Cost-Effectiveness in Health and Medicine

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Cost-Effectiveness Analysis as a Guide to Resource Allocation in Health: Roles and Limitations

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Cost-effectiveness analysis (CEA) is a method used to evaluate the outcomes and costs of interventions designed to improve health. It has been used to compare costs and years of life gained for such interventions as screening for breast cancer (Eddy, 1989), bypass surgery for coronary artery disease (Weinstein and Stason, 1982), and vaccination against pneumococcal pneumonia (Willems et al., 1980). The results of an analysis are usually summarized in a series of cost-effectiveness ratios that show the cost of achieving one unit of health outcome—for example, the cost per year of life gained—for different kinds of patients and variations of the intervention (Table 1.1).

By providing estimates of outcomes and costs, CEA shows the tradeoffs involved in choosing among interventions or variants of an intervention. Put another way, it helps define and illuminate the "opportunity cost" of each choice: the health benefits lost because the next-best alternative was not selected. It thus gives decision makers in diverse settings—physicians' offices, health maintenance organizations (HMOs), or state or federal programs—important data for making informed judgments about interventions.

When the same measure of health outcome, such as years of life gained or cases of a particular disease prevented, is used for all interventions, they can be ranked on the basis of their cost-effectiveness ratios. Those with the lowest cost per year or per case are the most efficient ways of improving health; the ratios show which interventions produce the most years of life, or prevent the most cases of disease, for a given expen-

Table 1.1 Cost-Effectiveness Analysis: An Example

Cost-effectiveness analysis (CEA) involves estimating the net, or incremental, costs and effects of an intervention—its costs and health outcomes compared with some alternative, which might be the care that would be given if the intervention were not used at all, or a different intensity of the intervention, such as less frequent screening. The cost-effectiveness ratio that compares two alternatives is calculated as the difference in costs between the alternatives (net costs) divided by the difference in health outcomes (net effectiveness).

A study of screening for cervical cancer illustrates the main features of CEA. The study compared outcomes and costs associated with different schedules of screening (Eddy, 1990). We return to consider this analysis in greater detail later in the chapter.

The measure of health outcomes is years of life gained (increase in life expectancy). The estimates were developed from a model of the natural history of cervical cancer and the screening process based primarily on data from a study of 1.5 million women screened over many years in eight countries (IARC, 1986). The estimates took into account the accuracy of the test, the fact that not all cervical dysplasia progresses to cancer, and the effectiveness of treatment when cervical cancer is detected at various stages.

Costs were estimated from a variety of sources, including Medicare claims files. They include the costs of regular screening with the Papanicolaou smear, follow-up physician visits for abnormal tests, and treatment for dysplasia or cancer when it occurs.

Screening starts at age 20 and ends at 75. The discount rate, used to allow comparison of screening schedules which have outcomes and costs occurring in different years, is 5%.

The table presents some of the estimated increases in life expectancy (LE) and costs, expressed in days and dollars per woman. In the first column, screening at intervals of 4 years is compared with no screening. Almost 94 days of life are gained by screening (9.54 days after discounting) at a cost of $264; thus the cost-effectiveness ratio is $10,101 ($264 divided by 9.54 days yields the cost per day of life, which is then multiplied by 365 days to get the cost per year).

The second column shows the gain in days of life and the additional cost if screening takes place more frequently, every 3 years instead of every 4. The final column compares screening every 3 years with a schedule that begins instead with three annual tests, dropping back to screening at 3-year intervals only if all three initial tests are normal.

	Screening Frequency		
	4 Years/No Screening	*3 Years/4 Years*	*3 Years After 3 Normal Annual Tests/3 Without Annual Testing*
LE increase in days	93.8	1.6	0.3
LE increase in days, discounted	9.54	0.18	0.06
Cost increase in dollars, discounted	264.00	91.00	112.00
Cost per life year	10,101.00	184,528.00	681,336.00

diture. Additional factors are almost always involved in selecting the final set of interventions, but CEA provides a useful guide to achieving a central objective, better health.

This chapter considers the uses of CEA and its limitations as an aid in the allocation of resources, broadly defined. The first section of the chapter asks which perspective is appropriate for CEA studies intended for this purpose. We conclude that the societal perspective is best, spell out some of the implications for identifying and valuing the health outcomes and costs included in an analysis, and consider the sort of information that CEAs conducted from the societal perspective can and cannot supply. Given this background, we discuss how CEA can be used as an aid to decision making. We then contrast CEA with other methods of evaluating choices in the allocation of health resources. Two examples show that CEA can suggest very different decisions from those reached by other methods. A discussion of the current and potential uses of CEA follows. We summarize our conclusions in the form of recommendations.

What Is the Appropriate Perspective?

When choices about the broad allocation of health resources are considered, who is affected? On whose behalf are decisions made? The answers to these questions define the perspective of the analysis, which, in turn, plays a crucial role in determining the relevant health outcomes and resources and how they should be measured and valued.

The broad nature of the problem suggests that the perspective should be equally broad. An analysis needs to consider not only those who gain health but those who pay for it. Relevant health outcomes include unwanted side effects, which can even occur in people who are not the intended recipients of the intervention, as well as longer life and improvements in health. Resource costs—which consist of all resources used whether or not money changes hands for those resources—would be included regardless of who incurs them.

Programs to increase the folic acid intake of pregnant women in order to reduce the incidence of neural tube defects in their infants demonstrate the value of taking a broad view. One approach to delivering folic acid is to add the nutrient to cereal grains. This approach would allow women to improve their diets with no extra effort on their part and is especially helpful for those who may not have adequate access to medical care and thus to other means of supplementation. The cost is borne by everyone who pays for products made with cereal grains. But fortification poses a risk, mostly for older people, because it masks pernicious anemia, which, undetected, can cause neurological problems. This adverse effect on the elderly should be counted as well as the gains for infants. A CEA intended to contribute to information about the broad allocation of health resources would need to evaluate all these health outcomes and costs, which would lead to consideration of the entire national population, not just pregnant women, as might appear to be the case at first.

What is described in this example is the societal perspective. When a CEA is conducted from the societal perspective, the analyst considers everyone affected by the intervention and counts all significant health outcomes and costs that flow from it, regardless of who experiences the outcomes or costs. Depending on where and how the intervention is applied, those affected could be confined to a small geographic area or subpopulation or could encompass the entire national population. The measure of health needs to be comprehensive and to include longer life, better function, and unwanted side effects. Costs include not only medical and other resources, but also the time of patients and unpaid caregivers.

By contrast, CEA done from other perspectives can reasonably omit some outcomes and costs if they are not of interest to the decision maker. For example, a CEA done for an employer might consider only outcomes and costs that affect the employer directly, such as the intervention's effect on workers' productivity or on medical bills reimbursed through the employee health plan; costs paid by employees might be excluded. Or an analysis done for a public program might consider only the health outcomes experienced by the program's beneficiaries and the costs paid by the program, not outcomes or costs experienced by others.

