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Part II: Economic Impact Analysis

Cost of Illness: The Second of a Five-Part Series

Disclaimer: The findings and conclusions in this presentation are those of the author and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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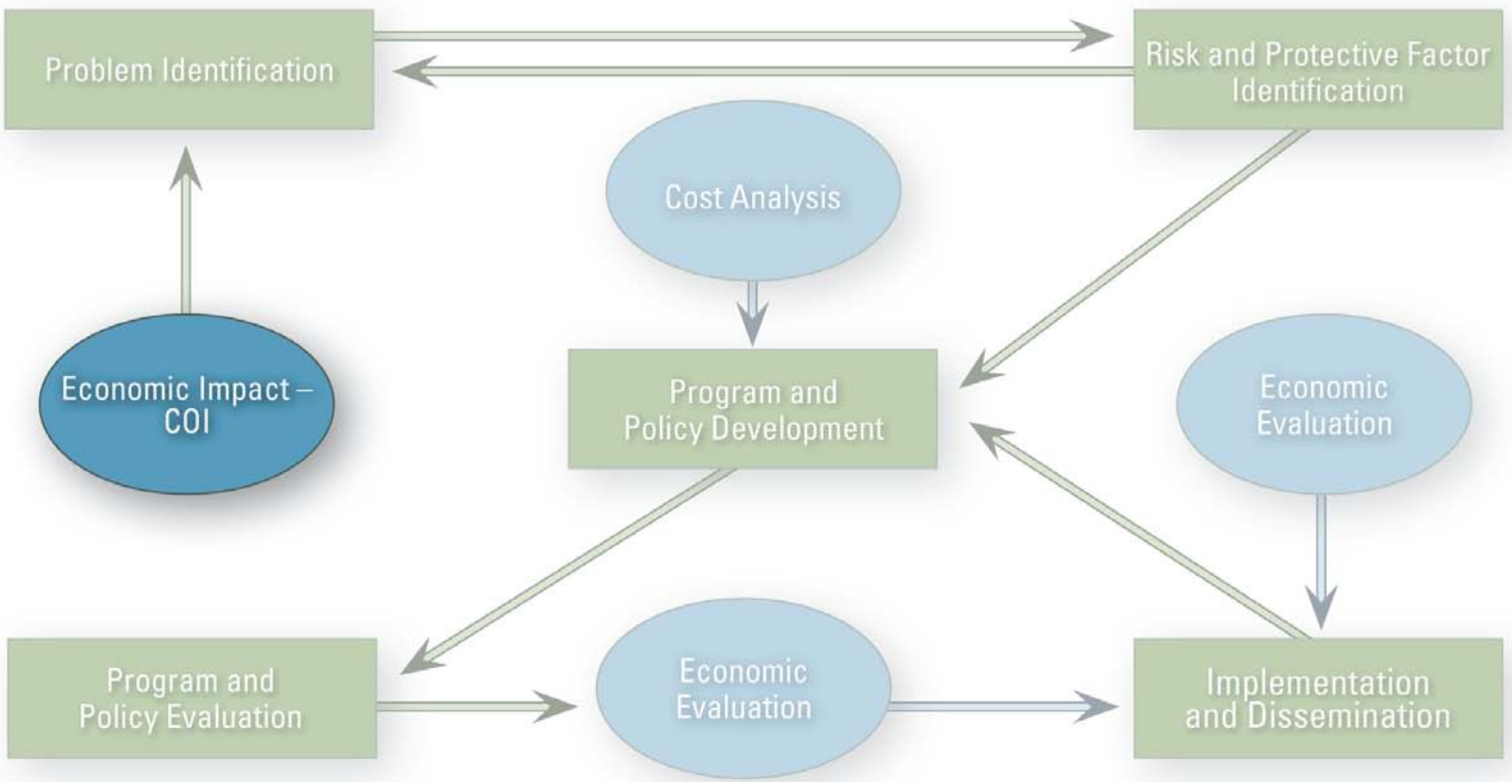
Module Two discusses economic impact analysis.

