

Review Article

Cost-effectiveness analysis for decision making in health care-concept, relevance and methodological challenges

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Received: 24 May 2017

Accepted: 12 June 2017

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ABSTRACT

With continuous rise in health spending among countries, the need to make use of limited resources in health systems has become crucial. Health policy makers in countries strive to identify the interventions which can contribute to improving health outcomes. Techniques of economic evaluation, especially cost effectiveness analysis (CEA) have been widely applied in health sector to identify interventions that are more effective in terms of resources utilization. An understanding of CEA will not only help policy makers to take appropriate decisions in health sector but also in judicious spending of scarce resources. However, CEA studies have been flaunted with series of methodological challenges and practicability issues. This paper provides an introduction to CEA as one of the techniques of economic evaluation of health interventions and its relevance in making decisions in health sector. The paper also discusses some of the practical issues that arise while doing a CEA study in the health sector.

Keywords: Cost, Effectiveness, Public health policy, Health interventions

INTRODUCTION

Last few decades witnessed a tremendous increase in health spending across many countries. As the countries continue to spend substantial share of their budgets on health care, it is paramount to ensure that these budgets are spend efficiently. Faced with resource crunch, decision makers in health sector need to identify the health interventions that contribute the most in improving health of the populations. Different techniques of economic evaluation are applied in health sector for informed decision making.¹ Major techniques are cost minimization analysis (CMA), cost effectiveness analysis (CE), cost benefit analysis (CBA), cost utility analysis (CUA). CMA is mainly applied in evaluations where

different interventions are expected to yield similar outcomes.^{1,4} CEA is generally applied in the health sector, to guide decision makers in identifying interventions that contribute most to health improvement.^{1,4} CBA considers monetary values on both costs and benefits of interventions.^{1,6} It includes both treatment and consequent costs.^{1,2,5,6} However, this technique is not commonly used in health care due to many challenges in valuing health benefits in monetary terms.^{1,4} CUA uses utility based outcome units to compare different interventions.^{1,4} Generally, it measures patient outcomes in quality adjusted life years (QALYs).^{3,5}

This paper provides an introduction to CEA as one of the techniques of economic evaluation of health interventions

and its relevance in making decision in health care. It also discusses some of the methodological challenges that arise while doing a CEA study in the health sector.

COST-EFFECTIVENESS ANALYSIS

CEA has been the most commonly used technique of economic evaluation in the health sector.^{1,3} In CEA we estimate the costs and effects of health interventions and sum up the results in cost-effectiveness ratios (CERs). Generally, the effect of health interventions are measured in natural units such as diseases prevented, life years gained, number of lives saved. As a general measure of health outcome, mostly quality adjusted life years (QALYs) is used to compare health interventions.

CER of an intervention can be calculated in the form of average cost effectiveness ratio (ACER) or incremental cost effectiveness ratio (ICER).¹⁻⁵ While ACER refers to single intervention, ICER is the ratio of difference in cost between two alternate interventions to the difference in effectiveness between these alternatives. It is the extra cost of the additional service divided by the extra outcome or effectiveness. Once the ICER of an intervention is calculated it can be compared with a threshold level above which interventions are considered to be cost effective.^{3,4} WHO recommended using a willingness-to-pay threshold defined by the nation's GDP.⁷ Where interventions falling under one GDP per capita are considered highly cost-effective and interventions with an ICER below three GDP per capita are considered cost-effective.⁸

In order to assess the cost-effectiveness (CE) of a new intervention, we need to compare an intervention at least to another intervention with similar expected outcome. A new intervention can be compared to another commonly accepted intervention and two estimates are made: the extra cost and the extra effect of the interventions. There can be four possibilities exist for the new intervention: (i) it can be more costly and more effective, (ii) more costly and less effective, (iii) less costly and less effective, and (iv) less costly and more effective. Usually, treatment that fall into the fourth category is considered cost effective. However, while applying to the clinical decisions, the treatments that fall into the other two categories: more costly but more effective and less costly but less effective may be considered on judgement basis.⁹

One can estimate the additional cost per one unit (ΔC) of additional effect (ΔE).¹⁻⁵ The extra cost per extra unit of effectiveness ($\Delta C/\Delta E$) represents the incremental cost-effectiveness ratio (ICER) for strategy A compared to strategy B.¹

$$ICER = \frac{\text{Cost (A)} - \text{Cost (B)}}{\text{Effect (A)} - \text{Effect (B)}} = \frac{\Delta C}{\Delta E}$$

ICERs can be compared with those of other interventions or with a threshold value representing what is considered cost-effective.⁹

Whenever, a new intervention or treatment is considered, it may not replace all existing services or therapies. In this context, it is important to study what additional benefits are added from the additional cost of new intervention or treatment.² Figure 1 shows a graphic representation of ICERs with the help of cost-effectiveness plane.