Implicit in the societal perspective is the recognition that societal resources are limited and that health should not be exempted from these limits. The societal perspective incorporates the value that many other social investments—in education, environmental quality, law enforcement, and the like—have merit. Thus no single activity, including health, should have such dominance that it always displaces other activities. Whether limits on health budgets are explicit or tacit, the societal perspective implies that resources devoted to health care should be invested wisely. Cost-effectiveness analysis offers a method for evaluating the choices made within these limits, attempting to account for all parties affected by the decisions.

This value—that health should be subject, at least to some degree, to the resource limits that constrain society—does not sit easily with everyone because it implies that CEA based on the societal perspective may sometimes recommend a course of action that is at odds with the wishes of individuals. Decisions about programs and coverage based in part on cost-effectiveness might mean, for example, that coverage would be denied for bypass surgery for individuals who are so old or in such poor health that the operation would add little to their life expectancies. Instead the insurer, public program, or HMO might choose to pay for exercise programs for the elderly because the resources would do more to improve health when used that way. But the individuals denied bypasses, and their doctors, might still value those benefits and want them.

What arguments can be advanced for choosing the societal perspective over others, when at times it may give less weight to the outcomes and costs of certain groups than they would like? One way to see the desirability of the societal perspective—of giving fair weight to all individuals and to all activities—is to imagine for a moment that we are looking at the world before we are born, or at least before we encounter any serious health problems, and to ask what kind of world we would like it to be. In that "ex

ante" position we would not yet know what health problems we were destined to develop—only that there was some chance that we might develop any of them. From that perspective, we would not want any health problem to be entirely neglected— after all, it might be ours some day. Nor would we want investments other than health to be neglected since we would live in the world created by that neglect.

This device—thinking about the world before we are born—has been used by many philosophers, operating from different philosphical perspectives, to argue for just ways of making decisions (Harsanyi, 1953, 1955; Rawls, 1971; Daniels, 1985, 1988; Menzel, 1992; Dworkin, 1981; Eddy, 1991). It is compatible with the common view that decisions are most likely to be fair if they are made by people who do not stand to gain or lose from them and with the related idea that decisions can be made in the public interest.

Viewing the situation from that perspective, we might reasonably prefer a system in which decisions about health interventions reflected the seriousness of the problem and the ability of the intervention to do something about it, without reference to the specific individuals with the problem or to particular budgets or special interests. In short, we would want a system that adopted the societal perspective. Some people would not get everything they want. But neither would anyone categorically be excluded.

If individual CEA studies are to serve this larger goal, they must be comparable. As noted in the Introduction, the mechanism proposed by the panel to promote comparability is a Reference Case, defined by the recommendations in this chapter and those that follow. A common perspective is the foundation for comparability. We recommend the societal perspective as the appropriate perspective for the Reference Case.

The societal perspective does not represent the situation from the viewpoint of particular agents in society, but it is the only perspective that never counts as a gain what is really someone else's loss. If an intervention adopted by an employer reduces the employer's costs for health insurance but increases costs for Medicare, the societal perspective includes both changes. Beyond the philosophical arguments in its favor, there is value in beginning with a perspective that includes all costs and effects because it provides a background against which to assess results from other perspectives. Analysts may, of course, include other perspectives in the same analysis.

Defining Outcomes and Costs from the Societal Perspective

The societal perspective has implications for which outcomes and costs should be measured and how they should be measured in a CEA. But in real-world situations the societal perspective, that is, a comprehensive viewpoint that tries to give proper weight to most or all of the significant aspects of a decision, can involve considerations than are not reflected, and in some cases cannot be, in the measures of outcome or cost used in CEAs. In this section we illustrate the problem with some examples.

In CEA done from the societal perspective, health outcomes are often represented by years of life gained. This is an important outcome for many interventions, but hardly the only one. When they work, health interventions do more than extend life: They relieve suffering, improve functioning, provide information, and convey care and compassion. Many effective interventions— acetominophen for headache, for example— have no effect on the length of life. They may also cause unintended and undesirable side effects. Ideally the measure of outcomes used in CEA should be defined more broadly to include these other outcomes.

Research conducted over the last 25 years has produced summary measures of health that reflect the quality as well as the quantity of life and increasingly CEAs have used these measures to estimate the quality-adjusted years of life (QALYs) gained from an intervention (Boyle et al., 1983; Oldridge et al., 1993; Patrick and Erickson, 1993; Spilker, 1990; Weinstein and Stason, 1976). The development of QALYs as an outcome measure has made it possible to encompass the diverse effects of a single intervention and to compare interventions with quite different kinds of outcomes, thus greatly expanding the applicability and usefulness of CEA. In Chapter 4, we discuss the use of health-related quality-of-life measures in the Reference Case and describe alternative approaches.

If these more comprehensive measures of health captured everything that mattered, then, with their use, CEA could identify the interventions that would contribute the most to societal goals. But even QALYs do not fully reflect what decision makers would like to accomplish in the public interest. To calculate the total health effect of an intervention, analysts sum all quality-adjusted life years. This simple addition implies that QALYs are of equal value no matter who gains them or when they occur during the life span. Both intuition and research suggest that this is not the case and that deviations from this assumption are substantial and important (Harris, 1987; Daniels, 1993). As a case in point, surveys of the general public (including the elderly) have revealed a strong consensus on the part of the general public, including the elderly, to the effect that the young should be favored over the old (Williams, 1988; Lewis and Charney, 1989).

The assumption that all QALYs are of equal value implies, for example, that it makes no difference whether extra years of healthy life go to people in good health or to people in poor health—perhaps people with a serious disability. Yet decision makers might give preference to those in poor health out of a sense that their need is greater. As another example, a therapy that saved the lives of a few people, allowing them to live many more years in good health, might produce the same number of quality-adjusted life years as treating mild arthritis in many people. Yet much of the general public would place a higher value on the intervention that helped fewer individuals because it made such a large difference for them. This "aggregation problem" occurs because the numerical sums are equal but we do not in fact value them equally.

These are difficult issues of equity and distributive justice that get to the core of what we care about as a society. In principle, QALYs received by different people at different

times could be weighted before they were added together to reflect the values society places on different circumstances. But societal values are not understood fully enough, or perhaps not even fully enough formed, to make it possible to define such weights (Daniels, 1993). In practice, then, we do not know what the weights should be and are not likely to solve the problem anytime soon.

