SCIENCE

CONNECTIONS

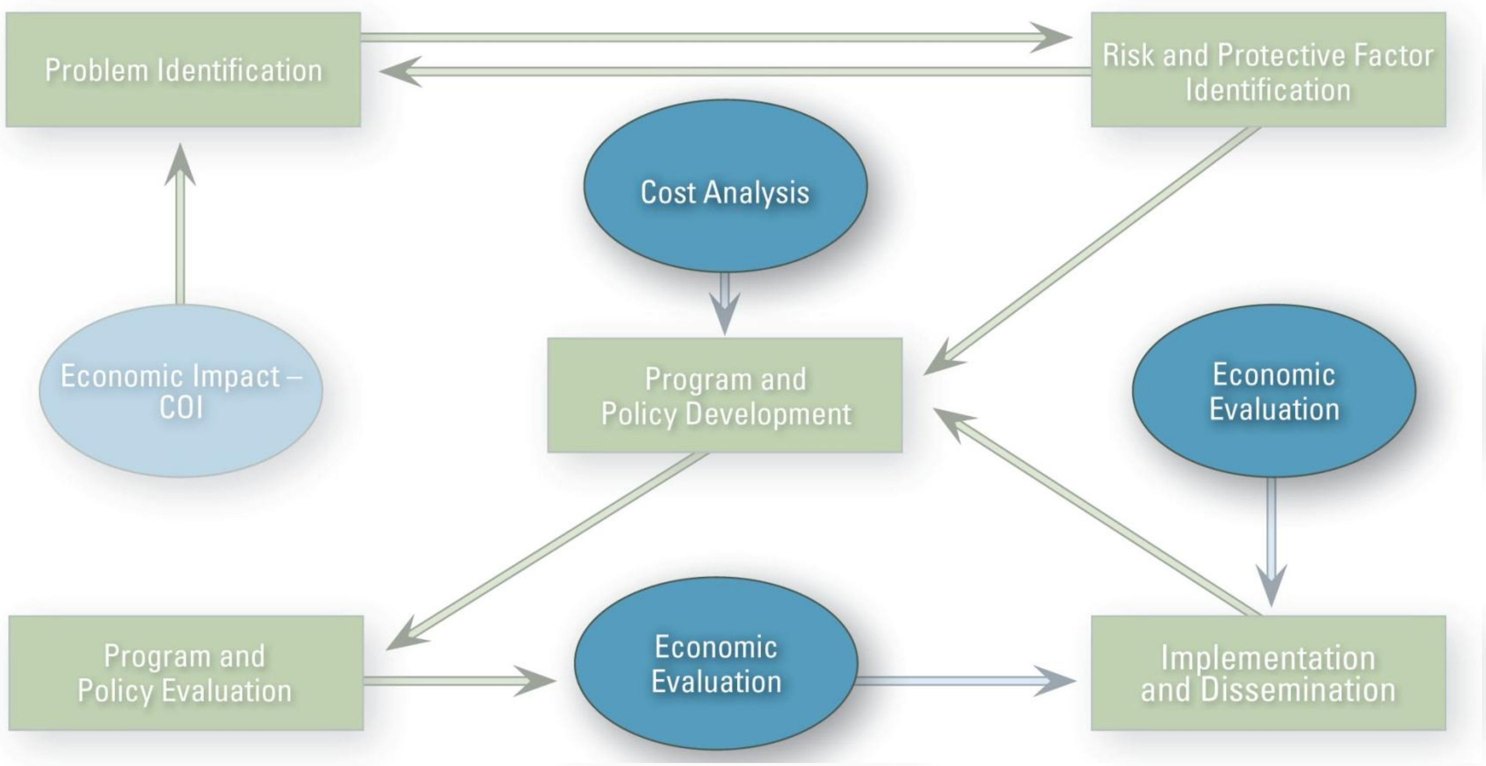
ACTION

Part IV: Benefit-Cost Analysis

Outcomes Quantified in Dollars: The Fourth of a Five-Part Series

This module focuses on benefit-cost analysis, a type of economic evaluation that compares the costs of a program, policy, or intervention to its outcomes, which are converted into dollars.

