

A Clinician's Guide to Cost-Effectiveness Analysis

Allan S. Detsky, MD, PhD; and I. Gary Naglie, MD

Cost-effectiveness analysis can be used to help set priorities for funding health care programs. For each intervention, the costs and clinical outcomes associated with that strategy must be compared with an alternate strategy for treating the same patients. If an intervention results in improved outcomes but also costs more, the incremental cost per incremental unit of clinical outcome should be calculated. The incremental cost-effectiveness ratios for various programs can be ranked to set funding priorities. By using this list, the person responsible for allocating resources can maximize the net health benefit for a target population derived from a fixed budget. Clinicians may not share this objective because, individually, they are appropriately concerned solely with the effectiveness of a specific intervention for their patients and are not concerned with the benefit derived from spending those resources on other patients in the target population. In addition, allocation may be driven by distributional and political objectives. Nevertheless, cost-effectiveness analysis demonstrates the consequences of allocation decisions. Because clinicians should participate in policy making, they must understand the role of this technique in setting funding priorities.

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From the University of Toronto and the Toronto Hospital, Toronto, Ontario. For current author addresses, see end of text.

The evaluation of new or existing health care interventions from the clinical and policy perspectives involves five steps (1). The first step is demonstration of efficacy—that a health care intervention can achieve its stated goal when used in optimal circumstances. For example, a new antihypertensive agent may first be shown to lower blood pressure when taken by patients in very controlled settings where compliance is assured and salt intake monitored. The second step involves assessment of effectiveness, the demonstration that a new health care intervention does more good than harm when used in usual circumstances. In the antihypertensive example, the drug would be deemed effective if it achieved its goal in ordinary patients whose compliance may not be as good and whose diet is less well controlled.

The third step assesses efficiency or cost effectiveness which considers both the effectiveness of the health care intervention as well as the resources required to deliver the intervention. (In this paper, the term "cost-effectiveness analysis" is used in two ways: as a generic term for economic analysis that includes "cost-effectiveness," "cost-utility," and "cost-benefit" analysis; and as a specific type of economic analysis

that measures clinical outcomes in units such as "life years gained" or "cases of disease prevented.") Efficiency can be defined as achieving the maximal increment in health benefit (that is, improvements in the health status of a target population) for a fixed amount of resources. Alternatively, one can establish a health-status objective and use efficiency analysis to determine the minimal amount of resources required to achieve that objective. In setting public policy, the amount of resources is often fixed and thus the former definition is more relevant. Using the same antihypertensive example, we would then ask whether more good is done by adopting the new antihypertensive agent in place of an older one instead of devoting the extra resources required for the new agent to some alternate new health care program, for example, screening and treating hypercholesterolemia.

The fourth step considers the issue of availability, that is, matching the supply of services to locations where they are accessible to persons who require them. The fifth, and often overriding step in a policy analysis concerning the evaluation of a health care technology, considers distribution, that is, an examination of who gains and who loses by choosing to allocate resources to one health care program instead of another.

We will examine the fundamental notions surrounding efficiency analysis in health care, more specifically known as cost-effectiveness, cost-benefit, or cost-utility analysis. Persons in organizations such as hospitals and health maintenance organizations (HMOs) constantly make decisions that affect the allocation of resources to various programs. We will show that cost-effectiveness analysis can be used to help those responsible for making decisions about allocating a fixed amount of resources across programs that compete for those scarce resources. The use of this technique for setting priorities assumes that the decision maker has one objective, namely, to maximize the net health benefit to a target population derived from using these fixed resources. The target population may be the HMO enrollees, the community served by a hospital, or a segment of that community. As we will discuss, the use of cost-effectiveness analysis assumes that health benefits accruing to all persons in the target population are valued equally by the decision maker. If this is not the case, then the technique may not be appropriate for setting priorities.