Equity issues arise on the cost side of the cost-effectiveness ratio as well. The valuation of time provides an example. CEA studies frequently do not include the time of patients and unpaid caregivers among the resource costs of a medical intervention. It is difficult to measure, but the societal perspective requires that it be included whenever it is significant. The societal perspective also requires that all resources be valued at their "opportunity cost." The best approximation of the opportunity cost of time for working-age adults is the wage they are, or could be, making in paid work. Chapter 6 gives analysts a choice, recommending that time be valued either at the average wage for persons of that age and sex or at the average wage for all workers.

But wage estimates that differ depending on characteristics such as gender and race raise troubling issues of fairness. Women are paid less than men. The lower wages of women mean that, other things equal, the same intervention will appear more cost-effective for them than for men because their time is valued at a lower rate. Yet most people would probably think it unfair to provide more of the intervention to women or to provide it only to them—the health of men and women is equally valuable. Thus decision makers might choose to ignore differences in cost-effectiveness ratios that arise because of the difference in wages between men and women, or analysts might choose to substitute the wage for all workers.

Other important public values simply cannot be incorporated into CEA in any useful way. This problem arises in part because health interventions affect things other than health. For example, society's views on individuals' rights can affect the desirability of some health interventions: the right to privacy has made mandatory human immunodeficiency virus (HIV) testing unacceptable outside of special situations such as the military, even though life-lengthening treatments are available for individuals diagnosed early. Thus the measures of health outcomes used in CEAs must remain an incomplete representation of societal goals and values. Where nonhealth benefits or costs are relatively minor, CEA of health outcomes and costs may be sufficient to inform decisions. When nonhealth benefits are substantial, it may be helpful to use the method of cost-benefit analysis, or to supplement the CEA with legal, ethical, or other kinds of analyses.

CEA as an Aid to Decision Making

The textbook exposition of CEA explains that once cost-effectiveness ratios are computed from the societal perspective and placed in rank order, a decision maker can select the intervention with the lowest cost per QALY and continue down the list selecting interventions, until the available funds are exhausted. The resulting set of

interventions are those that produce the largest possible number of QALYs for the expenditure. In textbook terms, the decision maker has selected the interventions that maximize health, represented by QALYs, within the constraint set by available resources.

For the kinds of reasons discussed in the last section, decisions in the real world are more complicated. Cost-effectiveness analysis provides valuable information about tradeoffs in the broad allocation of health resources, but other factors need to be considered as well—concepts of fairness and justice that are not fully captured in the sums of QALYs or in the way costs are valued, benefits and costs outside the health sector, and practical questions of feasibility. Thus, although it is possible to use CEA in a mechanical way, it is often not appropriate to do so. CEA is not a complete decision making process. The information it provides is, however, crucial to good decisions.

CEA can serve much the same function as the tables in an article in *Consumer Reports* (the well-known publication that evaluates consumer products). For example, typical tables show the benefits and costs of different models of cars, on various dimensions: repair records, crash tests, handling and style, fuel economy, space, and price. Summary indexes such as reliability or repair cost may be included as well. The final decision, however, is the reader's and differs from one reader to the next. Readers apply their own values to the information and decide which car to buy. And not all will choose the model recommended as "The Best Buy" because not all will share the values reflected in that recommendation.

In this role, CEA makes a simple, but crucial, contribution to decision problems by providing estimates of the magnitudes of costs and health outcomes. Accurate information is essential and can, by itself, lead to very different decisions, especially since many interventions are complex in their application and common beliefs about the magnitudes of costs and outcomes can be seriously mistaken. As appropriate for the problem, CEA can show the costs and health benefits of different frequencies and amounts of each intervention, when applied to different subgroups in the population, under circumstances that reflect different costs and service delivery systems. In addition, CEA's structured process of evaluating the strength of the evidence, stating assumptions explicitly, and working out their implications for cost-effectiveness can be as helpful as the final estimates in understanding alternatives.

The potential value of these estimates is exemplified by the common belief that preventive interventions save more money than they cost. According to the common belief, costs need not be considered, since they are outweighed by savings, and preventive interventions should be provided to all people for whom they are effective. Yet CEA shows that, depending on how they are applied, some effective forms of prevention can be very expensive. For example, screening for cervical cancer is effective in preventing deaths from the condition, but screening annually rather than every 2 years has been estimated to cost all payers more than $1 million per year of life gained because the health gain from annual screening, compared with biennial screening, is so small (Eddy, 1990). Simply knowing that costs are very large for a small benefit could influence decisions about screening frequency.

Ranking interventions by their cost-effectiveness ratios is a step beyond the *Consumer Reports*–style presentation of information on costs and effects. Rankings of ratios for a variety of interventions, sometimes termed "league tables," show how the interventions compare in terms of their cost per unit of health outcome, usually years of life in published studies (Drummond et al., 1993). Properly calculated cost-effectiveness ratios help the user interpret the data on costs and effects correctly and show, in simple, summary fashion, which interventions do the most to promote health.

Direct comparison of cost-effectiveness ratios can be useful across the spectrum of decisions to varying degrees: more useful when interventions and populations receiving them are less diverse and less useful when diversity is greater. At one end of the spectrum, cost-effectiveness ratios can be used to rank alternative interventions for the same group of people—say, treatments for people with end-stage renal failure or with severe hypertension. In these circumstances—a range of interventions which could be applied to a single condition in the same group of people, preferably a group that is similar in its other characteristics as well—it will often be possible to define health goals in terms that everyone can agree on and that are well represented by QALYs. If some facets of the effects and costs must be omitted, they may affect all patients in much the same manner, so omitting them does not bias the decision. Thus the cost-effectiveness ratios can provide strong guidance to the best choices.

For decisions that involve greater diversity in interventions and the people to whom they apply, cost-effectiveness ratios continue to provide essential information, but that information must, to a greater degree, be evaluated in light of circumstances and values that cannot be included in the analysis. Individuals in the population will differ widely in their health and disability before the intervention, or in age, wealth, or other characteristics, raising questions about how society values gains for the more and less healthy, for young and old, for rich and poor, and so on. The assumption that all QALYs are of equal value is less likely to be reasonable in this context. Similarly, differences in the values assigned to the time of different groups may raise questions of fairness. The issue of defining benefit packages—which of all the services available in the health care system to provide to the population in an HMO, a community, or the nation, and under what circumstances—lies at this end of the spectrum.

To serve well in any of these situations, the components of cost-effectiveness analysis and the cost-effectiveness ratios must follow generally accepted principles so that they are correct within studies and comparable across studies and interventions. Comparability among analyses is the foundation of CEA's usefulness as an aid to decision making. Because CEA methods have varied widely among studies in the past, authors comparing CEAs performed to date must be especially careful to check that the ratios presented are in fact comparable. The definition of the Reference Case in this volume is, as noted in the Introduction, intended to make such comparisons easier and more informative in the future.

