Incorporating Economic Evaluation in Clinical & Translation Research

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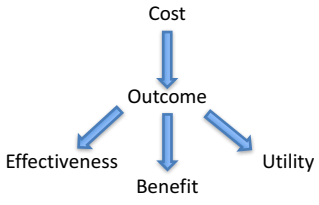
Setting expectations…

- Not possible to be an expert in economic evaluation in one hour
- However, you will…
  1) Understand the major types of economic evaluation
  2) Describe the economic evaluation process
  3) Understand how to prepare a CTR study to be evaluated
  4) Differentiate between return on investment and social return on investment
  5) Understand the limitations of economic evaluation

Introduction

- What do we mean by ”economic evaluation”?



Why bother with economic evaluation?

- Helps with decisions on optimal/efficient distribution of resources
- Funders may expect or value a return on investment
- Can help sell a policy in a climate of fiscal austerity

Midlands Mentoring Partnership launches effort to recruit mentors in Omaha

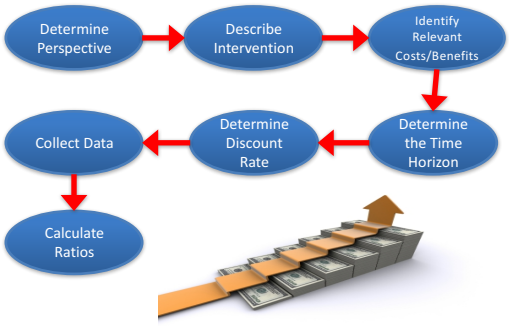
Most mentoring programs in Omaha require just four hours of commitment per month. According to research conducted by the Midlands Mentoring Partnership, more than 30,000 young people in Omaha live below the poverty line, and only about 10 percent have mentors.

Research from Fernando Wilson at the College of Public Health at the University of Nebraska Medical Center shows that for every dollar invested in mentoring, a community gets an $8 return on investment.

Given the state's fiscal uncertainties, we likely have further challenges ahea pledged to the Governor and Legislature that we will be a partner in navige current downturn – although we will also take every opportunity we can to fair and equitable treatment in the budget process, share stories of your go remind all Nebraskans that the university is the state's most important driv economic growth and social well-being.

In dollars alone, our impact is $3.9 billion annually – a 6-to-1 return on Nebraskans' investment in their university. Of course, that figure says nothing of what you do daily to

Economic evaluation in 7 steps



Last step…what are these "ratios"?

- Three types of economic evaluation commonly used in healthcare:
  - Cost-effectiveness analysis (CEA)
  - Cost-benefit analysis (CBA)
  - Cost-utility analysis (CUA)

Overview of CEA

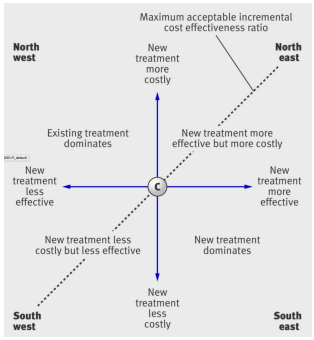
- CEA compares the costs of achieving a particular nonmonetary objective, such as lives saved
- CEA applies to problems where the goal is accepted at the start and the problem is only to find the best, most efficient, means to achieve it

Incremental Cost-Effectiveness Ratio (ICER)

Difference in costs between intervention and status quo (alternative) (*C1 - C0*) relative to improvement in health outcome between intervention and status quo (*E1 - E0*):

$$\text{ICER} = \frac{C1 - C0}{E1 - E0}$$

The cost-effectiveness plane



From Petrou & Gray(BMJ, 2011)

Advantages/disadvantages of CEA

- Conceptually, this approach amounts to identifying the lowest cost approach of producing a given benefit.
- CEA is the first step toward undertaking a cost-benefit study.
  - If you run into significant problems in undertaking a CEA, it is unlikely that a CBA will be feasible.
- A primary disadvantage is subjectivity of "willingness to pay"

Overview of Cost-Benefit Analysis (CBA)

- CBA = costs relative to monetary benefit
- Generally from a societal perspective
  - The benefits and costs of not only those directly attributed to project but also any indirect benefits or costs

Measurement issues

- May be difficult to monetize benefit or costs, especially in health care
  - Value of life
  - Value of improving quality of life

Methods in CBA

- Three methods to place value on human life:
  - The human capital approach, estimates the present value of an individual's future earnings
  - 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
  - The contingent valuation approach elicits individuals valuation of alternative contingent risks