Because cost-effectiveness analysis assumes the particular objective of maximizing net health benefit for all persons in the target population under conditions of constrained resources, the technique does not lend itself to the perspective of the clinician making allocation decisions for his or her individual patients or group of patients in the absence of direct responsibility for the expenditure of resources. For those decision makers, the objective is solely to maximize their patients' health

Table 1. Cost, Effects, Utility, and Benefits of Treating Patients with Disease X with Two Alternate Strategies, Treatment A and Treatment B

Strategy	Treatment Costs	Effectiveness (Life Expectancy)	Utility (Quality of Life)	Utility (Quality-Adjusted Life Expectancy)	Benefits
Treatment A	\$20 000	4.5 years	0.80	3.6 QALYs*	\$4000
Treatment B	\$10 000	3.5 years	0.90	3.15 QALYs	\$2000
Incremental cost-effectiveness ratio = $\frac{\$20\,000 - \$10\,000}{4.5\text{ years} - 3.5\text{ years}} = \$10\,000\text{ per life-year gained}$					
Incremental cost-utility ratio = $\frac{\$20\,000 - \$10\,000}{3.6\text{ QALYs} - 3.15\text{ QALYs}} = \$22\,222\text{ per QALY gained}$					
Incremental cost-benefit ratio = $\frac{\$20\,000 - \$10\,000}{\$4000 - \$2000} = 5$					

* QALYs = quality-adjusted life years.

status regardless of the effect of those decisions on other patients or resources. Clinicians may not be concerned about the constraint of a fixed amount of resources and the effect that using scarce resources for their patients will have on other patients. This difference in perspective and objectives is important in understanding why many clinicians object to the use of cost-effectiveness analysis in setting policies.

We will present simple examples in order to define cost-effectiveness analysis and to demonstrate how it can be used to set priorities. We will also put the technique in the context of other objectives and perspectives.

Simplified Model

Cost-effectiveness analysis of a health care intervention or program requires a comparison of that intervention with alternative methods of dealing with the patients in a given health state. The alternative method may be some other treatment or no treatment at all. For example, the use of a drug such as captopril might be compared with another antihypertensive medication such as a beta-blocker. In the areas of health promotion or disease prevention, specialized programs are compared with "usual care," which is defined as the standard of care currently available in the community. In some cases, a new health care technology is being introduced where there is no existing technology and where usual care implies doing nothing. For example, liver transplantation can only be compared with the alternative of allowing patients to die from end-stage liver disease.

It is important to note that all cost-effectiveness analyses must state explicitly the two interventions that are being compared. For example, consider two strategies known as "treatment A" and "treatment B" for treating patients with a given target disorder, X. Both methods of delivering health care will result in clinical outcomes (for example, life expectancy) that are either equivalent or different. Similarly, the two health care interventions result in resource costs that are either equivalent or different. If program A results in improved clinical outcomes and lower resource require-

ments, then it is said to be dominant and should be adopted without further analysis from an economic point of view. Programs such as polio immunization or phenylketonuria screening programs for newborns exemplify this characteristic of dominance. Most health-care interventions, however, result in improvements in the health status of a target population that are achieved at extra costs. The tension between the extra costs and the extra clinical benefits gives rise to the question of setting allocative funding priorities.

In measuring the tension between extra costs and extra benefits, the analyst usually derives a ratio of the extra costs required to achieve one extra unit of clinical outcome. The units of clinical outcome can be measured in direct clinical terms such as life-years extended or premature deaths avoided, in which case the analysis will estimate "cost-effectiveness ratios." If the unit of clinical outcomes is measured in units that also consider utility or quality of life, then the analysis estimates "cost-utility ratios." If the clinical outcomes are translated into dollar terms via approaches such as "willingness to pay" (that is, asking persons how much they would be willing to pay to receive a given health benefit such as avoiding pain or disability), then the ratio is known as a "cost-benefit ratio." When both the resource requirements and clinical outcomes are measured in dollar terms (that is, cost-benefit analysis), one can either examine the ratio of costs to benefits or determine the net costs of a program by subtracting treatment costs from treatment benefits (net costs = treatment benefits - treatment costs).

Table 1 compares two methods of treating patients with disease X, for example, patients with lung cancer. The treatments are designated treatment A (for example, aggressive chemotherapy after surgical resection) and treatment B (no chemotherapy after surgical resection). The average cost of treating patients with the two interventions are shown in the first column. These costs include the delivery of the intervention (for example, chemotherapy) and the care for the patients if they have side effects from treatment or a relapse, or both. The next three columns show three different measures of clinical outcomes associated with the two treatment

strategies. Effectiveness, measured in terms of life expectancy, is a straightforward concept for most clinicians. Utility is a quantitative measure of the strength of patients' preferences for certain health states. In doing a cost-utility study, the unit of measurement for the clinical outcome is usually quality-adjusted life expectancy or quality-adjusted life years (QALYs).

