EVALUATION OF HEALTH CARE PROJECTS

EE 474 Health Economics

Semester 2/2017

Topics

- Overview of Economic Evaluation
- Cost-Benefit Analysis
- Cost-Effectiveness Analysis
- Cost-Utility Analysis

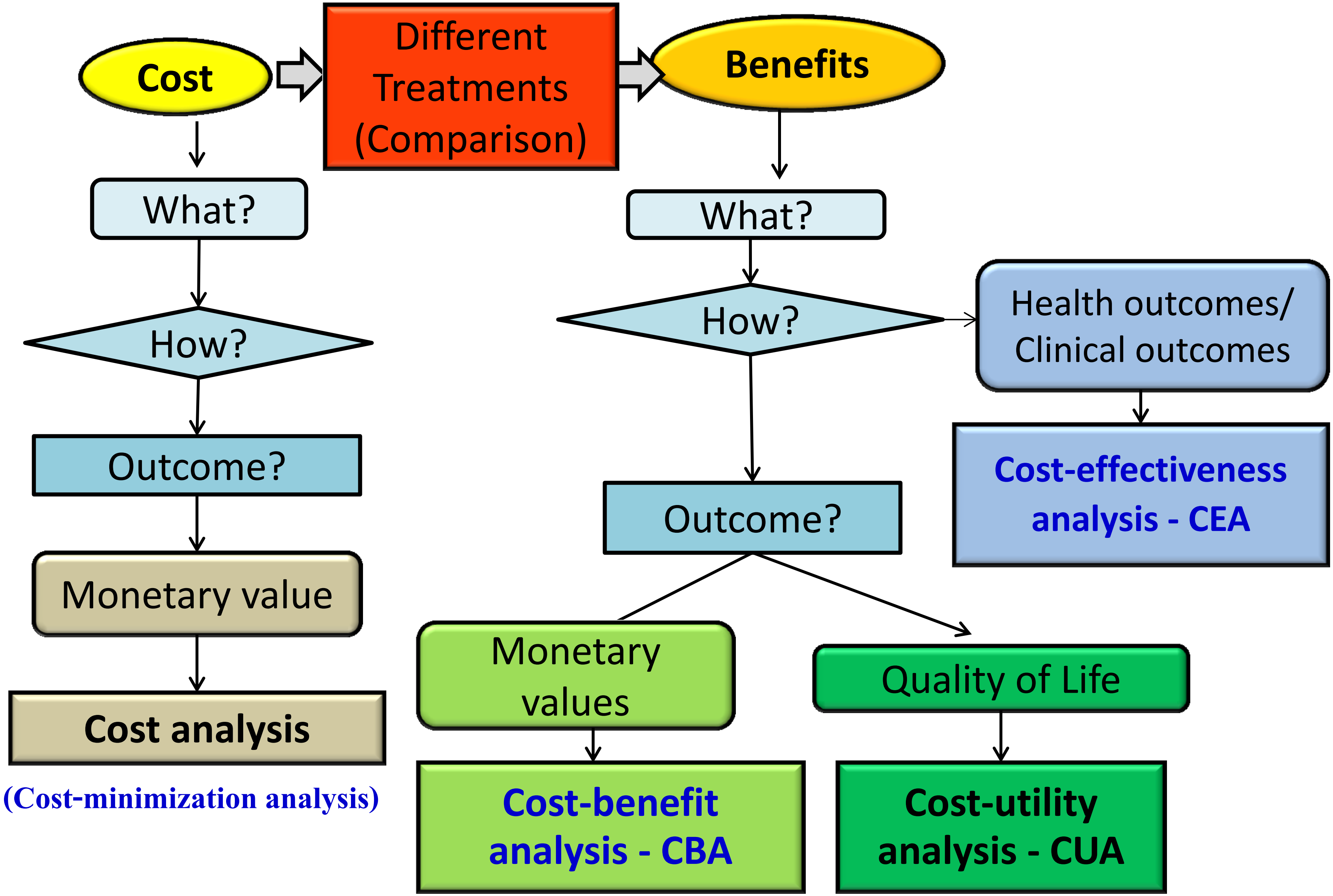
Health Economic Evaluation

- Cost-benefit analysis (CBA) is the general term for *economic evaluations* of new projects or intervention.
- CBA is based on the concept of allocative efficiency; it seeks to determine the optimal quantity by comparing incremental costs and incremental benefits.
- 3 commonly used tools for economic evaluation in health care:
  - Cost-benefit analysis (CBA)
  - Cost-effectiveness analysis (CEA)
  - Cost-utility analysis (CUA)

Overview of Economic Evaluation

		Outcomes			
		Consider either cost or benefit		Consider both cost and benefit	
		Consider cost	Consider benefit		
Compare among alternatives	No	Cost description	Outcome description	Cost-outcome description	Partial evaluation
	Yes	Cost analysis	Efficacy, Effectiveness analysis	Efficiency evaluation	Full economic Evaluation: CEA, CBA, CUA