Finally, even with QALYs and standardized methods, cost-effectiveness ratios cannot yet offer useful comparisons across all health interventions. This is the case when an intervention has important health outcomes that are not incorporated in existing QALY

systems. For example, CEA can be used to evaluate interventions for treating schizophrenia and interventions for treating heart disease. But the health outcomes are so different that it is difficult to capture them in the same measurement system, and direct comparisons of the QALYs created by the two kinds of interventions may not yet be possible. In choices of this kind, CEA still provides useful information, but a greater part of the decision-making process occurs outside of the analysis.

Other Methods for Making Decisions in Health

In general decision makers have used methods other than CEA to evaluate choices about health interventions, methods based on notions of "medical necessity," on "standards of evidence," on whether an intervention is "experimental," or other criteria. These criteria are commonly perceived to be technical statements—objective and free of value judgments—and are supposed to exclude consideration of cost. In practice, however, they usually involve important value judgments and costs often play a part without explicit acknowledgment. Moreover, decision makers still face the distributive issues that arise with CEA

Consider "medical necessity." Judgments about medical necessity, which can determine whether an insurer covers a procedure or a provider offers it, are interpreted as stating that particular medical problems cannot be addressed except by particular interventions. While they appear to be technical statements, they often disguise three important types of value judgment. The first is a judgment about the goals of medicine. If we ask, for example, whether growth hormone treatment is "medically necessary" for children who are not growth hormone deficient but are simply in the bottom 1% of the population in projected adult height, we are asking about the goals of medicine. Is medicine aimed at the treatment of disease and dysfunction or is the elimination of other sources of unhappiness and disadvantage an equally legitimate aim?

A second type of value judgment often implicit in statements of medical necessity is based on prior decisions about the social division of responsibility. A home health service may respond effectively to the medical condition of a frail, elderly person, making the difference between independence and institutionalization. Yet a payer may decide that the service is not "medically necessary" on the unstated ground that it is up to family or a social support agency, not the health care system, to offer the assistance, even when it is clear that the service will not be provided through these other sources. Thus, the decision may be in part a decision about costs and who should bear them.

Medical-necessity judgments also turn on beliefs about the limits of our obligations, for example, about when we have done enough to try to rescue a seriously ill patient. Should an HMO's medical director authorize a bone marrow transplant for a case of advanced cancer because the oncologist insists it is medically necessary—it is the patient's last hope? The director is well aware that authorizing the procedure may mean not staffing a program that provides other medically necessary benefits.

Other criteria thought to be technical often involve similar value judgments, including hidden judgments about costs and their relation to benefits. An insurer may be reluctant to decide that a new technology is no longer "experimental" if its expected benefits are modest and its costs high. Evidence about effectiveness is not so clear and objective that it cannot be made to flex in response to such assessments. When the evaluation of outcomes and costs is not based on the systematic considerations that govern CEA, the result is likely to be less consistent and less informed judgments about what is experimental and what is proven effective.

Since we face the same distributive issues when using these methods but lack information about costs, we make a difficult decision more difficult. How we address distributive problems is affected by costs. We must know what we are giving up by treating the more seriously ill—the opportunity cost—before we can evaluate whether we have gone beyond the limits of our obligations to help those who are sickest. Neither medical necessity nor expected medical benefit nor CEA gives us a decision procedure for resolving these distributive problems, but CEA offers more complete information relevant to our decision.

Results of CEA and Other Methods Compared

If other decision-making methods generated similar recommendations, there would be little reason to advocate the use of CEA. The examples summarized in this section demonstrate that the conclusions supported by CEA can be very different from those based on other methods. Thus the choice among methods is of real importance. Guidelines promulgated by professional societies are used as examples of decisions based on other methods and are contrasted with the results of CEAs for the same intervention. We discuss two examples: screening for cervical cancer and treatment of high blood cholesterol.

We draw here on CEAs that were done well but that nonetheless do not meet all the requirements for the Reference Case (Russell, 1994). For example, all of them use years of life gained rather than QALYs as the measure of health and none count among the costs of the intervention the time that patients spend receiving it. All of them use a discount rate of 5%, which makes them comparable with each other on this point but differs from the rate of 3% recommended for the Reference Case. (See Chapter 7).

Cervical Cancer

Professional recommendations for cervical cancer screening have undergone several revisions in recent decades. Initially, Papanicolaou (Pap) smears were recommended

annually for all women (ACOG, 1980). It was suggested that screening begin at age 18, and there was no upper age limit.

In 1980, the American Cancer Society (ACS) recommended that women aged 20–65 could be screened less often than annually if two consecutive annual tests were negative. And in 1988, after some disagreement with these ACS guidelines, more than ten professional organizations, led by the National Cancer Institute, the American College of Obstetricians and Gynecologists, and the American Cancer Society, issued a joint recommendation that screening start no later than age 18 and occur less frequently than annually at the discretion of the physician, but only after three consecutive annual smears were negative (e.g., Fink, 1988). No alternative frequency was suggested and many physicians continue to advise annual screening.

The ACS based its 1980 recommendation on a cost-effectiveness analysis of different screening schedules. We describe here an updated version of the analysis published later by the same author, which produced similar results (Eddy, 1990; some results from this study are shown in Table 1.1). The analysis estimated the costs and life years saved by screening at intervals of 1, 2, 3, and 4 years; by beginning screening at ages from 17 to 29; and by ending screening at age 65 or at later ages.

Compared with no screening, screening every 4 years—the longest interval shown—was estimated to cost about $10,000 for each year of life saved in 1985 dollars (Table 1.2, first row). To choose among screening frequencies, however, the decision maker needs to know how different frequencies compare with each other. Thus the study calculated the *additional* cost required to save an *additional* year of life by screening more often—every 3 years rather than every 4, say, or annually rather than every 2.

Table 1.2 Cost per Year of Life Saved for Different Frequencies of Screening[a] (in 1985 Dollars)

	Screening Every			
	4 Years	*3 Years*	*2 Years*	*1 Year*
Compared with no screening	10,101	—	—	—
Compared with screening at the next longer interval[b]	—	184,500	262,800	1,100,000
Worst-case scenario[c]				
Compared with no screening	—	15,500	—	—
Compared with screening at the next longer interval	—	—	167,900	503,700

Source: Eddy, 1990.

a. Future life years and costs are discounted at 5% per year. Costs are for 1985. All assumptions are based on data for an average woman who is asymptomatic when she begins screening at age 20 and who is screened to age 74 or 75.

b. For example, the number for a screening interval of 3 years, $184,500, shows the *additional* cost for each *additional* year of life saved due to screening every 3 years instead of every 4, and so on.

c. The worst-case scenario assumes that incidence is three times the U.S. rate of the mid-1980s and has increased among younger women in recent years, that 20% of cancers are of the fast-growing type rather than 5%, and that the rate of missed cancers is 15% higher than actual experience in centralized screening programs in Canada and Europe.

