**Lecture 7 Dr. Haider Raheem**

**Cost-Benefit Analysis**

**Definition and History**

**Cost-benefit analysis** (CBA) compares both costs and benefits in monetary units. The theoretical roots of CBA stem from welfare economics. In the 1800s and 1900s, CBA methodology was first used to help set policy for water projects such as irrigation and flood control. CBA was later applied to other public goods such as wildlife, air quality, public parks, and health care. The first use of CBA in health care dates back to the 1960s. In 1961, Weisbrod assessed the costs and benefits of a vaccination program for children in which the benefits of the program were monetized by using wages to value lost productivity and reduced survival.

**Advantages and Disadvantages of Cost-Benefit Analysis**

An advantage of this type of analysis is that many different outcomes can be compared as long as the outcomes measures are valued in monetary units. The disadvantage is that placing economic values on medical outcomes is not an easy task and there is no universal agreement on one standard method for accomplishing this.

 To illustrate the advantage of CBA compared with **cost-effectiveness analysis** (CEA), assume you are a decision maker and you must choose one program from Table 7.1to implement in your organization. Assume that you only had **cost-effectiveness ratios** available to help make the choice. How would you choose?

Table 7.1 Comparison of cost-effectiveness ratios and benefit-to-cost ratios.



 One can quickly see that it would be difficult to compare the programs using only cost-effectiveness ratios because of the varying outcomes (e.g., case prevented, life years saved). On the other hand, the benefit-to-cost ratios can be ranked, and programs with similar, as well as dissimilar, outcomes can be compared. If the goal of the decision maker is to maximize the investment, the program with the highest benefit-to-cost ratio (in this case, diabetes medication adherence program) would be chosen.

 The unique aspect of placing a monetary value on the outcome or benefit in CBA also presents a challenge or disadvantage of the method. For example, when comparing the cost-effectiveness ratios for an AIDS prevention and awareness program with the vaccination program for children, it would appear that the vaccination program would be the most cost-effective. But, when examining the benefit-to-cost ratios, the AIDS program is more cost-beneficial. In this example, the benefit (case prevented) was valued higher for AIDS patients than vaccinations for children.

**Conducting a CBA**

The first step in a CBA is to determine the type of program or intervention to be considered. The second step is to identify alternatives. In many cases, the alternative is to “do nothing.” In other cases, the alternative could be to implement a similar program that is smaller or larger in scale or to implement a different program. For example, a clinical pharmacist would like to start an asthma clinic. The alternative could be to compare the costs and benefits of having an asthma clinic with not having an asthma clinic. Another alternative could be to compare implementing an asthma clinic for all persons who had an asthma-related emergency department visit. A third alternative could be to compare implementing an asthma clinic with implementing a diabetes clinic.

 Figure 7.1 shows the basic components of CBA. As shown, there are two categories of costs, **direct medical** and **direct nonmedical,** and three categories of benefits, **direct benefits** (both medical and nonmedical), **indirect benefits** (productivity), and **intangible benefits.** When only direct medical benefits are measured, some researchers do not consider this to be a “true” CBA.



**Fig. 7.1 Components of cost-benefit analysis (CBA).**

**Difference between Costs and Benefit**

In CBA, both costs and benefits are measured in dollar values. This can sometimes cause confusion because benefits are also “cost savings” or “costs avoided.” As shown in Figure 7.1, costs and direct benefits are categorized as medical or nonmedical. For example, in the asthma program, a cost to the program could be an increase in medical costs related to visits to the pharmacy. A “cost saving” or benefit as a result of the program could be a reduction in medical costs for asthma-related emergency department visits.

**Measuring Indirect and Intangible Benefits**

Various methods have been developed to estimate the monetary value of health benefits. The two most common methods seen in the pharmacoeconomic literature are the **HC** approach and the **WTP** approach.

**Human Capital Method**

Indirect benefits are increases in productivity or earnings because of a program or intervention. The HC approach is one way to measure indirect benefits. HC estimates wage and productivity losses because of illness, disability, or death. There are two basic components to calculating HC: wage rate and missed time (days or years) because of illness. Because the HC approach is based on wages, it is necessary to have some estimate of income. Missed time because of illness can be obtained by self-report.

***Wage Rate Calculation***

Depending on the type of study, a yearly wage rate or a daily wage rate can be calculated. A yearly wage rate (income per year) would be calculated for a program or intervention that would reduce long-term disability or death. For example, a pneumococcal vaccination program might result in preventing premature death.