Partial evaluation


Cost
Different Treatments (Comparison)
Benefits
What?
How?
Outcome?
Monetary value
Cost analysis
(Cost-minimization analysis)
What?
How?
Health outcomes/ Clinical outcomes
Cost-effectiveness analysis - CEA
Outcome?
Monetary values
Quality of Life
Cost-benefit analysis - CBA
Cost-utility analysis - CUA

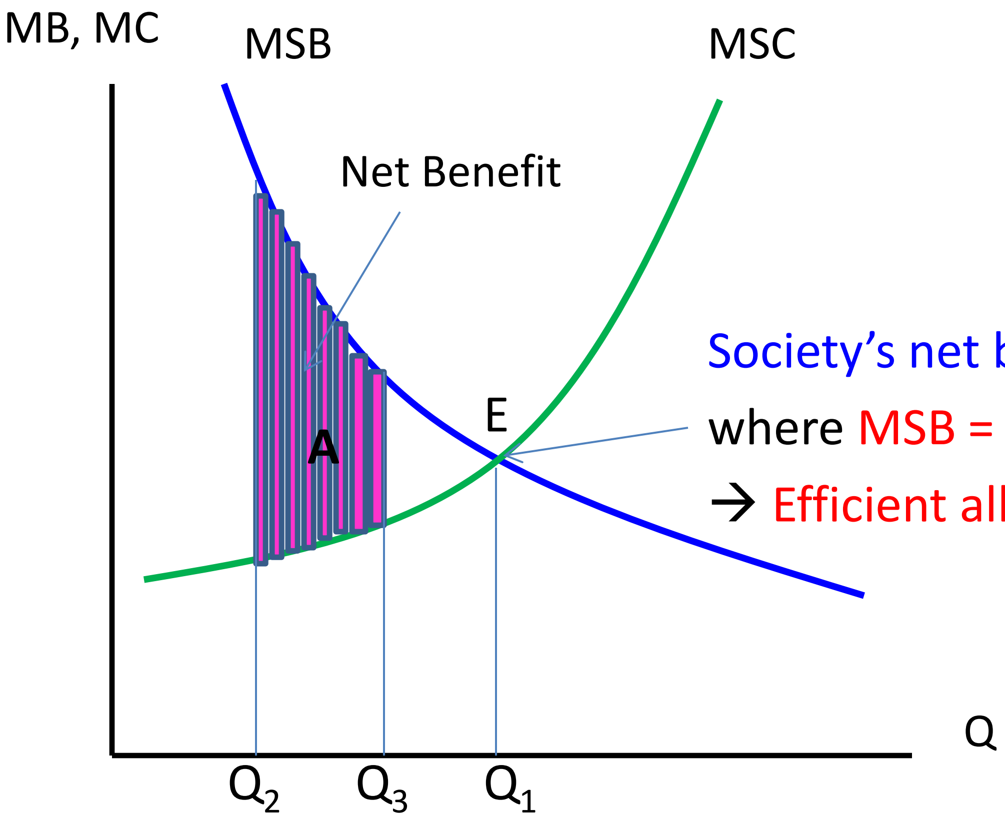
Different Types of Economic Evaluation

	Numerator (Cost)	Denominator (Benefit)
Cost-minimization	$	-
Cost-benefit	$	$
Cost-effectiveness	$	Health outcome in natural units (e.g. life-years gained, disability-days saved, points of blood pressure reduction, etc.)
Cost-utility	$	Healthy years (e.g. QALY, DALY)

1. Cost-Benefit Analysis

- CBA is based on the idea that a project or policy will improve social welfare if its benefits exceed the costs.
- The benefits and costs that are counted must include not only direct benefits or costs of the project but also any indirect benefits or costs through externalities or other third-party effects.
- Let B represents all the benefits and C represents all the costs.
  - A project is worthwhile if $B - C > 0$ (or $B/C > 1$).
  - When comparing across different projects, a project with higher B/C ratio is preferred.

Marginal Analysis in CBA



Society's net benefit is maximized,

where MSB = MSC.

→ Efficient allocation

Cost Measurement

- Costs are measured as opportunity costs.
  - Cost of the project itself.
  - Forgone costs associated with implementing the project.
- For public investment, the opportunity costs are difficult to measure because there is no market to serve as a guide for pricing.
  - Example: The costs of building a dam include the construction cost and the costs incurred from its negative impacts on animal habitat or historical landmark under water.
- Also, public investments may have side effects that create additional measurement difficulties.
  - Example: Immunization program, pollution abatement programs, etc.

Benefits: Valuing Human Life

- To monetize the benefits of a project or a treatment, one needs to place a value on human life.
- 3 possible approaches:
  1. The human capital approach
  2. The willingness to pay approach
  3. The contingent valuation approach

Benefits: Valuing Human Life

1. The human capital approach:
   - Estimates the present value of an individual's future earnings.
   - Example:

     If a treatment can extend Mr. A's life for 1 year and Mr. A's potential salary is $5,000 per month, the value of that treatment equals to the expected income Mr. A could earn during that extra year.

