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Smith PG, Morrow RH, Ross DA, editors. Field Trials of Health Interventions: A Toolbox. 3rd edition. Oxford (UK): OUP Oxford; 2015 Jun 1.

Chapter 19 Intervention costing and economic analysis

1. Introduction to intervention costing and economic analysis

This book is focused on intervention trials in which the effectiveness of some new or modified intervention is compared with a control intervention, which would generally be the currently used intervention for a particular disease or condition. At the end of the study, estimates should be available of the impact of the intervention, compared to the control intervention. However, the decision on whether or not to apply the new intervention in a public health programme will be governed not only by the effectiveness of the intervention, but also by its costs. This chapter gives an overview of the main methods used to assess the costs of health interventions and summarizes the types of economic analyses that can be conducted to assist decisions concerning resource allocation to the deployment of health interventions. Just as the statistical design and analysis aspects of a trial will generally require the involvement of a statistician, from an early stage, in the planning of a trial, similarly it is highly recommended that a health economist be involved from the stage of initially planning the trial to advise on how costs should be measured during the course of the trial and on how these will be used at the end for an economic analysis that may ultimately influence whether or not an intervention is implemented on a widespread basis. The chapter is aimed at those who will be working with economists, in order to help design and conduct the economic aspects of a field trial to collect the appropriate data and to obtain the most useful results from an economic analysis.

In the wider scheme of things, governments have to make decisions about resource allocation between health and all the other sectors such as defence, education, and agriculture. Along with social, political, and logistic considerations, economic analyses should be an important component in decision making about those allocations. In general, economic analysis should take into account the benefits of using resources for a proposed action, compared to the use of those resources for any other purpose. However, such broad considerations are well beyond the scope of the present book! Instead, we focus on the more narrow comparison of the costs and benefits of deploying a new or modified health intervention, compared with the currently used intervention.

2. Types of economic analyses

The main types of economic analyses are cost-effectiveness analysis (CEA), cost-utility analysis (CUA), and cost-benefit analyses (CBA). How the results of these different kinds of analysis are expressed is shown in Table 19.1. CEA and CUA are those most commonly used in the analysis of health interventions. The problem with CBA is that it requires putting a monetary value on a life saved.

Analysis of the costs involved in providing the health interventions under comparison in a trial is needed for all three types of analysis. Measurement of these costs can be made in the context of an intervention study, provided due account is taken of the fact that the costs associated with an intervention in a trial may be different from those which would apply if the intervention was applied in a public health programme. It is important therefore to separate out any trial-specific costs that would not be incurred in more widespread deployment of the intervention. For example, often checks are made in a trial that the intervention has been delivered to participants in the appropriate fashion at an appropriate time. Such checks might not be made, or not be made with the same rigour, in the context of the deployment of the intervention in the routine public health system. However, there may be additional costs in the public health deployment of an intervention that would not be incurred in a trial. For example, drugs or vaccines for use in a trial are often donated, whereas, for public health use, they may have to be purchased.

2.1. Cost-effectiveness analysis

CEA has been the most commonly employed type of economic analysis used in relation to randomized trials of health interventions. CEA compares the costs to accomplish a specific technical goal by a new method with the costs of the present method such as the costs per case of a particular disease diagnosed by the new method with the costs per case of disease diagnosed using the current diagnostic method, or the costs of the prevention of a death from a given cause by the new intervention compared to the costs of the prevention of a death with the present intervention. Note that it is the incremental cost-effectiveness ratio that captures the value of the new method being examined, i.e. the difference in costs between the new method and the present method, divided by the difference in effects between the new

method and the present method. This summary measure thus captures the extra cost per additional unit of effect and begs the question ‘is it worth it?’.

2.2. Cost-utility analysis

For CUA, the effects of an intervention are expressed as a measure of ‘utility’. Simply, the utility is a measure of the impact of the intervention on the health status of the individual or population, commonly stated as a combined measure of mortality (amount of life lost due to premature death) and morbidity (amount of life lived with disability, weighted according to its seriousness and duration). Commonly used utility measures are the disability-adjusted life-year (DALY) and the quality-adjusted life-year (QALY) (Hyder et al., 2012).

