Introduction to Economic Evaluations

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Cost-Effectiveness Analysis
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Outline

- Agenda for today: The big picture - an overview of this class
- What is economic evaluation?
- Several examples
- Types of economic evaluations
  - Cost analysis
  - Cost-effectiveness analysis
  - Cost-utility analysis
  - Cost-benefit analysis
- Overview of key concepts and elements of economic evaluations
- Methods: ICER, decision trees/Markov models
- Logistics and syllabus
What is an economic evaluation?

(Textbook) “The comparative analysis of alternative courses of action in terms of both their costs and consequences.”

- **Alternative courses of action**: Health interventions like screening programs, new ways of delivering care, new medications, or new imaging technology. Also, intensity (dosage, screening frequency)

- **Comparative analysis**: Always a comparison – current way of doings things versus new ways; old drugs versus new drugs; new imaging technology versus old imaging technology. A valid alternative could be “doing nothing”

- **Costs**: Measured in $

- **Consequences**: Outcomes measured in natural units (cases detected/averted), years of life gained, years of life gained combined with a measure of quality (e.g. QALY), or even $

(As with most definitions, not totally right. Will explain in a bit)
Purpose

- Resources are scarce; we need a way to decide how to allocate them
- The ultimate goal is to inform decision makers about the efficient allocation of resources
- Economic evaluations provide a way to systematically think about cost and consequences of alternatives
- An attempt to assess if an intervention or technology provides “value”
- We will talk more about how economic evaluations are used (or not) in the US and in other countries later in the class
A Cost Analysis of Preoperative Breast MRI Use for Patients with Invasive Lobular Cancer

Isabelle Bedrosian, MD¹, Yan Xing, MS¹, Shereen Abdel Rahman, BS¹, Lisa Allen, MD¹, Huong Le-Petross, MD³, Gary J. Whitman, MD³, Funda Meric-Bernstam, MD¹,², Kelly K. Hunt, MD¹, Gildy V. Babiera, MD¹, and Janice N. Cormier, MD, MPH¹

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Bedrosian et al. (2015)

- Does the use of MRI for women with invasive lobular carcinoma change the cost of care?
- MRI improves staging $\rightarrow$ fewer operative interventions to achieve a margin-negative $\rightarrow$ fewer re-excisions $\rightarrow$ lower costs
- On the other hand, MRI $\rightarrow$ delays and additional tests plus mixed evidence
- Compared costs in women who received MRI vs those who did not at MD Anderson (piggyback clinical trial; about 100 patients)
- Conclusion: MRI increases costs (but not a lot)
Training care givers of stroke patients: economic evaluation
Anita Patel, Martin Knapp, Andrew Evans, Inigo Perez, Lalit Kalra

Abstract

Background Training care givers reduces their burden and improves psychosocial outcomes in care givers and patients at one year. However, the cost effectiveness of this approach has not been investigated.

Assessment of care givers’ quality of life
Patel et al. (2004)

- Evaluate the cost effectiveness of (informal) caregiver training by examining health and social care costs, informal care costs, and quality adjusted life years in caregivers.
- About 300 caregivers were randomized into two groups: training and control group.
- They compared costs and benefits.
- Conclusion: Caregiver training during rehabilitation of patients reduced costs of care while improving overall quality of life in caregivers.
ARTICLE

Cost-effectiveness of Prostate Cancer Screening: A Simulation Study Based on ERSPC Data

Heijnsdijk et al. (2015)

- **Objective:** Assess the cost effectiveness of prostate cancer screening (PSA)
- **Used data from European Randomized Study of Screening for Prostrate Cancer (ERSPC)**
- **Simulation of clinical story of 10,000 men who are screening starting at 55**
- Predicted the numbers of 1) prostate cancers diagnosed, 2) prostate cancer deaths averted, 3) life-years and 4) quality-adjusted life-years (QALY) gained, and cost-effectiveness of 68 screening strategies for prostate cancer
- **Conclusion:** Prostate cancer screening can be cost-effective when it is limited to two or three screens between ages 55 to 59 years. Screening above age 63 years is less cost-effective because of loss of QALYs because of **overdiagnosis**.”
My examples

- **Colorado Family Planning Initiative**
  Targeted to low-income women at Title X clinics
  Provided free long-acting contraceptives (LARCs) (IUDs, implants)
  Supported by an anonymous private foundation
  Research question: what are the cost savings from the perspective of the state of Colorado?

- **Blood screening for celiac disease and diabetes**
  Large scale screening in children ages 2-17. UC-BDC plans to screen in Denver (and offer follow-up)
  Opportunity to measure (some) costs and benefits
  The intervention will last a couple of years but the effects have to be taken into account over a lifetime
  As in the prostrate screening example, we need to use simulations
Key elements of economic evaluations

1. **Perspective** or point of view of the analysis: Who is incurring the costs and consequences?
   - Provider, health department, societal, insurance company (private or Medicare/Medicaid)

2. **Time of analysis** (aka time horizon): short term, long term? Whole lifespan?