The relationship between life expectancy and quality-adjusted life expectancy is the proportionate reduction in quality of life resulting from being in a health state that is worse than perfect health. For the example in Table 1, the utility (patients' preference for a given health state relative to perfect health, on a scale from 0 to 1, with a value of 1 being equivalent to perfect health and a value of 0 being equivalent to death) of patients treated with treatment A is 0.80 and that for patients treated with treatment B is 0.90. The quality-adjusted life expectancy is calculated by multiplying the life expectancy by the utility value for the given health state (for example, for treatment A, 4.5 years $\times$ 0.80 = 3.6 QALYs; for treatment B, 3.5 years $\times$ 0.90 = 3.15 QALYs). Several techniques have been developed for measuring health-state utilities such as the standard gamble, the time trade-off, and the multi-attribute utility function (2-6). By measuring outcomes in terms of utility, the investigator can combine several different health states that patients may experience over a period into a single number.

Benefits convert the clinical outcomes into dollars (such as the patient's "willingness to pay" or the use of a patient's wages or income as a measure of worth). Because the conversion requires several value judgments that are based on controversial issues, investigators often prefer using utility over benefits as a measure of outcome.

Although effectiveness (when measured by life expectancy) may be easier to understand than utility, it does not reflect important clinical outcomes affecting quality of life. For example, the use of chemotherapy after resection of a lung tumor may have a considerable effect on quality of life that is missed if one uses life expectancy as a measure of outcome. Thus, clinical investigators are more often using cost-utility as the method of estimating efficiency of clinical interventions (2). However, although techniques for measuring utilities and quality of life are improving, there is still considerable skepticism about their use, particularly among clinicians who are not familiar with these concepts.

Table 1 also shows the three types of incremental or marginal cost-effectiveness ratios (that is, cost-effectiveness, cost-utility, and cost-benefit) that correspond to the three different measures of clinical outcomes. The incremental cost-effectiveness ratio is calculated by dividing the difference in costs between therapeutic strategies by the difference in life expectancy. The incremental cost-utility ratio is the cost difference divided by the difference in quality-adjusted life expectancy. The incremental cost-benefit ratio is the cost difference divided by the difference in benefits. Because both costs and benefits are measured in dollars, this last ratio has no units. In the context of cost analysis, the terms incremental and marginal are synonymous and indicate that both the numerator and denomi-

nator represent differences in costs and outcomes between treatment A and treatment B.

Using Cost-Effectiveness or Cost-Utility Ratios to Set Priorities

Measuring individual incremental cost-effectiveness, cost-utility, or cost-benefit ratios is only the first step in determining whether the funding of a specific health-care program is an efficient use of scarce resources. Such a determination would require comparing the incremental ratio for a specific program with those of other health care interventions. That is, incremental cost-effectiveness ratios are only useful in creating a rank-order list for setting funding priorities across programs that are competing for scarce resources. Each individual ratio is of no use by itself; it must be compared with the ratios associated with other programs. The priority list resulting from ranking the incremental cost-effectiveness ratios across programs helps the policy maker maximize the net health benefit that can be achieved from a fixed amount of scarce resources.

Consider the following simple example with only two programs competing for resources. If we had \$2 million per year that could go toward reducing mortality from cardiovascular causes and had two competing proposals, we could use cost-effectiveness analysis to prioritize the programs. One hypothetical program aims at reducing cardiovascular mortality by screening persons for their lipid status and implementing a program to reduce cholesterol by diet or pharmacologic intervention. The alternate strategy would be no screening or treatment program. A second program might involve the use of aspirin in middle-aged men who have a strong family history of premature deaths from coronary disease compared with the alternate strategy of not using aspirin for this target population. If the incremental cost-utility ratio associated with the cholesterol screening program was \$50 000 per quality-adjusted life-year extended and the incremental cost-utility ratio for the aspirin strategy was \$10 000 per quality-adjusted life-year extended, then we could save five times as many quality-adjusted life-years by investing the resources in the aspirin program compared with the cholesterol screening program.