Public Health Model for Prevention



Heart Disease & Stroke Prevention
Science · Connections · Action

Economic evaluations are best conducted once a program, policy, or intervention has proven effective but prior to widespread implementation and dissemination. In this way, economic evaluations are typically conducted retrospectively.

However, an economic evaluation is often conducted prospectively, alongside community or clinical trials. Either way, economic evaluations conducted *before* implementation are the best way to ensure efficient allocation of scarce public health resources.

Benefit-Cost Analysis (BCA)

- Compares costs and benefits of an intervention.
  - Standardizes all costs and benefits in monetary terms.
- Lists **all** costs and benefits over time:
  - Can have different time lines for costs and benefits.
  - Can include non-health benefits.
- Used primarily in regulatory policy analyses.
  - Clean Water Act, Clean Air Act.
- Increasingly applied to public health.

Benefit-cost analysis is a type of economic evaluation method where the costs of the program or intervention are compared to the benefits of the intervention, and both costs and benefits use the same units: dollars.

Benefit-cost analysis allows you to consider all costs and benefits over time, even those beyond the length of the intervention. As is often the case with preventive interventions, the costs of the intervention occur in the immediate future and benefits occur in the distant future. With benefit-cost analysis, costs and benefits, regardless of when they occur, are included in the analysis.

In addition, because all program costs and outcomes are converted into dollars, you can also consider including non-health outcomes associated with an intervention. If you can assign a dollar value to an outcome, you can include it in benefit-cost analysis.

For example, a program designed to increase physical activity among seniors living in an adult residential facility may have the added benefit of improving social or psychological relationships.

Benefit-cost analysis is typically used at the executive level of government when considering regulatory proposals that would be costly to implement but that would have potentially large economic benefits to society. Examples of these regulatory actions are the Clean Air Act and the Clean Water Act. Application of benefit-cost analysis to public health interventions is a more recent phenomenon.

BCA — Summary Measures

- Benefit-cost ratio (B/C).
  - Very popular with stakeholders.
  - “For every dollar spent on X, you will save Y dollars.”
  - Implement if B/C ratio > 1.
  - Often misleading.
    - Easy to manipulate costs to get higher ratios.
- Net benefit (B – C).
  - Subtract costs from benefits.
  - Implement if net benefit > 0.
  - Less easily manipulated.

There are two common summary measures used in a benefit-cost analysis.

The first is a benefit-cost ratio. To find this ratio, divide the program's net benefits by its net costs. The result is a summary measure that states, "for every dollar spent on program X, Y dollars are saved."

This type of summary measure is popular with policy makers because it's easy to understand. If the benefit-cost ratio is greater than 1 dollar, it implies that the program or intervention produces more benefit than it costs.

However, the benefit-cost ratio is somewhat misleading. If you have a negative ratio, in which the program doesn't save more than it costs, you can't easily determine whether the negative ratio comes from a negative *numerator* or a negative *denominator*. A negative numerator would mean that benefits are listed as "negative costs." A negative *denominator* means costs are listed as "negative benefits."

In other words, it's easy to manipulate how costs and benefits are described to get the ratio you want. In this same way, the ratio can be manipulated to show a bigger return on investment than really exists, again by labeling costs as negative benefits or labeling benefits as negative costs.

Perhaps a better summary measure for benefit-cost analysis is net benefits, derived by subtracting net costs from net benefits. In this way, programs show a positive return on investment if net benefits are greater than zero. This summary measure is less easily manipulated in terms of how costs and benefits are labeled and thus is the preferred summary measure in benefit-cost analysis.

When Is BCA Used?

- In deciding whether to implement a program.
  - If NB > 0, implement.
- When choosing among competing options.
  - Implement program with highest NB.
- For setting priorities when budgets are limited.

Benefit-cost analysis is used to decide whether to implement one specific intervention or program, which can be determined if net benefits are greater than zero. It can also be used when choosing between competing options. In this case, you would choose the intervention with the highest return on investment or highest net benefit.

Finally, benefit-cost analysis is useful when deciding between a whole set of possible interventions with a limited budget. In this case, the net benefits are determined for all the programs, which are ranked in order of decreasing net benefits, and the budget is spent according to the program ranking until the money is gone.

Because all costs and outcomes are converted into dollars, the objective ranking of programs by net benefits makes it easy for policy makers to spend a limited budget based on the highest return on investment for society.