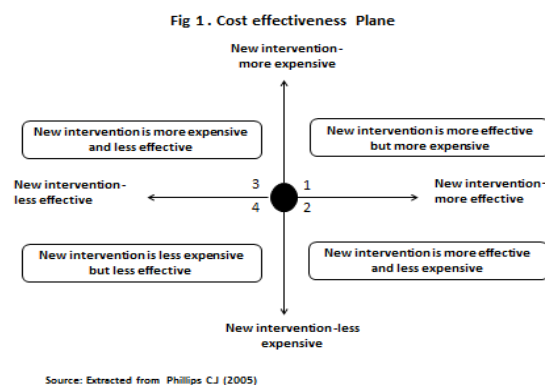


Figure 1: Cost effectiveness plane.

Figure 1 shows that interventions whose CERs are placed in quadrant-3 should not be considered because these interventions result in a decrease in effectiveness and requires additional costs. Interventions those are in quadrant-4 result in reduction in effectiveness but save some resources. However, interventions whose CERs are placed in quadrant-2 result in improvement in effectiveness and also save additional resources that can be spent on other interventions. Interventions located in quadrant-1 are more effective but are more expensive than alternatives. Decision to consider these interventions may depend on availability of resources or accepted threshold levels.²

STEPS IN CEA STUDIES

The following are the major steps involved in a CEA study.

Defining the scope of analysis

Initial step in a CEA study is to define the scope of health interventions. Since CE of an intervention is a relative concept and is compared to other health interventions, it is very critical to understand various types of activities that are undertaken under each intervention and details of costs that are incurred. The scope of a study should be set in due consultations with all stakeholders involved in the intervention such as program managers, health care providers, community, funding agencies both national

and international who will be benefited from the results.^{1,3}

Choosing the perspective of cost analysis

CEA can be conducted in different cost perspectives; provider's perspective or individual patient perspective or social perspective. A societal perspective of CEA takes into account value of all resources that are used in the intervention or program by the society as whole, regardless of who pays for them.¹⁻³ The choice of perspective will considerably affects the results of the study.¹⁻⁵

Identifying effectiveness indicators

Effects of an intervention can be assessed either in terms of outputs (e.g., the number of tests done), intermediate outcomes (e.g., number of malarial deaths prevented) or final outcomes (e.g., illness prevented, life years gained, lives saved). Intermediate outcome are only a partial measurement of effectiveness, but they can be easily measured and interpreted.² QALYs and DALYs are the measures of health outcomes introduced by economists which summarize changes in both the duration and quality of life in a single figure.³

Identifying and valuing costs

The perspective of analysis will determine which costs needs to be identified and measured. The first step is to identify all relevant resources that will be utilized for undertaking an intervention.¹⁰ It is important to capture all type of costs even in provider's perspectives. Cost of health interventions includes health services delivery costs such as cost health personnel, investigations, medicines, other health supplies etc.¹¹⁻²⁰ It can also include costs which are not directly related to service delivery, such as the costs of the building and equipment, costs of health facility administration.¹¹⁻²⁰ Next step is to estimate the amount of the resources used in the interventions and value each resource used in monetary terms. Adding all costs together will give total cost of intervention.

Generally, people like to delay costs as long as possible and receive benefits or outcome as early as possible. In other words, costs and effectiveness should be valued whenever they are actually incurred. Economists use discounting procedure to relate costs that are occurring at different times to a common basis. The principle is that future costs are less expensive than present costs because most people would accept less money to receive it sooner. This rate of interest is called the discount rate. Health interventions, particularly preventive interventions, often will result in lower future medical costs that need to be accounted for in present day term.³ For example, if a treatment for diabetes prevents hospitalization that occurs more in the future, these costs need to be discounted. In CEA analysis, all costs and

effectiveness value should be discounted.¹⁰ Usually future QALYs are discounted at the same rate as costs to avoid accounting problems.³ Most of the studies on CEA applies a discount rate of 5%.¹

The formula used for discounting future costs =
$$\frac{\text{Cost of future event}}{(1+\text{discount rate})^{\text{number of years}}}$$

Calculating CERs

CER provides information for comparison of alternate health interventions. It indicates the amount spend to purchase additional healthy life years with a new treatment or interventions compared with the standard treatment/interventions.^{3,7} If there are two interventions, CER can be estimated by using the following formula:

$$\frac{(\text{cost of intervention 2} - \text{cost of intervention 1})}{\text{QALYs gained 2} - \text{QALYs gained 1}}$$

Here QALYs is used as standard unit effectiveness in both interventions 1 and 2.

