Economic Evaluation in Health Care

Kaja Abbas
Learning objectives

● Describe the role of economic evaluation in health care.

● Differentiate between the different forms of economic evaluation.

● Explain how an incremental cost-effectiveness ratio is estimated and its meaning in relation to willingness-to-pay threshold.

● Identify the key steps in designing an economic evaluation.
Economic evaluation for health
What is economic evaluation (in health care)?

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

Drummond et al, 2005

“Based on the common sense notion that a decision to do or not to do something should depend weighing up the advantages (benefits) and disadvantages (costs).”

Morris et al, 2007
Economic evaluation in health care

- What is economic evaluation?
  - To evaluate the value of health

- Why conduct economic evaluation?
  - To determine cost-effectiveness of health care interventions/services
  - To assist decision-making in choosing to fund specific health care interventions

- Prioritisation of **limited resources** to maximise health gains
<table>
<thead>
<tr>
<th>Private markets’ focus</th>
<th>Public health care focus</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximisation of profits</strong></td>
<td><strong>Maximisation of health</strong></td>
</tr>
<tr>
<td>- Optimisation of health for sub-population</td>
<td>- Optimisation of health for whole population</td>
</tr>
<tr>
<td>- Provision of services based on individual’s ability to pay</td>
<td>- Provision of services based on state’s willingness to pay</td>
</tr>
<tr>
<td><strong>Asymmetry of information</strong></td>
<td><strong>Pooling of information by state</strong></td>
</tr>
<tr>
<td>- Disadvantageous to individual decision-making</td>
<td>- Advantageous for population health decision-making</td>
</tr>
<tr>
<td><strong>Negative externalities</strong></td>
<td><strong>Positive externalities</strong></td>
</tr>
<tr>
<td><strong>Effectiveness + Efficiency</strong></td>
<td><strong>Effectiveness + Efficiency + Equity</strong></td>
</tr>
</tbody>
</table>
Types of economic evaluation

● **Cost-effectiveness analysis**
  ○ Cost (versus) effectiveness (health outcomes)
    ■ Natural unit of health outcome
      ● cases, deaths averted, etc

● **Cost-utility analysis**
  ○ Cost (versus) utility (health-related quality of life measures)
    ■ DALYs - disability-adjusted life-years
    ■ QALYs - quality-adjusted life-years

● **Cost-benefit analysis**
  ○ Cost (versus) benefits (health outcomes)
    ■ Monetary valuation of health benefits/outcomes

● plus other related types of economic evaluation
Types of economic evaluation

- Cost-effectiveness analysis
- Cost-utility analysis
- Cost-benefit analysis

<table>
<thead>
<tr>
<th>Economic Evaluation</th>
<th>Summary Measures</th>
<th>Economic analysis</th>
<th>Cost measure</th>
<th>Health benefit measure</th>
<th>Example in HIV context</th>
</tr>
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<tbody>
<tr>
<td>Cost-effectiveness analysis (CEA)</td>
<td>Cost-effectiveness ratio (Incremental costs per cases averted)</td>
<td>Cost-effectiveness analysis</td>
<td>Monetary units</td>
<td>Natural units (Cases of disease or deaths averted)</td>
<td>The number of HIV cases averted by a female condom distribution program to sex workers (SWs) in South Africa.</td>
</tr>
<tr>
<td>Cost-utility analysis (CUA)</td>
<td>Cost-utility ratio (Incremental costs per QALY)</td>
<td>Cost-utility analysis</td>
<td>Monetary units</td>
<td>QALY or DALY averted</td>
<td>Cost-utility of tuberculosis prevention among HIV-infected adults in Kampala, Uganda.</td>
</tr>
<tr>
<td>Cost-benefit analysis (CBA)</td>
<td>Net benefits (Benefits – costs)</td>
<td>Cost-benefit analysis</td>
<td>Monetary units</td>
<td>Monetary units (US$, Tanzania Shilling (TShs), etc.)</td>
<td>Cost-benefit analysis of female primary education as a means of reducing HIV/AIDS in Tanzania.</td>
</tr>
</tbody>
</table>
Cost-effectiveness analysis (CEA)

- Treatment A
  - Cost: £30,000
  - Effectiveness: 0.5 life-years gained

- Treatment B
  - Cost: £55,000
  - Effectiveness: 1.5 life-years gained

Incremental Cost-Effectiveness Ratio

\[
\text{ICER} = \frac{(\text{cost B} - \text{cost A})}{(\text{effect B} - \text{effect A})}
\]

Activity: Calculate ICER
Cost-effectiveness analysis (CEA)

- Treatment A
  - Cost
    - £30,000
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    - 0.5 life-years gained

- Treatment B
  - Cost
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  - Effectiveness
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Incremental Cost-Effectiveness Ratio

\[
ICER = \frac{(\text{cost } B - \text{cost } A)}{(\text{effect } B - \text{effect } A)}
\]

\[
= \frac{(\£55,000 - \£30,000)}{(1.5 - 0.5) \text{ life–years gained}}
\]

\[
ICER = £25,000 \text{ per life-year gained}
\]
Cost-effectiveness analysis (CEA)

