

Anesthesiology
1997; 86:1197-205
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Lippincott-Raven Publishers

Principles of Economic Analysis

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A BASIC economic problem is producing and distributing goods and services for unlimited human desires and needs when resources are limited. The fundamental principles of economics apply to health care just as to other sectors of the economy.^{1,2} David Eddy illustrates this point: "If health interventions were offered for free, if people had infinite incomes, if programs such as Medicaid had unlimited budgets, the design of a practice policy could stop with the comparison of benefits and harms; every intervention for which the benefits outweighed the harms should be recommended and performed. However, health interventions are not free, people are not infinitely rich, and the budgets of programs are limited. For every dollars worth of healthcare consumed, a dollar will be paid."³

In medical practice, each patient's welfare is paramount. According to Eisenberg, "It is essential that the first commitment of the ethical physician be to the patient. However, to suggest that medical decision making can be divorced from consideration of cost denigrates the complexity of patient care."⁴ A physician who refuses to examine the economic consequences of his or her medical practice does not protect the welfare of his or her patients, at least not in the long run. The cost of a medical intervention must be balanced against

the health outcome produced and the amount of money we are able and willing to spend.

The fundamental premise of this article is that high-quality medical care demands that physicians be aware of the economic consequences of the practice of medicine. Yet most physicians are not prepared to assess these economic consequences. An increasing number of research manuscripts are published that purport to examine issues in medical economics, yet many physicians do not have the training to understand and to criticize the growing literature on health-care economics. Here I try to address this issue.

I address two fundamental concepts of health-care economics: costs and benefits. In addition, I discuss three common types of economic analyses: cost-identification analysis, cost-effectiveness analysis, and cost-benefit analysis. An understanding of these two concepts combined with a working knowledge of the three types of economic analyses will help an interested physician to understand and criticize studies of health-care economics.

The Concept of Costs

The most important feature about costs is that they are difficult to measure accurately. It is essential, therefore, that every economic study explicitly identifies which costs are counted and which are excluded from the study. It is also essential that the type of costs reported be stated explicitly. There is confusion in published economic analyses about the concept of costs.⁵

The first major issue with costs is that there are different types: fixed, variable, total, marginal, and average costs.

Fixed versus Variable Costs

When a medical service is rendered, resources are consumed that have both a fixed and a variable component to their cost. Fixed costs do not change with alterations in the level of production in short periods of time. For instance, the mortgage on the hospital building and payments for anesthesia equipment would not change

This article is accompanied by two editorials. Please see: Fisher DM and Macario A: Economics of anesthesia care: a call to arms! *ANESTHESIOLOGY* 1997;86:1018-9 and Shapiro BA: Why Must the Practice of Anesthesiology Change? It's Economics, Doctor! *ANESTHESIOLOGY* 1997;86:1020-2.

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Received from the University of Utah, Salt Lake City, Utah. Submitted for publication August 27, 1996. Accepted for publication January 2, 1997.

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if the number of patients admitted to the hospital decreased by 10%. Variable costs change in proportion to changes in the level of production. The cost for medical supplies, for instance, may be expected to increase by approximately 10% when the number of patients in the hospital increases by 10%. The total cost is the sum of fixed and variable costs.

For example, if an anesthesia machine is purchased on a 5-yr contract, then the yearly fixed cost for administering general anesthesia with the machine would equal the payments necessary to meet the contract. The yearly variable cost for delivering general anesthesia may include the cost for scheduled machine maintenance and supplies, plus the cost of volatile anesthetics and diluent gasses. The variable costs depend on the number of hours the machine is used. Suppose that the yearly payment for the anesthesia machine is \$10,000, and that the variable costs are \$100 per patient-hour. Then the total cost of delivering general anesthesia can be represented by the cost function:

$$\text{Total cost} = \$10,000 + \$100 \times \text{patient-hours.}$$

Although total cost is usually the important measure, fixed and variable costs may be appropriate measures in certain circumstances. As with other issues surrounding the concept of costs, it is most important that authors of an economic analysis be explicit about the costs measured and reported.