Table 2 shows an example of a more complex set of allocation decisions for a health planner who is responsible for the allocation of resources within an acute care facility such as a hospital or HMO. After all of the initial allocation decisions have been made for this facility, the health planner decides to allocate an additional \$2.4 million to new programs within the facility. Three groups approach him with new clinical programs for the facility, each of which has been shown to be effective in increasing quality-adjusted life expectancy. The three groups are the hematologists who want to begin a program of bone marrow transplantation for acute nonlymphocytic leukemia; the radiologists who want additional funds to convert from high osmolar to low osmolar contrast agents; and the neonatologists who want to expand the neonatal intensive care unit.

The policy maker for the institution asks each group to prepare a report documenting the economic con-

Table 2. Economic Consequences of Funding Five Health Care Programs*

Program	1 Incremental Cost-Utility Ratio ($\Delta C/\Delta Q$)	2 Incremental Costs per Patient ($\Delta C/\text{Patient}$)	3 Incremental Quality- Adjusted Life-Years per Patient ($\Delta Q/\text{Patient}$)	4 Total Number of Patients in the Facility	5 Total Incremental Cost per Year	6 Incremental Quality-Adjusted Life-Years Gained (ΔQ) per Year if Funded
	\$	\$			\$	
Neonatal intensive care unit for 1000- to 1499-g babies	5100	8600	1.7	200	1 720 000	340
Low osmolar contrast media for high-risk patients	22 600	22.6	0.0010	30 000	678 000	30
Neonatal intensive care unit for 500- to 999-g babies	30 900	17 900	0.58	100	1 790 000	58
Bone marrow transplant for acute nonlymphocytic leukemia	59 300	57 000	1.12	50	2 850 000	56
Low osmolar contrast media for low-risk patients	220 000	60.55	0.0003	70 000	4 238 500	21

* $\Delta C/\Delta Q$ = incremental cost-utility ratio; ΔC = incremental costs; ΔQ = incremental quality-adjusted life-years.

sequences of funding their program that includes the expected incremental costs and incremental health benefits achieved by funding the programs. The neonatologists and radiologists are asked to stratify their data in order to document the incremental cost effectiveness separately for each stratum. For the neonatologists, the two strata are low birth weight (1000 to 1499 g) babies and very low birth weight (500 to 999 g) babies. For the radiologists, the strata are patients at high risk for developing an adverse reaction to contrast media (approximately 30% of the patients) and patients at low risk for such a reaction (approximately 70% of the patients).

The resulting data from published sources (7-9) are shown in Table 2. The first column shows the incremental costs per QALY associated with each program. The program at the top of the list is associated with the lowest ratio and each successive program is associated with a higher ratio. Each program compares the use of the strategy listed in the table with an alternate strategy (for example, low osmolar compared with high osmolar contrast agents, bone marrow transplantation compared with traditional chemotherapy, neonatal intensive care compared with routine care in the hospital) and thus the figures in the first three columns are incremental. The second column shows the incremental costs required to implement the program on a yearly basis for each patient. These costs are different from the incremental cost-utility ratios as they are the average incremental costs of delivering the health care intervention to individual patients on a per year basis; that is, they are the numerators of the cost-utility ratios. The third column represents the average incremental QALYs per patient that can be expected to result from implementing the health care strategy, that is, the denominator of the cost-utility ratios.

If the objective of the policy makers is to maximize the net positive health benefit from the allocation of resources across these scarce programs, this list will help them set priorities to determine which program should be funded ahead of the others. Column 4 shows a hypothetical number of patients who could be treated

in this facility per year with the new intervention. Column 5 displays the total incremental costs that must be allocated to fund the new program fully. These costs are derived by multiplying the value in column 2, which represents the incremental cost per patient, times the value in column 4, representing the number of patients per year. Column 5 shows the total number of QALYs gained per year if the program is fully funded. This number is derived by either multiplying the numbers in column 3 and column 4 or, alternatively, by dividing the number in column 5 by the number in column 1 (these are equivalent expressions).