     → Value of health benefits = $5,000*12 = $60,000

Benefits: Valuing Human Life

2. The willingness to pay or willingness to accept approach:

- Measures what individuals are willing to pay (accept) to avoid (accept) additional risk to life and limb.
  - Measurement based on *stated preferences*
- This can be done by asking people about their WTP or WTA directly.

  Example: Suppose an air filter can reduce the probability of death by 0.01%. Would you be willing to pay $10 to buy this filter?

  - The value of benefits = $10/0.01% =$100000
- Alternatively, researchers can use *an experiment design* to investigate people's WTP or WTA.

Benefits: Valuing Human Life

3. The contingent valuation approach:
   - Elicits individuals valuation of alternative contingent risks.
   - Example: If you face a 10% risk of heart attack, how much would you be willing to pay for a treatment that reduces the risk to 5%?

     → Suppose the stated amount: $100,000

     - Yes → what about $150,000?
     - No → what about $75,000?

How Much Is One Life Worth?

Meta analysis of wage based studies	Years covered by the studies	Value of Life in 2009 dollars
Miller (2009)	1974–1990	5.2 million
Mrozek & Taylor 2002	1974–1995	2.0 to 3.3 million
Viscusi & Aldy (2003)	1974–2000	6.9 to 9.5 million
Kochi et al (2006)	1974–2002	11.1 million
Meta analysis of stated preference studies	**Years covered by the studies**	**Value of life in 2009 dollars**
Kochi et. al. (2006)	1988–2002	3.5 million
Dekker et al. (2011)	1983–2008	2.7 to 8.5 million
Lindhjem et al. (2010)	1973–2008	3.2 million

Note: These data are from Maureen Cropper, James K. Hammit, and Lisa A. Robinson, (2011), "Valuing Mortality Risk Reductions: Progress and Challenges," Discussion Paper, Washington, DC: *Resources for the Future.*

Discounting

- Because benefits or costs that occur in the future are not equivalent to benefits or costs that occur today, the future benefits and costs must be discounted.
- Reasons for discounting:
  - A dollar today has opportunities other than the project of study.
  - People have a tendency to prefer the present when allocating spending.
- Present value of net benefits:

$$PV = \sum_{t=1}^{t=T} \frac{(B_t - C_t)}{(1+d)^t}$$

Other Issues in CBA

- Risk adjustment:
  - Due to differences in riskiness across projects, it is important that benefits and costs be discounted at a rate that accounts for the riskiness of the project being evaluated.
- Distributional adjustment:
  - When benefits are disproportionately distributed across the population, adjustments may need to be made in the analysis.
- Inflation:
  - Inflation can be accounted for by introducing an inflation factor into the discount rate used in the analysis.

Example: Estimated Benefits and Cost for the Vaccination of College Students against Meningococcal Disease (m$)

2 scenarios:

1. Students contract the disease at 2 times the national average rate.
2. Students contract the disease at 15 times the national average rate.