Assessing Dollar Value of Benefits

Benefits can be direct, indirect, or intangible.

- Direct benefits:
  - Medical expenditures saved for other purposes.
- Indirect benefits:
  - Potential increased earnings or productivity gains.
- Intangible benefits:
  - Psychological benefits of health, satisfaction with life.

Assessing program costs in a benefit-cost analysis follows the same methods discussed in the last module.

Assessing program benefits in a benefit-cost analysis is a little more challenging than assessing program costs. Benefits of an intervention or program can be considered direct, indirect, or intangible.

Direct benefits are those medical expenses saved because of prevention or treatment of the disease or illness.

Indirect benefits are those associated with productivity gains because of prevention or treatment. Examples of indirect benefits include workplace interventions that have the direct intent of improving health outcomes but that may indirectly improve employee productivity, satisfaction, morale, and retention.

Intangible benefits, such as improved psychological health, are also important, but because they are difficult to quantify, they’re considered intangible.

Valuation of Indirect/Intangible Benefits

- Human capital approach.
- Friction cost method.
- Revealed preference.
- Stated preference.

Valuing direct benefits of a program, such as medical savings, follows the same methods discussed in module two on costs of illness.

Valuing indirect benefits in terms of productivity gains was also discussed in Module Two using the human capital method. In addition to that method, three other methods can be used for valuing benefits in a benefit-cost analysis.

Human Capital Approach

Theory of investment:

- Views the human being as a capital investment.
- A person's sole purpose is economically productive output.
- Value is measured by earnings generated and value of household productivity.

The human capital approach for valuing indirect benefits in a benefit-cost analysis is based on the theory of investment. People are viewed as capital investments whose sole purpose is to produce for society at large.

The value of their production potential in society is based on the wages they earn, including all the benefits associated with those wages, with some adjustments for their production potential within the household as well.

Human Capital Approach

- Assumes worker's value equals earnings, because fair-market workplace will not pay a worker more than the additional value he/she contributes.
- Lost productivity = lost earnings.
- Valuation is simplest when an intervention affects mortality.

The human capital approach assumes that workers have a value equal to their earnings because the fair market workplace would not pay workers more than they are worth.

If a disease, injury, or illness affects a person's productivity, the cost to society is valued in terms of lost earnings. Thus, the human capital approach is fairly straightforward when valuing a death associated with a disease.

Valuation of Death

- Values death factoring in age, sex, occupation.
- Calculates discounted value of expected labor.
- Uses gross earnings and fringe benefits.
- Adjusts value for non-market labor, such as household productivity.
- May subtract future consumption of goods and services.

The human capital approach would base the value of a death on the person’s age, sex, and occupation because wages differ by these factors.

The present value of future earnings, including gross earnings and fringe benefits, would be adjusted for non-market labor, such as household productivity.

In some cases, you would subtract future consumption from this value because these goods and services would still be available to other members of society.

You can use tables with calculated lifetime cost estimates using the human capital approach. See the Grosse chapter in the Haddix reference.

Valuation of Morbidity

- More complicated than valuation of death.
- Valuation may be more than work days lost:
  - Return to work may depend on occupation.
  - Return to work might not mean the same level of productivity.
  - Change in health may require job switching.

Valuing morbidity is a little more complicated than valuing mortality.

Although simplistically, we could say that the value of losing 5 days from work because of an illness is equal to 5 days of wages, adjusted for fringe benefits and household productivity, the ability to return to work might have less to do with the disease and more to do with the occupation. For example, if an airline pilot suffers a mild stroke, she may not be able to return to work. But if a professor suffers a mild stroke, she may be able to return to work.

Furthermore, returning to work doesn’t necessarily mean the same level of productivity. This may be particularly relevant to stroke and heart disease patients. You must value the reduced level of productivity once the person returns to work.

Finally, the person might return to work but in a different capacity. The professor may no longer be able to teach in a classroom after having a mild stroke, but she could continue to be a productive academic researcher.

Limitations of Human Capital Approach

- Discriminates against low wage earners.
- Assumes a perfect labor market, however:
  - Market imperfections are common.
    - Unequal job opportunities.
    - Unequal pay for same job.
- Ignores intangible consequences, such as pain and suffering, and loss of leisure time.
- Measures livelihood, rather than value of living.