Total versus Marginal versus Average Costs

Another way to look at costs is to examine marginal or average costs as compared with total costs. The marginal cost of a medical service is the cost of treating one more or one fewer patient. The average cost of a medical service is the total cost divided by the total number of patients treated. Both of these costs are reported in the same units (such as dollars per patient), and this can lead to confusion. Marginal and average costs generally are not equal.⁶ The context determines which type of cost (total, average, or marginal) is the appropriate cost for a given analysis.

Using our previous example of the cost of providing general anesthesia with an anesthesia machine that has a cost function total cost of $\$10,000 + \$100 \times \text{patient-hours}$, the marginal cost function is the slope of the total cost curve (the first derivative with respect to patient hours), which in this case is \$100 per patient-hour. The average cost function is calculated by dividing the total cost by patient-hours, or in this case, \$100

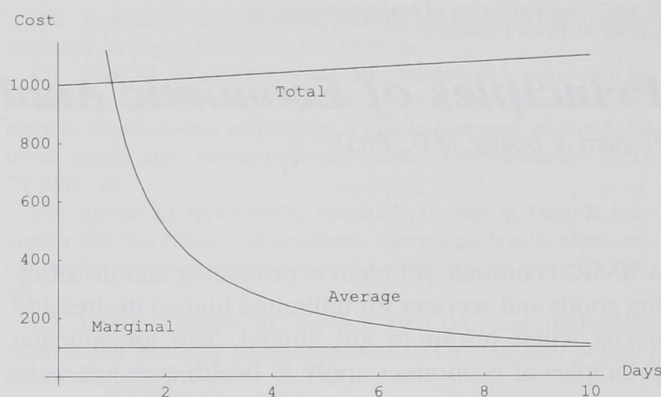


Fig. 1. Curves representing total cost, average cost, and marginal cost as a function of patient-days. The total cost and average cost values have been divided by 10 to present all three curves on a common graph.

+ \$10,000/patient-hours. The curves representing total cost, average cost, and marginal cost for this medical service are presented in figure 1.

The second important issue relating to the concept of costs is discounting, which is fundamental to all financial analyses. The idea is that a promise to receive a dollar next year is worth less than receiving a dollar today. Three fundamental reasons make this true: inflation, the investment opportunity for money, and risk. The value of a dollar next year will be less than the value of one today because of general economic inflation. A value of a dollar next year will be less than the value of one today because today's dollar could be invested and interest would be paid on today's dollar. A promise to receive a dollar next year is worth less than an actual dollar today because something could happen in the meantime to leave the promise unfulfilled.

To induce a rational economic entity to forgo a dollar today in exchange for a promise of a payment next year, the promise should be for more than one dollar. The "discount rate" determines the difference between one dollar and the promised amount. If a discount rate of 5% is required, then the promise must be for one dollar plus 5%, or \$1.05.

The discount rate must account for inflation, forgone investment opportunity, and risk. Risk is an important issue for financial investments but does not often come into play in medical economic analyses. The important issues for us to consider are inflation and forgone opportunity. Both of these issues can be combined into one discount rate. The typical discount rate in this situation is 3% greater than the rate of inflation.⁷

The common way to discuss this issue is in terms of

PRINCIPLES OF ECONOMIC ANALYSIS

"present value." A present value calculation is the inverse of the example just given. The present value of \$1.05 next year is \$1.00 at a discount rate of 5%; that is, a promise to pay me \$1.05 next year is the same to me (presuming that I am economically rational) as a payment of \$1.00 today.

Just as money that is left in a bank can earn compound interest, so the idea of compounding comes into play in discounting. If I were to leave \$1.00 in the bank for 2 yr at an interest rate of 5%, I would have \$1.00 plus 5%, or \$1.05, at the end of 1 yr, and \$1.05 plus 5%, or \$1.1025, at the end of 2 yr.

The same can be said for discounting. The promise to pay me \$1.1025 in 2 yr is equivalent to paying me \$1.00 today, or the present value of \$1.1025 in 2 yr is \$1.00 at a discount rate of 5%.

Similar to monetary benefits received in the future, costs that I pay in the future also should be discounted to a present value. In this case, inflation works in my favor because the dollars I pay back next year will be worth less than the dollars I have today. Costs in a medical economic study also should be discounted.