2.2.1. Disability-adjusted life-years and quality-adjusted life-years

The DALY was first given prominence in the *World development report 1993* (World Bank, 1993) and has become the most widely used composite measure of population health in LMICs. It built on earlier work by the Ghana Health Assessment Project Team (1981) who introduced the similar concept of ‘amount of healthy life lost’, combining measures of the effects of a disease, in terms of life lost both from mortality (expected years of life remaining had the disease not occurred) and from morbidity (severity and duration of disability).

DALYs are calculated by combining the years of life lost (YLL) from premature mortality with the years of life lived with disability (YLD), weighted according to a severity grading. Thus:

$$\mathrm{DALY} = \mathrm{YLL} + \mathrm{YLD}.$$

As originally formulated, the DALY directly incorporated three social value choices: (1) life expectancy values, (2) discount rates for future life, and (3) variable weighting for life lived at different ages. The recent *Global burden of disease report* for 2010, however, has dropped both discounting and age weighting (Murray et al., 2012).

A related measure, the QALY, was introduced in 1976 to provide a guide for individuals to select among alternative tertiary health care interventions (Zeckhauser and Shepard, 1976). The idea was to develop a measure of quality of life that would enable investigators to compare expected outcomes from different interventions, a measure that valued possible health states both for their impact on the quality of life and for their duration. The measure sums the time an individual spends in different health states, using weights on a scale of 0 (in a state equivalent to being dead) to 1 (perfectly healthy) for each health state; it is the sum of arithmetic products of the duration of time spent in a state and a measure of the quality of life in that state. QALYs in modified forms have come into widespread use in the UK (by the UK National Institute for Health and Clinical Excellence), Europe, and the USA (by the US Agency for Healthcare Quality and Research).

Despite distinctly different origins, DALYs and QALYs, with appropriate formulation and comparable parameters, can be considered equivalent indicators to assess intervention utility. However, there are many versions of both DALYs and QALYs, and it is very important to know exactly what is being counted in the study under consideration.

2.3. Cost–benefit analysis

CBA goes a step beyond CEA or CUA and expresses both costs and effects (or utility) of interventions in monetary terms. It directly compares the monetary costs of an intervention with the monetary benefits from the intervention. If the monetary benefits from an intervention exceed the monetary costs, the decision is straightforward in purely economic terms—implement the intervention. For most sectors, other than health, CBA is the standard form of economic analysis, and it lies at the centre of decision making in these sectors. For example, the decision to build a new road would be based on considerations of the cost of building the road, compared to the economic benefits it would bring (which might include reduction of wear and tear on vehicles, increased speed of delivery of people and goods, increase in trade, and also reduction in injuries and deaths from accidents). The aspect that has impeded its use in the health sector is that, in order to use CBA, a monetary value must be placed on human life. Some argue that this is done implicitly in any decision process, but there has been a reluctance to do this explicitly. Nevertheless, it should be recognized that decisions are regularly being taken in both public and private sectors that implicitly do place a monetary value on life. There are several different approaches to valuing human life which may give marked different

results (Australian Safety and Compensation Council, 2008; Viscusi and Aldy, 2003), but further discussion is beyond the scope of this book.

Sometimes, a narrower perspective may be taken with respect to CBA. For example, in consideration of whether the public health service should introduce a vaccine against pneumonia, the costs assessed may be limited to those for the health system. If the vaccine reduces the incidence of pneumonia, the costs of delivering the vaccine to the at-risk population could be compared with the reduction of health service costs from fewer cases of pneumonia to treat. If there is a clear benefit, simply based on a CBA that only considers costs spent and saved by the health system, the decision about the introduction of the vaccine may be relatively straightforward. It becomes more complicated if there is not a monetary saving to the health system (for example, it costs more to deliver the vaccine than the saving in health service costs), but there is a reduction in mortality and/or morbidity in the population. In fact, a 'true' CBA requires a comprehensive and comparable range of inputs and outcomes, all expressed in monetary terms and, for fatal diseases, that would include putting an explicit monetary value on human life at different ages.