The study showed that increasing frequency is an expensive way to extend lives (Table 1.2, second row). Compared with screening every 4 years, screening every 3 is estimated to cost an additional $185,000 for each life year saved. Shortening the screening interval from 3 years to 2 brings additional life years at a cost of almost $263,000 each. And compared with screening every 2 years, annual screening costs more than $1 million for each additional life year saved. The analysis also showed that varying the age to begin screening from 17 to 29 years, or ending screening at age 65 for women who had been screened regularly up to that age, made little difference to health outcomes. As well, requiring three negative annual smears before allowing less-frequent screening was very costly and produced, on average, only hours of additional life expectancy. These results reflect the fact that cervical cancer can take years to develop and most cases are detected early enough by screening at intervals of several years; more frequent screening yields only a few more cases.

By contrast, screening women who have not been screened on any regular schedule brings substantial health benefits. The same analysis showed that screening women who have never been screened saves about 60 days of life per woman compared with the 3 days saved by screening women once a year rather than every 3 years. A study of screening for low-income elderly women who had not been screened in recent memory found that it not only extended lives; it reduced medical expenditures (Mandelblatt and Fahs, 1988). These findings are relevant to the one-quarter of all women in the United States who, according to a national survey done in 1987, had not had a Pap smear in the last 3 years (Harlan et al., 1991).

If the cost of screening annually is not much more than that of screening every 2 or 3 years, the choice of screening schedule makes little difference. The available estimates suggest that the cost is substantial, even though they include only the costs of the initial test itself, not the costs of follow-up tests or the (net) costs of treatment. Eddy estimated that screening every woman in the United States every year would cost about $6 billion (Kolata, 1988) compared with $2 billion for screening every 3 years.

Thus less frequent screening would free up substantial resources with relatively little loss of health benefits. A decision maker reviewing the broad allocation of health resources might well decide that some of the money spent on annual screening would be better, and more fairly, spent elsewhere—for example, to recruit and screen women who have not been previously screened.

Treatment of High Blood Cholesterol

In 1985, in response to the first evidence from a randomized controlled trial that reducing cholesterol reduces the risk of death from heart disease (Lipid Research Clinics Program, 1984), the National Institutes of Health created the National Cholesterol Education Program (NCEP). Three years later the NCEP published guidelines for the management of high blood cholesterol which recommended that all adults have their

cholesterol checked at least every 5 years and that those with high levels (240 mg/dl or higher), or borderline-high levels (200–239 mg/dl) plus other risk factors, be tested further. It was suggested that those whose low-density lipoproteins (LDL) levels were also high should be treated by changes in diet or with cholesterol-lowering drugs (NCEP, 1988). It has been estimated that more than one-third of the adult population requires dietary change and/or drugs when judged by these criteria (Sempos et al., 1989).

Cost-effectiveness analyses done in the wake of the 1988 guidelines focused on the management of high blood cholesterol once detected. Both lovastatin, a frequently prescribed drug, and dietary counseling were shown to vary widely in cost-effectiveness depending on age and other risk factors for heart disease.

One study examined the use of lovastatin for people initially free of heart disease and for those who had already suffered a heart attack (Goldman et al., 1991). The authors found that, for healthy people, saving a year of life is much more costly among those with cholesterol as their only risk factor than it is for those with several risk factors, even when cholesterol is very high; the cost ranged up to $330,000 for men aged 35–44 with no other risk factors and up to $1.5 million for women in the same category (Table 1.3, top half). The cost was considerably lower for people with other risk factors, reflecting the widely accepted assumption that risk factors interact to make the adverse effects of any one greater when others are present. Lovastatin treatment

Table 1.3 Cost per Year of Life Saved by Lovastatin[a] (in 1989 dollars)

Healthy, Blood Cholesterol ≥ 300	*Cost per Year of Life[b]*	
	Low-Risk Patient	*High-Risk Patient*
Women 35–44	$1,500,000	$195,000
Women 55–64	130,000	34,000
Men 35–44	330,000	24,000
Men 55–64	58,000	15,000
Heart Disease, Blood Cholesterol ≥ 250	*All Patients*	
Women 35–44	4,500	
Women 55–64	8,100	
Men 35–44	—[c]	
Men 55–64	1,600	

Source: Goldman et al., 1991.

a. Dose is 20 mg of lovastatin daily. Costs include physician visits and tests required to monitor people taking lovastatin. Costs and health gains are discounted at 5% per year.

b. A low-risk person is a nonsmoker with diastolic blood pressure below 95 who is not more than 10% overweight. A high-risk person is a smoker with a diastolic pressure of 105 or higher who is 30% or more overweight.

c. Lovastatin estimated to save lives and money.

was still more costly per life year gained for people with levels in the range 250–299 (data not shown).

By contrast, the study found that it is potentially very cost-effective to treat people with elevated cholesterol who have had heart attacks (Table 1.3, bottom half). Costs per life year gained are relatively low and for some, such as men aged 35–44, drug treatment might save money as well as extend life.

Another study found similar results for a program of intensive diet therapy modeled after the one in the Multiple Risk Factor Intervention Trial (MRFIT) (Taylor et al., 1990). For example, diet therapy costs more than $500,000 per year of life for 20-year-old men with an initial cholesterol of 240 mg/dl and no other risk factors (Table 1.4, top line). For men with several risk factors, the cost per life year gained is much lower.

These results suggest that management of high cholesterol in people without heart disease is often very costly per life year saved. Since they show that treatment of people whose blood cholesterol levels are not far above 240 mg/dl can be extremely costly, they suggest that the same would be true for people with levels in the borderline-high range, although the studies did not analyze this group. Taken together, cost-effectiveness results suggest that resources might better be concentrated on those with very high cholesterol levels and/or other risk factors for heart disease (and on those in whom heart disease is already present). Revised guidelines, published by NCEP in 1993 (NCEP, 1994), were somewhat more modest in their aims, in response to studies like these as well to the ongoing debate over whether reducing cholesterol lengthens life in those without heart disease.

If NCEP's 1988 guidelines were followed to the letter, it would cost, depending on the effectiveness of diet in reducing blood cholesterol levels, $20 billion to $27 billion

Table 1.4 Cost per Year of Life Saved by Diet[a] (in 1986 Dollars)

Age	*Blood Cholesterol*	*Cost per Year of Life for a:[b]*	
		Low-Risk Man	*High-Risk Man*
20	240	$510,000	$99,000
	300	300,000	56,000
40	240	180,000	21,000
	300	94,000	11,000
60	240	280,000	23,000
	300	160,000	13,000

Source: Taylor et al., 1990.

a. Diet is assumed to reduce initial blood cholesterol levels by 6.7 percent, the average reduction in the MRFIT trial. Costs and health gains are discounted at 5% per year.

b. A low-risk man is a nonsmoker with systolic blood pressure lower than all but 10% and high-density lipoprotein (HDL) cholesterol equal to or higher than 90% of men of the same age. A high-risk man is a smoker with systolic blood pressure equal to or higher than 90% and HDL cholesterol lower than all but 10% of men of the same age.

to provide lovastatin at doses of 20 mg per day, and $47 billion to $67 billion to provide a higher, more effective, dose of 80 mg per day (Garber and Wagner, 1991). Again, as in the case of cervical cancer, the savings from a more selective strategy would be substantial, freeing resources to be applied elsewhere. The CEA results suggest that more selective treatment strategies could be designed that would lose little in health benefits.