As an example, assume that I purchase an anesthesia machine for \$50,000, that the manufacturer allows me to pay for it in five equal installments of \$10,000 each, and that the first payment is due 1 yr after I receive the machine. Then, because of the principle of discounting, the "true cost" of the machine is not \$50,000, but rather \$43,294, if the discount rate is 5% (fig. 2). In any medical economic analysis it is essential that future cost be appropriately discounted to the present value.

The third major issue to understand about costs is that they are different when viewed from different perspectives. Therefore whose perspective should we adopt? Any author of an economic analysis should carefully and consistently consider the perspective of the analysis.

Costs can be examined from the perspectives of the society, patient, provider, and payer. Each perspective has its merits, although in general I would argue that the most appropriate perspective is either the provider or the society. The recommendation of the US Public Health Service Panel on Cost-Effectiveness in Health and Medicine is that all published cost-effectiveness analyses include an analysis from the perspective of society.⁸ The societal perspective is the most general, but it also is the most difficult and may not provide the best answers to specific questions. For example, if the question concerns the cost of administering antiemetic medication to patients having surgery, then the best perspec-

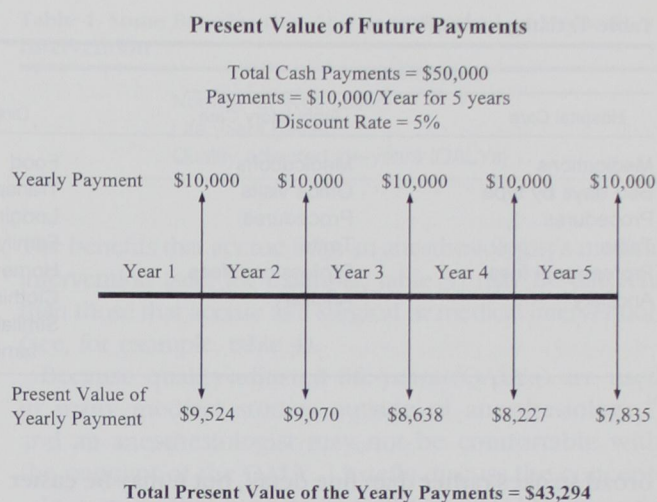


Fig. 2. The present value of yearly payments over 5 yr. Because of the principle of compounding, the present value of the payment for year ($n + 1$) is less than that for year (n). The present value of the first payment is less than the value of the actual payment because it occurs 1 yr after the anesthesia machine is delivered.

tive for examining the cost is the provider's. It is important that the author of a medical economic study explicitly identify the perspective of the study.

The cost to society is the net cost of all the different components of society, including the patient's lost productivity and the expenses involved in giving and receiving medical care. This is the broadest perspective taken, and for health policy decisions it is probably the best. It is, however, difficult to enumerate and appropriately quantify all of the costs to society.

The cost to the provider, such as a hospital or a physician, is the true cost of providing a service, regardless of the charge, and few medical institutions are prepared to identify their true economic costs.^{4,9} The provider's perspective is appropriate if the cost of producing health care is being examined. It is, however, difficult to determine true cost. Industrial engineering and time-motion studies are often necessary for this kind of cost accounting. If time-motion studies are performed correctly they can be useful: To understand and control costs, it is best to understand and control the activities that incur costs. Time-motion studies are expensive, however, and require significant effort and commitment from everyone involved in the study.

An alternative to performing detailed time-motion studies is to calculate certain aggregate performance indicators such as the cost-to-charge ratio, which converts hospital charges to hospital costs. This ratio paints

Table 1. Categories of Costs

Direct Medical		Direct Nonmedical	Indirect	Intangible
Hospital Care	Ambulatory Care			
Medications	Medications	Food	Work absenteeism	Pain
Bed days by type	Office visits	Transportation	Loss of life	Suffering
Procedures	Procedures	Lodging	Loss of livelihood	
Tests	Tests	Family care		
Professional fees	Professional fees	Home aids		
Ancillary	Ancillary	Clothing		
		Similar costs for other family members		

broad strokes rather than fine detail, but it may be easier to estimate this number than to perform a detailed time-motion study. In fact, for many medical economic studies, the cost-to-charge ratio may be the only mechanism available to estimate production costs.

