

Primer on Cost-Effectiveness Analysis

Cost-effectiveness analysis (CEA) is a technique for selecting among competing wants wherever resources are limited. Developed in the military, CEA was first applied to health care in the mid-1960s and was introduced with enthusiasm to clinicians by Weinstein and Stason in 1977:

"If these approaches were to become widely understood and accepted by the key decision makers in the health-care sector, including the physician, important health benefits or cost savings might be realized."

Regardless of whether this hope was realized, CEA has since become a common feature in medical literature.

The Basics of CEA

CEA is a technique for comparing the relative value of various clinical strategies. In its most common form, a new strategy is compared with current practice (the "low-cost alternative") in the calculation of the cost-effectiveness ratio:

$$\text{CE ratio} = \frac{\text{cost}_{\text{new strategy}} - \text{cost}_{\text{current practice}}}{\text{effect}_{\text{new strategy}} - \text{effect}_{\text{current practice}}}$$

The result might be considered as the "price" of the additional outcome purchased by switching from current practice to the new strategy (e.g., \$10,000 per life year). If the price is low enough, the new strategy is considered "cost-effective."

It's important to carefully consider exactly what that statement means. If a strategy is dubbed "cost-effective" and the term is used as its creators intended, it means that the new strategy is a good value. Note that being cost-effective does not mean that the strategy saves money, and just because a strategy saves money doesn't mean that it is cost-effective. Also note that the very notion of cost-effective requires a value judgment—what you think is a good price for an additional outcome, someone else may not.

It's also worthwhile to recognize that CEA is only relevant to certain decisions. Table 1 delineates the various ways a new

TABLE 1
Conditions under Which CEA Is Relevant

EFFECTIVENESS	COST	
	NEW STRATEGY COSTS MORE	NEW STRATEGY COSTS LESS
New strategy is <i>more</i> effective	CEA relevant	Adopt new strategy
	New strategy is "dominated"	CEA relevant

strategy might compare with an existing approach. Note that a CEA is relevant only if a new strategy is *both* more effective and more costly (or both less effective and less costly).

An Example

Consider two strategies intended to lengthen life in patients with heart disease. One is simple and cheap (e.g., aspirin and β -blockers); the other is more complex, more expensive, and more effective (e.g., medication plus cardiac catheterization, angioplasty, stents, and bypass). For simplicity, we will assume that doing nothing has no cost and no effectiveness. Table 2 shows the relevant data.

Note that CEA is about marginal (also called incremental) costs and benefits. So the marginal cost of a simple strategy is the difference between the cost of that strategy and the cost of doing nothing. The marginal cost for the complex strategy is the difference between the cost of the complex strategy and the cost of the simple strategy (not the cost of doing nothing). The calculation is similar for effectiveness. The final outcome measure for the analysis is the CE ratio: the ratio of marginal cost to marginal effectiveness.

TABLE 2
A CEA Examining Three Strategies

STRATEGY	COST	MARGINAL COST	EFFECTIVENESS	MARGINAL EFFECTIVENESS	CE RATIO
Nothing	\$0	—	0 years	—	—
Simple	\$5000	\$5000	5 years	5 years	\$1000/yr
Complex	\$50,000	\$45,000	5.5 years	0.5 years	\$90,000/yr

TABLE 3
A CEA Examining Two Strategies

STRATEGY	COST	MARGINAL COST	EFFECTIVENESS	MARGINAL EFFECTIVENESS	CE RATIO
Nothing	\$0	—	0 years	—	—
Complex	\$50,000	\$50,000	5.5 years	5.5 years	\$9091/yr

Things To Ask

If a study is of interest and its primary outcome is a cost-effectiveness ratio, critical readers should seek answers to the following questions.

1. Are the relevant strategies being compared?

Because CEA involves marginal cost and benefits, the choice of which strategies to compare can drive the calculation and the conclusion of a CEA. Consider the effect of repeating the above analysis *without* the simple strategy (Table 3).

By excluding the simple strategy, the CE ratio for the complex strategy falls from \$90,000 per life-year to \$9091 per life-year.

Thus, CEA is very sensitive to the choice of strategies being compared. Readers need to carefully consider whether the choice being presented is really the choice that interests clinicians.

2. How good are the effectiveness data?

It's hard to get too excited about cost-effectiveness if the effectiveness of the strategy is really unknown. So as a first step, the critical reader should examine the information used for effectiveness. Ideally, the data should come from randomized trials. If they don't, you'll want to scrutinize the face validity of the assumptions. Unfortunately, sometimes the analyses get way ahead of the data (one CEA was published on autologous bone marrow transplantation in metastatic breast cancer 8 years before a randomized trial showed no benefit).

3. Do the effectiveness data reflect how the strategy will be used in the real world?

Even if the effectiveness data are from randomized trials, it's important to ask whether they really pertain to the population and setting in which the strategy is likely to be applied. Consider a CEA of carotid endarterectomy in asymptomatic patients with more than 70% stenosis. If the trial data represent the best surgical practice while broad implementation of the strategy would involve community providers, then effectiveness is being overestimated—as is cost-effectiveness. A similar problem may occur if the trials involve patient selection criteria that are not easily replicated in practice. A critical reader of CEAs should carefully consider the generalizability of the effectiveness data.

4. Where do the cost data come from?

The basic question here is, "Was resource use modeled, or was it measured in real practice?" In modeling, investigators have to make assumptions about which services are likely to be utilized differently—thus driving the difference in cost. The measurement of resource use in practice has the advantage of capturing utilization that may not be anticipated by investigators (e.g., extra testing, extra visits, readmissions).

In either approach, there can be considerable debate about how to attach dollar amounts to utilization counts (debates that can get very tedious very quickly). Critical readers should look at the utilization counts themselves and have some confidence about the face validity of the dollars attached to them (probably the most practical standard being the Medicare fee schedule/allowed charges). If more utilization doesn't equal more money, something's wrong.

5. Who's funding the CEA?

Unfortunately, funding sources seem to matter. There is now considerable evidence that researchers with ties to drug companies are indeed more likely to report favorable results than are researchers without such ties. Because they are so sensitive to both the choice of strategies and assumptions, CEAs are particularly susceptible to bias—intentional or not. Consequently, some journals have chosen not to publish industry-supported CEAs. For those that are published, readers must consider the conflict posed by funding from a manufacturer of one of the analyzed strategies.

6. Did we get anywhere?

Finally, readers may want to consider whether the entire exercise somehow helped them with a decision. Although some CEAs have extremely high CE ratios (i.e., > \$200,000 per quality-adjusted life-year—a poor value) and others have very low CE ratios (i.e., < \$10,000 per quality-adjusted life-year—a good value), most fall somewhere in the middle. Analyses with CE ratios of \$50,000 per quality-adjusted life-year may conclude with an assertion that the analyzed strategy is "cost-effective." Whether or not this helps anyone make a decision is hard to know.

Suggested Reading

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