3. **Discounting**: Time preference. A benefit/cost now is not the same as the same benefit/cost 30 years later (inflation/opportunity cost)

4. **Sensitivity analysis**: Evaluates the effects of uncertainty in numbers

5. **Methods**: Incremental cost effectiveness ratio, decision trees, Markov models
This may sound obvious, but...

You want to make sure the alternative you want to compare works and does no harm (efficacy/effectiveness)

A story about economic evaluation proposals (or why most EEs never happen)
Challenges

- The fundamental challenge of EEs is... lack of **DATA**
- Data synthesis (e.g. meta-analysis) is many times a key component of EEs
- Rarely a single source of data; EEs combine multiple sources of data
- I’ll try to provide examples of data sources for the US
Types of economic evaluations

- How benefits are measured (or not) distinguishes different types of economic evaluations
  1. Cost-analysis (CA)
  2. Cost-effectiveness analysis (CEA)
  3. Cost-utility analysis (CUA)
  4. Cost-benefit analysis (CBA)
Cost analysis

- Objective: compare the cost of two or more alternatives
- Consequences are not examined (partial evaluation)
- But... if benefits are the same → it’s like comparing costs and benefits
- A common version of cost analysis: cost of illness study (COI): COI measures the economic burden of a disease(s) and estimates the maximum amount that could potentially be saved if a disease were to be eradicated
- We will spend some time in cost analysis because it’s common to all types of economic evaluations
More on costs

- What costs should be considered depends on the perspective of the analysis and the time horizon

  **Health sector**: drugs, equipment, hospital stays of the program and possibly follow-up

  **Other sectors**: Social services, follow-up personnel, home health

  **Patient and/or family**: Travel time, caregiver’s lost income, cost of informal care...

  **Productivity changes**: Interventions may affect ability to work now but could increase the ability to work in the future

- We’ll talk about these issues for at least two weeks...
Objective: compare the cost and benefits/sequences of two or more alternatives

- Benefits are measured in “natural units”
- Effectiveness measure should be relevant/important
- Example of benefits: cases averted, births averted, cases detected, years of life gained, blood pressure, days free of pain...
- Can compare several alternatives with same benefit measure
Cost-effectiveness Analysis (CEA)

- Results presented as (incremental) costs per unit of outcome
- Incremental Cost Effectiveness Ratio (ICER)

\[
ICER = \frac{C_1 - C_2}{E_1 - E_2}
\]

- \(C_i\) and \(E_i\) are the costs and effectiveness measure of alternative \(i\)
- We will spend some time discussing and calculating ICERs
- Limitations: a) There is no preference/value associated with the measure of benefit. b) Can only compare alternatives in which the “natural unit” of benefit is the same.
Cost-utility Analysis (CUA)

- Same objective: compare the cost and consequences of two or more alternatives
- Benefits are measured in quality-adjusted life years (QALYs)
- QALYs combine both gains in extra years of life (quantity) with the quality of those gains
- Can compare more alternatives
We will talk a lot about how economists measure “quality” (preferences)

As before, ICER provides a summary of results but now $E_i = QALY_i$

$$ICER = \frac{C_1 - C_2}{QALY_1 - QALY_2}$$

Limitation: not all measures of benefits are transformed into preferences or quality
We have ICER comparing alternative B to usual care, A. Now what?

Easy cases:

1. B is more expensive and less effective (prefer A)
2. B is less expensive and more effective (prefer B)

Not-so-easy cases:

1. B is more expensive and more effective (how do we know if extra benefit is worth the extra cost?)
2. B is both less expensive and less effective (how do we know if the cost savings are worth the reduced effectiveness?)
The cost-effectiveness plane

- Quadrant I: Intervention more effective and more costly than O
- Quadrant II: Intervention less effective and more costly than O
- Quadrant III: Intervention less effective and less costly than O
- Quadrant IV: Intervention more effective and less costly than O
Back to the harder cases

- A) Is the extra benefit worth the extra costs or B) Are the costs savings worth the reduced benefits?
- There is an implicit notion of value. Think about how you make decisions in your life.
  - Is it worth it to get an MPH?
  - Last year’s ski boots (cheaper) than this year’s model (more expensive)?
- Key is what we are giving up and how we value it
- The notion of **opportunity cost**: the loss of potential gain from other alternatives when one alternative is chosen
- The notion of a **threshold value**. The (in)famous $50,000 per QALY.
- We will come back to these issues during the semester
Cost-benefit Analysis (CBA)

- Once again, same objective: compare the cost and consequences of two or more alternatives
- But now benefits are measured in monetary units
- CBA is the type of economic evaluation that is more consistent with economic theory
- CBA can tell us if an intervention is worth doing
- The problem of using CBA in health is that it is very difficult to transform measures of benefits into monetary values
Cost-benefit Analysis (CBA)