An essential concept from this perspective is that charges do not necessarily equal costs.⁹ The cost of producing a certain medical service may be more or less than charges that are levied for the service. Rarely is the charge equal to the production cost.

A brief example can clarify this important point. The present acquisition cost to my hospital for a 1-l bag of lactated Ringers IV solution is \$0.86, but the charge to a patient is \$36.00. What is the cost of administering a liter of this solution to a patient? Certainly the true cost to the hospital is greater than the acquisition cost because the hospital must store and process the intravenous fluid, and a nurse (or an anesthesiologist) must prepare and administer the fluid. However, the hospital financial officer readily concedes that other services (such as linen and housekeeping) are subsidized by the excess charge for intravenous fluids. The practice of subsidizing one part of the hospital from excess revenues generated in another part of the hospital is common. This means that patient charges for a given service may not equal the cost of producing the service.

The concept of the inequality of costs and charges raises another important issue related to provider costs. To compute the cost to the hospital or other provider for rendering a medical service, certain overhead costs must be added to the acquisition cost of the products involved. In the case of administering a liter of intravenous fluid, it was determined that, at a minimum, overhead costs include processing and storing the fluid as well as preparing and administering the fluid. How

should this overhead cost be determined and allocated to a given liter of intravenous fluid? There are no hard and fast rules. The key idea is that overhead allocation affects costs. Some overhead allocation will be arbitrary. Rules used to allocate overhead to the various activities involved in providing a medical service must be explicit in any economic analysis so that readers can judge for themselves whether the allocation makes sense.

The perspective of the patient may be appropriate if the question is patient welfare. From a patient's perspective, his or her cost is the amount he or she pays for the service (the amount over and above that covered by insurance), plus any other costs that might be incurred because of illness and treatment, including time missed from work.

From the perspective of the payer, costs equal charges that are allowed by the specific payer. This perspective generally is not useful unless the economics of the insurance industry are being examined.

The last issue relating to the concept of costs is which costs should be counted. There is truth to the saying "All that counts can't be counted, and not all that can be counted counts." Although the perspective taken determines the specific costs that are counted, four general categories of costs are useful in organizing any examination of costs. These four categories are direct medical costs, direct nonmedical costs, indirect costs, and intangible costs. The four categories are expanded in table 1. Some of these costs, particularly the intangible ones, are difficult to quantify and value.

Once a perspective for costing is selected and the categories of costs to be included in the study are determined, then authors of a medical economic study should carefully aggregate the costs while paying attention to the concepts already discussed re-

PRINCIPLES OF ECONOMIC ANALYSIS

Table 2. Components of Net Health Resource Cost

Cost of treatment
Cost (savings) of morbidity averted
Cost of treating side effects and complications
(Net) cost of treating illnesses that occur in added years of life

garding total, marginal, and average costs and appropriate discounting of future costs and savings. Typically the total cost is the appropriate measure to determine. However, as in the rest of cost determination, context determines the appropriate measure. The aggregate or net health resource cost is the cost that is used in economic analysis. The components of net health resource cost are presented in table 2.

The Concept of Benefits

Most of what has been said about costs could also be said about benefits. Benefits must be viewed from either the perspective of society, the provider, the patient, or the payer. The natural beneficiaries for a medical economic study are either the society or the patient. The type of benefit must be specified - either direct medical, direct nonmedical, indirect, or intangible. Future benefits must be discounted to obtain the present value.

For health-care policy studies, the benefits to be determined are usually the benefits that accrue to the entire society.³ Societal benefits can be difficult to measure with completeness and accuracy.

For the typical medical study, patient benefits are the focus. In fact, because the patient's benefits are a part of the society's benefits, and because for anesthesiology-type benefits the patient's benefits are the only truly identifiable ones, they may be the same. For the purpose of a patient-centered study, it is essential to identify the health outcomes generated by the medical service or procedure that is being investigated. Clinical endpoints are not comparable across all disease states or across all medical interventions.

Table 3. Some Benefits that Accrue to an Anesthesiologist's Medical Intervention

Episodes of nausea and vomiting
Duration of postanesthesia care unit stay
Duration of hospital stay
Pain score

Table 4. Some Benefits that Accrue to Surgical or Medical Intervention

Number of lives saved
Life years gained
Quality adjusted life-years (QALYs)

The benefits that accrue from an anesthesiologist's medical intervention (see, for example, table 3) may be different than those that accrue to a surgical or medical intervention (see, for example, table 4).