3. Framing the analysis

For all types of economic analyses, the perspective, range of inputs and outcomes, and the time frame of all components of the interventions and of their effects should be comparable and explicitly stated. The focus of this chapter is on CEA conducted in the context of randomized trials. For purposes of health intervention assessment, we generally take the perspective of society as a whole and attempt a comprehensive consideration of the range of inputs to be costed and of outcomes to be considered that result from the intervention. The time frame will be the period of time over which these inputs and outcomes will be assessed.

3.1. Perspective

Quantification of the economic consequences of disease and the full costs of an intervention can be viewed from different perspectives, for example, an individual, family (household), community, health system, or government (local, district, national). The societal viewpoint examines the economy as a whole. Though, for some purposes, the perspective of the individual and family or of the health system may be appropriate, taking this narrower view can be misleading and lead to erroneous conclusions about the best use of resources from a societal perspective. For example, the cost to the health service of providing access to treatment at a clinic would be much less than the cost of taking the treatment to patients at home. However, the reverse would be the situation for patients. A societal perspective would take both sets of costs into account.

3.2. Range of inputs and outcomes

The economic consequences (costs) of disease are directly related to the type and extent of disability and, for fatal diseases, to the age at death, with loss of expected healthy life that results from the disease. Ideally, all consequences of disease that the intervention addresses should be tracked (and valued), including loss of work, education, and leisure of the patient, family, and friends, emotional stress, fear, and anxiety. To a large extent, these consequences may be subsumed in measures of utility lost from disease (see Section 2.2).

3.3. Time frame

Generally, time factors involved in assessing the costs of interventions are fairly straightforward, whereas the time factors for assessing the outcomes of an intervention may be much more problematic. For example, the costs of adding hepatitis B vaccine to an immunization programme are immediately expended, but the most important consequences of hepatitis B infection include chronic liver disease and liver cancer that occur many years after the initial infection. Adequate assessment of the impact of a hepatitis B vaccine will require continuing observations of the trial populations for very long periods. Usually, the longer term is modelled, rather than measured. Furthermore, since these gains in healthy life will occur in the distant future, some would argue that their value should be discounted in some way. The key issue related to the time frame concerns the differential timing of intervention costs and intervention effects, and this is particularly problematic if these differ between interventions under consideration (for example, comparing measles vaccination with hepatitis B vaccination). Generally, there is a longer gap between a preventive intervention and realization of its effects than there is with treatment interventions. Whatever the nature of differential timing, discounting should be considered to equate future costs or effects to present costs or effects. It is generally accepted that discounting should be applied to costs, but discussions continue concerning whether to discount future effects and, if so, what rate of discounting to apply (Mathers et al., 2006).

Joint costs are those resources that are shared with other interventions or programmes. Costs frequently shared include buildings and their overhead costs such as for maintenance, electricity, and water. Other types of joint costs might include personnel or equipment such as those involved in diagnostic tests that typically are shared among several interventions. In practice, joint costs are estimated by applying some allocation rule related to the use of the resource. For example, personnel costs can be allocated to the intervention on the basis of the proportion of time devoted to it, vehicle costs according to the proportion of the total distance travelled, and building costs by the proportion of the space used. The notion of joint costs is straightforward, but exactly how best to do that is often problematic. Creese and Parker (1994) discuss the allocation of joint costs.

4. Health intervention costs

When planning to obtain cost information in the context of an intervention trial, it is important to plan and budget for the collection of cost data as an integral part of the trial design. While it is usually possible to carry out an economic analysis with retrospective estimation of costs at the end of the trial, this is likely to be less satisfactory than if the cost data are obtained concurrently.

4.1. Types of costs

Two types of costs should be considered in analysing the costs of a health intervention: the costs of providing the intervention (provider costs) and the costs of obtaining it (user costs).