 A daily wage rate (income per year divided by number of days worked per year) may be calculated for a program or intervention targeted at an acute or chronic illness with short-term disability. For example, asthma, a chronic disease state, may include episodic asthma attacks. Thus, a person may only experience problems with the disease state on a periodic basis. For this type of disease state, a daily wage rate would be calculated.

To calculate a daily wage rate both income and number of days worked per year must be assessed. We may assume that the average person works 240 days a year when accounting for weekends, vacation, and sick leave. A formula to calculate number of days worked per year is:

Number of days in a year (365) − Number of weekend days (104) −

Number of vacation days (14) − Number of sick-leave days (7) = 240.

***Missed Time (Days or Years) Because of Illness***

If a yearly wage rate is calculated, then assessment of the number of years lost because of a disease or illness must be made. If a daily wage rate is calculated, an assessment of the number of missed days because of illness must be calculated. Because many pharmaceutical interventions involve chronic disease states with intermittent episodes, we will use an example calculating the daily wage rate and number of missed days. Missed days because of illness can fall into four groups (Table 7.2).

Table 7.2 Categories of missed days.



 Using the asthma clinic example, we will calculate an indirect benefit. Assume that the population served by the clinic is made up of adults with an average income (including fringe benefits) of $40,000 and 240 days worked per year. The daily wage rate (average income/number of days worked per year) would be $40,000/240 = $167/day. An average of 20 days a year were missed from work before participating in the asthma clinic, and an average of 7 days a year were missed from work after participating in the asthma clinic. Multiplying the daily wage rate times the number of missed days results in the value of lost productivity. In other words, the value of 20 days lost from work is $3,340, and the value of 7 days lost from work is $1,169. The difference between before and after the program is $2,171, which is the cost savings or the indirect benefit of the program or intervention (see Table 7.3 for the calculation).

Table 7.3 Calculation of indirect benefit (missed work).



***Advantages and Disadvantages of the HC Method***

Measuring indirect benefits using the HC approach has several advantages. It is fairly straightforward and easy to measure. Income estimates can be obtained or estimated from publicly available sources, and days lost from illness can be readily obtained from the patient or another secondary source.

 The HC approach also has several disadvantages. The primary concern with using the HC approach is that it may be biased against specific groups of people, namely unemployed individuals. It assumes that if a person is not working, he or she has little or no economic benefit. Children and unemployed elderly individuals are two groups with which bias can occur.

 The HC assumption that the value of health benefits equals the economic productivity they permit may also be biased. The earnings for some individuals may not equal the value of their output. For example, there is a large difference between the daily wage rate of a professional football player compared with that of an elementary school teacher.

 The HC method also does not incorporate values for pain and suffering if these values do not impact productivity. There may be certain disease states or conditions (e.g., menopause, hair loss) that may not impact productivity but do have an impact on a person’s **health-related quality of life.**

**Willingness-to-Pay Method**

The WTP method can value both the indirect and intangible aspects of a disease or condition. The WTP method determines how much people are willing to pay to reduce the chance of an adverse health outcome. **Contingent valuation** (CV), in which the respondent is asked to value a contingent orhypothetical market, is a direct method that is used to elicit the dollar valuesor the WTP amounts. WTP values can be collected through face-to-face interviews,mail, telephone, or via the Internet. Measuring WTP using the CV method should include two general elements, a hypothetical scenario and a bidding vehicle.

***Hypothetical Scenario***

The hypothetical scenario should include a description of the health care program or intervention (e.g., **medication therapy management** program, new drug therapy). The intent of the scenario is to provide the respondent with an accurate description of the good or service that he or she is being asked to value. In addition, the scenario should detail the amount of time the person should expect to spend, as well as the benefit (e.g., percent improvement in the condition) of the intervention. An example of a hypothetical scenario for the asthma clinic might read:



***Bidding Vehicles***

After the program or intervention has been adequately described, respondents are then asked to “bid,” or place a value on the program or intervention. Bids can be obtained through a variety of formats, such as open-ended questions, closed-ended questions, a bidding game, or a payment card. Below is a brief description of each of the methods.

