Decision Analysis: an Overview

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Spring 2014

What will you learn?

- Why to use decision analysis
- Different types of decision analysis
- Jargon → definitions
- The difference between cost-effective and cost-saving

Why engage in decision analysis?

- Have to choose between funding different interventions
  - limited resources
- There is generally no clear “right” answer of the best intervention to fund
- Logical, transparent, quantitative way to weigh the pros and cons of each intervention
  - Make an informed decision

Weighing the pros and cons of a decision

- Not all “pros” and “cons” are equal:
  - Consequences of pro/con
  - Probability of pro/con
    - Variation in probability

Pros and cons

- Option A:
  - 80% probability of cure
  - 2% probability of serious adverse event
- Option B:
  - 90% probability of cure
  - 5% probability of serious adverse event
- Option C:
  - 98% probability of cure
  - 1% probability of treatment-related death
  - 1% probability of minor adverse event

Opportunity costs

- Choosing one option means forgoing another
  - Due to funding
  - Due to resources

- Example:
  - Tuberculosis directly-observed therapy versus Promatora-based breast-feeding campaign
  - Cap-and-trade versus carbon tax

Variation

- In medicine/healthcare, we have a lot of variation!
  - Variation:
    - application of intervention (if it is non-pharmacological)
    - adherence to intervention
    - response to intervention
  - Sampling error (uncertainty)

Recap, Why to use Decision Analysis

- Allocation of limited resources
- Each intervention has pros and cons
- Each intervention is different:
  - Condition/population
  - Cost
  - Health outcome
- And we are know there is uncertainty around much of our estimates of pros, cons, costs and health outcomes

Advantages of Decision Analysis

- Evaluates each intervention using the same measure(s)

- Compare results using the same metric:
  - Costs
  - Cost per Life Year Saved
  - Cost per Quality-Adjusted Life Year

Decision Analysis can be applied to…

- Drugs
- Procedures
- Health programs
- Screening
- Vaccines
- Reimbursement decisions
- Etc.

Types of decision analysis

Types of decision analysis

- Cost-effectiveness analysis
- Cost-benefit analysis
- Budget impact analysis

Cost-Effectiveness Analysis (CEA)

Costs : Health effects

Health effects can be anything:

- Life-Years Saved
- Cases of Cancer Avoided
- Etc

CEA and ICERs

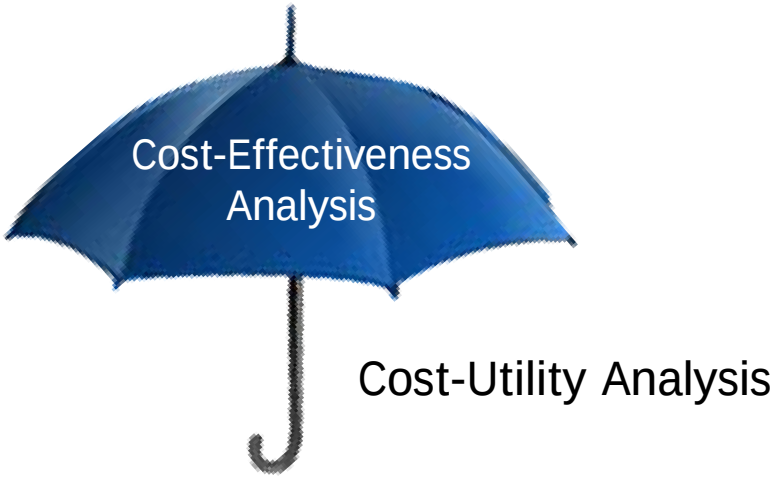
- Cost-Effectiveness Analyses compare the impact of 2 or more interventions

- Result is an Incremental Cost-Effectiveness Ratio (ICER)

$$\text{ICER} = \frac{\text{Cost}_B - \text{Cost}_A}{\text{Health Effect}_B - \text{Health Effect}_A}$$

Cost-Utility Analysis

- A particular form of cost-effectiveness analysis



- Health Effect is a Quality-Adjusted Life Year (QALY)

  QALY is derived from Utility

CEA versus CUA

Both compare 2 or more interventions

Method	Cost-Effectiveness Analysis	Cost-Utility Analysis
Outcome	Δ Cost / Δ Health Effect	Δ Cost / Δ QALY

QALYs and Utilities

- QALY = # of years of life * Utility of life

- Example:
  - Utility = 0.8
  - # of years of life lived = 5
  - QALY = 0.8 *5 = **0.40**

Utilities

- Preference for health
  - Not just a measure of health!
- Combine:
  - Health state a person is in
  - Valuation of health state
- Conventionally range from 0-1
    - 0 = death
    - 1.0 = perfect health
- More info in Dr. Sinnott's upcoming HERC lecture