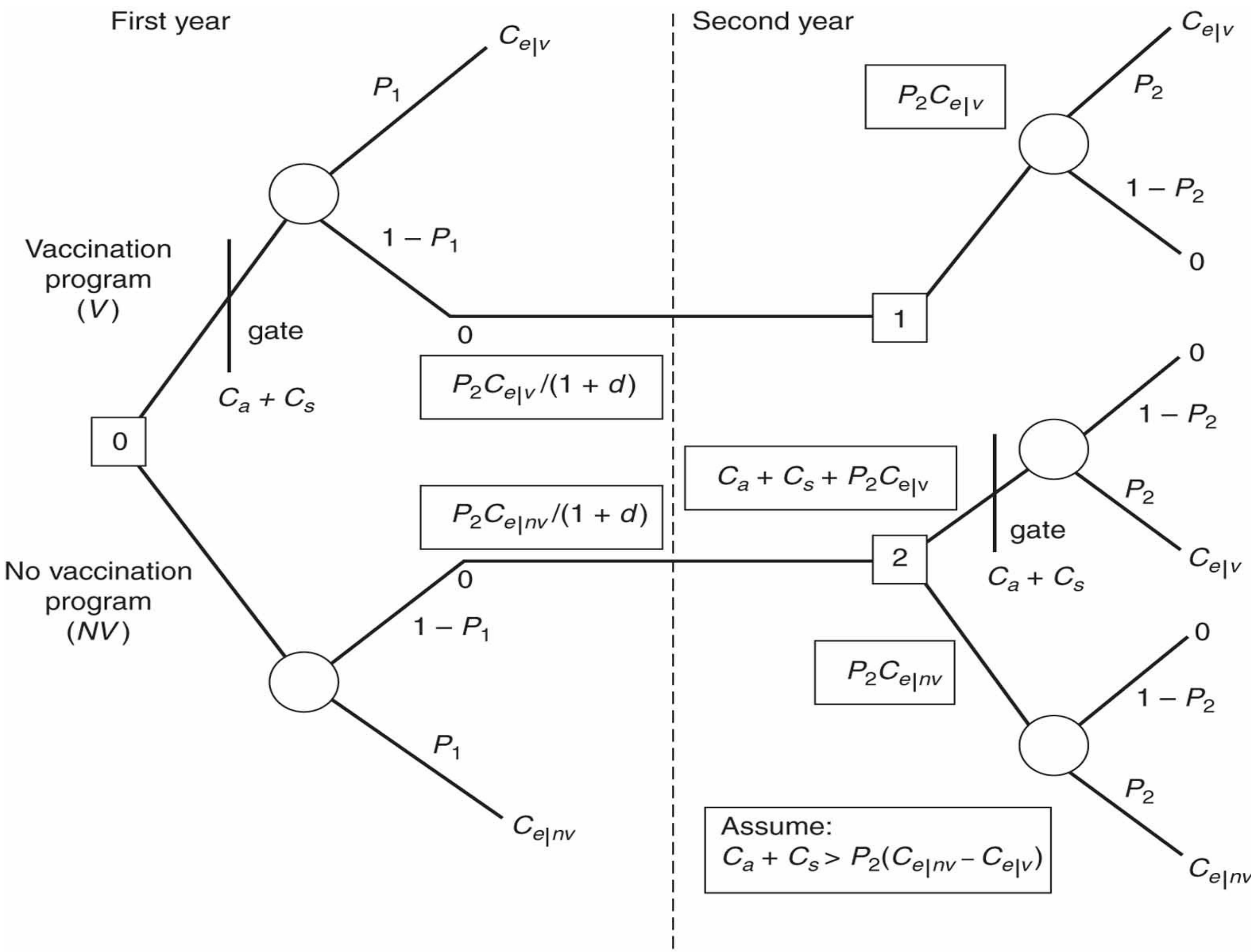
	Baseline x 2	**Baseline x 15**
Cost of the vaccination program	$56.2	$56.2
Total benefits	9.3	63.8
Direct medical benefits	0.5	3.1
Indirect benefits – value of lives saved	8.8	60.7
Net Benefits (Benefits – Cost)	-46.9	7.6

Source: Jackson et al. (1995). Cited in Santerre and Neun (2007)

Example: CBA of a Vaccination Program

- Consider a vaccination program against a type of influenza (which may infect a population over the next 2 years).
  - Costs – immunization expenditures (C_a) and possible adverse side effects (C_s)
  - Benefits – the adverse health effects that are avoided if an epidemic occurs.
- Decisions:
  1. Implement vaccination program
  2. No vaccination program
- Let P be the probability that the influenza infects the population.
- Costs from adverse health effects when epidemic occur:
  - $C_{e|v}$ – costs when epidemic occurs given that the vaccination program has been implemented.
  - $C_{e|nv}$ – costs when epidemic occurs given that the vaccination program has not been implemented.

Decision Tree for Vaccination Program



CBA: Pros & Cons

- Pros
  - Easy to compare the costs of a project with the benefits, because both are in monetary terms.
  - When there are diverse benefits, these benefits can be aggregated into one value.
- Cons
  - Must attach monetary values to health benefits or human life, which is not easy to do.

2. Cost-Effectiveness Analysis (CEA)

- CEA applies to problems where the goal is accepted at the start, and the problem is only to find the best, most efficient, means to achieve it.
- CEA compares the costs of achieving a particular nonmonetary benefits, including health outcomes or clinical outcomes.
- These benefits are measured in terms of 'natural units', such as:
  - Decrease in the number of days being ill
  - Number of lives saved
  - Number of life expectancy
  - Clinical outcomes: blood pressure, LDL cholestorol level (mg/dl) , etc.

CEA Measurement

- Let the change in social costs incurred due to a particular project be $C_1 - C_0$, and let the gain in health output be $E_1 - E_0$.
  - ➢ C_0 and E_0 can be the cost and effectiveness of the original treatment, which could be no health intervention.
- Then the various projects are compared by the incremental cost-effectiveness ratio (ICER):

$$ICER = \frac{C_1 - C_0}{E_1 - E_0}$$

- The project with the lower ICER is more cost-effective.

CEA: Example

- Suppose there are two drugs to reduce LDL-cholesterol:
  - Drug A reduces 5 mg/dl of LDL cholesterol, and costs $0.4/pill.
  - Drug B reduces 8 mg/dl of LDL cholesterol, and costs $1/pill.
- Assume that there is *no previous treatment*. Which drug should be prescribed?
  - $ICER_A$ = $0.4/5 per unit of reduced LDL cholesterol
    - ➢ $ICER_A$ = $0.08 per unit of reduced LDL cholesterol
  - $ICER_B$ = $1/8 per unit of reduced LDL cholesterol
    - ➢ $ICER_B$ = $0.125 per unit of reduced LDL cholesterol
  - Thus, drug A is more cost-effective.