**Open-Ended Questions** Open-ended questions simply ask respondents how much they would be WTP for the program or intervention. This question would immediately follow the hypothetical scenario. Here is an example:

What is the maximum amount that you would be willing to pay for a 1-hour consultation with a pharmacist? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The respondent would then write in their maximum WTP amount. This method is used the least because it results in WTP values that vary widely. Many people do not know how to value health care programs because they do not normally pay the full amount out of pocket. The other methods discussed below provide respondents with more guidance in determining their maximum WTP.

**Closed-Ended Questions** Closed-ended questions are also called “take-it-or-leave-it” or dichotomous choice questions. Respondents are asked whether or not they will pay a specified dollar amount for the program or intervention. Here is an example:

Would you be willing to pay $60 for a 1-hour consultation with a pharmacist?

\_\_\_Yes\_\_\_\_No

This method more closely resembles the marketplace. When consumers shop for products, they must decide based on the price of the product whether to “take-it-or-leave-it.” One drawback to this method is that only one question is asked, so only one WTP value can be elicited from a respondent. Thus, a very large sample would be required to determine the overall WTP value.

**Bidding Game** The bidding game resembles an auction in that several bids are offered to reach a person’s maximum WTP. Before soliciting a second response, the bids are adjusted based on the first response. This iteration could go on a number of times, but it is suggested that three times is optimal. Here is an example:

Would you be willing to pay $60 for a 1-hour consultation with a pharmacist?

\_\_\_Yes If yes, ask: “Would you be willing to pay $80?”

\_\_\_No If no, ask: “Would you be willing to pay $40?”

This method is useful to try to arrive at a person’s maximum WTP value. It is time consuming and is best conducted via a face-to-face interview or over the Internet. In addition, the WTP values can be biased depending on how high (or low) the first bid is. This is called “starting point bias.”

**Payment Card** The payment card method provides the respondent with a list of possible WTP amounts (i.e., payment card) to choose from. Here is an example:

What is the maximum amount that you would be willing to pay for a 1-hour consultation with a pharmacist? Please circle your choice.

$150 $90 $30

$130 $70 $10

 $110 $50 $0

This method is very easy to use and it provides respondents with a range of values to choose from. The advantages of the method can also result in disadvantages. Providing respondents with a range of values can bias their WTP values. The range provided can “suggest” the value of the intervention and can influence what respondents say. Also, “range bias” can influence the WTP amount. For example, if the range of values was from $0 to $75 versus $0 to $150, the respondents’ WTP amount can vary depending on which range or starting point was provided.

***National Oceanic and Atmospheric Administration Recommendations***

NOAA recommends face-to-face interviews and the dichotomous choice (closed-ended) bidding vehicle. Face-to-face interviews are very time consuming and may be cost prohibitive for some researchers. The use of the dichotomous choice format requires a large sample size to accommodate the varying bid levels. Although these are the preferred methods, most studies in the literature have used mail surveys and the payment card format.

***Advantages and Disadvantages of the Willingness-to-Pay Method***

The main advantage of the WTP approach is that it is a method to place a dollar value on intangible benefits. However, there are several disadvantages to the WTP methodology. Many critics question the validity of the WTP responses because of the various methods used to elicit dollar values as well as the hypothetical nature of the health care benefit. It is difficult for people to place a dollar value on a health benefit or an increase in health-related quality of life or satisfaction. Because a “hypothetical” or artificial scenario is presented, it is possible that respondents might give a “hypothetical response” or that the respondent may not understand the value of the market (e.g., pharmaceutical care program) being presented.

 Another disadvantage of this method includes the biases involved in measuring WTP. “Compliance bias” occurs when respondents want to “please” the interviewer and may overstate their WTP values. Strategic bias occurs when respondents over- or understate their WTP values to strategically impact the outcome. For example, a respondent may understate a WTP value so that they will not have to pay as much.

**Calculating Results of Costs and Benefits**

CBA can be presented in the following three formats: **net benefit** calculations, benefit-to-cost ratios, and **internal rate of return** (IRR). When evaluating interventions, it is important to assess the method used.

**Net Benefit (or Net Cost) Calculations**

The net benefit (or net cost) calculation simply presents the difference between the total costs and benefits.

Net benefit = total benefits − total costs;

Net cost = total costs − total benefits.