Utility Calculations

Variable	Jane's health (0-1)	Jane's valuation (sum to 1)		Joe's Health (0-1)	Joe's valuation (sum to 1)	
ADL	0.8	0.15	0.12	0.8	0.50	0.40
Exercise	0.2	0.40	0.08	0.2	0.10	0.03
Mental Clarity	0.4	0.40	0.16	0.4	0.25	0.12
Emotional well-being	0.9	0.05	0.045	0.9	0.15	0.045
Total	---	1.0	**0.405**	---	1.0	**0.595**

Utility → QALY

- Jane's utility is **0.405**
  - Jane lives for 10 years
    - 0.405 * 10 = 4.05 QALYs
  - Jane lives for 12 years
    - 0.405 * 12 = 4.86 QALYs

- Joe's utility is **0.595**
  - Joe lives for 10 years
    - 0.595 * 10 = 5.95 QALYs
  - Joe lives for 5 years
    - 0.595 * 5 = 2.975 QALYs

Advantages of Utilities/QALYs

- Incorporate morbidity and mortality into a single measure

- Allows for comparison across disparate strategies
  - Newborn screening versus prostate cancer treatment
  - Early childhood education versus community health centers

ICERs in a Cost-Utility Analysis

- $$\text{ICER} = \frac{\text{Cost}_B - \text{Cost}_A}{\text{QALY}_B - \text{QALY}_A}$$

- If ICER < $50,000/QALY, is generally considered cost-effective
  - More on this later

ICERs in a CUA, Example

- $$\text{ICER} = \frac{\text{Cost}_B - \text{Cost}_A}{\text{QALY}_B - \text{QALY}_A}$$

	Program A	Program B
Intervention	Mobile text messaging for medication adherence	Diabetes care coordinator
Cost	$40,000	$150,000
QALYs	25	35

$$\text{ICER} = \frac{\$150{,}000 - \$40{,}000}{35 - 25} = \frac{\$110{,}000}{10} = \$11{,}000$$

Cost-Effective

Cost saving

- Cost-effective ≠ cost-saving!!

Cost-Saving	Cost-Effective
Cost less, provides greater health	Costs more, provides proportionally more health
	Costs less, provides proportionally less health

Cost-Effective

- Cost-Effective:
  - Program B costs more than Program A, but Program B provides proportionally more health benefit than Program A

- Proportional?
  - ICER is < Willingness to Pay Threshold

Willingness to Pay (WTP)

- U.S. – Often $50,000/QALY
  - Willing to pay *up to* $50,000 for one additional QALY

- Arbitrary, heavily criticized
  - Not an empirically-derived threshold

Thresholds for WTP

- Panel on Cost-Effectiveness in Health and Medicine does not endorse any WTP threshold

- NICE (U.K.) does not have an explicit threshold for reimbursement
  - Recommended results are presented using WTP of £20,000 and £30,000

Cost-Benefit Analysis

Cost-Benefit Analysis

- Costs and Effects are expressed entirely in dollar terms
  - Convert health effect → cost

Incremental Benefit (cost) – Incremental Costs = Net social benefit

- If Net social benefit is positive, then program is worthwhile

Assigning a dollar value to life

- Willingness to Pay (WTP)
  - Examine revealed WTP or elicit WTP
  - Framing effects, loss aversion, age-related effects, varying levels of disposable income
- Human Capital Approach
  - Use projected future earnings to value a life
  - Assumes an individual's value is entirely measured by formal employment.
    - Children?
    - Retired people?
    - Pay differential between men and women, different races

Cost-Benefit Analysis in Healthcare/Medicine

- Very rarely used:
  - Problems with assigning a dollar value to life
  - Problems with evaluating quality of life

Budget-Impact Analysis

Budget Impact Analysis

- Estimate the financial consequences of adopting a new intervention.

- Usually performed in addition to a cost-effectiveness analysis
  - CEA: does the intervention provide good value?
  - BIA: can we afford it?

BIA, example

Drug A has an ICER of $28,000 per QALY compared with Drug B. It is cost-effective.

Drug B costs $70,000.

Therefore, Drug A costs $98,000. There are 10,000 people eligible for Drug A, resulting in a total cost of $980 million dollars.

BIA tells us

- The true “unit” cost of the intervention
- The number of people affected by the intervention

- To give us an understanding of the total budget required to fund the intervention

CEA versus BIA

	CEA	BIA
Purpose	Does this intervention provide high value?	Can we afford this intervention?
Outcome	Cost and health outcomes	Cost
Size of Population	Not explicitly considered	Explicitly Considered

More info in Dr. Sinnott's upcoming BIA lecture

Approaches to Decision Analysis

Methods for decision analysis

- Modeling
- Measurement alongside a clinical trial

Types and Methods for Decision Analysis

	Measurement alongside a clinical trial	*Modeling*
Cost-Effectiveness Analysis	**x**	**x**
Cost-Benefit Analysis	**x**	**x**
Budget Impact Analysis		**x**

