

Principles of Pharmacoeconomics

Incremental costs and marginal costs

The terms **incremental cost** and **marginal cost** are often used in economic evaluations. An incremental cost is the difference in overall costs between two alternatives.

A marginal cost is the **cost of** carrying out **one more** intervention or expanding a program or service by one unit (e.g. increasing the length of stay in hospital by one day).

Average cost

Average cost is calculated by dividing the total costs for the intervention by the total quantity of treatment units provided, such as the number of patients receiving a course of antibiotics.

How are costs valued?

The two ways of collecting costs are either '**top down**' or '**bottom up**'. Top-down studies use the total budget to produce average cost per patient. This method is the quicker one, but assumes that all patients have the same diagnosis, severity of illness and treatment.

Bottom-up (micro costing) studies measure resource use by individual patients and so are able to detect treatment differences between patients. This method produces much better quality costs, but can be time-consuming and expensive.

When to stop collecting costs

It is important to carry on collecting information about resource use until it is clear that no more events are likely to occur related to the original intervention.

These events may be further improvement upon treatment, or they can be side effects of the intervention, and consequences of failed treatment. The study must carry on collecting cost information until all these events have stopped occurring. This may be a month, a year, or longer, depending on the type of intervention or illness being treated. The time when costs are no longer collected should coincide with when outcomes are also no longer going to be collected and is called the **time horizon**.

Often, trials do not continue with such a long-term follow-up period because of expense, and a shorter time horizon will be employed.

Timing Adjustments for Costs

1-Bringing Past Costs to the Present: Standardization of Costs

When costs are estimated from information collected for **more than 1 year** before the study, adjustment of costs is needed; this is also referred to as **standardization of costs**. If retrospective data are used to assess resources used over a number of years back, these

costs should be adjusted. If you compared costs for patients who received treatment in 2000 with patients who received treatment in 2005, the comparison of resources used would not be a fair comparison because treatment costs tend to go up each year, so patients who received the same treatment in 2000 would have lower costs than those who received the treatment in 2005. Adjustment of the 2000 costs to the amount they would have cost in 2005 is needed before a direct (fair) comparison can be made between these groups.

For example, if the objective of the study is to estimate the difference in the costs of chemotherapy regimens, information on the past use of these two treatments might be collected from a review of medical records. If the retrospective review of these medical records dates back for more than 1 year, it may be necessary to standardize the cost of both medications by calculating the number of units (doses) used per case and multiplying this number by the **current** unit cost for each medication.

Table 2.2 illustrates an example of adjustment using this first method to estimate the treatment costs for a mild infection.

TABLE 2.2. EXAMPLE OF STANDARDIZATION: UNITS MULTIPLIED BY COSTS

<i>Medical Resources Used to Treat Mild Infection</i>	<i>Units of Each Resource</i>	<i>Cost per Unit in 2005 US Dollars</i>	<i>Total Cost in 2005 US Dollars</i>
Office visit	Two visits	\$62.00	\$124.00
Laboratory service to culture organism	One laboratory service	\$53.00	\$53.00
Antibiotic medication	28 capsules	\$1.03	\$28.84
TOTAL			\$205.84

Another more common method used to standardize past costs is to multiply all of the costs from the year the data were collected by the medical inflation rate for that year (Table 2.3). Medical Consumer Price Index (CPI) inflation rates can be found at the Bureau of Labor Statistics' website (www.bls.gov) and have been between 4% - 5% each year since 2000.

TABLE 2.3. EXAMPLE OF STANDARDIZATION: USING MEDICAL CONSUMER PRICE INDEX (MCPI) INFLATION RATES

<i>Medical Resources Used to Treat Mild Infection</i>	<i>Cost Estimate for Resource</i>	<i>Year of Cost Estimate</i>	<i>Cost Adjusted to 2005 US Dollars</i>
Office visits	\$115.00	2003	\$125.46 ^a
Laboratory service to culture organism	\$50.00	2004	\$52.25 ^b
Antibiotic medication	\$28.84	2005	\$28.84
TOTAL			\$206.55

Medical CPI for 2004 = 4.4 %; Medical CPI for 2005 = 4.5%

^a\$115 x 1.044 [1 + MCPI 2004] x 1.045 [1 + MCPI for 2005]

^b\$50 x 1.045 [1 + MCPI for 2005]

2-Bringing Future Costs to the Present: Discounting

If costs are estimated based on dollars spent in future years, another type of modification, called discounting, is needed. There is a time-value associated with money. People (and businesses) prefer to receive money today rather than at a later time. Therefore; money received today is worth more than the same amount of money received next year.

Modifications for this time value are estimated using a discount rate. From this parameter, the present value (PV) of future expenditures and savings can be calculated. The discount rate generally accepted for health care interventions is between 3% and 6%.

