Cost Effectiveness Studies
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Cost Effectiveness

- What is cost effectiveness?
- Types of economic study approaches
- When and how to measure cost and “HRQoL”?
- Data analysis approaches
- Modeling designs
- CEA/CUA quality checklist

What is Cost Effectiveness?

- Cost effectiveness analysis is a way of measuring the value of using a new treatment, as compared to current practice (the “bang” for the “Buck”)
- The value measure is generically called a cost effectiveness ratio (CER)
- There are 2 types of CERs: A CER that can only be compared for conditions with similar outcome measures, and a CUR that can be compared across most conditions
Types of Economic Studies

- Cost minimization (cost comparison): $ vs $
- Cost effectiveness: $ per outcome
- Cost utility: $ per QALY (current gold standard)
- Cost benefit: net $ savings (includes cost of health differences)

How is a CER Calculated?

A: (Cost of treating 100 patients with new therapy) –
   (Cost of treating 100 patients with current therapy mix)
   = delta $

B: (Outcomes for 100 patients treated with new therapy) –
   (Outcomes for 100 pts. treated with current Tx.mix)
   = delta outcomes

C: \[ \text{CER} = \frac{\text{delta } \$}{\text{delta outcomes}} = \text{$/ improved outcome unit} \]

When do you need a CER?

<table>
<thead>
<tr>
<th>Cost</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher</td>
<td>Use old therapy</td>
</tr>
<tr>
<td>Lower</td>
<td>Need CER</td>
</tr>
<tr>
<td></td>
<td>Worse</td>
</tr>
</tbody>
</table>
So what is a good value for the production of another QALY?

What is a good CER value?

- We can only judge the absolute CER values when the outcome is expressed in years of life saved, or in quality-adjusted life years QALYs
- A “good” value for the US is < $50,000/YLE or QALY, but it varies by type of intervention
- In all other cases: e.g. cost per case averted, cost per mmHg of BP reduction, we need to judge if “it is worth it”

US League Table

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Cost per QALY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost saving: no QALY value</td>
<td></td>
</tr>
<tr>
<td>Childhood vaccination</td>
<td>$3,420/QALY (Calvert et al. 1994)</td>
</tr>
<tr>
<td>Kaletra vs. Nelfinavir in Tx.-naive HIV patients</td>
<td>$17,300/QALY (Furberg et al., APS 2001)</td>
</tr>
<tr>
<td>Early ARV (CD4 500) vs. Late ARV (CD4 200) for Medicaid</td>
<td>$58,200/QALY (Furberg et al., I AIDS 1997)</td>
</tr>
<tr>
<td>Prophylaxis with azithromycin against MAC in HIV patients</td>
<td>$173,000/QALY (Furberg et al., AIDS 1997)</td>
</tr>
</tbody>
</table>
What is Special about Economic Studies?

**Special measures:**
- Health state preferences, utilities, cost, and cost effectiveness ratios
**Special data sources:**
- Resource use, billing and encounter data
**Special data collection methods:**
- Utility or patient preference data
**Special statistical approaches:**
- Multivariate analysis (regression) to control for biases or to reduce variance in randomized trial data
**Special designs:**
- Trial results combined with modeling

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When and how to measure COST?

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Resource Use or Cost

- Cost (our proxy for resource use) should be measured whenever the new treatment is more costly, but you have reason to believe that a the new Tx improves outcomes and/or shifts costs from money spent on hospital time, surgery, complementary therapies, or management of side effects.
- Or when the new Tx is cheaper but less effective
Measuring Cost

- Count the stream of all relevant resources used in the care process
- Use the perspective of the medical care system
- Continue counting resources as long as you count survival (same horizon)
- Combine resources at the level of the individual patient by using standard cost weights
- For economic assessment, discount costs (and benefits) by 3% per year to get their present value
- Inflated “old” costs to present value using the Medical Care CPI index for the respective years