Interventions would be considered to be cost-beneficial if:

Net Benefit > 0 or Net Cost < 0

**Benefit-to-Cost (or Cost-to-Benefit) Ratio Calculations**

CBA results can also be calculated by summing up the total benefits and dividing by the total costs. The ratio may be expressed as a benefit-to-cost ratio or a cost-to-benefit ratio. Depending on how the ratio is calculated, interventions are cost-beneficial if:

Benefit-to-cost > 1 or Cost-to-benefit < 1

**Example Using Different Calculation Techniques**

Suppose a decision maker had to choose between two proposals for implementation. Also assume that the projects are for 1 year, so discounting is not needed.

Proposal A: Cost = $1,000; Benefit = $2,000

Proposal B: Cost = $5,000; Benefit = $7,500

Table 7.4 shows the net and ratio calculations for both proposals. Although four calculations are shown in the table, the benefit-to-cost ratio (when compared with the cost-to-benefit ratio) and the net benefit calculation (when compared with the net cost calculation) are used most often because the higher the result, the more cost-beneficial an option becomes.

Table 7.4 Comparison of two proposals using net and ratio calculations.



 Using the criteria outlined above for cost-beneficial programs, it is apparent that both programs are cost-beneficial using both the net and ratio methods of calculations. However, when comparing net calculations, proposal B is more cost-beneficial than proposal A (net benefit 5 $2,500 versus $1,000), but proposal A is more cost-beneficial than proposal B (benefit-to-cost ratio 5 2.0 versus 1.5) when using ratio calculations. Thus, the ratio and the net calculation may indicate that different options are the most beneficial.

 In this example, in which both proposals are cost-beneficial, the decision maker may consider other issues, such as the amount of money available for investment. Whereas A would require $1,000 input costs, proposal B would require $5,000. Another consideration may involve the return on investment. Proposal A, with a 2:1 benefit-to-cost ratio, has a higher return than proposal B (i.e., 1.5:1 benefit-to-cost ratio). A third consideration is the actual net benefit amount. Proposal B has a higher net benefit than proposal A ($2,500 versus $1,000). The choice between proposal A and B would depend on the goals (both programmatic and financial) of the organization.

**Internal Rate of Return**

The internal rate of return (IRR) is the rate of return that equates the **present value** (PV) of benefits to the PV of costs. The goal isto find the rate of return that would make the costs and benefits equal. After theIRR is calculated, it is compared with a specified **hurdle rate.** The decision rule for IRR is to accept all projects with an IRR greater than the hurdle rate. If the IRR is greater than the hurdle rate, then it means that the project can yield a higher rate of return compared with some other investment. For example, the IRR should be higher than the interest rates available for savings accounts or secured bonds.

 IRR is difficult to calculate by hand. Computer programs and special functions on calculators are available for determining IRR. Assume that the IRR for the asthma pharmaceutical care program described above is 6.3%. If the market rate of return is 4.5% for other investments, this is the hurdle rate. Because 6.3% exceeds 4.5%, the pharmaceutical care program should be chosen because it will yield a greater return, or greater value for every dollar invested.

**IRR Calculation**

Net present value (NPV) = 0; or

Present value (PV) of future cash flows − Initial Investment = 0; or

CF1/(1 + *r*)1 + CF2/(1 + *r*)2 + CF3/(1 + *r*)3 + . . . − Initial Investment = 0

Where,

*r* is the internal rate of return, (discount rate)

CF1 is the period one net cash inflow,

CF2 is the period two net cash inflow,

CF3 is the period three net cash inflow, and so on.

But the problem is we cannot isolate the variable *r* on one side of the above equation. However, there are alternative procedures which can be followed to find IRR. The simplest of them is described below:

1. Guess the value of *r* and calculate the NPV of the project at that value.

2. If NPV is close to 0 then IRR is equal to *r*.

3. If NPV is greater than 0 then increase *r* and jump to step 5.

4. If NPV is smaller than 0 then decrease *r* and jump to step 5.

5. Recalculate NPV using the new value of *r* and go back to step 2.

Find the IRR of an investment having initial cash outflow of $200,000.

The cash inflows 5 Year = 5$60,000; Year 2 = $100,000; and Year 3 = $75,000 respectively.

**Solution**

Assume that *r* is 10%.

NPV at 10% discount rate = $193,539 − $200,000 = −$6,461

Since NPV is less than 0 we have to decrease discount rate, thus

NPV at 6% discount rate = $208,575 − $200,000 = +$8,575

But it is greater than 0 we have to increase the discount rate, thus

NPV at 8% discount rate = $200,826 − $200,000 = +826 = close to 0

IRR ≈ 8%