Public Health Model for Prevention



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Economic impact analysis is sometimes referred to as cost-of-illness analysis. In the public health model for prevention, cost-of-illness analysis often falls within measuring the burden of disease or illness.

Mortality, morbidity, life expectancy, quality of life, quality-adjusted life expectancy, disability-adjusted life expectancy, healthy-days equivalent, and activities of daily living are all measures of disease burden related to health outcomes.

Cost-of-illness analysis represents another measure of disease burden that incorporates costs of disease.

Economic Impact or Cost of Illness (COI) Analysis

- Estimates total costs incurred because of a disease or condition.
  - Costs of medical resources to treat disease.
  - Costs of non-medical resources to treat disease.
  - Loss in productivity.

In the United States, cost-of-illness analysis typically includes the value of medical care resources used to treat a disease and the losses in productivity to society because of the illness. Non-medical costs associated with the illness are sometimes included as well.

Examples of medical costs are inpatient visits, emergency department visits, outpatient visits, prescription drugs, medical equipment, and home health services.

Examples of non-medical costs include child care and travel expenses associated with receiving treatment and special education costs if cognitive function is impaired by the illness.

When assessing productivity losses, we typically use the human capital approach. This method calculates a person's production potential based on average wages, with some adjustments for household productivity. Although the human capital approach is fairly standard in cost-of-illness analysis in the United States, other countries may rely on different methods for calculating productivity, such as the friction cost method, which calculates productivity based on what an employer would have to pay to replace you as an employee.

Examples of productivity losses include days lost from work, or other activities associated with the illness itself or with receiving treatment for the illness.

COI Reporting

- Prevalence-based.
  - Amount spent each year to care for a person with a disease or injury.
- Incidence-based.
  - Amount spent over a person's lifetime for a disease or injury first occurring within a particular time period.

Just like other measures of disease burden, cost-of-illness analysis can either be prevalence based or incidence based.

The question underlying prevalence-based cost-of-illness analysis is: How much do we spend each year to take care of individuals with condition X?

Prevalence-based cost-of-illness analysis includes the total costs of an illness or disease within a specified time period, typically 1 year, regardless of when the disease first occurred. In other words, prevalence-based estimates are a cross-sectional view of costs associated with the illness. But prevalence-based estimates don't tell us how much can be saved by prevention. They only look at the annual costs of a disease, rather than costs of a disease over the course of a life.

In contrast, incidence-based cost-of-illness analysis calculates the value of lifetime costs for new cases of the disease or illness. Incidence-based analyses are essential for calculating the value of prevention. To assess lifetime costs without longitudinal data taken over a lifetime, we may need to model a synthetic cohort of people with the illness over time. In modeling this synthetic cohort, we also may need to assume cross-sectional differences regarding the costs that apply in future years and assume that costs are relatively stable over time.

Although incidence-based cost-of-illness analyses are better tools for knowing what could be saved through prevention efforts, these analyses require more assumptions and perhaps even more sophisticated modeling techniques than other methods.

COI Methods

- All medical costs.
- Only diagnosis-specific medical costs.
  – Add attributable fraction.
- Incremental cost approach.
  – Match against control.
  – Regression.
  – Attributable fraction.

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There are several approaches for measuring cost of illness.

You can total all the medical costs for the population of interest—for example, a group of people with hypertension. *Or* you can add only hypertension-specific medical costs for a group of people with hypertension. *Or* by matching cases to controls or running regression analyses, you can assess the incremental, or marginal, medical costs for people with hypertension compared to a non-hypertensive group.

Following are more detailed descriptions of these three methods and their pros and cons.

Sum of All Medical Costs

- Provides average utilization and costs of illness.

Pros	Cons
• Good for relative comparisons.	• Possible inaccuracies in gauging costs.

Using hypertension as the example, we could assess the prevalence-based costs associated with hypertension by identifying all people with hypertension within a specific time period—say 2007—and then summing up all the medical costs associated with that cohort.

The pros are that this approach is straightforward and easy. It works well for relative, not absolute comparisons. For example, in 2007 there were X people with hypertension and their medical costs were Y. In comparison, 10 years earlier, there were A people with hypertension and their health care costs were B.

