Introduction to Economic Evaluation

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The Horizon of New Health Technologies

- Diagnostics: Virtual colonoscopy
- Devices: Computerized knee
- Procedures: Breast MRI
- Drugs: Biologics

New Technology #1

Image removed.

Image description: a man’s head with a cellphone strapped to it with a rubber band
New Technology #2

Image removed.

Image description: a woman blowing her nose using toilet paper that is from a roll strapped on to her head

Cost and outcomes evaluation

- Scarcity of resources
- Need to make choices: opportunity vs. cost
- Decisions need to be based on comparisons of costs and benefits
- Efficiency is not the same as cost cutting
- The emergence of genetic information and genetic-based technology will necessitate careful appraisal by payers and society as to
  - clear benefits of identification and treatment
  - clear patient sub-groups
  - cost implications

Value

Cost
Health outcome
Important types of economic analysis

- **Cost-effectiveness analysis**
  - used to decide between different treatments for same condition
  - measures cost (money) per unit of effect (outcome measures or natural units), e.g., cost per life years gained, cost per mmHg blood pressure decrease
  - the lower the cost-effectiveness ratio, the better

- **Cost-utility analysis**
  - a type of cost-effectiveness analysis that can compare treatments for different conditions since a common outcome measure is used
  - costs measured in benefits, outcomes as utility
  - best-known utility measure is the quality-adjusted life-year (QALY)

Nature of economic assessments

Outcomes for economic evaluation

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Outcome valuation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost-consequences</td>
<td>Multiple outcomes in natural units ‘Consumer Report’</td>
</tr>
<tr>
<td>Cost-effectiveness</td>
<td>Single outcome Intermediate – blood pressure Final – life-years gained</td>
</tr>
<tr>
<td>Cost-utility</td>
<td>Multiple outcomes combined into weighted index (e.g., QALYs)</td>
</tr>
<tr>
<td>Cost-benefit</td>
<td>Monetary values (willingness-to-pay) Contingent valuation Conjoint analysis</td>
</tr>
</tbody>
</table>

QALY = Quality-adjusted life-years
Quality-adjusted life-years (QALYs)

- Most therapies have multiple health consequences
- Trade-offs between survival and quality of life (e.g., chemotherapy)
- Trade-offs between different aspects of health (e.g., depression and dry mouth from drug therapy)
- Policy makers need to compare across diseases
- QALYs and cost-utility analysis

QALYs are a statistical trade-off between length and quality of life

- The years of life gained from treatment are multiplied by a QoL score on a scale of 0 (worst) to 1 (best) to give QALYs
- e.g. 3 years gained with a QoL of 0.5 = 1.5 QALYs

Applying cost and outcomes assessment to decision making

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Costs ($)</th>
<th>Survival</th>
<th>QoL</th>
<th>QALY</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>20,000</td>
<td>4.5 years</td>
<td>0.80</td>
<td>3.6</td>
</tr>
<tr>
<td>B</td>
<td>10,000</td>
<td>3.5 years</td>
<td>0.90</td>
<td>3.15</td>
</tr>
</tbody>
</table>

Which treatment would you select?
Which outcome do you value most?
Costs and benefits of treatments are compared using the incremental cost-effectiveness ratio (ICER)

- Compares costs of different treatments using same measure of effectiveness or utility, e.g., cost per QALY
- When drug A has higher treatment costs and higher outcomes than that of drug B, the decision is based on the ICER

\[
\text{ICER} = \frac{\text{Treatment cost of A} - \text{Treatment cost of B}}{\text{Effectiveness of A} - \text{Effectiveness of B}}
\]

(CQALY = quality adjusted life-year)

**Example: t-PA versus Streptokinase**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Costs ($)</th>
<th>Survival at 1 year</th>
<th>Projected life expectancy</th>
<th>QoL</th>
</tr>
</thead>
<tbody>
<tr>
<td>t-PA</td>
<td>27,420</td>
<td>91.0</td>
<td>15.41</td>
<td>0.90</td>
</tr>
<tr>
<td>Streptokinase</td>
<td>24,990</td>
<td>89.9</td>
<td>15.27</td>
<td>0.90</td>
</tr>
</tbody>
</table>

The NNT is 110 and the CNT is $243,000 to save one life

NNT = number needed to treat; CNT = cost needed to treat

**t-PA versus Streptokinase: cost-effectiveness differs by age and location of the infarction**

<table>
<thead>
<tr>
<th>Group of patients</th>
<th>Increased life expectancy with t-PA</th>
<th>Cost-effectiveness ratio ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary analysis</td>
<td>0.14</td>
<td>32,678</td>
</tr>
<tr>
<td>Inferior MI, age &lt;40</td>
<td>0.03</td>
<td>203,071</td>
</tr>
<tr>
<td>Anterior MI, age &lt;40</td>
<td>0.04</td>
<td>123,609</td>
</tr>
<tr>
<td>Inferior MI, age 40–60</td>
<td>0.07</td>
<td>74,816</td>
</tr>
<tr>
<td>Anterior MI, age 40–60</td>
<td>0.10</td>
<td>49,877</td>
</tr>
<tr>
<td>Inferior MI, age 61–75</td>
<td>0.16</td>
<td>27,873</td>
</tr>
<tr>
<td>Anterior MI, age 61–75</td>
<td>0.20</td>
<td>20,601</td>
</tr>
<tr>
<td>Inferior MI, age &gt;75</td>
<td>0.26</td>
<td>16,246</td>
</tr>
<tr>
<td>Anterior MI, age &gt;75</td>
<td>0.29</td>
<td>13,410</td>
</tr>
</tbody>
</table>

MI = myocardial infarction
Framing the problem

- Viewpoint of study determines which data to collect
  - hospital
  - health care system
  - society
- Time of study should be long enough to capture main costs and effects

THE HEALTH TECHNOLOGY VALUE PLANE

NW

NE

SW

SE

Maximun acceptable ICER

New treatment more costly

Existing treatment dominates

New treatment less effective

New treatment less costly but less effective

New treatment more effective but more costly

New treatment more effective

New treatment dominates

GRADES OF RECOMMENDATION FOR THE ADOPTION OF NEW TECHNOLOGIES

Image removed.