Estimates for the value of life vary substantially

Table 12. Values of Statistical Life Used by U.S. Regulatory Agencies, 1985 – 2000*

Year	Agency	Regulation	Value of a Statistical Life (millions, 2000 $)
1985	Federal Aviation Administration	Protective Breathing Equipment (50 Federal Register 41452)	$1.0**
1985	Environmental Protection Agency	Regulation of Fuels and Fuel Additives; Gasoline Lead Content (50 FR 9400)	$1.7
1988	Federal Aviation Administration	Improved Survival Equipment for Inadvertent Water Landings (53 FR 7480	$1.5**
1988	Environmental Protection Agency	Protection of S	
1990	Federal Aviation Administration	Proposed Estal Service Area,	
1994	Food and Nutrition Service (USDA)	National Scho Program (59 F	
1995	Consumer Product Safety Commission	Multiple Tube FR 34922)	
1996	Food Safety Inspection Service (USDA)	Pathogen Redu Control Point S	
1996	Food and Drug Administration	Regulations Re Cigarettes and and Adolescen	
1996	Federal Aviation Administration	Aircraft Flight Simulator Use in Pilot Training, Testing, and Checking and at Training Centers (61 FR 34508)	$3.0**
1996	Environmental Protection Agency	Requirements for Lead-Based Paint Activities in Target Housing and Child-Occupied Facilities (61 FR 45778)	$6.3
1996	Food and Drug Administration	Medical Devices; Current Good Manufacturing Practice Final Rule; Quality System Regulation (61 FR 52602)	$5.5**
1997	Environmental Protection Agency	National Ambient Air Quality Standards for Ozone (62 FR 38856)	$6.3
1999	Environmental Protection Agency	Radon in Drinking Water Health Risk Reduction and Cost Analysis (64 FR 9560)	$6.3
1999	Environmental Protection Agency	Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements (65 FR 6698)	$3.9, $6.3
2000	Consumer Product Safety Commission	Portable Bed Rails; Advance Notice of Proposed Rulemaking (65 FR 58968)	$5.0**

From Viscusi & Aldi(2003, NBER)

Other estimates on value of life

Table 1: VSL Studies Using CFOI Database

(VSLs in millions of dollars)

	Study	Year of Study $	VSL in Study-Year $	VSL in 2012$	Comments
1.	Viscusi (2003) *	1997	$14.185M	$21.65M	Implausibly high; industry-only risk measure
2.	Leeth and Ruser (2003) *	2002	$7.04M	$8.90M	Occupation-only risk measure
3.	Viscusi (2004)	1997	$4.7M	$7.17M	Industry/occupation risk measure
4.	Kniesner and Viscusi (2005)	1997	$4.74M	$7.23M	Industry/occupation risk measure
5.	Kniesner *et al.* (2006) *	1997	$23.70M	$36.17M	Implausibly high;
6.	Viscusi and Aldy (200 *				
7.	Aldy and Viscusi (200 *				
8.	Evans and Smith (200				
9.	Viscusi and Hersch (2008)	2000	$7.37M	$9.86M	Industry-only risk measure
10.	Evans and Schaur (2010)	1998	$6.7M	$9.85M	Industry-only risk measure
11.	Hersch and Viscusi (2010)	2003	$6.8M	$8.43M	Industry/occupation risk measure
12.	Kniesner *et al.* (2010)	2001	$7.55M	$9.76M	Industry/occupation risk measure
13.	Kochi and Taylor (2011)*	2004			VSL estimated only for occupational drivers
14.	Scotton and Taylor (2011)	1997	$5.27M	$8.04M	Industry/occupation risk measure; VSL is mean of estimates from three preferred specifications
15.	Kniesner *et al.* (2012)	2001	$4M - $10M	$5.17M - $12.93M	Industry/occupation risk measure; mean VSL estimate is $9.05M

From US DOT Memorandum dated Aug. 8, 2016

What about ROI?

- Special case of CBA
  - Perspective narrowed to a particular institution
- Reported as either net present value (PV) dollar return or percentage return
  - %ROI = 100*(Dollar benefit – Dollar cost) / Dollar cost
- CBA reported as an ICER (cost per dollar benefit gained), ratio of dollar benefit to cost, or as dollar difference between benefit to cost (net benefit)

Social Return on Investment (SROI)

- Similar to calculating ROI, PV of benefits relative to PV of costs
- Benefits include non-traditional monetary measures using multiple perspectives
  - Like CBA, non-pecuniary outcomes must be monetized, e.g., using "willingness to pay" approach
- Expansive view of return on investment

Overview of Cost-Utility Analysis

- CUA uses quality-adjusted life-years as health-related outcome (QALY)
- Projects evaluated on basis of their incremental costs per extra QALY delivered to the patients

Measurement

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

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.