The cons are that we may not properly isolate the burden associated with a particular disease or identify costs of comorbidities, which are other illnesses a person may suffer from that might be associated with the disease.

Also, we may overestimate the cost of the disease itself.

Another problem with this approach is that some of the medical costs included in the analysis would also be the same for the non-hypertensive group (for example, the costs of preventive teeth cleanings), so the total medical costs may overinflate the medical resources required for the hypertensive population.

Diagnosis-Specific

- Total of related medical costs for all patients with a given diagnosis.
- Best for assessing specific costs of the disease or condition.

Pros	Cons
• Represents lower-bound actual costs. • Good for incidence-based models.	• May underestimate costs.

Alternatively, we could include only those medical costs in the hypertension population that are explicitly related to hypertension. This approach allows us to assess the percentage of medical costs attributable specifically to hypertension and not other reasons for seeking health care—such as teeth cleaning.

The advantage of this approach is that it’s conservative, representing a lower bound of actual costs, and it can be easily applied to incidence-based models of disease that assess lifetime costs.

However, this approach may underestimate costs if comorbid events aren’t included.

For example, if people with hypertension also have other conditions, such as cardiovascular disease, then the costs of cardiovascular disease attributable to hypertension may not be counted in the hypertension-specific study design.

Attributable Fraction

- The indirect health expenditures associated with a given diagnosis, through other diseases or conditions.
- The attributable fraction is added to the total costs.

To deal with the comorbidity issue, we can use epidemiologic data that show the attributable fraction of hypertension and cardiovascular disease. We can then include that fraction of the total costs of cardiovascular disease in our calculation.

But epidemiological data may not exist for all comorbidities. Use of mental health resources is an area with limited information on the attributable fraction for other comorbidities. On the other hand, the attributable fraction could vary so much across the population that using averages may skew the results.

Cost of Illness: Example 1

Hodgson & Cai. Medical care expenditures for hypertension, its complications, and its comorbidities. *Medical Care* 2001;39(6):599–615.

This is an example of the cost of illness from Hodgson and Cai. They examined the medical care expenses for hypertension, its complications, and its comorbidities.

Example: Attributable Costs

- $108.8 billion in health care spending attributable to hypertension in 1998.
  - $22.8 billion for hypertension as primary diagnosis.
  - Other costs attributable to hypertension:
    - $29.7 billion — cardiovascular complications.
    - $56.4 billion — other diagnoses.

Hodgson & Cai. Medical care expenditures for hypertension, its complications, and its comorbidities. *Medical Care* 2001;39(6):599–615.

Hodgson and Cai found that in 1988, 108.8 billion dollars in health care spending was attributable to hypertension. Of this, 22.8 billion was for hypertension as the primary diagnosis. Other costs attributable to hypertension included 29.7 billion for cardiovascular complications and 56.4 billion for other diagnoses.

Matched Control

- Shows incremental costs by calculating the difference in costs between those patients with and those without a given disease or condition.
- Must match controls.

Pros	Cons
• More accurate results.	• Possibility of overestimating due to factors not accounted for in matching.

Another method for conducting cost-of-illness analysis is to match cases, in this case people with hypertension, to controls and determine the incremental differences in use and costs of health care. This approach assumes that all confounding factors, such as age, are observable and accounted for in matching.

This method may provide more accurate results. However, we still may overestimate incremental costs if there are other confounding factors that were not accounted for in matching. For example, we may not have information on important demographic factors that might impact medical costs, such as age.

Regression Methods

- Statistical modeling that can account for confounding variables.

There are regression methods available to help improve some of the problems associated with data's observable and unobservable confounding factors. Although we won't get into the details of these methods here, we'll show an example in the next few slides.

Cost of Illness: Example 2

Balu & Thomas. Incremental expenditure of treating hypertension in the United States. *American Journal of Hypertension* 2006;19:810–816.

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Balu and Thomas conducted a regression analysis to assess the incremental costs of treating people with hypertension in the United States.

