

Basic Concepts in Economic Analysis of Health Interventions

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Overview

- \$ Why do economic analysis in health care?
- \$ Major types of economic analysis
- \$ Study perspective
- \$ Basic concepts related to cost and health outcomes
- \$ Calculation of cost-effectiveness ratio
- \$ Decision rule
- \$ Assessment of a cost-effectiveness article

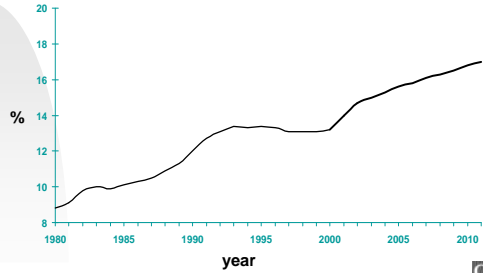


Why do economic analyses?

- \$ Health care resources are limited



National Health Expenditures as a Share of Gross Domestic Product



Source: CMS, Office of the Actuary, National Health Statistics Group.



Why do economic analysis? continued



Cost-effectiveness of selected diabetes interventions in the US

Intervention	\$/life year with full health
ACE inhibitors or beta-blocker treatment for intensive hypertension control	<0
Intensive group-based lifestyle intervention for preventing type 2 diabetes among person with IGT	<25,000
Annual (vs. every 2 y) screening for diabetic retinopathy among persons with type 2 diabetes	25,000-100,000
Universal screening for undiagnosed type 2 diabetes comparing with targeting screening	>100,000

Ping Zhang and Rui Li. "Cost-effectiveness of diabetes interventions"
Diabetes Public Health: From Data to Policy, Oxford University Press, forthcoming



Why do economic analyses?

continued

\$ Policy makers, public health agencies,
insurers, health care providers, patients;
etc. all have to make choices



Types of economic analyses in Health

\$ Cost Analyses

\$ Cost-effectiveness Analyses

\$ Cost-utility Analyses

\$ Cost-benefit Analyses



Cost Analysis

*How much does an intervention,
program, or disease cost?*



Cost of diseases: Examples

Disease or risk factor	Direct medical cost	Indirect cost
Smoking*	\$75.5	\$81.9
Obesity*	\$51.6	>\$46
Diabetes**	\$116	\$58
Cancer***	\$56.4	\$100.3

All costs are in billion, *in 1998, **in 2007, ***in 2001



Cost of interventions: example

Cost of screening 1000 persons for pre-diabetes

Screening strategies	Direct medical cost	Direct nonmedical costs
Testing all with OGTT	\$63,100	\$33,100
FPG testing	\$45,800	\$19,700
A1C screening	\$69,200	\$28,200
CBG screening	\$39,800	\$19,700
Risk assessment questionnaire	\$39,800	\$18,600

Source: Zhang et al, Diabetes Care 2003



Cost-effectiveness analysis

\$ An analytic tool in which costs and effects of one program are compared to costs and effects of another program or doing nothing.



Cost-effectiveness example:

Among persons with high risk of DM, over 3 years, the intensive lifestyle intervention costs \$24,400 per case of DM prevented or delayed, compared to placebo (DPP Research Group, *Diabetes Care*, 2002)



Cost-utility analysis

\$ A type of cost-effectiveness in which the outcome is adjusted to account for the impact of the intervention on quality of life.



Cost-utility example:

Among persons > 25 years and with newly diagnosed DM, intensive glycemic control costs \$41,400 per QALY gained, compared to conventional control (CDC Diabetes Cost-effectiveness Group, *JAMA*, 2002)



Cost-benefit analysis

\$ A analytic tool for estimating the net social benefit of a program relative to another program or doing nothing, with all benefits and costs measured in dollars.



Cost-benefit example:

Every dollar invested in self-management training among diabetic pregnant women cuts preventable hospitalization costs by up to \$8.76 (Fishbein, *Diabetes Care*, 1985)



Study perspectives

- \$ When choices about allocation of health resources are considered, who is affected?
- \$ On whose behalf are decisions made?
- \$ Who gains health benefit, and who pays for it?
- \$ The answers to these questions define the *perspective* of an economic evaluation.

Gold MR et al. Cost-Effectiveness in Health and Medicine. Oxford University Press, New York, 1996



Three Major Perspectives

- \$ Health System: An HMO might consider only costs related to the clinical services they provide.
- \$ Employer: An employer might consider additional costs that affect employee productivity.
- \$ Society: Consideration also given to costs incurred directly by the patients.