Use of CEA under Budget Constraints

Project	Cost ($)	# Life Years Saved	Cost-effectiveness Ratio ($/Life years saved)	
A	1,000,000	80	12500	2
B	1,250,000	125	10000	1
C	2,500,000	125	20000	5
D	1,750,000	100	17500	3
E	1,950,000	100	19500	4

<u>Question</u> Suppose that the budget is fixed at $4,000,000. Which project(s) should the policy maker choose to invest?

CEA: Another Example

- Suppose there are 2 alternative treatments: A and B.
- Treatment A extends life expectancy by 3 years, compared with doing nothing, and treatment B extends it by 5 years.
- Treatment A costs $20,000 and B costs $50,000.
- Which one should be used?
  - ICER = $(C_B – C_A)/(E_B-E_A)$
  - ICER = ($50,000 - $20,000)/(5-3) years of life expectancy
  - ICER = $15,000/years of life expectancy
  - ➢ If the value of a life expectancy is greater than $15,000, the use treatment B instead of treatment A.

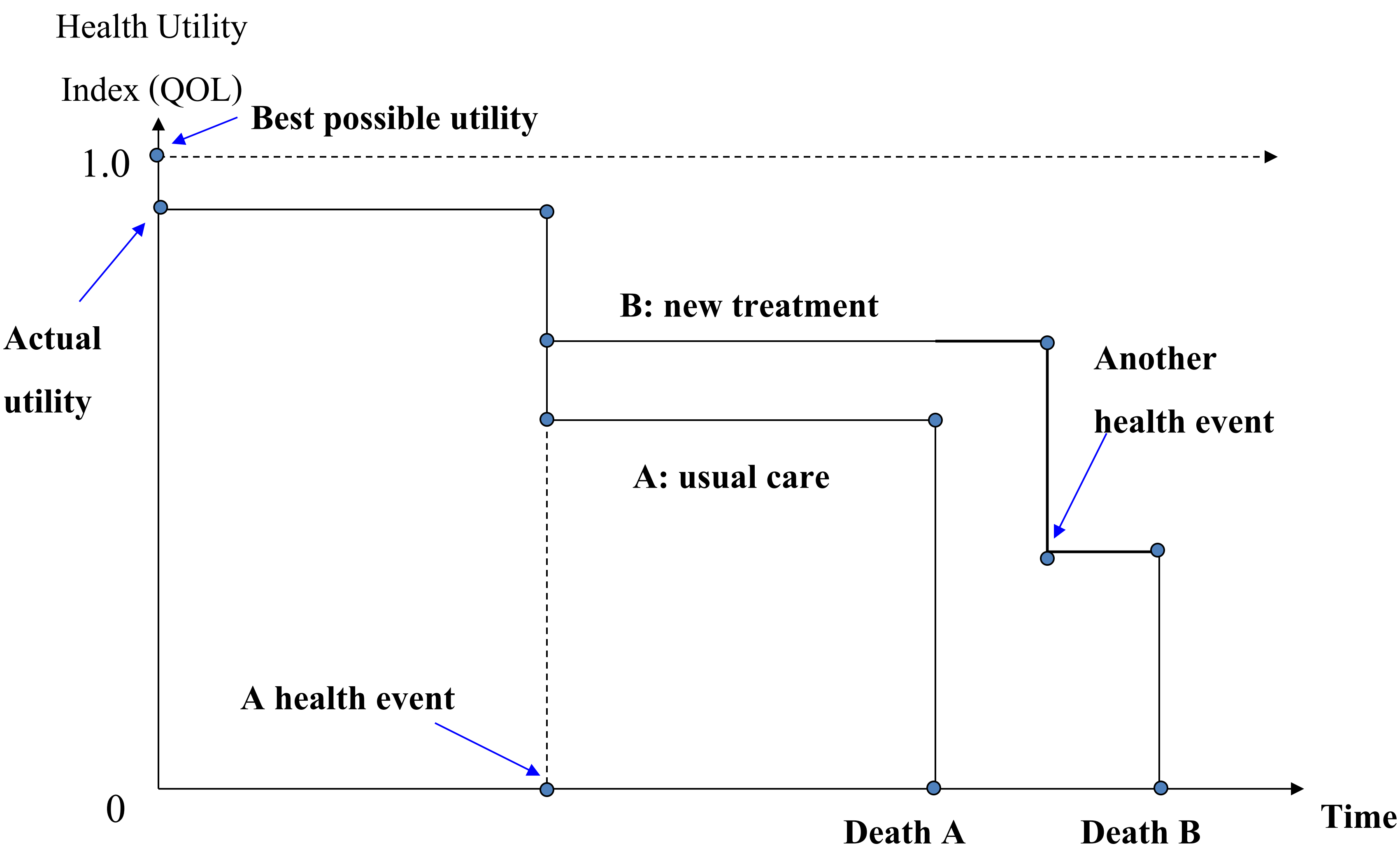
CEA: Pros & Cons

- Pros:
  - CEA can be a useful first step toward undertaking a cost-benefit study. If the project is not cost-effective, it is unlikely that a CBA will be feasible.
  - No need to convert health outcomes into monetary values.
- Cons:
  - Effectiveness often has many dimensions.
  - ICER is a relative information, not absolute.