4.1.1. Provider costs

Many kinds of inputs are needed to carry out health interventions. A helpful way to describe and catalogue the inputs required is to plot each step in the intervention process on a flow chart, reviewing all inputs needed (costs) at each step. The Panel of Experts on Environmental Management (PEEM) for Vector Control guidelines (Phillips et al., 1993) provide an excellent framework for estimating both financial and economic costs of an intervention. Financial costs are expenditures on the inputs for the intervention (the usual lay use of the term ‘cost’); economic costs are the value of the benefits foregone by employing the resources for the intervention, rather than for something else.

A common approach to categorizing costs is to separate them into recurrent and capital (Box 19.1).

The main categories of cost involved in providing a health intervention are likely to include staff time, provision of drugs or vaccines, laboratory tests, other diagnostics, information and education costs, transport costs, utilities, space or rent costs, equipment, any incentives or reimbursements provided to patients, and other administrative costs, including any indirect costs or ‘overheads’. Most of these data can be obtained from the project accountant or the health facility or the health programme itself. It may be worth focusing time and effort to get more precise estimates of costs of the items that account for a large share of the budget. Staff costs are likely to be a major component, and getting as much precision as possible, in terms of the time allocation of different categories of staff and their different salary levels, will be essential. For example, if, in one arm of the trial, the patients are seen by a doctor and, in the other arm, by a nurse, it is important to establish the number of hours and the hourly rate of the two categories of staff. It is also useful to focus on those elements that are likely to differ between arms of the trial; if the trial is comparing a laboratory-intensive intervention with an intervention that depends simply on clinical signs, it will be important to obtain as much precision as possible on the costs of laboratory tests involved.

4.1.2. User costs

The second type of cost data to be collected includes the costs patients and families incur in seeking care or availing themselves of the intervention. Usually, these data can be collected fairly simply through a brief interview with patients. A short questionnaire, using only a few questions, can provide sufficient data to estimate patient costs. PIs are often reluctant to add questions to existing instruments, and even more reluctant to add entire new questionnaires, however brief. But the downside of not collecting patient cost data may be large.

Patient cost elements may include:

- cost of travel to and from a clinic to obtain the intervention
- time of patients and, where relevant, their family for travel to the clinic or intervention site
- other costs incurred—lunch, overnight stay, childcare, etc.

- wages/salary foregone or costs of work not done (for example, on the family farm).

As an example of the importance of estimating patient costs, in a trial in Uganda, HIV-infected patients were randomized to receive home-based or facility-based delivery of antiretroviral therapy. The outcomes (disease progression) for patients in the two arms were similar, but the home-based strategy, which relied on monthly home visits by trained lay workers, used less of the time of doctors and nurses. However, the main difference in cost-effectiveness was due to the costs to patients in obtaining care; the cost of a clinic visit was assessed as, on average, $2.30, which represented about 13% of reported monthly cash incomes for men and 20% for women (Jaffar et al., 2009). Given the disparities in average wealth, this level of expenditure would be approximately equivalent to an average European taking an intercontinental flight every month for a clinic visit!

Saunderson (1995), in an economic evaluation of options for the treatment of TB in Uganda, found that 70% of the cost of tuberculosis treatment was borne by patients themselves. Similarly, Ettling et al. (1991) found that 90% of the costs of seeking treatment for malaria fell on patients, while Needham et al. (1998) found that patient costs of seeking care for tuberculosis in Zambia were prohibitive.

4.2. Approaches to costing

Although categorizing and listing costs of inputs needed for interventions are an important first step, there are three further important aspects of costing that should be considered to ensure comparability and completeness. The first is to examine costs by unit of service (such as days in hospital, outpatient visits, education campaign, or delivery of bed-nets or vaccines to a community). The second is to use a functional approach to costing, such as activity-based costing (ABC), where each specific activity, such as a hospital-based delivery, is costed. This is more useful for understanding the nature of costs than that of a line item that simply lists costs by type of input such as personnel or travel. The third is to annualize all costs for a given population for a given period of time, using depreciation methods for capital expenditures and appropriate discount rates, to bring all costs to the current year value (see Section 3.3).