Measurement alongside a trial

- “Piggyback” onto an existing RCT
- Collect extra information from patients enrolled in the trial
  - Cost (based on utilization)
  - Utilities
  - (Efficacy and AEs are already being collected)

Modeling

- No real-world experiment exists
- Build a mathematical framework to understand the relationship between inputs and outputs
- Build model structure in software, populate it with inputs (from literature). Run model to derive outputs
- You decide on the boundaries of the analysis
  - Time frame, population, interventions of interest

Modeling versus Measurement

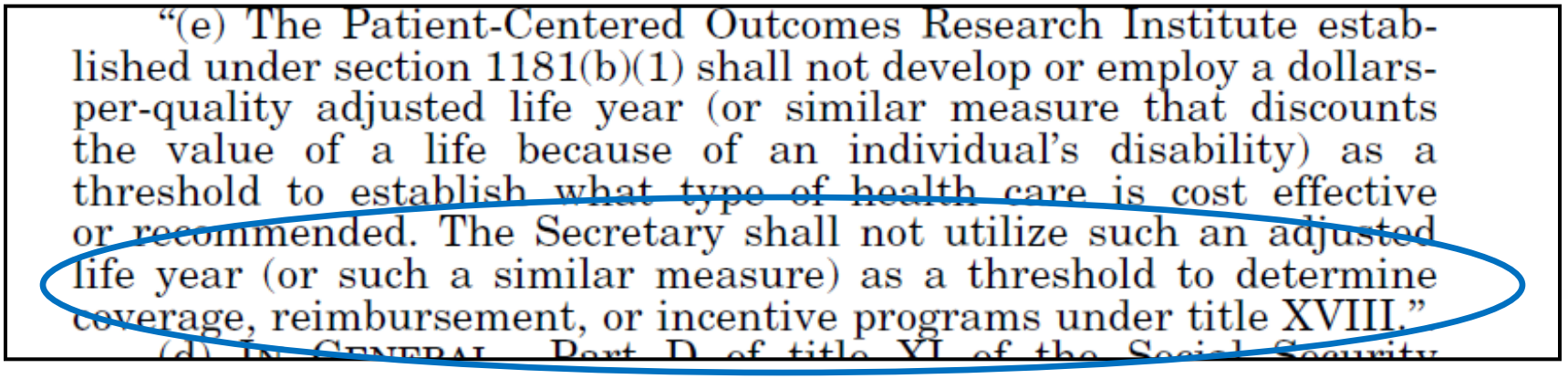
	Measurement	Modeling
Treatments considered	• Only the ones in the RCT (which may include placebo)	• Any of interest – But they also come from RCTs
Advantage	• Design case-report forms • Individual-patient data (subgroup analysis) • Utilities may be more accurate (treatment and health condition specific)	• Don't need to wait for a trial to be funded to do your analysis
Disadvantage	• Short time frame – will still have to project beyond the trial • Will not provide all of your inputs • Utilities come from patient perspective, rather than community	• Inputs need to come from similar studies on your population of interest

Cost-effectiveness Analysis for Resource Allocation

How is CEA used for decision making?

- Ex-US: Used by NICE (U.K.), PBAC (Australia), CADTH (Canada) for regulatory/market access purposes

- US: Medicare has historically not used cost-effectiveness to drive coverage decisions, ACA prohibits this



"(e) The Patient-Centered Outcomes Research Institute established under section 1181(b)(1) shall not develop or employ a dollars-per-quality adjusted life year (or similar measure that discounts the value of a life because of an individual's disability) as a threshold to establish what type of health care is cost effective or recommended. The Secretary shall not utilize such an adjusted life year (or such a similar measure) as a threshold to determine coverage, reimbursement, or incentive programs under title XVIII."

(d) IN GENERAL.—Part D of title XI of the Social Security

U.S. Cost-Effectiveness Analysis

- Pharmaceutical companies – international markets
- Academia
- Veterans Health Administration

- NOT used by FDA or CMS

Summary

- 3 major types of decision analysis:
  - **Budget Impact Analysis**
  - **Cost-Benefit Analysis**
  - **Cost-Effectiveness Analysis**
    - Cost-Utility Analysis
      - ↳ QALYs, a measure of morbidity and mortality

- Operationalize your decision analysis:
  - Measurement alongside a clinical trial, or
  - Modeling

- Cost-effective ≠ cost-saving!

Resources: Decision Analysis and CEA

- Gold MR, Siegel JE, Russell LB, Weinstein MC, eds. Cost-Effectiveness in Health and Medicine. New York: Oxford University Press; 1996.

- Hunink M, Glasziou P, Siegel J, et al. Decision Making in Health and Medicine: Integrating Evidence and Values. Cambridge, UK: Cambridge Press; 2004.

- Muennig P. Designing and Conducting Cost-Effectiveness Analyses in Medicine and Health Care. San Francisco, CA: Jossey-Bass; 2002.

Questions?

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