Methods and Data Sources

- Compared population of persons with one or more hypertension diagnoses to a population with no hypertension diagnoses.
- Controlled for other factors using Charlson co-morbidity index.
- Did not include attributable fraction.

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Balu and Thomas conducted their analysis using a national dataset of medical claims that had information on current health outcomes. In the analysis, they compared a population of persons reporting one or more hypertension diagnoses to a population reporting no hypertension diagnoses.

To account for confounding effects, they controlled for age, sex, ethnicity, education, and other comorbidities in their regressions using the Charlson comorbidity index.

So in this analysis, the authors were conservative in their estimate because they did not include the attributable fraction of the costs of the other comorbidities that hypertension may cause.

Results

- **Conclusion:** Annual incremental expenditures for hypertensives were $1,130.70 more than for non-hypertensives.
- **Implication:** Hypertension alone costs more than $55 billion per year.

The authors concluded that the increased cost in medical expenditures per year for a person with hypertension compared to a person without hypertension was a little more than $1,000. This implies that hypertension alone costs $55 billion per year.

What Costs Are Missing?

- Other costs of an illness:
  - *Individual:* Losses in household, leisure, quality of life.
  - *Employer:* Loss of productivity.
  - *Society:* Loss of patient's contributions.

Despite the large estimate reported, there are still many other costs of hypertension not included. First and foremost, productivity losses associated with hypertension were not included in the estimate.

To think about other costs that could be considered in a cost-of-illness analysis, we must examine the perspective of the analysis. That is, who is the audience for the study, how will they be using the results, and based on that, what costs should be considered?

From the health care system perspective, costs gleaned from the medical expenditure panel survey may be enough. But if you also include the individual perspective, you would want to include the loss in household productivity and leisure resulting from the illness. You also may place a value on the loss in quality of life.

From an employer's perspective, you would want to include productivity losses, not only in terms of days missed from work, but also days at work when the person with hypertension may not be as productive as usual.

From a societal perspective, all these costs should be included.

Complexities with Cost Modeling

- Zero mass bias
  - A lot of cases with $0 costs.
- Skewed outcomes
  - Some cases with extreme right tails, or *REALLY* high medical costs.
- Approaches for dealing with these complexities:
  - Log transformations
  - Multiple part regression analyses

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There are a few hazards in collecting medical costs for use in a cost-of-illness analysis, either at a patient or participant level, or even from national datasets, such as the medical expenditure panel survey.

First, there are many cases with zero health care costs and a few cases with extraordinarily large health care costs. These two phenomena can skew outcomes, making the use of an “average” cost inaccurate.

Although we won’t get into the details in this presentation, there are methods for dealing with skewed health care costs. One approach is to log-transform the cost data. This can only be done if costs are non-zero because you can’t log-transform a zero value. To deal with this problem, you can also conduct multiple-part regression models to determine average costs and their confidence intervals. For example, you could first run a regression that incorporates the probability of having any medical care costs, then add to that a regression that incorporates the probability of having an inpatient admission. In looking at all of these regressions simultaneously, you can better assess average costs based on the variability of total costs predicted by these events.

Common Mistakes in COI Analyses

- Using cost estimates from different sources without converting into the same base year.
- Not adjusting market prices to reflect true costs.
- Including average and incremental costs in the same example.
- Not using present value of future potential earnings.

When conducting cost-of-illness analyses, you’ll want to avoid some common mistakes.

First, if cost data are available from multiple years, you must convert them to the same base-year dollars for comparison.

Second, in some cases, the market value for some resources may not reflect the true value of the resources. For example, if you included the cost of an inpatient admission, you would probably want to use the hospital cost for that admission and not the charge, since the latter reflects the negotiated reimbursement rate, depending upon insurance status.

Third, when conducting the analysis, you must decide whether costs will reflect the average costs of all health care resources for someone with the illness or the incremental costs of health care resources when those with the illness are compared to those without the illness. This approach corresponds to the diagnosis-specific cost approach mentioned earlier.

Finally, if you consider costs that occur in the future, they must be adjusted to reflect present value.