Because quality-adjusted life-years (QALYs) are used in many medical studies outside of anesthesiology,¹⁰ and an anesthesiologist may not be comfortable with the concept of the QALY, I briefly discuss the concept.

In a study that reports benefits as a QALY, numeric weights are assigned to each possible health state. These weights range from 1 (perfect health) to 0 (equivalent to death) and reflect relative preferences of the affected population. There are many ways to obtain the preference weights used in a QALY determination.⁷ For example, the following weights can be assigned to the indicated health states: side effects of hypertension treatment = 0.98; mild angina = 0.90; moderate angina = 0.70; severe angina = 0.50.¹¹ The weight of 0.5 for severe angina means that a group of patients believe that 1 yr of life with severe angina is only as good as one-half year of life in a healthy state. The duration of time in each health state is multiplied by its weight, and the sum of weight times duration equals QALYs.

The idea of the QALY makes explicit the preferences of patients for quality of life, not just life. According to Russell *et al.*,⁸ "since the purpose of investing in health is to make people better-off, it seems appropriate to let them be the judge of what constitutes better or worse outcomes and of the relative magnitudes of health effects." The importance of using a measure of the quality of life is underscored in an article by Barry *et al.*¹² in which the authors studied men with prostate disease. They compared the expected outcome for immediate transurethral resection with the expected outcome for watchful waiting. In their analysis of 70-yr-old men, immediate surgery resulted in a loss of 1.01 months of life expectancy, but when adjustments were made for quality of life, immediate surgery resulted in a gain of 2.94 quality-adjusted life-months.

Three Types of Economic Analyses

Cost identification is an element of all medical economic studies. How benefits are treated, however, de-

termines the type of economic study. Three basic types of economic study are common to the medical literature: cost-identification analysis, cost-effectiveness analysis, and cost-benefit analysis.

Cost-identification Analysis

If all benefits are considered equal, then cost-identification analysis is the appropriate type of study. Cost-identification analysis is sometimes called cost-minimization analysis. This is one of the most common types of study in the anesthesiology literature. If a difference in outcome is not the issue, but rather the cost of comparable outcomes is, then a rigorous determination of the costs of each option is appropriate. The presumed goal for this analysis is to find the least-expensive way to achieve the outcome.

For example, if drugs A and B are equally effective at preventing postoperative nausea and vomiting, and both drugs have a similar side effect profile, and if the issue is which drug to use, then the appropriate analysis is cost identification. The least-expensive drug in this scenario is judged to be the preferred drug. The analysis does not, however, address the question of whether we should spend the money for either drug in light of other possible uses of our resources.

An example from the recent literature used cost identification as an analytical tool. Todd *et al.*¹³ examined three anesthetic regimens for neurosurgery. Patients having elective neurosurgery were assigned to receive either 1) anesthetic induction with propofol followed by anesthetic maintenance with propofol and fentanyl infusion, 2) anesthetic induction with thiopental followed by anesthetic maintenance with isoflurane and nitrous oxide, or 3) anesthetic induction with thiopental followed by anesthetic maintenance with fentanyl infusion, nitrous oxide, and low-dose isoflurane. The authors concluded that there was no difference in short-term outcome for patients randomized to receive any of the anesthetic regimens. The drug cost for the three regimens were, however, different: The drug cost of regimen 1 was more than that for regimen 2, which was more than that for regimen 3. (Note, however, that that study inappropriately called the value of the hospital charges the cost of hospitalization. The cost of hospitalization was one of the short-term outcome variables.)

Cost-effectiveness Analysis

If benefits are measured but are not converted to monetary units, then cost-effectiveness analysis is appro-

priate.¹⁴ This technique assumes the possibility that one could achieve improved outcome in exchange for the use of more resources. The assumed goal is not just cost minimization. In this technique, either the measured health outcomes are used directly or disparate outcomes are converted into a common scale using the technique of utility analysis, such as the QALY scale discussed before.