If the health planners have at their disposal \$2.4 million to allocate across these programs, they should fund the programs from the top of the list down (that is, from lowest to highest cost-utility ratios) until the budget is exhausted. This strategy gives the allocation pattern which maximizes the total gain in QALYs for a fixed budget. In this example, priority should be given to the top two programs, the neonatal intensive care unit for low birth weight babies and low osmolar contrast media for high-risk patients. This would exhaust the budget of \$2.4 million (with \$2000 to spare) and would yield an additional 370 QALYs for the patients served by the facility. Any other distribution of resources across the programs would result in a smaller number of incremental QALYs. For example, if the bone marrow transplant program was funded instead of the top two programs, this would use up slightly more than the \$2.4 million budget for the facility, and the net gain would only be 56, instead of 370, QALYs.

Average Compared with Incremental Cost-Effectiveness Ratios

As noted earlier, the cost-utility ratios listed in Table 2 are all incremental (marginal), meaning that each ratio's numerator represents a difference in cost and each ratio's denominator signifies the difference in utility between the two strategies for treating the same patients (for example, low osmolar compared with high osmolar

agents). Many publications of economic analyses report and compare "average" cost-effectiveness ratios. It is important to understand the difference between these two types of ratios (10). Average cost-effectiveness ratios are derived by dividing the average cost of treating patients with that strategy by the average outcome per patient. For Table 1, the average cost effectiveness of treatment A would be \$20 000/4.5 years, the average cost utility would be \$20 000/4.0 QALYs, and the average cost benefit would be \$20 000/\$2000. Table 3 compares the average and incremental cost-utility ratios for low osmolar contrast media for high-risk patients. The average cost-utility ratio is \$1.23 (\$36.98/29.9996 QALYs) and the incremental cost-utility ratio is \$22 600 [(\$36.98 - \$14.39)/(29.9996 QALYs - 29.9986 QALYs)]. Conceptually, the difference between these two types of ratios is that the incremental cost-effectiveness ratio reveals the cost per unit of benefit of switching from one treatment strategy (usually already in operation) to a new strategy, whereas average cost effectiveness reflects the cost per benefit of the new strategy independent of alternative strategies.

Although average cost-effectiveness ratios may be easily calculated, they cannot be used to set priorities for allocating scarce resources across programs in order to maximize the net health input. Table 4 shows why this is so: It displays the average costs and average QALYs for each of the interventions in Table 2, listed in the same order dictated by ranking of incremental cost-utility ratios. The average cost, average QALY, and average cost per QALY ratio were derived from information contained in the original publications of these reports. Column 5 of the table shows the rank ordering based on average cost-utility ratios.

The reader will immediately note the discrepancy between the average compared with the incremental cost-utility ratios themselves and the rank ordering. If the average cost-utility ratios are used to rank order programs, low osmolar contrast media for high-risk and low-risk patients would be funded. The program with the least attractive incremental cost-utility ratio (low osmolar contrast media for low-risk patients) would be funded ahead of the program which is most attractive from the incremental cost-utility ratio point of view (neonatal intensive care for low birth weight infants). In fact, funding low osmolar contrast media for both low-risk and high-risk patients would exhaust the entire \$2.4

million budget and would be over budget by close to \$3.6 million. Further, this would yield a much lower positive health benefit than if funds were allocated on the basis of incremental cost-utility ratios. That is, the total number of QALYs gained from completely funding low osmolar contrast media would be considerably fewer than the QALYs gained from funding neonatal intensive care for low birth weight infants and low osmolar contrast media only for high-risk patients (51 compared with 340).

Thus, although average cost-effectiveness ratios are easy to calculate, they cannot be used to set priorities for funding decisions if the objective is to maximize the net health benefit from a fixed budget, because they do not compare the costs and outcomes of alternate therapeutic strategies that exist for dealing with patients in a given health state. They are often presented in published reports of economic analyses, and care must be taken not to confuse them with incremental ratios. Of course, the average ratios are equal to the incremental ratios if both the costs and clinical outcomes associated with the alternate therapy (for example, treatment B) are both zero. In these circumstances, the difference in costs between the two therapies equals the cost of treatment A and the difference in clinical effects also equals the effects associated with treatment A. There are, however, very few clinical circumstances where the alternate therapeutic strategy for patients results in both zero costs and zero clinical outcomes. Even a "do nothing" strategy results in some costs and effects.