Study perspectives: example

Cost per case of DM prevented or delayed over 3 years in Diabetes Prevention Program

Inversion	Health care system	society
Intensive lifestyle	\$15,804	\$24,581
Metformin	\$31,452	\$34,604

Source: DDP Research Group, Diabetes Care 2003



Summary

- \$ Economic analyses are important for evidence-based policy decisions
- \$ It can address many policy questions, but with focus on the "value" of interventions



Concepts Related to Costs and Health Outcomes

- \$ Opportunity cost
- \$ Marginal cost
- \$ Discounting
- \$ Inflation adjustment
- \$ Types of costs
- \$ Types of health outcomes
- \$ Quality-adjusted life year (QALY)



Opportunity Cost



Definition of cost: Dictionary

- \$ "The outlay or expenditure (as of effort or sacrifice) made to achieve an object."
- \$ "The loss or penalty incurred in gaining something."

*Webster's Ninth New Collegiate Dictionary,
1990*



Definition of cost: Economics

\$ "In economic theory, 'costs' refer to the value of *foregone* benefits which may or may not be measurable in dollars."

Richardson J. Economic evaluation of health promotion: Friend or foe? Aust NZ J Public Health 1998;22:247-53.



"Opportunity" Cost

Because you can't spend a dollar in two places at once,

Opportunity cost is the value of the opportunity foregone by spending resources in one place and not in another.



Opportunity Cost: An example

\$ A state Diabetes Control Program has \$1M for its new programs next year.

\$ The money can be used either on a primary prevention program or a tertiary prevention program of increasing the eye exam rate.



Opportunity Cost:

An example, continued

\$ Each program will cost \$1 million

\$ The state DCP decides to use the money for the primary prevention program



Opportunity Cost:

An example, continued

\$Q: What is the "opportunity cost" of the state's new primary prevention program?



Opportunity Cost:

An example, continued

\$Answer: The "value" of the benefit from the tertiary prevention program of increasing the rate of eye exams.



Opportunity Cost: a question to you

\$What is your opportunity cost of attending DDT conference?



Marginal Costs

“Economic evaluation of health interventions is generally concerned with *marginal* costs and NOT with the total costs of an intervention.”

Richardson J. Aust NZ J Public Health 1998;22:247-53.



What does “Marginal” mean?

\$Marginal → Extra or additional

Marginal cost = Additional costs of producing one more unit of output



Why marginal costs?

\$ Marginal costs tend to increase after a certain level of production, i.e., producing a unit of output become more and more expensive



Marginal Cost: An example

\$ Eye exam annually

- Cost for HMO = \$2 M

\$ Eye exam every 2 year

- Cost for HMO = \$1.2 M

\$ Question: What is the Marginal Cost of switching from a two-year to an annual exam schedule?



Marginal Cost: An example

\$ Answer:

Marginal costs = \$2 M - \$1.2 M = \$ 0.8 M



Marginal Cost:

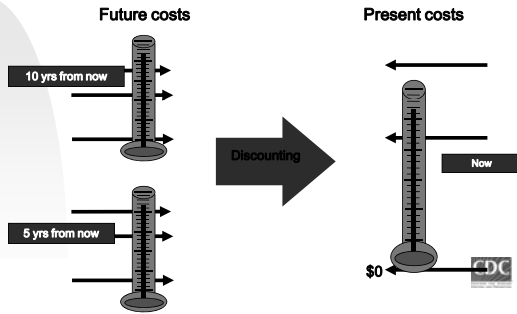
A question to you

What is your marginal cost to attend the another training session, considering you are already here?



Time Discounting

A computational process to adjust for differential timing of costs or consequences of an intervention



Time Discounting, Why do it?

\$ If funds are not spent on health programs then they may be invested and earn a rate of interest.

- At some future date the funds can buy more health.
 - However, when the future date is reached, the same argument could be used.
 - ✓ Hence, one could justify *never* spending on health NOW.

\$ Thus, we need to express costs relative to the same time period, i.e. present value.



Time Discounting: How to do it?

Present Value = Future Value / $(1+r)^t$
r = real discount rate, t = time period

as r increases, now is worth more;
as r goes to 0, now is worth less.



Example: converting future costs into the present value

Discount rate	\$100, 1 year from now	\$100, 5 years from now
15%	\$73.09	\$20.86
10%	\$84.06	\$41.97
5%	\$92.46	\$67.59
3%	\$97.09	\$86.26
0%	\$100	\$100



Inflation adjustment

A practice of adjusting the increase in
price levels over time.



Inflation adjustment: why do it?