Functional costing is usually based on a unit of service such as an outpatient visit or a hospital stay. All activities (processes) needed to carry out a unit of service are mapped out by a flow chart; each step in the process is analysed for the inputs used, including personnel time and overhead; a cost schedule is constructed to determine the full costs of each activity; and finally these are summed to determine the costs of that unit of service.

The idea of putting all costs involved in providing a service (intervention) onto a comparable basis of time and population is straightforward, but the details of depreciation and appropriate rates of depreciation for different inputs are beyond the scope of this chapter, and input from a health economist should be sought.

4.2.1. Valuing resource use

Sometimes, unit costs will be estimated from trial centres, but more commonly they are derived from national data. Another option is to use the estimates provided by the WHO-CHOICE programme (<http://www.who.int/choice/en>). WHO-CHOICE has the objective of ‘providing policy makers with the evidence for deciding on the interventions and programmes which maximize health for the available resources’. Among the data provided are unit cost estimates for a variety of health services, by country or region; examples include the cost of a hospital bed-day by type of hospital, outpatient visit, and other patient-level costs.

As indicated in Section 1, collection and management of costing data should be planned during the study design phase and linked to the intervention outcome data. As with any prospective study, there should be a plan for ongoing data quality monitoring to address missing and poor-quality data issues immediately. Queries should be managed on an ongoing basis, rather than at the end of the trial, to maximize data completeness and quality and the timeliness of the final analysis.

5. Presentation of results

The incremental cost-effectiveness ratio (ICER) is a common way of summarizing results from a cost-effectiveness study (expressed as the ratio of two differences in costs and in effects of the alternative interventions):

$$\text{ICER} = \{\text{Cost (new intervention)} - \text{Cost (current intervention)}\}/\{\text{Effect (new intervention)} - \text{Effect (current intervention)}\}$$

The result can be considered as the cost of the additional effect obtained by switching from current practice to the new intervention. If the differential cost is low enough or the differential effect is large enough, the new intervention is considered 'cost-effective', as compared to the current. If an intervention is considered to be 'cost-effective', it means that local and/or global policymakers believe it is worth paying the amount estimated to produce an additional unit of effect.

Table 19.2 indicates the various ways a new intervention might be compared with the current intervention. Note that the decision is straightforward only if a new intervention is *both* less effective and more costly (or both more effective and less costly).

CEA is sensitive to the choice of interventions being compared. Researchers should consider whether the choices of interventions being compared are really the choice of interest. Clearly, this decision must precede the final design of the trial.

Consider two strategies intended to lengthen life in patients with heart disease. One is 'simple' and cheap (for example, aspirin and beta (β)-blockers) and lengthens life, on average by 5 years; the other is more 'complex', more expensive, and more effective (for example, aspirin and β-blockers plus cardiac catheterization, angioplasty, stents, and bypass), lengthening life, on average, by 5.5 years. Table 19.3 shows the relevant (hypothetical) data.

The incremental cost of the simple intervention is the difference between the cost of that strategy ($5000) and the cost of doing nothing ($0), so the ICER = ($5000 − $0)/(5.0 − 0.0) = $1000/life-year gained. The incremental cost for the complex intervention relative to the simple intervention is the difference between the cost of the complex intervention ($50 000) and the cost of the simple intervention ($5000), so the ICER = ($50 000 − $5000)/(5.5 − 5.0) = $90 000/year gained.

Thus, implementation of the simple intervention costs $1000 for every year of life gained, and implementation of the complex intervention, compared to the simple intervention, costs $90 000 for every year of life gained. The decision maker will have to decide between these different options, based upon the resources available and taking into account the years of life that might be gained (and the cost of so doing) by intervening against different diseases (with different interventions). But, in this example, while paying $1000 for an extra year of life seems cost-effective, paying $90 000 for an additional year of life appears to be a less worthwhile use of scarce resources. In practice, comparison is often made to cost-effectiveness 'thresholds', in order to facilitate the interpretation of ICERs. The most commonly used threshold is the gross domestic product (GDP) per capita of the country in question, i.e. if the cost per DALY averted or QALY gained is less than the country's GDP per capita, then the intervention being assessed is considered to be relatively cost-effective and hence worth implementing.