Cost-effectiveness analysis is used to compare two or more treatment schemes. All cost-effectiveness analyses must state explicitly which two interventions are being compared. Once the costs for the two treatment schemes are determined, and the outcomes from the two treatments are converted to a common unit, then a ratio can be formed for each treatment scheme. A typical ratio might be dollars per unit improvement in pain score, dollars per decreased episode of postoperative vomiting, or dollars per QALY. The ratios for the two treatment schemes then can be used to determine which treatment provides the most benefit for a given investment of resources.

The term cost-effective has been misused widely. As Doubilet *et al.*¹⁵ note, cost-effective is not synonymous for cost saving. Cost-effectiveness analysis is used to examine treatments that cost money rather than save money. The term *cost-effective* also involves more than simply being effective. Just because a treatment has been shown to be effective does not mean that it is cost-effective. Similarly the term should not be reserved only to describe those treatment options that save money with an equal or better health outcome when compared with other options. Although these types of treatment options are desirable, such a use of the term is too stringent to be useful.

Cost-effectiveness analysis has been used in many different ways, which has led to some confusion. According to Russell *et al.*⁸: "[Cost-effectiveness analysis] can be difficult to follow, and results are often presented in a way that impedes rather than facilitates understanding. Studies vary widely in the health effects and costs included and in the way these are valued and combined, so that studies of the same intervention can produce very different cost-effectiveness ratios; potential users may be confused and suspicious that [cost-effectiveness analysis] can be manipulated to support almost any conclusion." Because of this potential for confusion, the US Public Health Service convened the Panel on Cost-effectiveness in Health and Medicine in 1993. The report of this panel became available in

1996,^{7,8,16,17} and it makes many specific recommendations for standardizing cost-effectiveness analyses.

Cost-effectiveness analysis was used recently to examine issues important to anesthesiologists. I describe two: the diagnostic strategies for patients who are potential candidates for carotid endarterectomy, and the use of thrombolytic therapy for patients thought to be experiencing acute myocardial infarction.

In a study to assess the cost-effectiveness of four diagnostic strategies for the preoperative evaluation of symptomatic patients who are potential candidates for carotid endarterectomy, Kent *et al.*¹⁸ found that for the detection of 70–99% carotid artery stenosis, the combination of duplex sonography and magnetic resonance angiography, supplemented by contrast angiography for disparate results, is associated with the lowest rates of long-term morbidity and mortality and has a favorable cost-effectiveness ratio.

In a study by Krumholz *et al.*¹⁹ that examined the potential benefit of thrombolytic therapy for suspected acute myocardial infarction in elderly patients, thrombolytic therapy with streptokinase was a beneficial and cost-effective treatment in a wide variety of circumstances.

Although cost-effectiveness analysis has become an important tool in clinical economic studies, not all researchers are satisfied with the technique. Opponents argue that the cold, rational results yielded by cost-effectiveness analysis are not very helpful to clinicians who use their hearts as well as their heads in deciding diagnostic and treatment issues. A recent study found that even those trained in medical decision-making often prefer a policy that they perceive as more equitable than would be produced by adhering strictly to cost-effectiveness analysis.²⁰

Cost-benefit Analysis

If benefits are converted to monetary units, then cost-benefit analysis is the appropriate tool. Cost-effectiveness analysis is useful to clinicians but it does not explicitly determine whether the outcomes are worth the costs. Cost-benefit analysis forces this comparison by measuring costs and benefits in the same units.²¹

The difference between cost-effectiveness analysis and cost-benefit analysis can be demonstrated using a hypothetical example taken from Detsky and Naglie.²² Table 5 compares two treatment options, treatment A and treatment B. The cost for treatment A is \$20,000, and the cost for treatment B is \$10,000. A patient's life expectancy with treatment A is 4.5 yr, whereas it is 3.5

yr with treatment B. The importance of the desirability of life in a given health state is demonstrated by the weights assigned to life after each treatment option: 0.8 for A and 0.9 for B. Thus treatment A results in 0.8×4.5 yr, or 3.6 QALYs, and treatment B results in 0.9×3.5 years, or 3.15 QALYs.

This information is sufficient to perform a cost-effectiveness analysis. Treatment A costs \$10,000 more than treatment B and results in 1 extra year of life, or 0.45 extra QALYs. Thus the cost-effectiveness ratio for treatment A compared with treatment B is \$10,000 per life-year gained, or \$22,222 per QALY gained.