Current and Potential Uses of CEA

In recent years, the number of CEAs of health and medical interventions has grown steadily (Elixhauser, 1993). Well over 100 studies per year are published in general medical, medical specialty, public health, and policy journals. CEAs are conducted and funded by agencies of the federal government, industry, insurers, consulting firms, and universities.

The strongest current focus of interest is in the area of pharmaceuticals, where a number of factors have converged to generate interest in CEA. Cost-effectiveness analysis in this area is supported by the relative availability of data on effectiveness, since effectiveness studies are required for the approval of pharmaceuticals. In the United States, higher market-entry prices for innovative drugs coupled with tighter budgets throughout the health care system appear to be inducing a demand for studies. Formulary committees in hospitals, HMOs, and Medicaid agencies require information on the value drugs offer before agreeing to purchase them (Luce and Brown, 1995). Pharmaceutical firms compete with one another to demonstrate that products are cost-effective. As a result, they are funding studies at a high rate, either in-house or through consulting firms or academic institutions.

Outside the US, the demand by pharmaceutical firms for CEAs of their products is driven by government requirements or price regulation. Australia requires pharmaceutical companies to submit CEAs in order to be reimbursed on the national formulary (Henry, 1992). Canada is instituting a similar regulation (Ontario Ministry of Health, 1994; CCOHTA, 1994). While these two countries explicitly require CEA, European governments are implicitly promoting CEA by requiring drug companies to demonstrate during price negotiations that a medication is of sufficient value to justify its price (Drummond, 1992).

For other health care services and technologies, CEA is believed to have played a key role in some policies, although its influence is not well documented. For instance, Congress is thought to have based its decision to make the pneumoccocal vaccine the first preventive service covered by Medicare on a CEA conducted by the Congressional Office of Technology Assessment (OTA, 1979). Blue Cross/Blue Shield of California is said to have adopted cancer screening policies based on a series of CEAs done by David Eddy (1980).

There is little indication, however, that CEA contributes systematically to resource allocation decisions in United States medicine. On the contrary, both HMOs and insurers deny considering cost when they make coverage decisions (Luce and Brown, 1995). Presumably, their reluctance to use CEA—at least formally—stems from a reluctance to risk the perception that they explicitly limit care due to cost.

Although it is difficult to identify an existing formal role for CEA, interest in the method suggests that CEA is able to influence policy makers' views in informal ways. CEAs are often cited as evidence of the value (or lack of value) of a particular program, technology, or type of intervention in order to promote (or discourage) its use. For example, federal agencies and consumer advocates have publicized cost-effectiveness results for prevention strategies (CDC, 1993; Institute for Women's Policy Research, 1994). These publications assemble the range of available information on cost-benefit and cost-effectiveness of prevention with the purpose of informing decision makers and the public. CEA is most convincing in this role when an intervention has a very low cost per unit of health outcome, or a very high cost, relative to medical technologies generally.

Few have taken issue with the dissemination of this type of cost-effectiveness information—whether these efforts were motivated by interest group or government politics or by public interest concerns. However, cost-effectiveness claims by commercial interests, such as pharmaceutical companies and medical device manufacturers, have generated greater concern. Clearly, it is possible for producers of medical technologies to use studies selectively to demonstrate the cost-effectiveness of their own products for specific conditions. Professional organizations and individual practitioners, similarly, can conduct or sponsor CEAs in areas where they have a professional, financial, or ideological stake, obtaining results that justify the recommendations they support. The lack of guidelines for conducting cost-effectiveness analyses and of standards by which to judge their quality have contributed to the potential for bias.

Efforts to assure the quality of cost-effectiveness analyses have begun on several fronts. Seeking to uphold its requirements for "adequate and well-controlled studies" (21 CFR Part 314.126), the Food and Drug Administration (FDA) currently applies strict standards to claims of cost-effectiveness by pharmaceutical companies. In general, the type of claim reviewed by the FDA compares a given drug to a competitor. The FDA requires that the evidence of effectiveness used in CEAs be obtained from rigorous studies that directly compare the drugs in question.

On another front, *The New England Journal of Medicine* has developed a policy for the review of cost-effectiveness analyses intended to preclude financial conflicts of interest that might affect the choice of methods or data used in an analysis (Kassirer and Angell, 1994). The journal reported that it would not consider CEAs for publication if an author has a financial relationship with a sponsoring company—a stronger restriction than the disclosure requirements it applies to other forms of original research.

To develop voluntary ethical guidelines for the sponsorship and conduct of CEA,

faculty at the Leonard Davis Institute organized the Task Force on Principles for Economic Analysis of Health Care Technology. This committee, sponsored by pharmaceutical companies, consisted of academics and representatives from industry and the federal government and issued guidelines for the pharmaceutical industry (Task Force on Principles for Economic Analysis of Health Care Technology, 1995). Efforts to standardize CEA methodology address concerns about bias by reducing discretion in the choice of methodology and by providing a benchmark for judging the quality of analyses.

With improvements in the standardization of CEA methods, policy makers will be able to move toward a more systematic use of CEA. One set of potential applications involves reimbursement decisions for new procedures and treatments. A drug or procedure could be required to meet standards of cost-effectiveness before it could be reimbursed. This gatekeeping function would parallel the international efforts to use cost-effectiveness in the development of drug formularies.

Cost-effectiveness analysis could also be used in the development of medical and public health practice guidelines. Guidelines are currently developed on the basis of effectiveness; when costs are examined, they play a secondary role. For example, the guidelines panels sponsored by the Agency for Health Care Policy and Research (AHCPR) have considered the cost of implementing a proposed guideline, but to date no formal cost-effectiveness analyses have been factored into guideline development (OTA, 1994). The recommendations of the U.S. Preventive Services Task Force for clinical preventive services are based primarily on evidence of effectiveness. While the task force acknowledges that clinical decisions may be made on other grounds, and that these grounds may include cost, it does not consider cost-effectiveness formally (USPSTF, 1989). The introduction of CEA into guidelines processes would allow expert panels to weigh the cost implications of various protocols along with differences in effectiveness, side effects, and other risks.