Despite its widespread use, the human capital approach for valuing indirect benefits of interventions has many limitations.

First, because it's based on wages, it discriminates against low wage earners, such as the elderly; the very young; the disabled; and women, in comparison to men of the same age and occupation.

Second, it assumes that the labor market has perfect equality in that people are paid at their true production potential, there are equal job opportunities for all, and people get paid the same wage for the same job. Unfortunately, we know these things aren't true. A teacher's salary may have more to do with geographic location than experience, quality, or productive potential.

Finally, the human capital approach only values the indirect benefits associated with productivity losses and does not incorporate pain, suffering, and losses in leisure time.

Example

- Estimating benefits of a hypertension health promotion program:
  - Before program, participants missed 20 days of work per year on average.
  - After program, missed 7 days of work per year.
  - Average income = $40,000 + $10,000 benefits.
  - Average earnings = $200/day.
  - 13 days of productivity gained X $200 = $2,600.

Here’s an example of how you would estimate the indirect benefits associated with a hypertension prevention program that increased productivity.

If annual income is 40,000 dollars and the fringe rate is 25 percent, then total earnings are 50,000 dollars.

If you assume 250 working days in the year, then the average total earnings, including fringe benefits, is 200 dollars per day.

Before the program, participants missed an average of 20 days of work per year, but after the program, the average was only 7 days.

Thus, the program gained 13 days of productivity potential per year. The value of this benefit is 2,600 dollars.

Friction Cost Method

- Value of productivity loss during friction period.
- **Friction period:** Time it takes to replace a worker and train replacement.
  - Costs to recruit and train replacement worker.
  - Transitory change in productivity.

An alternative to measuring productivity loss by the human capital approach is the friction cost method, which is typically used in European economic evaluations. This method is based on valuing productivity loss in the costs required to replace a given worker and the loss in productivity during the time it takes to do so.

In the case of a short-term illness, a firm has no production loss if sick individuals make up the lost production on their return to work or if there is a pool of permanent reserve labor that can cover the sick worker.

A firm has a production loss if there is a once-and-for-all drop in production while the sick individual is away from work.

The sick person’s lost production is compensated for by overtime payments on his or her return to work, overtime to colleagues, or temporary workers.

In reality, unemployment exists in most societies; therefore, there is always a pool of workers to draw from, and the opportunity cost of labor is zero after replacement. Hence, the value of productivity loss using the friction cost approach should be less than the value using the human capital approach. In fact, in many studies, the friction cost approach comes to 18 to 44 percent of costs valued using the human capital approach.

Revealed Preference

- Infers value of non-market attributes from real-world decisions.
- Based on consumer choices involving health vs. money.
- Challenge is finding markets where people purchase risk reductions or take compensation for extra risk.

An alternative to the human capital or friction cost approaches for valuing direct and indirect benefits in a benefit-cost analysis is the revealed preference approach.

In this approach, you assess market goods to infer a value for non-market goods. The approach is based on real consumer choices for goods that may be similar to the non-market good under consideration, such as a reduction in mortality risk.

Example

- Job A
  - – Income = $40,000.
  - – Risk of death = 0.
- Job B
  - – Income = $42,000.
  - – Risk of death = 1 in 1,000 (0.001).
- Calculate value of statistical life.

For example, we could look to the labor market to see how much people are willing to accept in extra compensation to have an increased risk of on-the-job fatality. This will help us infer how much they're willing to pay for a statistical life.

Suppose a person is willing to trade Job A that pays 40,000 dollars with no risk of death for Job B that pays 42,000 dollars with a 1 in 1,000 risk of death.

That person is willing to accept 2,000 dollars to take a .001 risk of death. Therefore, society, which is defined as 1,000 people, values one statistical death as 2 million dollars.

The problem with this approach is that the compensation people are willing to take for increased mortality risk varies widely, based on the context of the occupation. Many other factors may influence these decisions. For example, market imperfections exist where there are no other jobs in the area, so everyone must become a coal miner. This has nothing to do with the willingness to accept the extra risk of death. Another factor is the limited ability to understand occupational risks, which may occur when people join the military.

