to make the analysis more relevant to public policy decisions.

It is frequently noted that ours is a pluralistic society—one with many individuals and institutions making decisions that ultimately affect the allocation of society's resources. The field of health care is no different. "Society" does not make decisions; private consumers, physicians, Congress, administrators of hospitals, managers of philanthropic organizations, and officials of medicare or medicaid and of local government agencies, and other people within society do. In addition to considerations of societal efficiency, their decisions depend on such diverse notions as reimbursement guidelines, community interests, the attracting of professional staff, intangible humanitarian objectives, pride, financial solvency, and sometimes institutional survival (335,336).

Also, because of the manner in which health care in the United States is organized and financed, there is ample reason to believe that the objectives of key private individuals and institutions have an entirely different focus than the objectives of society. For instance, in health promotion/disease prevention programs, costs

are often incurred by a private party in the present, whereas benefits usually accrue in the distant future—and they accrue to others as well as to the party who funded the program.

On the other end of the spectrum are diagnostic and therapeutic procedures. For these, private incentives tend toward overutilization. The procedures are often paid for by insurance on a fee-for-service basis; hence, increased utilization tends to be financially rewarding to the provider without being costly to the patient. This situation has given added emphasis to nonmarket controls such as the certificate-of-need process that health systems agencies require of an institution for major capital investments. Likewise, the current interest in a hospital, or systemwide, revenue cap perhaps stems in part from the lack of financial incentives toward cost-decreasing technologies (758).

All these reasons, then, lead to questioning of the applicability of traditional, societally oriented CEA/CBAs. The problem is similar to that of a mass screening program when there has been made no provision for treating discovered disease. In both cases, the information produced is very important, but is useless unless a system is in place to use it. Just as the answer in the case of the screening program is not to discard the screening, the answer in the case of CEA/CBA may not be to discard the technique. The answer in part is to make the analysis more relevant—by attempting to identify the private objectives, and by noting when they conflict with and when they support society's objectives. If this is done well, decisions may better reflect reality.