The development of benefit packages for government and private insurance coverage is a potential use of CEA, but a controversial one. In Oregon, pioneering efforts to prioritize medical benefits for the Medicaid program initially attempted to use a cost-effectiveness formulation (Klevit et al., 1991). The results contained counterintuitive rankings (e.g., suggesting a higher priority for dental caps than for appendectomy) and were widely criticized. (See Hadorn, 1991; Brown, 1991; Fox and Leichter, 1991; Tengs et al., 1996, for descriptions of the process and reviews of the reactions Oregon received.) Although the Oregon Health Services Commission attributed problems in the rankings to inadequate data, it ultimately backed away from cost-effectiveness as a decision criterion.

Much of the controversy over this kind of application concerns whether medical services should be limited explicitly in any way. If policy makers opt for explicit, as opposed to implicit, means of allocating resources, CEA will provide critical information about the value of alternative investments in health.

Conclusion

The perspective of a CEA—the study's point of view—determines which health outcomes and costs are relevant and plays a part as well in how they should be valued. In this chapter, we considered the appropriate perspective for CEAs used to inform the broad allocation of health resources and concluded that the societal perspective best serves that purpose. Some implications of the societal perspective were discussed in the chapter and more are brought out in the chapters that follow.

Although CEA done from the societal perspective is comprehensive, counting the health effects and costs experienced by all those who are significantly affected by the intervention, it does not reflect everything of importance to decision makers. The chapter discussed in particular some of the distributive values that are not yet reflected in the methods used in CEA. Because of this, we envision CEA as a crucial aid to decision making, but not as a complete decision-making procedure.

Screening for cervical cancer and treatment of high blood cholesterol, the two examples discussed in the chapter, demonstrate that CEA suggests resource allocations very different from the allocations that flow from recommendations based on other methods of decision making. These analyses suggest changes from current policy in order to direct health care resources where they would do the most to extend life and improve its quality. Although other factors may sometimes offset cost-effectiveness considerations, we urge decision makers to take good CEAs into account when they are available. The policy debate would also be served, in many cases, if the decisive tradeoffs between health and other goals were more explicitly identified.

The use of the CEA approach for making decisions about the broad allocation of resources requires comparisons of health outcomes and costs across a wide range of interventions. To facilitate these comparisons it is important to standardize CEAs so that comparisons are valid. Differences in reported health outcomes, costs, and cost-effectiveness ratios should reflect, as much as practicably possible, true differences in the consequences of the interventions and not be artifacts introduced by unnecessary differences in method.

The main task of the Panel on Cost-Effectiveness in Health and Medicine has been to develop standards for the conduct of CEAs for decisions in the public interest. The Introduction of this book introduced the notion of the Reference Case, which is defined in the rest of the book. We summarize the contribution of this chapter in the following recommendations.

Recommendations

1. CEAs intended to contribute to discussion of the broad allocation of health resources should include the Reference Case.
2. The Reference Case is based on the societal perspective.

3. CEAS are an aid to decision making, not a complete procedure for making decisions, because they cannot incorporate all the values relevant to the decisions.

4. The use of CEA in decision making should be studied in a collaborative effort by decision makers and analysts to improve its usefulness.

References

American Cancer Society (ACS). 1980. *Guidelines for the cancer-related health checkup: Recommendations and rationale.* New York: ACS.

American College of Obstetricians and Gynecologists (ACOG). 1980. *Periodic screening for women: Statement of policy.* Washington, DC: ACOG.

Boyle, M.H., G.W. Torrance, J.C. Sinclair, and S.P. Horwood. 1983. Economic evaluation of neonatal intensive care of very-low-birth-weight infants. *N Engl J Med* 308:1330–37.

Brown, L.D. 1991. The national politics of Oregon's rationing plan. *Health Aff* 10:29–51.

Canadian Coordinating Office of Health Technology Assessment (CCOHTA). 1994. *Guidelines for economic evaluation of pharmaceuticals: Canada.* Ottawa: CCOHTA.

Centers for Disease Control and Prevention (CDC). 1993. *An ounce of prevention: What are the returns?* Atlanta: CDC.

Daniels, N. 1993. Rationing fairly: Programmatic considerations. *Bioethics* 7:223–33.

Daniels, N. 1988. *Am I my parent's keeper? An essay on justice between the young and the old.* New York: Oxford University Press.

Daniels, N. 1985. *Just health care.* Cambridge, MA: Harvard University Press.

Drummond, M. 1992. Cost-effectiveness guidelines for reimbursement of pharmaceuticals: Is economic evaluation ready for its enhanced status? *Health Econ* 1:85–92.

Drummond, M., G. Torrance, and J. Mason. 1993. Cost-effectiveness league tables: More harm than good? *Social Sciences in Medicine* 37:33–40.

Dworkin, R. 1981. What is equity? Part 2: Equality of resources. *Philosophy and Public Affairs* 10:283–345.

Eddy, D.M. 1991. The individual vs. society: Resolving the conflict. *JAMA* 265:2399–2406.

Eddy, D.M. 1990. Screening for cervical cancer. *Ann Intern Med* 113:214–26.

Eddy, D.M. 1989. Screening for breast cancer. *Ann Intern Med* 111:389–99.

Eddy, D.M. 1980. *Screening for cancer: Theory, analysis, and design.* Englewood Cliffs, NJ: Prentice-Hall.

Elixhauser, A., ed. 1993. Health care cost-benefit and cost-effectiveness analysis (CBA/CEA) from 1979 to 1990: A bibliography. Appendix C. *Med Care* 31:JS139–JS141.

Fink, D.J. 1988. Change in ACS check-up guidelines for the detection of cervical cancer. *CA Cancer J Clin* 38:127–28.

Fox, D.M., and H.M. Leichter. 1991. Rationing care in Oregon: The new accountability. *Health Aff* 10(2):8–27.

Garber, A.M., and J.L. Wagner. 1991. Practice guidelines and cholesterol policy. *Health Aff* 10(2):52–66.

Goldman, L., M.C. Weinstein, P.A. Goldman, and L.W. Williams. 1991. Cost-effectiveness of HMG-CoA reductase inhibition for primary and secondary prevention of coronary heart disease. *JAMA* 265:1145–51.

Hadorn, D. 1991. Setting health care priorities in Oregon: Cost-effectiveness meets the rule of rescue. *JAMA* 265:2218–25.

Harlan, L.C., A.B. Bernstein, and L.G. Kessler. 1991. Cervical cancer screening: Who is not screened and why? *Am J Public Health* 81:885–91.

Harris, J. 1987. QALYfying the value of life. *J Med Ethics* 13:117–23.

Harsanyi, J.C. 1953. Cardinal utility in welfare economics and in the theory of risk-taking. *J Political Economy* 61:434–35.

Harsanyi, J.C. 1955. Cardinal welfare, individualistic ethics, and interpersonal comparisons of utility. *J Political Economy* 63:309–21.