- \$ Prices tend to increase over time
- \$ Price or cost data that are available to you may be from different years
- \$ Prices are needed to be adjusted to the same base year using an adjustor



Choosing an adjustor

Consumer Price index (CPI) measures the average level of prices of goods and services typically consumed by urban consumers annually

- All-item
- Medical care component
- Medical services
- others



Adjusting for inflation How to do it?

$$C_B = C_A \times (CPI_B / CPI_A)$$

Where:

C_B = cost at based yr

C_A = cost at the yr available

CPI_B = index value for the base yr

CPI_A = index value for the yr available



Adjusting for inflation: example

Given:

1 day of hospital stays = \$1,000 in 1997

$CPI_{1997}=234.6$

$CPI_{2000}=260.8$

What would be the cost in year 2000?

$$\begin{aligned} C_{2000} &= C_{1997} \times (CPI_{2000}/CPI_{1997}) \\ &= \$1000 \times (260.8/234.6) \\ &= \$1112 \end{aligned}$$



Adjusting for inflation

Not equal to

Time Discounting



Types of Costs

\$ Direct:

- costs of the intervention itself
- costs of routine care
- costs of treating side-effects

\$ Medical vs. Non-medical

- Medical, e.g., MD time, x-ray, lab tests, medications, hospital costs, paid by health care system
- Non-medical, e.g., patient time and transportation cost, not paid by health care system



Types of Costs Continued

\$ Indirect:

- cost of lost productivity due to death
- cost of lost productivity due to illness



Types of Health Outcomes

\$ Natural units

- \$ # diabetes avoided or delayed
 - \$ # of diabetes cases identified
 - \$ # diabetes complications (eg CVD) avoided
 - \$ # lives saved
 - \$ # life years saved
- \$ Quality-adjusted life years (QALY)



Quality-adjusted life years (QALY)

A summary outcome measure that incorporates the quality or utility of a health state with the duration of survival



Why use QALY?

Two possible effects of a disease or an intervention:

- Extending life or
- improving the health related quality of life

\$ QALY combines the two effects in a multiplicative way



How to calculate QALY

1. Assign a health utility value that corresponds to the quality of health state at each period during the survival by giving

- a value of 1 to full health,
- a value of 0 to death,
- a value between 1 and 0 to any other health states,
- a negative value to a health state that is worse than death.

2. Add the utilities across time periods

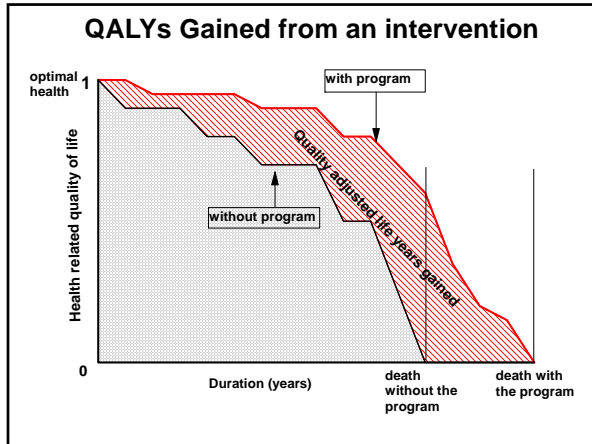


An example of estimated health utility values for persons with diabetes



Source: Coffey et al. 2002 Diabetes Care





How to calculate QALY: an example

1. Implementing the DPP Intensive lifestyle intervention over a lifetime would delay diabetes for 5 years, compared for Placebo
2. Question: What is the gain in QALY?
3. Gain in QALYs = $5 \times (QOL_{IGT} - QOL_{DM})$
 $= 5 \times (0.72 - 0.70)$
 $= 0.1 \text{ QALYS}$


Cost-Effectiveness Ratio (Incremental CE Ratio)

=
$$\frac{(\text{Cost Intervention B} - \text{Cost Intervention A})}{(\text{Outcome Intervention B} - \text{Outcome Intervention A})}$$

Or
$$\frac{(\text{Incremental cost of new intervention})}{(\text{Incremental change in outcome due to new intervention})}$$

What is in the cost ?
When denominator is in natural units


Total Cost = direct medical costs plus direct non-medical costs plus indirect costs



What is in the cost ?
When denominator is in QALY

Total Cost = direct medical costs plus direct non-medical costs


Indirect costs are not included



What is in the effectiveness?