For those who wish to pursue these issues further, Drummond (2005) and Eichler et al. (2004) give a much fuller discussion of CEA.

6. Generalizability

6.1. Uncertainty

Results of economic evaluations in trials are subject to several sources of uncertainty.

6.1.1. Sampling uncertainty

Economic outcomes in trials are usually based on effectively a single sample drawn from the population. In general, there is uncertainty with respect to both costs and outcomes, and this variability should be reflected in CEAs to determine to what extent uncertainty in the estimates might influence the decisions that might be made as a result of the analyses. For example, if an intervention appears to be, on average, cost-effective, but the uncertainty interval includes instances of cost-ineffectiveness, then the confidence with which the intervention can be recommended

might need to be tempered. Methods for taking into account uncertainty are not always straightforward and generally benefit from the input of a health economist.

6.1.2. Parameter uncertainty

Uncertainty related to parameter estimates, such as unit costs and the discount rate, should be assessed by the use of sensitivity analysis. For example, if a discount rate of 3% is used, it may be desirable to assess the impact of this assumption by repeating the analysis, but using a 0% or 5% rate. Analysts should evaluate the effect of varying all major cost parameters (such as the proportion of personnel time allocated to the intervention), as this may influence policy decisions.

6.2. Policy inferences

Policy inferences about the adoption of an intervention should be based on the level of confidence that the cost of the intervention for a unit of outcome, for example, a DALY, is affordable, with a threshold, or ceiling, beyond which it would be unacceptable to adopt it. Ranges of ceiling ICERs should be reported, for which the analyst: (1) is confident that the intervention is good value for the cost; (2) is confident that the intervention is not good value; or (3) is unsure that the cost-effectiveness of the two interventions differ from each another sufficiently to make a choice between them based on the ICER alone. Policymakers can then draw inferences by identifying into which of the ranges it falls. The ranges of ceiling ratios where the analyst can and cannot be confident about the value of a new intervention relative to the current intervention can be calculated by the use of confidence intervals (CIs) for the cost-effectiveness ratios, allowing for the various sensitivity analyses done.

6.3. External validity

Some field trials may have low external validity (i.e. they cannot be generalized easily, and the impact of the intervention may be different when applied in a public health setting). The threats to external validity come from:

- inclusion of study sites with access and availability of health care services which are not representative of the wider population that would be targeted in a public health programme
- restrictive inclusion and exclusion criteria (patient population, disease severity, co-morbidities)
- artificially enhanced compliance (for the purposes of the trial).

In such circumstances, it might be possible to test the potential cost-effectiveness of the new intervention in programmatic conditions within sensitivity analyses, after making assumptions about how each of these factors might differ in the routine programmatic situation relative to the situation within the trial.

7. Modelling

The cost-effectiveness measured within the trial follow-up period may be substantially different from what would have been observed with longer follow-up. For example, at the time a phase III trial is completed and a vaccine is licensed, there may still be substantial uncertainty about the duration of protection offered by the vaccine beyond the follow-up period in the trial. Modelling of various kinds can be used to estimate costs and outcomes that would have been observed had follow-up of the trial population been prolonged. This involves projecting costs and outcomes over the expected duration of disease and of the intervention and its effects. This may involve making significant assumptions about the future, for example, the life expectancy of a patient on a given treatment. Any such assumptions should be specified. In general, modelling of costs and effectiveness of interventions is being more widely used to assist in decision making (World Health Organization, 2004) but is beyond the scope of this book.

8. Publication of findings

The impact of a publication on health practice and policy is likely to be strengthened if the results of an economic analysis are included in the main publication from an intervention trial itself. However, constraints on word limits often mean that full details of the economic analysis methods cannot be included. Thus, it is common practice to write a companion paper, in which the data collection method, analytic techniques, and assumptions for the economic analyses are fully presented and discussed. An example of the abstract from such a paper is shown in Box 19.2.