Image description:

This figure can be viewed at Laupacis, et al, CMAJ, 1992.

The figure displays a box with 4 quadrants representing the intersection of cost and QALY continuum. The upper left quadrant represents interventions that are less effective and more costly. The lower left quadrant represents interventions that are less costly and less effective, and includes as examples interventions with a $/QALY ratio of $100,000 and $20,000. The lower right quadrant represents interventions that are more effective and less costly. The upper right quadrant represents interventions that are more costly and more effective, including as examples interventions with a $/QALY ratio of $100,000 and $20,000.
The authority’s view
– example from UK NICE

- Below an ICER of £20,000/QALY, the acceptability of a treatment as an effective use of NHS resources is judged primarily on cost-effectiveness.
- Above £20,000/QALY, acceptability is also judged on other factors:
  - the degree of uncertainty in the calculation of ICERs
  - the innovative nature of the treatment
  - the particular features of the disease and the unmet need in the population benefiting from the new treatment
  - the wider societal costs and benefits
- Above £30,000/QALY, the case for supporting the treatment on these factors has to be increasingly strong.

UK NICE

<table>
<thead>
<tr>
<th>Cost per QALY</th>
<th>Accepted</th>
<th>Restricted</th>
<th>Rejected</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; £20,000</td>
<td>14</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>£20,000 - £30,000</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>&gt; £30,000</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

NICE = National Institute for Clinical Excellence (UK); ICER = incremental cost-effectiveness ratio; QALY = quality-adjusted life-year; NHS = National Health Service (UK)

NICE Guide to the Methods of Technology Appraisal, April 2004
## Examples of estimated ICER thresholds

<table>
<thead>
<tr>
<th>Unit</th>
<th>Lower boundary</th>
<th>Upper boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA QALY</td>
<td>US$50,000</td>
<td>US$100,000</td>
</tr>
<tr>
<td>Canada QALY</td>
<td>US$17,600</td>
<td>US$87,800</td>
</tr>
<tr>
<td>Australia LYG</td>
<td>US$28,200</td>
<td>US$51,000</td>
</tr>
<tr>
<td>NICE QALY</td>
<td>US$32,000</td>
<td>US$48,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WHO GDP/capita/DALY averted</th>
<th>&lt;3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia GDP/capita/life-year gained</td>
<td>1.26</td>
</tr>
<tr>
<td>UK NICE GDP/capita/QALY</td>
<td>1.4</td>
</tr>
</tbody>
</table>

**ICER** = incremental cost-effectiveness ratio; **QALY** = quality-adjusted life-year; **LYG** = life-years gained; GDP = gross domestic product; WHO = World Health Organization; NICE = National Institute for Clinical Excellence (UK); PBAC = Pharmaceutical Benefits Advisory Committee. Value in Health 2003;7:518.

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## Example:

**Cost-effectiveness of the implantable cardioverter-defibrillator (ICD)**

- **Can**
- **Lead**
- **Electric current**

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## Canadian Implantable Defibrillator Study (CIDS):

**Gains in life expectancy**

<table>
<thead>
<tr>
<th>Life expectancy (years)*</th>
<th>Non-parametric: Kaplan-Meier (95% CI)</th>
<th>Parametric exponential</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICD</td>
<td>4.91 (4.65–5.16)</td>
<td>4.88 (4.60–5.10)</td>
</tr>
<tr>
<td>Non-ICD</td>
<td>4.65 (4.60–5.10)</td>
<td>4.80 (4.60–5.10)</td>
</tr>
<tr>
<td>Difference</td>
<td>0.26 (0.095, 0.55)</td>
<td>0.28</td>
</tr>
</tbody>
</table>

*Values in 6-month intervals, no discounting.

ICD = implantable cardioverter-defibrillator

O’Brien B et al. Circulation 2001;103:1416–21
Cost-effectiveness of ICD versus non-ICD (discounting at 3%/year)

<table>
<thead>
<tr>
<th></th>
<th>ICD</th>
<th>non-ICD</th>
<th>Difference (ICD–non)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cost per patient ($)</td>
<td>87,715</td>
<td>38,600</td>
<td>49,115</td>
</tr>
<tr>
<td>Life expectancy (years)</td>
<td>4.58</td>
<td>4.35</td>
<td>0.23</td>
</tr>
</tbody>
</table>

Incremental CE of ICD:

CA $213,543 per life-year gained

O'Brien et al. Circulation 2001;103:1416–21

Willingness to pay for health gain

Bootstrap ($\Delta C$, $\Delta E$) by left ventricular ejection fraction (LVEF)

LVEF >35%

LVEF <35%
Conclusions

- Increasing demand for economic evaluation
- Payers focus on value for money
- Economics helps but it does not make decisions
- Evidence from trials and the need for models
- Emerging role of pragmatic trials with CE
- Patient-centered outcomes; QoL, utility
- Need for transparency of studies
- Need to educate consumers of studies

References & Resources