Effectiveness is measured by a change in health outcome such as

- \$# diabetes cases prevented
- \$A1c level lowered
- \$# years of life saved
- \$ Quality-adjusted life years saved



Major types of cost-effectiveness studies

- \$** Within-trial cost-effectiveness analysis
- Deciding the research question
 - Developing a study protocol to collect the effectiveness and cost data needed prior to the trial
 - Collecting data along the trial
 - Analyzing the collected data
- \$** Long-term cost-effectiveness analysis
- Defining the research question
 - Building or identifying the appropriate disease progression model
 - Simulating health and economic outcomes with and without the intervention



How to calculate CE ratio: An example of within-trial analysis

3-year intensive lifestyle intervention in the US Diabetes Prevention Program

Cost difference = cost of lifestyle intervention (\$27,065) - cost of placebo intervention (\$23,525)
= \$3,540



How to calculate CE ratio: An example of within-trial analysis (continued)

Effectiveness difference →
lifestyle intervention reduced the absolute risk of getting DM by 14.5%, compared with Placebo

Cost effectiveness ratio = Cost difference (\$3,540) / Effect. Difference (0.145)
= \$24,414 per case of diabetes prevented or delayed



How to calculate cost-utility ratio: An example of long-term CE analysis

Intensive glyceemic control among persons > 25 years and with newly diagnosed DM

$$\begin{aligned} \text{Cost difference} &= \text{cost of Intensive glyceemic control } (\$56,270) - \text{cost of conventional care } (\$48,343) \\ &= \$7,927 \end{aligned}$$



How to calculate cost-utility ratio : An example of long-term CE analysis (continued)

$$\begin{aligned} \text{Diff. in QALYs} &= \text{QALYs with the intensive glyceemic control } (12.0707) - \text{QALYs with conventional care } (11.8791) \\ &= 0.1916 \text{ QALYS} \end{aligned}$$

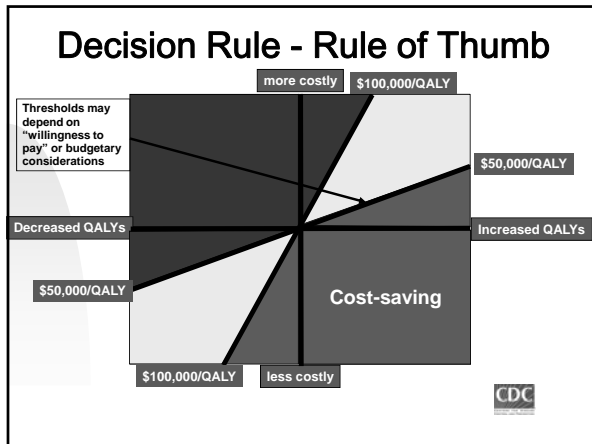
$$\begin{aligned} \text{CE ratio} &= \text{Cost diff. } (\$7,927) / \text{Effect.diff. } (0.1916) \\ &= \$41,373 \text{ per QALY gained} \end{aligned}$$



Decision Rule - Rule of Thumb

- \$ Negative CE ratio → cost-saving
- \$ CE ratio < \$50,000/QALY → considered cost-effective and good value for the money in the United States
- \$ CE ratio > \$100,000/QALY → considered not cost-effective and bad value for the money in the United States
- \$ Thresholds may depend on "willingness to pay" or budgetary considerations





Assessing a cost-effectiveness article :

Good, bad , or indifferent?

CDC

- ### Essentials of a Cost-effectiveness Study
- ✓ Question and the Audience
 - ✓ Perspective
 - ✓ Alternative interventions
 - ✓ Health Outcome measures
 - ✓ Time frame & Discounting
- CDC

Checklist

Framework

- ✓ Study question defined?
- ✓ Audience
- ✓ Perspective (key concept)
- ✓ Intervention and Alternatives
- ✓ Opportunity costs (key concept)
- ✓ Time and discounting (key concept)



Checklist

Data and Methods

- Analytic method specified ?
- cost-benefit
 - cost-effectiveness
 - cost-utility



Checklist

Data and Methods

- Costs - key concept
- ✓ Cost identified - sources
 - "Real" costs (opportunity costs)?

 - ✓ Costs differentiated?
 - direct
 - indirect
 - intangible



Checklist

Data and Methods

- ✓ Health outcomes identified?
- ✓ Value of health outcomes?
cost-of-illness/ human capital
willingness-to-pay
QALYs, DALYs etc.



Checklist

Data and Methods

- ✓ Sensitivity and threshold analyses
"key" input variables;
what "drives" the results?
- ✓ Sufficient info to replicate?



Checklist

Results

- ✓ Summary measure
net value, cost-per case averted
- ✓ Distributional effects
who pays, who benefits
- ✓ Graphs and tables stand alone?



Checklist

Discussion

- ✓ Limitations acknowledged?
- ✓ Relevance for health policy?
- ✓ Key variables discussed?
- ✓ Comparison to other studies?