Caveats Regarding Cost-Effectiveness Ratios

Health planners who use the information obtained in Table 2 to set priorities will note that the entire exercise depends on the validity and reliability of the incremental cost-effectiveness or cost-utility ratios used to set priorities. These ratios are estimated by investigators who may or may not follow a consistent methodologic approach. Major areas of methodologic inconsistency include the measurement techniques used for utility or quality-of-life assessment and the methods used for estimating costs. Cost-effectiveness studies also vary with respect to the "time horizon" (that is, the length of time into the future considered in the analysis) over which costs and outcomes are projected.

The three published reports on which the cost-utility

Table 3. Average Compared with Incremental Cost-Utility Ratios for Low Osmolar Contrast Media for High-Risk Patients

Strategy	Treatment Costs	Quality-Adjusted Life-Years
Strategy under consideration		
Low osmolar contrast media only for high-risk patients	\$36.98	29.9996
Alternate strategy		
High osmolar contrast media for all patients	\$14.39	29.9986
Average cost-utility ratio for low osmolar contrast media for high-risk patients	$= \frac{\$36.98}{29.9996} = \1.23	
Incremental cost-utility ratio for low osmolar contrast media for high-risk patients	$= \frac{\$36.98 - \$14.39}{29.9996 - 29.9986} = \$22\ 600$	

Table 4. Average Compared with Incremental Cost-Utility Ratios

Program	Average Cost	Average QALY*	Average Cost/QALY Ratio	Incremental Cost/QALY Ratio	Rank According to Average Cost/QALY	Rank According to Incremental Cost/QALY
	\$			\$		
Neonatal intensive care unit for 1000- to 1499-g babies	20 700	8.1	2555	5100	3	1
Low osmolar contrast media for high-risk patients	36.98	29.996	1.23	22 600	1	2
Neonatal intensive care unit for 500- to 999-g babies	19 900	1.8	11 055	30 900	4	3
Bone marrow transplant for acute nonlymphocytic leukemia	193 000	3.32	58 132	59 300	5	4
Low osmolar contrast media for low-risk patients	97.53	29.999	3.25	220 000	2	5

* QALY = quality-adjusted life-years.

ratios shown in Table 2 are based used entirely different methods of estimating quality of life. The study on neonatal intensive care used a multi-attribute utility function based on interviews of parents. The study on low osmolar contrast media made arbitrary assumptions about quality of life for patients after they have contrast reactions (that is, the authors estimated utilities without measuring them). An examination of the study on bone marrow transplantation shows that, in fact, quality of life was not considered at all. The hematologists who presented the data from this study to the health planner made the mistake of confusing a cost-effectiveness analysis for a cost-utility analysis.

As noted above, the science of measuring preferences, utilities, and quality of life has advanced considerably in the last 10 years, but there is still considerable controversy over which measurement technique or techniques should be used in carrying out cost-utility studies. It is not clear whether a comparison of cost-utility ratios across programs is valid if different measures have been used to estimate utilities (11, 12). This uncertainty raises concerns about using cost-utility ratios to set funding priorities across competing programs, unless the methods for establishing these ratios are standardized.

Estimates of the cost side of the ratio are also subject to skepticism. Do all of the ratios reflect the same costing methodology? Do they all consider true costs as opposed to charges (13)? Do they all "discount" future costs to the same degree (that is, do they consider that dollars spent or saved in the future are not weighed as heavily as dollars spent or saved in the present) (14)? Are some costs included in some of the studies (for example, costs outside of health care delivery for the neonatal intensive care unit study) and not included in others?

Finally, all of these ratios require projection of what would happen to patients over a specified time horizon. Given that patients in the clinical studies on which the estimates are based have not been observed over their lifetime, how long a time horizon should be chosen? The bone marrow transplantation paper uses a 5-year time horizon. The authors of that paper also included a

lifetime horizon. The lifetime calculation raises concern because it projects events into the future which clearly cannot be known now. The neonatal intensive care unit study projects costs to 12 years. The radiocontrast media paper projects utilities for a 30-year period, assumed to be the life expectancy of the average patient. These examples indicate the variability of the time frames used for different cost-effectiveness and cost-utility ratios and raise doubts about the validity of some of these ratios due to uncertain projections into the future.