The discount factor is equal to $1 / (1 + r)^t$ where r is the discount rate and t is the number of years in the future that the cost or savings occur.

For example, if the expenses of cancer treatment for the next 3 years are \$5,000 for the first year, \$3,000 for year 2, and \$4,000 for year 3, discounting should be used to determine total expenses in present value (PV) terms.

If one assumes that the expenses occur at the beginning of each year, then first year costs are not discounted (see Table 2.4).

TABLE 2.4. EXAMPLE OF DISCOUNTING: COSTS ASSESSED AT BEGINNING OF EACH YEAR*

<i>Year Costs are Incurred</i>	<i>Estimated Costs without Discounting</i>	<i>Calculation</i>	<i>Present Value</i>
Year 1	\$5,000	$\$5,000/1$	\$5,000
Year 2	\$3,000	$\$3,000/1.05$	\$2,857
Year 3	\$4,000	$\$4,000/(1.05)^2$	\$3,628
Total	\$12,000		\$11,485

*Using a 5% discount rate.

It is equally acceptable to assume that expenses occur at the end of the first year (12 months later) and therefore, they are discounted (see Table 2.5).

TABLE 2.5. EXAMPLE OF DISCOUNTING: COSTS ASSESSED AT END OF EACH YEAR*

<i>Year Costs are Incurred</i>	<i>Estimated Costs without Discounting</i>	<i>Calculation</i>	<i>Present Value</i>
Year 1	\$5,000	$\$5,000/1.05$	\$4,762
Year 2	\$3,000	$\$3,000/(1.05)^2$	\$2,721
Year 3	\$4,000	$\$4,000/(1.05)^3$	\$3,455
Total	\$12,000		\$10,938

*Using a 5% discount rate.

The following example illustrates the impact of discounting the costs of an intervention using information from a theoretical hip replacement operation compared to drug treatment for a patient with osteoarthritis.

<i>Intervention</i>					
<i>Costs (£) arising during</i>					
	<i>Year 0</i>	<i>Year 1</i>	<i>Year 2</i>	<i>Year 3</i>	<i>Year 4</i>
Hip replacement	5,000				
Painkillers (undiscounted)	1,000	1,000	1,000	1,000	1,000

1- What are the total costs for a hip replacement?

The total cost for the hip replacement operation is £5,000.

2- What are the total costs for drug treatment?

The total cost for the drug treatment is £5,000.

3- What is the impact of discounting the costs?

The costs for the hip replacement all occur in the first year (now); this means that they should not be discounted.

The costs for drug treatment occur over a 5-year period. This means that they must be adjusted for discounting. In the analysis, future costs must be given less weight because they have a lower impact than an equivalent cost occurring now. The further in the future the cost, in terms of years, the less weight they are given.

Using the above formula and discount rate of 3.5% we can calculate the discount factor for each year.

$$\begin{aligned}D_0 &= 1 / (1 + 0.035)^0 = 1 \\D_1 &= 1 / (1 + 0.035)^1 = 0.966 \\D_2 &= 1 / (1 + 0.035)^2 = 0.934 \\D_3 &= 1 / (1 + 0.035)^3 = 0.902 \\D_4 &= 1 / (1 + 0.035)^4 = 0.871\end{aligned}$$

The discounted costs are calculated by multiplying the discount factor by the costs for each year.

Intervention	Costs (£) arising during					
	Year 0	Year 1	Year 2	Year 3	Year 4	Total
Hip replacement	5,000					5,000
Painkillers (discounted)	1,000	1,000 x 0.966 = 966	1,000 x 0.934 = 934	1,000 x 0.902 = 902	1,000 x 0.871 = 871	4,673

This example shows that when discounting is taken into account, drug treatment over 5 years period is cheaper than hip replacement.

Therefore, future costs have to be discounted in any economic evaluation. Studies will generally discount costs if the intervention lasts more than 1 year.

Cost of illness

The cost of illness (COI) is the personal cost of acute or chronic disease. The cost to the patient may be economic, social or psychological, ...etc.

The direct medical costs of illness include diagnosis, medical treatment, surgery and follow-up care. Indirect costs of illness are costs attributable to loss of productivity of patients with that disease or condition.

Intangible costs of illness are the pain and suffering associated with illness.

COI studies are used to indicate the magnitude of resources needed for a specific disease or condition, and they may be used to compare the economic impact of one disease versus another (e.g., costs of schizophrenia versus costs of asthma) or the economic impact of a disease on one country compared with another (e.g., costs of DM in Iraq versus costs of DM in Jordan).

One aim of treating a patient with a disease is to reduce these costs of illness.