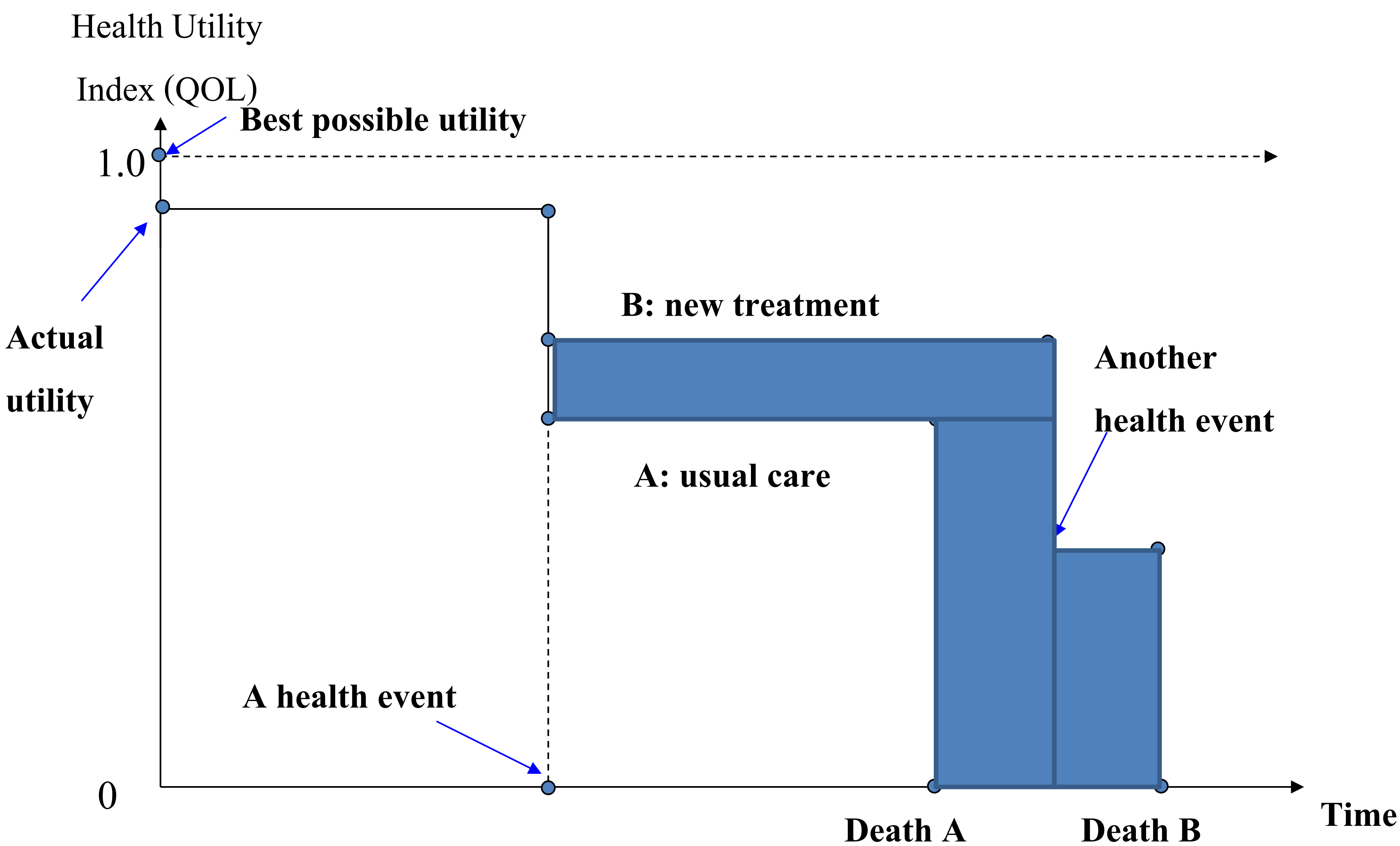
3. Cost-Utility Analysis (CUA)

- CUA is a special form of CEA, but the effectiveness is measured in terms of quality-adjusted life years (QALY).
  - QALYs measure the aggregate effect of an intervention on health by combining its effects on mortality (the number of years of life) and morbidity (the quality of life in each year of life).
  - Quality of life is measured on a 0 to 1 scale, with 1=perfect health and 0=death.
  - Example:
    - Suppose an ill person's quality of life is equal to 0.5 and a healthy person's is equal to 1.0.
    - A person who lives an extra 5 years in a healthy state and extra 5 years ill would have a gain of (5 + 2.5 =) 7.5 QALYs.