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Tables

Table 19.1 Types of economic analysis

Type of analysis	Costs	Outcome (effect)	Results expressed as:
Cost	Monetary units (commonly US $)	Not relevant	$ per unit of output (for example, $ per fully vaccinated child)
CEA	Monetary units (commonly US $)	Effect of intervention (for example, cases prevented)	$ per effect (for example, $ per case prevented)
CUA	Monetary units (commonly US $)	Premature mortality and disability averted (measured in DALYs) or healthy life time gained (QALYs)	$ per DALY averted or QALY gained
CBA	Monetary units (commonly US $)	Monetary units (for example, value of a statistical life)	Benefit–cost ratio or net present value (for example, money value of benefits–costs)

DALY, disability-adjusted life-year; QALY, quality-adjusted life-year.

Table 19.2 Cost-effectiveness analysis as an aid to decision making

Effectiveness	**Cost**	
	New intervention costs more	**New intervention costs less**
New intervention is more effective	CEA needed	Adopt new intervention
New intervention is less effective	Do not adopt new intervention	CEA needed

Table 19.3 Example of the application of cost-effectiveness analysis

Strategy	Additional cost	Incremental cost	Effectiveness (years gained, compared to 'nothing')	Incremental effectiveness	ICER ($/year gained)
Nothing (0)	–	–	–	0.0	–
Simple intervention (S)	$5000	(S vs 0) $5000	5.0	5.0 − 0.0 = 5.0	$1000
Complex intervention (C)	$50 000	(C vs S) $45 000	5.5	5.5 − 5.0 = 0.5	$90 000

Boxes

Box 19.1 Categorization of costs into recurrent and capital

Recurrent costs—those used up in the course of a year and needing regular replenishment such as:

- personnel and other labour (wages, salaries)
- supplies
- building operating and maintenance costs (electricity, water, etc.)
- in-service training (in-service courses for specific skills and knowledge)
- information, education, and communication (IEC) costs.

Capital (fixed) costs—investments in items that last for more than a year such as:

- buildings
- vehicles
- equipment
- basic training
- land.

Generally, capital costs are discounted over the expected lifespan of the entity.

Box 19.2 Cost-effectiveness of improved treatment services for sexually transmitted diseases in preventing HIV-1 infection in Mwanza Region, Tanzania

THE TRIAL: A community-randomised trial was undertaken to assess the impact, cost, and cost-effectiveness of averting HIV-1 infection through improved management of sexually transmitted diseases (STDs) by primary-health-care workers in Mwanza Region, Tanzania.

METHODS: The impact of improved treatment services for STDs on HIV-1 incidence was assessed by comparison of six intervention communities with six matched communities. We followed a random cohort of 12 537 adults aged 15–54 years for 2 years to record incidence of HIV-1 infection. The total and incremental costs of the intervention were estimated and used to calculate the total cost per case treated, the incremental cost per HIV-1 infection averted, and the incremental cost per disability adjusted life-year (DALY) saved.

FINDINGS: During 2 years of follow-up, 11 632 cases of STDs were treated in the intervention health units. The incidence of HIV-1 infection during the 2 years was 1.16% in the intervention communities and 1.86% in the comparison communities. An estimated 252 HIV-1 infections were averted each year. The total annual cost of the intervention was US$59 060, equivalent to $0.39 per head of population served. The cost for each STD case treated was $10.15, of which the drug cost was $2.11. The incremental annual cost of the intervention was $54 839, equivalent to $217.62 per HIV-1 infection averted and $10.33 per DALY saved (based on Tanzanian life expectancy). In a sensitivity analysis of factors influencing cost-effectiveness, cost per DALY saved ranged from $2.51 to $47.86.

INTERPRETATION: Improved management of STDs in rural health units reduced the incidence of HIV-1 infection in the general population by about 40%. The estimated cost-effectiveness of this intervention ($10 per DALY) compares favourably with that of, for example, childhood immunisation programmes ($12–17 per DALY).

Reprinted from *the Lancet*, Volume 350, Issue 9094, Gilson, L., et al., Cost-effectiveness of improved treatment services for sexually transmitted diseases in preventing HIV-1 infection in Mwanza Region, Tanzania, pp.1805–

Bookshelf ID: NBK305512