Stated Preference

- Survey to elicit preferences for goods or services by finding out what people would be willing to pay.
- Give respondents hypothetical scenarios and ask the maximum they would pay, or amount they would take for the program not to occur.
- Values depend on the hypothetical market described to the respondent (contingent valuation).

Another alternative to valuing benefits in a benefit-cost analysis is simply to ask people to state how much they are willing to pay.

This is accomplished through sophisticated survey methodology. Respondents are presented with a hypothetical scenario, such as a risk of cardiovascular disease, and asked how much they would pay for a risk reduction in that scenario or how much they would have to be paid to take an increased risk.

How much respondents are willing to pay is contingent on the scenario presented, so it’s called a contingent valuation.

Stated preference, although used extensively in valuing non-market goods in environmental health, has not been widely applied in the field of public health, particularly in the field of cardiovascular disease.

BCA Example

- Canadian pharmacy-based intervention to improve blood pressure control.
  - When prescription was filled, pharmacist would take blood pressure and assess adherence to treatment.
- Costs included time spent by pharmacists.
- Benefits included saved costs between cases and controls, and willingness to pay for the intervention (pre/post, comparing cases to controls).

Côté et al., *Pharmacoeconomics* 2003

Here is an example of a benefit-cost analysis in the field.

This is a study by Cote and colleagues, who conducted a benefit-cost analysis of a pharmacy-based intervention to improve blood pressure control. The program costs included the time it took pharmacists to take blood pressure and assess adherence to treatment.

There were two types of intervention benefits: direct benefits in saved treatment costs between cases and controls and indirect benefits based on what participants were willing to pay for the intervention. The assessment of indirect benefits assumed respondents were thinking about the decreased risk of complications associated with elevated levels of blood pressure when they were responding to the willingness-to-pay survey.

Example

Côté et al. A pharmacy-based health promotion programme in hypertension: cost-benefit analysis. *Pharmacoeconomics* 2003;21:414-428.

Table VII. Benefits, costs and scenario analysis on fixed costs per participant exposed to the programme over the 9-month intervention period

Costs/benefits	$Can
Benefits	
Willingness to pay[a] ($Can0.54 × 9 months)	4.86
Savings[b]	290.60
Total of benefits	295.46
Costs	
Scenario 1: privately supported programme	
fixed costs (10% of hypertensive population exposed to the programme, 50% profit)	0.24[c]
intervention costs	30.68
total costs with scenario 1	30.92
Scenario 2: publicly supported programme	
fixed costs (100% of hypertensive population exposed to the programme, 0% profit)	0.02[c]
intervention costs	30.68
total costs with scenario 2	30.70
Costs-benefits (with scenario 1)	−264.54
Costs-benefits (with scenario 2)	−264.76
Ratio costs : benefits (with scenario 1 or scenario 2)	1 : 9.6

a We consider the answers ‘I don't know’ or ‘I refuse’ as a willingness to pay of $Can0.00.

b Between-group difference of mean cost variation.

c Formula: ($Can8500 + $Can4700) × 0.8638 (discount factor) = 11 402.00 where $Can4700 is for services contracted on a 3-year period ($Can1175 for 9 months). For publicly supported programme: $Can11 402.00/717 538 hypertensive individuals (100%) = $Can0.02 per individual. For privately supported programme: ($Can11 402.00 + 5701) / 71 754 hypertensive individuals (10%) = $Can0.24 per individuel.

$Can = Canadian dollars.

Heart Disease & Stroke Prevention
Science · Connections · Action

In Canadian dollars, the authors found that intervention saved approximately 290 dollars in medical costs, which were the direct benefits, with an additional savings of almost 5 dollars in indirect benefits because that’s what the respondents were willing to pay for a decreased risk of complications associated with elevated blood pressure.

In comparison to the costs of the program, benefits were almost 10 times greater, suggesting that this program is a good investment.

Note that the authors use the two summary measures we mentioned before, but instead of net benefits, they assessed net costs, or costs minus benefits, and instead of a benefit-cost ratio, they assessed a cost-benefit ratio of costs divided by benefits.

However, the interpretation of the results is the same.

Return-on-Investment (ROI) Analyses

- Analysis of net financial costs and benefits to entity paying for an intervention.
- Similar to BCA except short-term (1–5 years), and ignores external costs and benefits to stakeholders (including health of participants).
- Common labels:
  - Business case analysis.
  - Budget impact analysis.