Perform sensitivity analysis

The final step in a CEA is to perform a sensitivity analysis. Many of the procedures required to estimate costs and effects involve estimates of data and preferences that are not known with certainty. These may include variation in methodologies and approaches used, parameters used, and uncertainty associated with prediction from observational data.² The sensitivity analysis is the process of deliberately varying these uncertain factors to examine their effect on the decision rule. It is possible to vary these assumptions individually or collectively to see the change in effectiveness or outcome.

DISCUSSION

In almost all countries resources for health care are scarce and therefore appropriate decisions needs to be made for allocation of limited resources to produce optimum health care to population. CEA is considered as a key technique available for decision-makers in all areas including health sector to make use of limited resources to maximize health gains. The technique can be used while comparing one intervention with others like comparison of different interventions for the same disease, comparison of interventions for certain group of patients, or different interventions for different diseases.

However, many methodological challenges arise while assessing effectiveness of public health interventions. Traditionally, CEAs assesses the outcomes of interventions measured in terms of years of life and quality of life gained. CEAs used QALYs, which is a composite measure of burden associated with disease or disability in a given health state, ranging from 0 refers

death to 1 refers perfect health.¹ Subsequently, DALYs was introduced on the basis of burden of disease study conducted by the WHO.^{7,21,22} In DALYs, disability weights, quantified on a scale from 0 (full health) to 1 (death), are used to calculate years of life living with disability and combine with years of life lost due to disability to produce the DALY estimate, accounting for both disability and mortality.⁷ Many of studies in developed countries used QALYs as the measure of benefits as compared to DALYs in developing countries.²³

Most of CEA studies derived QALYs from surveys conducted in different settings. However, there are many limitations in the use of QALYs as outcome measurement, due to the fact that common utility weight does not consider differential in life expectancy across countries.²⁴⁻²⁶ On the other hand, DALYs try to avoid these biases and is preferred over QALYs, particularly in developing countries.²⁴ DALYs are also not free from limitations. The disability weights given in the global burden of diseases has been much debated on theoretical grounds.^{21,24,28-30} Another technical issue is the valuation of benefits overtime, particularly in disease prevention and promotion programmes where benefits will have longer time period as compared to other health intervention which have shorter time period.^{26,31} Further the valuation of outcomes will become more complex, particularly when studies adopt different techniques to compare health interventions over a time horizons.

Most of the studies used to measure the costs from health providers perspectives, health programme perspective or patient perspectives. Studies on health programs, generally consider cost of the programme, especially for design, development and implementation of interventions. It may also include training, communication, monitoring and evaluation etc., at district, regional or national levels. Patient related costs comprise mostly of direct health care costs incurred by the patients at the service delivery points, which include physician fee, medicine cost, investigation cost etc. Many studies do not include non-medical costs like cost of transportation and other indirect costs incurred by patients and care givers, and opportunity cost such as loss to productivity. Generally, in most studies the quantities of resources used were determined on the basis of WHO-CHOICE assumptions.²² The total cost of an intervention was then calculated as the sum of the product of the quantities of resources with their respective unit prices.

An ideal study on economic evaluations needs to consider broader social implications of health intervention on the welfare of the society.^{2,3} CEA can become a controversial tool when taking ethical decision without viewing broader social implications.³ Society refers to everyone who is affected by the intervention, and therefore it should include cost to the health care providers, to patients, their families and also to the rest of society.³ It should also include direct costs, indirect costs and

opportunity costs to the society.^{3,26} However, in reality, social perspectives of cost and effectiveness are not taken into account in most studies due to difficulties of obtaining relevant data or due to time and resource constraints. Moreover, there are issues related to unvalued resources like children, elderly, housewives etc., where the principles of labour market do not hold good.²⁶ Similarly, there are issues related to estimating costing of donated time, goods and services which are often not used, had there been no intervention.²³