To get around some of the uncertainties in estimating costs and utilities, most analyses will present ranges for cost-utility ratios based on "sensitivity analysis." Sensitivity analysis is a method for testing the stability of a cost-utility ratio over a range of estimates and assumptions (15). In doing a sensitivity analysis, a range of cost-utility ratios is calculated by substituting a range of estimates for each of the variables of the cost-utility ratio. Sensitivity analysis does not account for methodologic differences between studies, so those who use cost-utility ratios for setting priorities must be aware of potential methodologic difficulties that may invalidate a comparison of the ratios across programs.

Distributional Consequences of Allocation Decisions

We have shown that the choice of allocating funds across programs will affect the total net positive health impact for a group of patients served by the facility. It is important to note, however, that the choice of allocating funds across programs also has an effect on the distribution of benefits to groups of patients; that is, some gain and some lose. The use of cost-effectiveness analysis to forego funding of a bone marrow transplant program will result in losses for patients with acute nonlymphocytic leukemia and gains for patients who receive the funded interventions. The decision maker or group of persons making decisions for the organization may value a positive health effect for some patients served by the facility to a greater degree than gains achieved by others. If the measurement of incremental cost-effectiveness ratios across programs is done in a consistent fashion, the rank order list shown in Table 2

will be neutral to these value or distributional considerations: They value incremental QALYs for all persons equally.

Many factors may influence the relative value placed on saving lives or life-years for different segments of the population. Programs aimed at helping children are often valued more than programs aimed at other segments of the population. Programs with identifiable beneficiaries or victims (for example, transplantation programs) are often favored by an institution or the public compared with programs where specific beneficiaries are never identified (for example, disease prevention or screening programs).

Distributional issues are also seen on the provider side. For example, the hematologist will benefit financially from having the facility fund a transplantation program. The failure to fund the conversion of radio-contrast media from high osmolar to low osmolar agents may raise the malpractice premiums of radiologists or, by increasing the time needed to do procedures because they must deliver the contrast agents more slowly, reduce their incomes.

The position of the institution may have an important influence on resource allocation decisions that are independent of cost-effectiveness considerations. For example, an institution that sees itself as the main provider of tertiary care may wish to fund a program such as bone marrow transplantation and neonatal intensive care ahead of screening or immunization programs (not shown on Table 2). Alternatively, an institution that sees itself as the caregiver for an underprivileged segment of the population may have as its objective raising the health status of that segment to a minimally acceptable level rather than improving the health status of another segment that already exceeds that minimum.

Finally, historical or political factors may have substantial influence on funding or allocation decisions. For example, in 1986, an Ontario consensus conference on the use of low osmolar radio-contrast agents recommended funding the provision of this media for both high- and low-risk patients despite the unfavorable cost-utility ratios associated with low-risk patients (7). This decision was greatly affected by two widely publicized deaths related to contrast agents, the subsequent coroner's inquest, and the provincial government's unwillingness to put itself at political risk despite the cost. For the lack of a better term, we will label these influences as "political."

Thus, the influence of distributional or political considerations or both may dictate an allocation of resources across programs that is not consistent with the priorities determined by cost-effectiveness ratios. As such, the allocation of resources will not maximize the net positive health impact derived from scarce resources. Nevertheless, from a societal or organizational point of view, this allocation may still be rational; it meets a different objective, namely favoring certain segments of the population.

It might be said that efficiency considerations and distributional considerations are independent of each other and that those who allocate resources may often ignore efficiency considerations because of overwhelming distributional or political issues, or both. Alternatively,

it might be said that if the decision maker has an objective other than maximizing the net societal benefit from a fixed amount of resources (for example, maximizing the number of patients treated regardless of relative effectiveness, achieving re-election, avoiding liability exposure), then cost-effectiveness analysis using a societal perspective (that is, considering all the costs and benefits attributed to all members of society) will not be relevant. Of course, cost-effectiveness analysis can be done from the perspective of some of the decision makers in society by using the same analytic framework. From the perspective of a third-party payer, for example, the costs and benefits that accrue to patients may not be relevant, but a cost-effectiveness analysis could still be useful for the third-party payer if it included only the costs and benefits that accrue to the payer.