Henry, D. 1992. Economic analysis an an aid to subsidisation decisions: The development of Australia's guidelines for pharmaceuticals. *PharmacoEconomics* 1:54–67.

IARC Working Group on Evaluation of Cervical Cancer Screening Programmes. 1986. Screening for squamous cervical cancer: Duration of low risk after negative results of cytology and its implications for screening policies. *BMJ* 293:659–64.

Institute for Women's Policy Research. 1994. *Preventive health services: Benefits and cost-effectiveness.* Washington, DC: Institute for Women's Policy Research.

Kassirer, J.P., and M. Angell. 1994. The journal's policy on cost-effectiveness analysis. *N Engl J Med* 331:669–70.

Klevit, H.D., A.C. Bates, T. Castanares, E.P. Kirk, P.R. Sipes-Metzler, and R.Wopat. 1991. Prioritization of health care services: A progress report by the Oregon Health Services Commission. *Arch Intern Med* 151:912–16.

Kolata, G. Medical groups reach compromise on frequency of giving Pap tests. *New York Times* January 7, 1988, B13.

Lewis, P.A., and M. Charney. 1989. Which of two individuals do you treat when only their ages are different and you can't treat both? *J Med Ethics* 15:28–32.

Lipid Research Clinics Program, 1984. Lipid research clinics coronary primary prevention tria results, II: The relationship of reduction in incidence of coronary heart disease to choles terol lowering. *JAMA* 251:365–74.

Luce, B.R., and R. Brown. 1995. The use of technology assessment by hospitals, health main tenance organizations, and third party payers in the United States. *Int J Technol Asses. Health Care* 11:79–92.

Mandelblatt, J.S., and M.C. Fahs. 1988. Cost-effectiveness of cervical cancer screening for low income elderly women. *JAMA* 261:2409–13.

Menzel, P.T. 1992. *Strong medicine.* New York: Oxford University Press.

National Cholesterol Education Program (NCEP). 1988. *High blood cholesterol in adults: Repor of the expert panel on detection, evaluation, and treatment.* Bethesda, MD: Nationa Institutes of Health, Department of Health and Human Services.

National Cholesterol Education Program (NCEP). 1994. The second report of the Expert Pane on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. *Circulatio* 89:1329–1445.

Office of Technology Assessment (OTA), U.S. Congress. 1994. *Identifying health technologie that work: Searching for evidence.* OTA-H-608. Washington, DC: U.S. GPO.

Office of Technology Assessment (OTA), U.S. Congress. 1979. *Review of selected federal vac cine and immunization policies based on case studies of pneumococcal vaccine.* Wash ington, DC: U.S. GPO.

Oldridge, N., W. Furlong, D. Feeny, G. Torrance, G. Guyatt, J. Crowe, and N. Jones. 199 Economic evaluation of cardiac rehabilitation soon after acute myocardial infarction. *A J Cardiol* 72:154–61.

Ontario Ministry of Health. 1994. Ontario guidelines for economic analysis of pharmaceutic products.

Patrick, D.L., and P. Erickson. 1993. *Health status and health policy: Quality of life in health care evaluation and resource allocation.* New York: Oxford University Press.

Rawls, J., 1971. *A theory of justice.* Cambridge, MA: Harvard University Press.

Russell, L.B. 1994. *Educated guesses: Making policy about medical screening tests.* Berkeley, CA: University of California Press and Milbank Memorial Fund.

Sempos, C., R. Fulwood, C. Haines, M. Carroll, R. Anda, D.F. Williamson, P. Remington, and J. Cleeman. 1989. Prevalence of high blood cholesterol levels among adults in the United States. *JAMA* 262:45–52.

Spilker, B. 1990. *Quality of life assessment in clinical trials.* New York: Raven Press.

Task Force on Principles for Economic Analysis of Health Care Technology. 1995. Economic analysis of health care technology: A report on principles. *Ann Intern Med* 123:60–69.

Taylor, W.C., T.M. Pass, D.S. Shepard, and A.L. Komaroff. 1990. Cost effectiveness of cholesterol reduction for the primary prevention of coronary heart disease in men. In *Preventing disease: Beyond the rhetoric*, ed. R.B. Goldbloom and R.S. Lawrence, 437–41. New York: Springer-Verlag.

Tengs, T.O., G. Myer, J.E. Siegel, J.S. Pliskin, J.D. Graham, and M.C. Weinstein. 1996. Oregon's Medicaid ranking and cost-effectiveness: Is there any relationship? *Med Decis Making* 16:99–107.

U.S. Preventive Services Task Force (USPSTF). 1989. *Guide to clinical preventive services: An assessment of the effectivness of 169 interventions.* Baltimore: Williams and Wilkins.

Weinstein, M.C., and W.B. Stason. 1982. Cost-effectiveness of coronary artery bypass surgery. *Circulation* 66:III-56–III-66.

Weinstein, M.C., and W.B. Stason. 1976. *Hypertension: A policy perspective.* Cambridge, MA: Harvard University Press.

Willems, J.S., C.R. Sanders, M.A. Riddiough, and J.C. Bell. 1980. Cost-effectiveness of vaccination against pneumococcal pneumonia. *N Engl J Med* 303:553–59.

Williams, A. 1988. Economics and the rational use of medical technology. In *The economics of medical technology*, ed. F.F.H. Rutten and S.J. Reiser. Berlin: Springer Verlag.

2
Theoretical Foundations of Cost-Effectiveness Analysis

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Cost-effectiveness analysis (CEA) informs resource allocation decisions in he
medicine: How well it does so depends on the comparability and consistency of
of diverse interventions. But even a cursory examination of the literature rev
investigators have made different assumptions about such issues as which c
effects should be included in the analysis, which rate (if any) should be used to
health effects that occur in the future, and the ways in which the cost of peop
should be incorporated. In the absence of uniform methods and perspective
time-consuming efforts to reconstruct analyses that have used disparate meth
results of different analyses cannot be compared.

If cost-effectiveness studies adhered to a fixed set of methodological standa
problems might disappear. But why should one set of standards be adopted in p
to others? One way to answer this question is to seek consistency with a tl
foundation that is broadly acceptable and informative. Such a theoretical co
followed through to its logical consequences, would have specific implicatio
structure of CEA. An examination of the theoretical foundations of CEA will p
resolve controversies and assist in the development of standards. This chapter
possible theoretical foundations of CEA and their implications for the perfor
interpretation of analyses.

Historically, there is no single theoretical foundation for CEA. Its roots can
to a variety of sources, prominent among them such fields as decision an
operations research. Many tools of CEA, such as the optimization technique
for its application and the instruments developed to measure health-related
life, reflect the contributions of researchers of diverse backgrounds. Indeed, i
said that CEA developed as an applied engineering technique for allocating