Heart Disease & Stroke Prevention
Science · Connections · Action

In the literature, you might also see a return-on-investment analysis, which assesses the business case model for prevention.

This analysis is similar to a benefit-cost analysis, except it typically only takes the perspective of the entity paying for the intervention, rather than assessing the benefits and costs of the intervention from the societal perspective.

As such, a return-on-investment analysis typically relies on short-term returns and often ignores the health of beneficiaries.

Nonetheless, return-on-investment analyses are also important because they show the returns on investing in prevention from the *payer's* perspective.

Limitations to ROI Analysis

- Different incentives for providers and payers.
  - Better care/reduced use = lower fee-for-service revenues.
  - May be no reimbursement for case management.
- User turnover makes long-term cost reduction less important to payers.
- Impacts on other sectors.
  - Most disability costs borne by public programs or families.
  - Psychosocial costs and benefits.

There are several limitations to return-on-investment analysis.

First, incentives for the private sector are often different than those from the public health perspective. For example, case management might be a good method for improving outcomes, but health insurance companies may not reimburse for case management.

Second, although some interventions to improve cardiovascular disease outcomes have been effective in workplace settings, there’s no incentive for the employer to invest in prevention if the employer has a high turnover rate and the potential cardiovascular benefits won’t be realized until far in the future.

Finally, return-on-investment analyses are limited because other sectors, such as Medicaid and Medicare or the individual, may benefit from the intervention, but these benefits are not included in the analysis.

Hypothetical ROI Analysis

- Prevention of child obesity.
- Medical costs associated with at-risk or overweight.
  - Incremental cost ~$200/year.
- Implications:
  - Counseling would have to eliminate 100% of incremental cost to achieve positive ROI.
  - Public health should not rely on business case argument for prevention.

Here’s an example of a return-on-investment analysis conducted from the public health perspective. The costs and benefits included in the analysis are only those of the public health intervention, excluding costs and benefits for the individual or society.

Using data from the medical expenditure panel survey on the costs associated with being overweight, the authors determined that a hypothetical counseling intervention would have to eliminate 100 percent of incremental intervention costs to achieve positive return on investment. Therefore, no strong business argument for prevention existed in this case. However, expanded to a societal perspective, perhaps a better argument could have been made.

ROI & Cardiovascular Disease Interventions

- Common applications of ROI methods.
  – Disease management.
  – Worksite health promotion.
    - Most show positive ROI after 2–5 years.
    - ROI ratios of 3–6 to 1 often reported.

Common applications of return-on-investment analysis in the field of cardiovascular disease include disease management programs and worksite health promotion programs. The latter have typically shown positive returns within 5 years, which is appropriate for a business model, with returns outweighing costs.

Congestive Heart Failure Disease Management

- Pilot program for Federal employees in Maryland:
  - Intensive for high-risk employees.
  - Less intensive for at-risk employees.
- Study design:
  - Comparison group from Northern Virginia.
  - Regression approach to control for severity.
- Findings:
  - Average ROI of 1.08.
  - ROI = 1.40 for at-risk employees.
  - ROI = 0.95 for high-risk employees.

In a study of a congestive heart failure disease management program conducted with federal employees in Maryland, the authors found a slight positive return on investment for at-risk employees and a negative return for high-risk employees. The reason for these results had to do with the increased costs for the intensive program designed for high-risk employees.

This analysis provided useful information to the employer for consideration. First, the results could indicate that too many resources were put into the intensive plan without enough of a return. If that was the case, the next step would be to see if the level of resources used in the less-intensive plan would yield a better return when applied to high-risk employees.

Acknowledgments

This webcast was developed by the Division for Heart Disease and Stroke Prevention at the Centers for Disease Control and Prevention under the leadership and guidance of:

Rashon Lane, Applied Research and Evaluation Branch, and

Angela Soyemi, Communications

In collaboration with presentation author:
Phaedra S. Corso, PhD, MPA, Department of Health Policy and Management at the University of Georgia College of Public Health.

The National Center for Health Marketing was integral in the development of this webcast. We thank:

- **Anatavia M. Benson**
- **Charlotte U. Duggan**
- **Thomas G. Race**

Heart Disease & Stroke Prevention
Science · Connections · Action