Because few decision makers actually have the objective implied in cost-effectiveness analysis and even those who do rarely have a societal perspective (that is, include all members of society in their scope of concern), it is not surprising that societal cost-effectiveness analysis has been infrequently used to set policy. Nevertheless, cost-effectiveness measurement may be part of the evaluation of a new technology by pointing out the consequences of allocating resources to new programs. Recently, however, those responsible for setting allocation policies have started to look more closely at the technique in order to support their decisions. The U.S. Health Care Financing Administration, for example, has recently proposed the inclusion of cost-effectiveness as a criterion for funding (16).

Relevance to Clinicians

This type of economic analysis has a very limited role in the care of individual patients by individual clinicians. When patients seek care from practitioners they expect them to choose an intervention that will be of net benefit to them without considering alternate uses of those scarce resources for other patients. Specifically, we have pointed out that cost-effectiveness analysis results from the tension between those who wish to maximize effectiveness for individual patients and those who wish to minimize costs. The allocation decision across possible interventions results in resources going to one type of patient as opposed to another.

Individual practitioners cannot be put in the position where they must make these kinds of value judgments; it is probably inappropriate therefore to consider cost-effectiveness considerations in most individual clinical circumstances. Clinicians dealing with individual patients do not share the objective implied in cost-effectiveness analysis. They are not concerned with maximizing the net health benefit derived from a fixed budget for all patients served by the facility. Their "primary concern [is] the welfare of patients under [their] care" (17). This difference in perspective may explain why clinicians react with hostility when presented with cost-effectiveness analysis, as shown in the following quote: "Goel and colleagues should confine themselves to their mathematical model and not make judgemental

statements about physicians trying to do the best for their patients" (17).

The exception is the "life boat scenario" where patients are in a queue for a scarce resource such as the sole bed remaining in a coronary care unit on a given day. It is usually expected that those who have the most acute need for the resource will receive it ahead of those who have a less acute need. Even in this situation, however, distributional considerations and value judgments may well play a major role in deciding who benefits from the scarce resource.

If cost-effectiveness analysis is not relevant to individual practitioners when dealing with individual patients, then for whom is it relevant? It is relevant for persons who are responsible for allocating resources across programs for groups of patients, including policy makers, administrators, and clinical practitioners who provide input to such decision making bodies. Some practitioners may also be administrators in their organizations. Practitioners in this dual role have the objective of maximizing the health outcomes for their individual patients when functioning as clinicians and the potentially competing objective of maximizing collective benefits for all patients served by the organization when functioning as administrators. We emphasize that these physicians are not obligated to hold these competing objectives simultaneously (for example, when caring for individual patients); rather, they must pursue these competing objectives separately as they act in their different roles.

Summary

Cost-effectiveness analysis aids policy makers seeking to allocate scarce resources across competing uses. They will be better able to set priorities for funding if they have the perspective and objective of a cost-effectiveness analysis, namely, to maximize the net health benefit to a target population from a fixed amount of resources where gains and losses to all persons in the target population are valued equally. If the decision maker does not have that perspective (for example, he or she is an advocate for only one patient or one group of patients in the target population), does not have that objective (for example, maximum health benefit is not the goal), is not constrained by a fixed amount of resources, or does not value all persons equally, cost-effectiveness analysis is not the method to help set priorities.

Although clinicians may not have direct responsibility

for allocating scarce resources in their organization, they must operate under the consequences of those policies and decisions. Consequently, they may wish to help those who do have direct responsibility for those decisions. Clinicians should therefore clearly understand cost-effectiveness analysis and its caveats even though it is not an analytical tool that they use in making decisions for their own patients.

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Requests for Reprints: Allan S. Detsky, MD, PhD, Toronto General Hospital, EN G-246, 200 Elizabeth Street, Toronto, Ontario M5G 2C4.

Current Author Addresses: Drs. Detsky and Naglie: Division of General Internal Medicine and Clinical Epidemiology, Toronto General Hospital, 200 Elizabeth Street, Toronto, Ontario M5G 2C4.

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