Cost utility and quality-adjusted life years (QALYs)

- Scale bounded by 0 and 1
- Death = 0 and perfect mental/physical health = 1
- Mental and physical health assessed using self-reported general or disease-specific quality of life instruments

Figure 1: EQ-5D-Y (UK English sample version)

Describing your health

Under each heading, please tick the ONE box that best describes your health TODAY

Mobility *(walking about)*
- I have no problems walking about ☐
- I have some problems walking about ☐
- I have a lot of problems walking about ☐

Looking after myself
- I have no problems washing or dressing myself ☐
- I have some problems washing or dressing myself ☐
- I have a lot of problems washing or dressing myself ☐

Doing usual activities *(for example, going to school, hobbies, sports, playing, doing things with family or friends)*
- I have no problems doing my usual activities ☐
- I have some problems doing my usual activities ☐
- I have a lot of problems doing my usual activities ☐

Having pain or discomfort
- I have no pain or discomfort ☐
- I have some pain or discomfort ☐
- I have a lot of pain or discomfort ☐

Feeling worried, sad or unhappy
- I am not worried, sad or unhappy ☐
- I am a bit worried, sad or unhappy ☐
- I am very worried, sad or unhappy ☐

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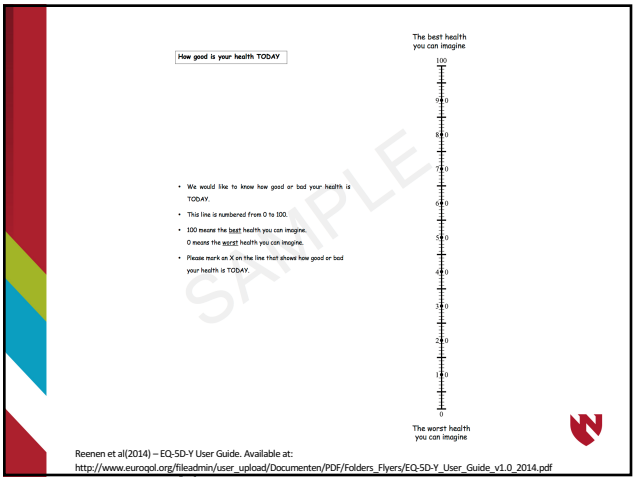
Reenen et al(2014) – EQ-5D-Y User Guide. Available at: http://www.euroqol.org/fileadmin/user_upload/Documenten/PDF/Folders_Flyers/EQ-5D-Y_User_Guide_v1.0_2014.pdf



Reenen et al(2014) – EQ-5D-Y User Guide. Available at: http://www.euroqol.org/fileadmin/user_upload/Documenten/PDF/Folders_Flyers/EQ-5D-Y_User_Guide_v1.0_2014.pdf

Afterward, use an algorithm to derive utility weights…

Health State 11223	
Full health = 1.000	
Mobility: level 1	(subtract 0.000)
Self-Care: level 1	(subtract 0.000)
Usual Activities: level 2	(subtract 0.140)
Pain/Discomfort: level 2	(subtract 0.173)
Anxiety/Depression: level 3	(subtract 0.450)
D1: number of dimensions at level 2 or 3 beyond first = 2	(subtract $-0.140 \times 2 = -0.280$)
I2-squared: square of number of dimensions at level 2 beyond first = 1	(subtract $0.011 \times 1 = 0.011$)
I3: number of dimensions at level 3 beyond first = 0	(subtract $-0.122 \times 0 = 0.000$)
I3-squared: square of number of dimensions at level 3 beyond first = 0	(subtract $-0.0148 \times 0 = 0.000$)

Hence, the predicted value for state 11223 is
$1.000 - 0.000 - 0.000 - 0.140 - 0.173 - 0.450 - (-0.280) - 0.011 - 0.000 - 0.000 = 0.506$

From Appendix 2 in Shaw et al(2005) – US valuation of the EQ-5D health states – Med Care

Advantages of QALYs

- ”Standardized” outcome (common yardstick)
  - Can evaluate a wide range of disparate interventions & programs
- Relatively easy to implement
- Measures ”high level” outcomes from healthcare services
  - Increased life span
  - Decreased morbidities

Critique of QALYs

- Some may view it as “age-ist”
- Different survey instruments may provide different utility weights
- Construction of QALYs is not really grounded in economic theory

Illustration: organ transplant

- Intervention costs $350,000, including direct and indirect costs
- Fourteen patients lived an average of 4.46 months.
- CER = (Cost − Averted Future Costs) / Life-years gained.
- CER = ($350,000 − 0) / (4.46/12) = $942,000.