Converting Dollars into Same Base Year

- Use the Consumer Price Index (CPI)
  - All items component, medical care component, or other component appropriate to adjusting costs.
  - Example: If MD visit in 2000 = $45, what is the cost of that visit in 2005?
    - CPI medical care component in 2000 = a.
    - CPI medical care component in 2005 = b.
    - MD visit in 2005 = MD visit in 2000*b/a.

To convert costs into the same base year, researchers commonly use the all items component or medical care cost component of the consumer price index, which is found in the U.S. statistical abstract published by the U.S. Census.

Here's an example where the cost of a physician visit in 2000, 45 dollars, needed to be converted to 2005 dollars for the cost-of-illness analysis. To do this, you look up the consumer price index rate in 2000, divide it by the rate in 2005, and then multiply it by the value in 2000 to determine the corresponding 2005 value.

Adjusting Market Prices

In converting a hospital's charge to reflect true cost of the service, charges might differ from costs.

- Hospitals may provide ratios as well.
- HCFA publishes state-level hospital cost-charge ratios for Medicare and Medicaid.

To convert hospital charges to costs, several sources are available. First, hospitals themselves might provide these data. If that isn’t possible, another source is the Health Care Financing Administration’s published cost-to-charge ratios provided by each state. These are typically published annually in the *Federal Register*.

Cost-to-Charge Ratios: Hospitals

State	FY 96 Urban	FY 96 Rural
Alabama	0.436	0.484
Alaska	0.535	0.721
Arizona	0.459	0.643
Arkansas	0.552	0.516
California	0.438	0.537

National average: Rural + Urban = 0.53

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Here is an example of the Health Care Financing Administration's ratios published for 1996. Note that the ratios differ by urban or rural location. The national average suggests that the true cost of a hospital inpatient admission in 1996 was 47 percent lower than the hospital charge for the same time period.

Converting Future Costs into PV

Present Value = **Future Value / (1 + r)^{n}**

where:
r = discount rate
n = future year

To convert future costs into present-day dollars, you can use this simple formula: Take the future value and divide it by 1 plus the discount rate to the power of the number of years in the future.

For example, to calculate a cost of 100 dollars that you expect to occur 5 years from now, divide it by 1 plus the discount rate to the fifth power.

The discount rate typically used in economic analyses of health care interventions is 3 percent, although you could use a rate between 0 and 10 percent in a sensitivity analysis. Note that the discount rate already accounts for inflation.

In the case of a 3 percent discount rate, you would divide 100 by 1.03 to the fifth power. That equals 86 dollars and 28 cents. So the present value of 100 dollars 5 years from now equals 86 dollars and 28 cents.

Cumulative PV

$$\textbf{Cumulative Present Value} = \textbf{Future value} \left[1 - \left(1/(1 + r)^n\right)\right] / r$$

where:

r = discount rate

n = analytic horizon (in years)

If you needed to convert a whole set of common future values to present values, say 100 dollars every year for the next 10 years, you could use the same formula from the last slide and simply make the calculation separately for every year.

Alternatively, you could use this similar, but slightly more complicated, formula.

So What?

- COI highlights the magnitude of the burden relative to other burdens.
- It provides data to argue for more resources to prevent the burden.
- Used with estimates of costs to prevent the burden, COI can provide policy-makers with return-on-investment information.

So, at the end of the cost-of-illness analysis, when you find that, for example, hypertension costs 108 billion dollars, why is this value important and to whom?

Cost-of-illness estimates have value for public health practitioners who want to highlight the economic impact of a disease, beyond the morbidity and mortality incidence and prevalence statistics. These data provide additional information to argue for more prevention resources.

Cost-of-illness estimates also have value for policy makers charged with allocating scarce public health resources. If they can quantify the economic impact of hypertension relative to other diseases or illnesses, it provides another argument for allocating these resources.

Finally, cost-of-illness estimates provide policy makers with one piece of a return-on-investment analysis. Cost-of-illness estimates show what could be saved through successful prevention—the next step will determine the costs of the prevention program.

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