Analysis of Cost Data

- Cost curves in complex diseases are inverted U shapes: must account for penalty for survival
- Costs and LOS have distributions with long right tails, so use log transformation
- Prices and costs are not the same, so use opportunity costs or adjusted charges
- Chose neutral cost weights, determined by multivariate analysis; because costs are strongly affected by population SES, severity, comorbidity, local treatment patterns, insurance coverage, geographic region, and medical care infrastructure

When and how to measure “quality of life”?
When Should You Expect Quality Adjustment in a CEA

In conditions where both survival and sequela may be affected, or where the intervention may have profound side effects

In this case, you should also expect the time frame of the analysis to capture the average patients’ remaining lifetime

Quality of Life

Quality of life should be considered any time you would expect that a treatment could induce any differences in functional status, symptoms, comorbid conditions, pain, suffering, debility, energy, or feeling of well being beyond a brief period of time

How is Quality of Life Measured?

• Valuation by subjective instruments: How important is it to you to function and feel as you do?
  – Standard Gamble Utilities (gold standard)
  – Time Trade-off Utilities (nearly gold standard)
  – Visual Analog Scale: health thermometer preference rating (quick, cheap, but varies)
How is Quality of Life Measured?

- By a mixed “translation” using a generic quality of life instrument, like the EQ5D (EuroQol), a rating scale and data from a population that received both the instrument and a Standard Gamble assessment

Health State Description 1

- You feel exhausted, dizzy, feverish, and have no appetite
- Your head, joint, and muscles ache so much that you need to stay in bed
- You can not go to work or visit with friends or family
- You have to take medicine 4 times per day to control unpleasant symptoms

Visual Analog Scale Response
Health Date Description 2

- You have trouble walking about
- Your sight is blurry, making it difficult to read or watch TV
- Your head, joints and muscles ache much of the time
- Your health keeps you from working or joining friends or family outings
- You require medications 4 times per day to control symptoms

How would you rate health state 2?

100 | Best possible health

0 | Worst possible health or death

Special Data Analysis Problems
Problems (most to least important) in Archival Billing or Encounter Data for CE Research

1. **Confounding by indication**
2. Other selection biases
3. Right and left censoring or holes in episodes
4. Limited clinical information
5. Unknown sensitivity and specificity for each variable
6. Systematic omissions of populations
7. Delayed availability
   - depends on bill submission
   - codes for new interventions take 2+ years for approval

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Reasons for Selection Biases

- Sicker patients get newer Tx
- Institutionalized patients are sicker
- Some patients do not seek care
- Really sick patients may die before admission
- Academic medical centers attract referrals of complex, poor patients

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Multivariate Methods

- Multivariate methods (such as regression) are used to control for differences in the groups that are compared.
- These differences may be due to biasing factors, such as age, sex, race, severity, low SES, insurance type, or the fact that during the early time of adoption of a new therapy, some patients have a higher likelihood (propensity) of receiving the new therapy instead of the old ones
How to Adjust for Selection Bias by Statistical Modeling

- Risk adjustment
- Propensity scores
- Instrumental variable analysis
- Econometric sample selection methods
- Heckman models

Selection bias is common, and selection bias by indication against a new therapy is the most serious flaw in outcomes studies that use archival data

CEA / CBA Checklist


- The perspective of the analysis should be made explicit
- Study should be broad enough to encompass all potential beneficiaries of the treatment
- Time horizon should be long enough to capture all relevant future costs and benefits
- Analysis should compare treatment of interest to existing practice
CEA / CBA Checklist
(continued)

- All major cost and benefit categories should be included in analysis
- In CEA, benefits to length of life go in denominator, and are not “priced out” in numerator
- Time spent undergoing treatment must be included as cost
- Include lost productivity of others

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CEA / CBA Checklist
(continued)

- All resources should be valued at (marginal) opportunity cost
- Future costs should be discounted
- In CUA, future benefits should be discounted as well
- Base discount rate should be “risk-free rate” (3%)
- Transfer costs or benefits are not included

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Summary

- Cost effectiveness is a secondary question
- The magnitude of the benefit difference is (at least) as important as the cost difference
- Economic studies may need to use special measures, data sources, statistical approaches, and designs
- Cost effectiveness study results should use to INFORM discussions