There are conflicts with respect to cost effectiveness threshold levels, which is defined in terms of a dollar per QALY gained or dollar per DALY averted. CE threshold levels recommended by the WHO has been used for assessing health interventions, and according to which cost of the intervention per DALY averted lower than three times the country's per capita GDP is considered cost effective.²² Even if an intervention meets a CE threshold, the ICER value does not necessarily reflect the bottom line cost associated with implementation.²⁵ The use of WHO-recommended cost-effectiveness benchmarks of one and three times GDP per capita has been criticized by experts due to lack of theoretical or empirical basis'.^{32,33}

Decision rule such as willingness to pay (WTP), which assigns a monetary value to a given package of health benefits are flaunted with criticisms as these values are based on hypothetical scenarios and are mostly relevant to developed countries.³⁴⁻³⁶ WHO advocates regional GDP as an alternate method to WTP thresholds. Three types of cost-effectiveness is derived based on GDP: highly cost effective interventions having cost less than per capita GDP; cost effective intervention that are between one and three times per capita GDP; and interventions that cost more than three times per capita GDP are not considered cost effective.^{22,34} Again the categorization based on regional GDP thresholds does not consider intra-regional variations and country specific situations and their economic complexities.²⁵ In few countries health programmes are implemented through external support. Application of CE thresholds of health programmes may be undermined in those countries where health interventions are primarily funded by donor agencies with certain specific objectives.^{37,38} In such situations, decision making for allocation of resources for new health programs should also take into consideration the role of external donors.²⁵

CEA is considered as an aid to decision making, not a procedure for making decision.²⁶ In reality, the efficiency with which we spend scarce resources is not the only criteria that need to be considered for making decisions. Even though an intervention may be cost-effective, there are other considerations also play important role in decision making. It is argued that decision making based on CEA should reflect society-specific concern in terms of severity of disease and disability. Severity considerations may be addressed by the use of equity

based weights.³⁹⁻⁴¹ Few studies have also used multi criteria decision analysis to quantify competing priorities of equity and efficiency.^{42,43} While taking decision regarding the new health intervention it is also important to consider factors like ethical issues, budget constraints and logistic factors related to the intervention.²³ Other factors may include implementation aspect of interventions and their ability to address major causes of or health problem or disease. Finally, the political, social, organizational and environmental contexts of the intervention or programme are also considered while making a decision.³¹

CEA can also support decision-making at the patient level.⁹ By understanding the relative costs and effectiveness of available treatment options, physicians can ensure whether they are providing the best possible care for their patients.⁹ Physicians can collect information from various sources when discussing treatment choices with their patients. CEA can also be used as a reference while considering whether or not a treatment is viewed as a good use of resources from the perspective of both providers and payers. With an understanding of economic evaluations, particularly the technique of CEA, physicians can improve their knowledge of the types of treatments available and the extent to which they can be viewed as good value.

In order to develop an evidence based health policy, policy makers should consider incremental effect and cost associated with the alternatives compared to existing interventions.⁴⁴ It is widely accepted that limited number of CEA studies and inadequate information on costs and outcomes are the reasons for not implementing many of the decisions of economic evaluations in developing countries.⁴⁵ Quality and availability of data is a prerequisite for CEA studies and sometimes quality data may not guarantee a good analysis. Again quality of the analysis is subject to methodological limitations and inappropriate application of discounting procedures and sensitivity analysis.

Even if new interventions are comparably better and scalable, but translating the result of CE studies in to resource allocation decision becomes more complex. The relevance and adoptability of CEA results in one setting to another is still debatable though there are examples of such adaptations after adjusting with situations in countries using decision analytic model.² While adapting such results, a wide range of confounding variables relevant to country settings and explicit assumptions need to be considered.

CONCLUSION

Health policy makers in both developed and developing countries are faced with the task of implementing interventions that contribute to improvement in health of populations while allocating limited health care resources. Economic evaluation techniques, especially

CEA can be applied in health sector to identify interventions that are more cost effective. Despite many practical challenges involved, CEA plays a key role in decision making process in the health sector. There are ample evidences that countries have applied CEA to guide their decisions on allocation of resources and to compare the effectiveness of alternative health interventions. Development of refined methodologies, simulation models, and uncertainty analysis has made further improvement in quality of analysis in CEA studies and decision making in health sector. It is therefore imperative for policy makers and professionals in the health sector to understand and develop skills in economic evaluation as part of decision making process in health.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: Not required

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Cite this article as: Nair KS, Jehan M, Albejaidi F, Pasha SA. Cost-effectiveness analysis for decision making in health care-concept, relevance and methodological challenges. *Int J Community Med Public Health* 2017;4:2212-8.