QALY activity scale definitions

Activity Limitation	Excellent	Very Good	Good	Fair	Poor
Not Limited	1.00	0.92	0.84	0.63	0.47
Limited-other	0.87	0.79	0.72	0.52	0.38
Limited-major	0.81	0.74	0.67	0.48	0.34
Unable-major	0.68	0.62	0.55	0.38	0.25
Limited in IADL	0.57	0.51	0.45	0.29	0.17
Limited in ADL	0.47	0.41	0.36	0.21	0.10

Source: (Erickson et al. 1995)

Cost-effectiveness after adjusting for quality of life

- Assume health is poor after the operation.
- Assume ‘Limited in ADL’ after the operation.
- CER = $350,000 / ((4.46/12)×0.10) = $9,420,000.
- Is this cost-effective?

Cost-Effectiveness of Selected Preventive Measures and Treatments for Existing Conditions (2006 Dollars).*

Intervention	Cost-Effectiveness Ratio
Preventive measures	
Haemophilus influenzae type b vaccination of toddlers	Cost-saving
One-time colonoscopy screening for colorectal cancer in men 60–64 years old	Cost-saving
Newborn screening for medium-chain acyl-coenzyme A dehydrogenase deficiency	$160/QALY
High-intensity smoking-relapse prevention program, as compared with a low-intensity program	$190/QALY
Intensive tobacco-use prevention program for seventh- and eighth-graders	$23,000/QALY
Screening all 65-year-olds for diabetes as compared with screening 65-year-olds with hypertension for diabetes	$590,000/QALY
Antibiotic prophylaxis (amoxicillin) for children with moderate cardiac lesions who are undergoing urinary catheterization	Increases cost and worsens health
Treatments for existing conditions	
Cognitive-behavioral family intervention for patients with Alzheimer's disease	Cost-saving
Cochlear implants in profoundly deaf children	Cost-saving
Combination antiretroviral therapy for HIV-infected patients	$29,000/QALY
Liver transplantation in patients with primary sclerosing cholangitis	$41,000/QALY
Implantation of cardioverter–defibrillators in appropriate populations, as compared with medical management alone	$52,000/QALY
Left ventricular assist device, as compared with optimal medical management, in patients with heart failure who are not candidates for transplantation	$900,000/QALY
Surgery in 70-year-old men with a new diagnosis of prostate cancer, as compared with watchful waiting	Increases cost and worsens health

Source: Cohen JT, Neumann PJ, Weinstein MC. (2008). Does preventive care save money? Health economics and the presidential candidates. *N Engl J Med* 358(7): 661-3.

Additional Reading

- Gray AM, Clarke PM, et al. *Applied Methods of Cost-effectiveness Analysis in Health Care*. New York, NY: Oxford University Press; 2011
- Cape JD, Beca JM, Hoch JS. Introduction to cost-effectiveness analysis for clinicians. UTMJ 2013;90(3):103-5
- Viscusi WK, Aldy JE. The value of a statistical life: a critical review of market estimates throughout the world. NBER Working Paper 9487. February 2003
- Hirth RA, Chernew ME, et al. Willingness to pay for a quality-adjusted life year: in search of a standard. Med Decis Making. 2000;20:332-42
- Ubel PA, Hirth RA, Chernew ME, Fendrick AM. What is the price of life and why doesn't it increase at the rate of inflation? Arch Intern Med. 2003 Jul 28;163(14):1637-41
- Neumann PJ, Cohen JT, Weinstein MC. Updating cost-effectiveness—the curious resilience of the $50,000-per-QALY threshold. NEJM 2014;371(9):796-7
- Gargani J. The leap from ROI to SROI: Farther than expected? Eval Prog Plan 2017; [Epub ahead of print]
- Petrou S, Gray A. Economic evaluation alongside randomised controlled trials: design, conduct, analysis, and reporting. BMJ. 2011;342:d1548.

Thank you!

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