Cost-Effectiveness Analysis: Basic Models and Measuring Costs

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Cost Effectiveness Ratio

\[
\text{CE ratio } = \frac{\Delta \text{ Costs}}{\Delta \text{ Health Outcomes}}
\]
CE Ratios

■ Average CE
  - measures the total cost divided by the total benefit of a program or intervention, relative to no intervention

■ Incremental CE
  - compares the relative effect of multiple programs or interventions
  - assumes sequential implementation of multiple programs

■ Marginal CE
  - measures the effect of expanding an existing program or intervention
    • this type of CEA is rarely performed
# CE Ratios: Decision Rules

<table>
<thead>
<tr>
<th>Outcomes (H)</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE &lt; 0 and $\Delta H &lt; 0 \Rightarrow$ do not adopt</td>
<td>CE &gt; 0 and $\Delta H &gt; 0 \Rightarrow$ adopt if $&lt; CE(max)$ =&gt; “cost effective”</td>
</tr>
<tr>
<td>CE &gt; 0 and $\Delta H &lt; 0 \Rightarrow$ adopt only if savings is worth health cost</td>
<td>CE &lt; 0 and $\Delta H &gt; 0 \Rightarrow$ adopt =&gt; “cost saving”</td>
</tr>
</tbody>
</table>
CE of Preventive Treatment

\[ \Delta C = p_1 \cdot C(1) + p_2 \cdot C(2) + p_3 \cdot C(3) + p_4 \cdot C(4) - p_5 \cdot C(5) - p_6 \cdot C(6) \]

\[ \Delta H = p_1 \cdot H(1) + p_2 \cdot H(2) + p_3 \cdot H(3) + p_4 \cdot H(4) - p_5 \cdot H(5) - p_6 \cdot H(6) \]

\[ \text{ICER} = \frac{\Delta C}{\Delta H} \]
## CE of Preventive Treatment

\[
\sum_{i=1}^{\text{post outcomes}} p_i \overline{C}(\text{post})_i - \sum_{j=1}^{\text{pre outcomes}} p_j \overline{C}(\text{pre})_j
\]

\[
\sum_{i=1}^{\text{post outcomes}} p_i \overline{H}(\text{post})_i - \sum_{j=1}^{\text{pre outcomes}} p_j \overline{H}(\text{pre})_j
\]

where \(i\) and \(j\) represent the full range of outcomes in a decision tree.
CE of a New Diagnostic Test

A decision tree demonstrating the outcomes of a new diagnostic test compared to an old test. The diagram shows the probabilities associated with each outcome:

- **Positive result**:
  - True positive (p1) with outcomes (C[1]) / (H[1])
  - False positive (p2) with outcomes (C[2]) / (H[2])

- **Negative result**:
  - True negative (p3) with outcomes (C[3]) / (H[3])
  - False negative (p4) with outcomes (C[4]) / (H[4])

- **Positive result** (old test):
  - True positive (p5) with outcomes (C[5]) / (H[5])
  - False positive (p6) with outcomes (C[6]) / (H[6])

- **Negative result** (old test):
  - True negative (p7) with outcomes (C[7]) / (H[7])
  - False negative (p8) with outcomes (C[8]) / (H[8])
CE of a New Diagnostic Test

\[
\begin{align*}
&\sum_{i=1}^{\text{new outcomes}} p_i C(\text{newDx})_i - \sum_{j=1}^{\text{old outcomes}} p_j C(\text{oldDx})_j \\
\sum_{i=1}^{\text{new outcomes}} p_i H(\text{newDx})_i - \sum_{j=1}^{\text{old outcome}} p_j H(\text{oldDx})_j
\end{align*}
\]

where \( i \) and \( j \) represent the full range of outcomes in a decision tree
CE of a New Treatment
## CE of New Treatment

\[
\begin{align*}
\text{new outcomes} & \quad \sum_{i=1}^{\text{new outcomes}} p_i \bar{C}(newRx)_i - \sum_{j=1}^{\text{old outcomes}} p_j \bar{C}(oldRx)_j \\
\text{old outcomes} & \quad \sum_{i=1}^{\text{new outcomes}} p_i \bar{H}(newRx)_i - \sum_{j=1}^{\text{old outcomes}} p_j \bar{H}(oldRx)_j
\end{align*}
\]

where \( i \) and \( j \) represent the full range of outcomes in a decision tree.
BREAK

QUESTIONS ?
Measuring Costs
Cost Categories

- Medical costs
  - Hospital costs
  - Other institutional costs, including nursing home, rehabilitation, etc.
  - Ambulatory costs, including physicians, home health services, etc.
  - Pharmaceuticals

- Social costs
  - Costs borne by patients and their families, including lost income, travel costs, etc.
  - Costs borne by society, such as criminal justice system costs
Measuring Costs
Types of Costs

- **Fixed vs. variable costs**
  - Fixed costs are considered “sunk,” and thus can be excluded
  - In practice, it is often difficult/impossible to measure only variable costs
    - Thus average costs are most often used

- **Joint products**
  - May be difficult to separate joint production costs

- **Time horizon**
  - Should be long enough to capture relevant health benefits
Identifying and Measuring Costs

- **Identify resources used**
  - Requires a careful specification of all relevant resources used in the intervention or treatment being assessed

- **Measure resources used**
  - Requires data collection or abstraction tools, developed to collect the information identified in the previous step
  - In some cases, may be available from administrative data

- **Place a monetary value on resources used**
Micro versus Gross Costing

- **Gross costing**
  - Uses readily available sources of data about either the cost of production, or more commonly, the price paid for services
  - Requires collection of aggregate utilization data, which is then priced using standard reimbursement or payment rates
    - Data are easier to collect, but refined analyses of changes in resource use aren’t possible

- **Micro costing**
  - Requires collection of detailed utilization data, usually with instruments developed specifically for an individual study
  - Usually requires collection of detailed cost or pricing data
    - Costs may lack external validity
Measuring Costs

- Pharmaceuticals
  - acquisition costs
  - costs of administering, monitoring, compliance

- Hospitals
  - time and motion studies may be necessary to obtain accurate measure of resources used in treatment
  - costs are often estimated from charges using the ratio of costs-to-charges (RCC)
  - public payment rates, such as Medicare DRG rates, can be used if we assume that marginal revenue for public payers (roughly) equals marginal costs
Measuring Costs

- Physicians
  - cost data are usually difficult to obtain
  - payment data, such as Medicare payment rates based on the Resource-Based Relative Value Scale, again may be used assuming that marginal revenue roughly equals marginal cost
Measuring Costs

- **Personal/Family Costs**
  - Often ignored, because in CUA, costs of lost productivity or functional status are already included in outcome measure (i.e., QALY)
  - Depending on the intervention, may be important
    - Caregiver costs
    - Travel costs
    - Time in treatment

- **Social Costs**
  - Missed school
  - Criminal justice system
  - Environmental effects
Measuring Costs

- Induced costs, i.e., costs of added years of life
  - may have a large impact on programs with low CE ratios
  - Panel on Cost-Effectiveness in Health and Medicine suggests ignoring these costs, unless they are likely to have a large impact
QUESTIONS ?