QALY Profile



QALY Profile



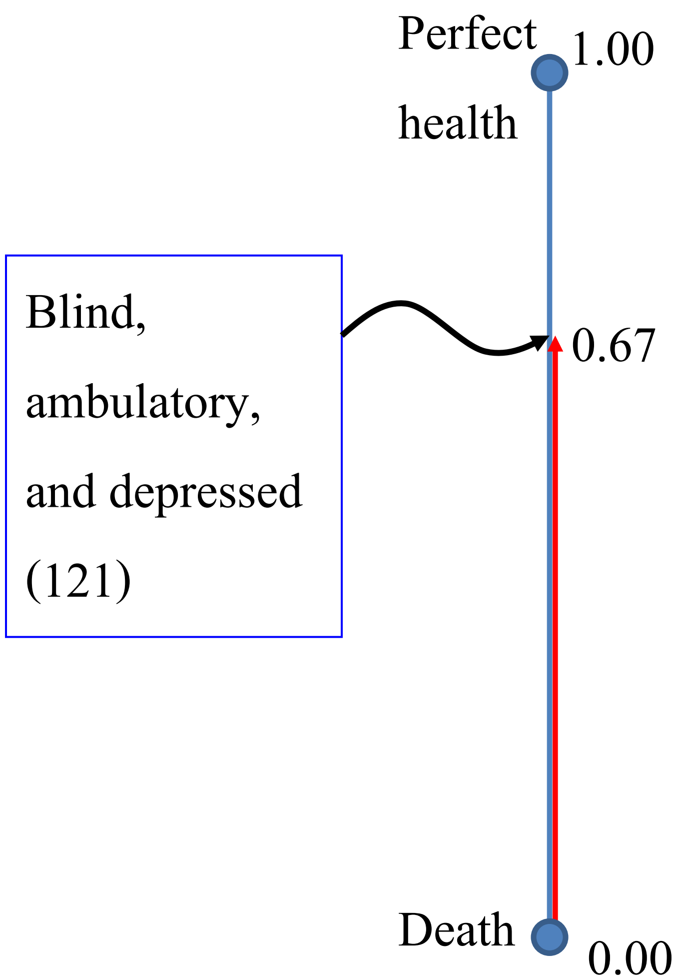
How to Determine Quality of Life Weight?

- Specify health dimensions that you think are important.
- Specify health state of each health dimension

  Example:
  - Sighted (2) vs. Blind (1)
  - Ambulatory (2) vs. Wheel Chair (1)
  - Good mental health (2) vs. Depressed (1)

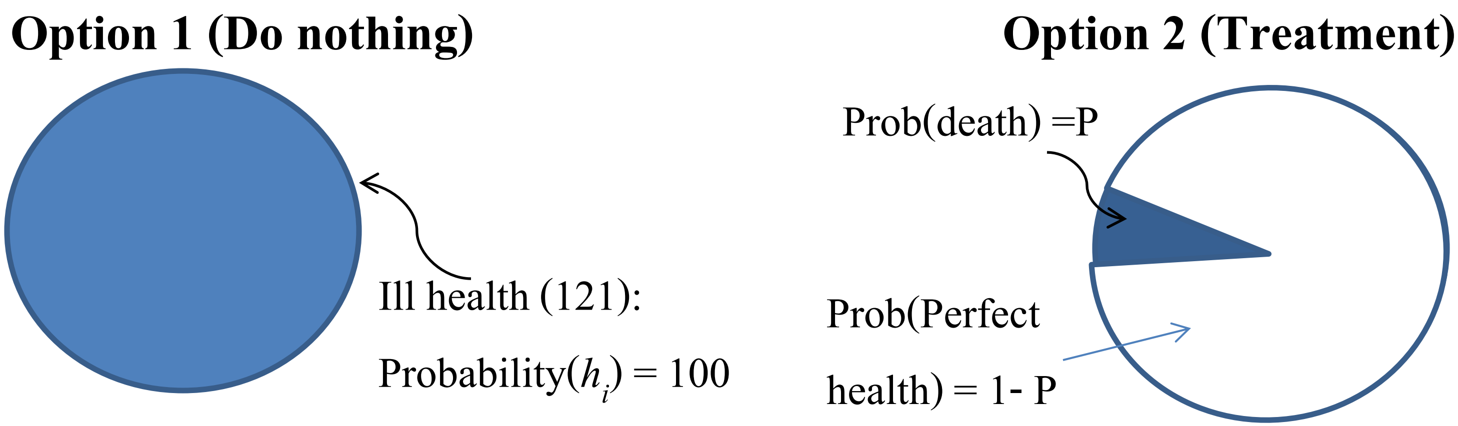
- For each health state, determine quality of life (QOL) weights. Three methods are:
  1. Visual Analogue Scale (Rating Scale)
  2. Standard Gamble
  3. Time Trade-Off

Visual Analogue Scale



- Respondent is asked to draw a line on a visual analogue scale to represent the health state, where the value is between 0 and 1.
- The distance from 0.00 to that point is the QOL.
  - E.g. QOL =0.67