- What is the dollar value of a case averted? What is the value of an extra year of life? What is the value of not being able to walk?
- This doesn’t mean that economists don’t try... We will study ways to assign monetary values to (some) benefits
- CBA is extensively used in certain project evaluations (infrastructure) but not so often in health
- If benefits > costs, then it is worth it to do the project
- Summary measure: \( \frac{\text{benefit}}{\text{cost}} \) ratio or \( (\text{benefit} - \text{cost}) \)
A note on terminology (jargon)

- “Economic evaluation” is the more general term. It may refer to one of the four types of studies we discussed (CA, CEA, CUA, and CB)
- “Cost-effectiveness analysis” is also used as a general term but it refers to CEA and CUA. Blame your textbook (up to third edition) for insisting on separating CEA and CUA
- There is always confusion with names – this class is called Cost Benefit and Effectiveness in Health...
- More important than definitions is understanding the principles and making the right decisions
- Remember, EE is about making decision on how to allocate resources
We have talked about how to calculate ICER

But there are other ways of conducting economic evaluations: decision trees/Markov models

Think of them as alternative ways of calculating ICER, but ways that allow us to incorporate uncertainty more directly

It’s going to be clearer by the end of the semester, don’t worry
Methods

Decision analysis

- Definition: A systematic approach to decision making under uncertainty (Raiffa 1968)
- It originated as a way of figuring out how we should make decisions when there is uncertainty (that is somehow quantifiable)
- Here is the confusing part: it can also be used to perform an economic evaluation study
- Another definition: Decision analysis is a way to gather all the information needed to perform an economic evaluation, including uncertainty about effects
- Your textbook does not cover much on decision analysis; we will complement it with other readings
- We will use Excel; TreeAge is the most popular software but it’s not the best tool for learning (black box). Excel is actually more flexible (but requires more programming)
Methods

Decision Tree

```
Migraine attack
  - Sumatriptan
    - Relief (0.558)
      - No recurrence (0.594)
      - Recurrence (0.406)
    - Endures attack (0.92)
      - No relief (0.442)
        - Relief (0.998)
        - ER (0.08)
        - Hospitalisation (0.002)
      - Relief (0.998)
      - ER (0.08)
      - Hospitalisation (0.002)
  - Caffeine/ergotamine
    - Relief (0.379)
      - No recurrence (0.703)
      - Recurrence (0.297)
    - Endures attack (0.92)
      - No relief (0.621)
      - Relief (0.998)
      - ER (0.08)
      - Hospitalisation (0.002)
```

Pathway
A
B
C
D
E
F
G
H
I
J
### Methods

#### Decision Tree

![Decision Tree Diagram]

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Probability</th>
<th>Cost</th>
<th>Expected Cost</th>
<th>Utility</th>
<th>Expected Utility</th>
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<tbody>
<tr>
<td><strong>Sumatriptan</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>0.331</td>
<td>16.10</td>
<td>5.34</td>
<td>1.00</td>
<td>0.33</td>
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<tr>
<td>B</td>
<td>0.227</td>
<td>32.20</td>
<td>7.29</td>
<td>0.90</td>
<td>0.20</td>
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<td>C</td>
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<td>6.55</td>
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<td>-0.12</td>
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<tr>
<td>D</td>
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<td>79.26</td>
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<td>-0.000003</td>
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<tr>
<td><strong>Total</strong></td>
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<td></td>
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<td><strong>0.41</strong></td>
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<table>
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<th><strong>Caffeine/ergotamine</strong></th>
<th>Probability</th>
<th>Cost</th>
<th>Expected Cost</th>
<th>Utility</th>
<th>Expected Utility</th>
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<td><strong>4.73</strong></td>
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Markov Models

- Useful when events are recurrent (like migraines)
- Essentially, a recursive decision tree with cycles/periods
- Mutually exclusive “states” representing possible consequences
- Simulate a cohort going from one state to the other in each cycle with certain probability
- Each state may have a cost and/or benefit associated with it, which transforms Markov models into an economic evaluation
Example: Burlone et al. (2013)

Evaluating the effects of extending contraceptive coverage under the ACA in OR
Why this class should be useful

- Although CEA is not often considered as a basis for making decisions in the US, the field is advancing rapidly
- Several studies have influenced practice (e.g. screening for cancer)
- Techniques to allocate costs are helpful in the real world
- Decision analysis tools are also helpful in the real world
- We will talk about ways to measure health (the benefits part of CEA)
- And there is of course the **joy of learning**
At the end of the class you will be able to:

- Critically assess an EE evaluation study
- Replicate an EE study
- Present results of an EE study
- Know where to start if asked to do an EE (then call a friend)
- The school of pharmacy offers a more advanced class PHSC 7611: Applied Cost-Effectiveness Analysis
Textbook and homeworks

- The great thing about the textbook is that it covers pretty much every important topic in EE. **The problem is that it covers every topic**
- The class notes are your guide to the key parts in each chapter but you **should** read the assigned chapters
- Read chapter before or after class?
- We will have homework most weeks. First homework due next week. Choose articles wisely

- Groups
- Excel
- Office hours (do stop by)