For a cost-benefit analysis, the QALYs must be converted into a dollar equivalent, which is a difficult exercise. Converting a QALY into a dollar figure requires a chain of value judgments, and not all persons doing this will exercise the same set of values. This conversion can be approached by examining a patient's willingness to pay for a certain outcome, or by using the patient's wages or income as a measure of worth. The potential controversy surrounding the conversion of health outcomes into dollar figures explains why few true cost-benefit analyses have been published. For the sake of illustration, assume that the benefits from treatment A are worth \$4,000 and the benefits from treatment B are worth \$2,000. With these values, the cost-benefit ratio is 5, and thus the benefits of treatment A are worth the cost.

Sensitivity Analysis and Statistical Tests

Cost-effectiveness analyses and cost-benefit analyses cannot be subjected to statistical testing in the manner that we have become accustomed in other areas of medical science. Parts of the analysis can, and should, be subjected to statistical testing. The primary postanalysis testing that should be performed is sensitivity analysis. A sensitivity analysis examines the extent to which uncertainty in the cost and benefit data could affect the results of the analysis.

In a sensitivity analysis, the independent values (such as the cost of the specific treatments) are allowed to vary from those values that are measured in the study, and the cost-effectiveness or cost-benefit ratios are recalculated. If the independent variable can assume a wide range of values without changing the conclusions drawn from the ratio calculations, then we can have more confidence that the conclusions are correct. If, in contrast, the conclusions are sensitive to a small change in the independent variables, then we can have less confidence in the conclusions drawn from the data.

Table 5. Cost-effective Ratio and Cost-Benefit Ratio for Two Hypothetical Treatments

Strategy	Treatment Costs (\$)	Health Benefit (yr)	Quality Weight	QALYs	Benefits (\$)
Treatment A	20,000	4.5	0.8	3.6 QALYs	4,000
Treatment B	10,000	3.5	0.9	3.15 QALYs	2,000

$$\text{Cost-effectiveness ratio} = \frac{\$20,000 - \$10,000}{4.5 \text{ years} - 3.5 \text{ years}} = \$10,000 \text{ per life-year gained.}$$

$$\text{Cost-effectiveness ratio} = \frac{\$20,000 - \$10,000}{3.6 \text{ QALYs} - 3.15 \text{ QALYs}} = \$22,222 \text{ per QALY gained.}$$

$$\text{Cost-benefit ratio} = \frac{\$20,000 - \$10,000}{\$4,000 - \$2,000} = 5.$$

Adapted from Detsky.²²

All medical economic analyses should have at least a univariate (one way) sensitivity analysis in which the estimates for the important variables are changed one at a time. A quality economic analysis might also have a multivariate sensitivity analysis in which the key variables are allowed to vary at the same time. A multivariate sensitivity analysis is especially important if some of the key variables are correlated.

Conclusions

An understanding of the concepts of costs and benefits is essential for performing any medical economic analysis. First, any author of a medical economic study must decide which perspective (society, patient, payer, provider) to take in the analysis. It is essential that this perspective be consistent throughout the analysis and that it be obvious to the reader. Second, the author of the analysis must decide which costs and benefits to count in the analysis (direct medical, direct nonmedical, indirect, intangible). Future costs and benefits must be properly discounted before aggregation with current costs and benefits.

Cost determination is common to all medical economic studies. It is difficult to count costs accurately. Authors of an economic analysis must make the case that the appropriate costs were included and that overhead costs are properly allocated to the various cost categories.

Benefits are also difficult to measure with accuracy, but they are especially difficult to value. If benefits are assumed to be equivalent for the treatments being examined, then a cost-identification analysis is appropriate. The goal in this analysis is to minimize costs. If benefits are measured and converted to a common unit,

and then cost-effectiveness analysis can be used to compare two treatment options. If benefits are measured and converted into dollar amounts, then cost-benefit analysis can be performed. Conversion of benefits into dollar values is more or less subjective and generally controversial.

Anesthesiologists who perform these types of economic analyses and those who read them must be conversant with the ideas I have presented. To be ignorant of these basic principles is to be less qualified to understand and to criticize the growing body of literature relating to medical economic analysis.

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