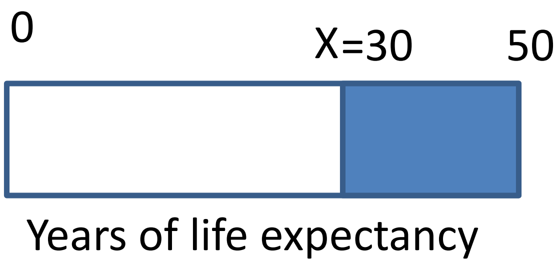
Standard Gamble



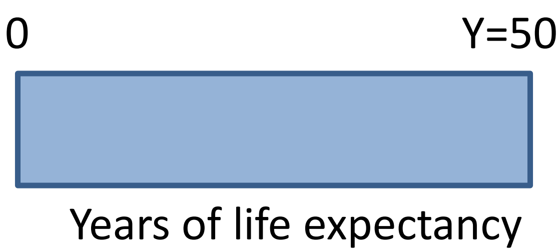
- Respondent is asked: "There is a treatment that has a P chance of painless death, but a (1-P) chance of total cure to perfect health. What is the largest P that you would accept to try this treatment?"
- If the health state 121 is really bad, you might have said 0.4 is the largest chance of death that would tolerate.
  - Health states with higher Ps have a lower QOL.
- The quality of life weight = 1-P. Eg. QOL =0.6

Time Trade-Off

(1) Perfect health



(2) Blind, ambulatory, & depressed



Suppose there are two alternatives:

1. X years of life expectancy with perfect health
2. Y years of life expectancy with ill health (e.g. health state 121), Y > X

Ask: How many years (X years) of best possible health would be equivalent to Y years in health state 121?

- QOL weight = X/Y

Ex:

QOL for health state 121 =30/50 =0.6

CUA Measurement

- Once the weights (q) are agreed upon and the QALYs are acceptably calibrated, then the measure becomes:

$$QALY = \sum_{t=1}^{t=T} \frac{F_i q_i}{(1+d)^t}$$

where F_i is the probability that the person is still alive at age i; *d* is the time discount factor; and the value q_i is the quality weight

  - Example: A treatment can extend life by one year with Prob of 0.9 and by two years with Prob of 0.5. The patient will die within two years, and q_1 =0.8 and q_2=0.6. (d=5%)

  - QALY = (0.9*0.8)/(1.05) + (0.5*0.6)/$(1.05)^2$ = 0.96

- Projects are evaluated on the basis of their incremental costs per extra QALY delivered to the patients or other subjects (Garber and Phelps, 1997; Ried, 1998).

Cost-Utility Ratio

- Costs per QALY (Cost-utility ratio) can be used to compare alternative intervention.
- This cost-utility ratio is one type of ICER, except that the denominator is QALY.

$$ICER = \frac{Cost_1 - Cost_0}{QALYs_1 - QALYs_0}$$

- The project or intervention with lower costs per QALY are preferred.
- If there's no previous health intervention
  - ICER = Cost/QALYs.

Example: League Table

Health Project	Cost per QALY gained (£)
1. GP advice to stop smoking	170
2. Pacemaker in heart block	700
3. Hip replacement	750
4. GP control of total serum cholesterol	1,700
5. Kidney transplantation	3,000
6. Breast cancer screening	3,500
7. Heart transplantation	5,000
8. Hospital haemodialysis	14,000

Total = 3,320

Total = 9,820

Total Budget = £5,000

Total Budget = £10,000

Compare CEA and CUA

Treatment option	Cost	Life-years gained	QOL	QALY
Current procedure	$20,000	2 years	0.7	1.4
New procedure	$110,000	8 years	0.4	3.2

Source: Santerre & Neun (2007)

CEA: ICER = ($110,000-$20,000)/(8-2) life-years gained
= $15,000 per life years gained.

CUA: ICER = ($110,000-$20,000)/(3.2-1.4) QALYs gained
= $50,000 per QALY gained.

CUA: Pros & Cons

- Pros:
  - Provides another technique for judging public projects.
    - Can compare many diverse interventions
  - Consider capabilities in terms of health and function when evaluating alternative treatments.
- Cons:
  - Like CEA, CUA is based on a relative information.
  - QALYs tend to place a reduced value on older people when evaluating a medical intervention.
  - The method’s linear valuation of medical interventions (the simple sum of quality gains times life-years saved times the number of people treated) is questionable.

Comparison of Economic Evaluation Tools

Tools	Outcomes	Evaluation
1. Cost-minimization analysis	Assume the exact same outcome.	Evaluate in terms of costs only.
2. Cost-effectiveness analysis	Require outcomes to be one type and be in the same unit.	Evaluate in terms of costs per improved outcomes (i.e. clinical outcomes or health outcomes
3. Cost-benefit analysis	Outcomes need not be the same.	Evaluate in terms of net benefits (monetary values)
4. Cost-utility analysis		Evaluate in terms of costs per QALY gained