- Treatment A
  - Cost: £30,000
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- Treatment B
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Incremental Cost-Effectiveness Ratio

\[
\text{ICER} = \frac{(\text{cost B} - \text{cost A})}{(\text{effect B} - \text{effect A})} = \frac{(55,000 - 30,000)}{(1.5 - 0.5) \text{ life-years gained}}
\]

\[
\text{ICER} = £25,000 \text{ per life-year gained}
\]
Cost-effectiveness analysis (CEA)

Comparison of Cost and of Effectiveness between Interventions: Conditions for Dominance
DALYs averted ~ QALYs gained

- DALY (disability-adjusted life year)
  - Healthy life year lost
- DALYs averted
  - Reduction of DALYs from new treatment of an early-onset disease

- QALY (quality-adjusted life year)
  - Healthy life year gained
- QALYs gained
  - Increase in QALYs from new treatment of an early-onset disease
<table>
<thead>
<tr>
<th>Organization/group</th>
<th>Cost-effective thresholds</th>
<th>Reference</th>
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<tbody>
<tr>
<td>Australia*</td>
<td>Costs per LYG &lt; AU $42,000 – 76,000 (costs per LYG &lt; AU $42,000: reimbursement likely, costs per LYG &gt; AU $76,000: reimbursement unlikely)</td>
<td>George et al. (2001)</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>Costs &lt; € 20,000 per QALY or LYG: cost-effective* Costs &lt; € 80,000 per QALY: cost-effective**</td>
<td>Welte et al. (2004c); Raad voor de Volksgezondheid &amp; Zorg (2007)</td>
</tr>
<tr>
<td>UK National Institute of Clinical Evidence (NICE)*</td>
<td>Costs per QALY &lt; £ 20,000–30,000: cost-effective Costs per QALY &lt; £ 45,000: cost-effective</td>
<td>Devlin and Parkin (2004); Appleby and Devlin, Parkin (2007)</td>
</tr>
<tr>
<td>US Institute of Medicine (IOM)**</td>
<td>Saves money and QALYs: most favorable Costs per QALY &lt; US $10,000: more favorable Costs per QALY &gt; US $10,000 and &lt; 100,000: favorable Costs per QALY &gt; US $100,000: less favorable</td>
<td>Institute of Medicine (2000)</td>
</tr>
<tr>
<td>World Health Organization (WHO)**</td>
<td>Costs per DALY &lt; GDP per capita: highly cost-effective Costs per DALY = 1x – 3x GDP per capita: cost-effective Costs per DALY &gt; 3x GDP per capita: not cost-effective</td>
<td>WHO (2008)</td>
</tr>
<tr>
<td>International and especially US decision analysts**</td>
<td>Costs per QALY or LYG &lt; US $50,000: cost-effective</td>
<td>Grosse (2008)</td>
</tr>
<tr>
<td>US and British health economists**</td>
<td>Costs per LYG &lt; US $60,000: cost-effective</td>
<td>Newhouse (1998)</td>
</tr>
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* Thresholds derived from past decisions
** Officially stated thresholds
LYG = Life year gained
QALY = Quality-adjusted life year
GDP = Gross domestic product
Activity:
Calculate incremental-cost-effectiveness ratio (ICER)
Activity:
Calculate incremental-cost-effectiveness ratio (ICER)

ICER = \frac{(\text{cost B} - \text{cost A})}{(\text{effect B} - \text{effect A})}

\text{ICER} = \frac{(0.9 \times 200) + (0.1 \times 10200)}{(0.9 - 0.8)} - \frac{(0.8 \times 0) + (0.2 \times 10000)}{(0.9 - 0.8)}

= -$8000 / case averted (cost saving)
Significance of incremental approach

- Incremental cost-effectiveness ratios (vs) average cost-effectiveness ratios
  - ICERS (vs) ACERs

- Activity: Calculate ICER and ACER for one or two sequential tests within a screening programme for a health condition.

Table 10.1 Incremental cost-effectiveness calculations

<table>
<thead>
<tr>
<th>Number of tests</th>
<th>Costs (£)</th>
<th>Cases detected</th>
<th>ACER (£)</th>
<th>ICER (£)</th>
</tr>
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<tbody>
<tr>
<td>None</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One</td>
<td>100,000</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sequential</td>
<td>180,000</td>
<td>12</td>
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Source: Adapted from Morris et al. (2007).
Significance of incremental approach

- Incremental cost-effectiveness ratios (vs) average cost-effectiveness ratios
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<td>—</td>
<td></td>
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<td>10</td>
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<td>10,000</td>
</tr>
<tr>
<td>Sequential</td>
<td>180,000</td>
<td>12</td>
<td>15,000</td>
<td>40,000</td>
</tr>
</tbody>
</table>

Source: Adapted from Morris et al. (2007).
Economic evaluation approaches

- Alongside a randomised controlled trial
- Using decision modelling techniques
  - Static model
    - Decision tree
    - Markov model
  - Dynamic model
    - Transmission dynamic modelling for infectious diseases
- Combination of RCT and decision modelling
Perspective & Time horizon

● Perspective
  ○ Societal
  ○ Others
    ■ health care payer
    ■ health department
    ■ hospital
    ■ health insurance
    ■ employer
    ■ pharmaceutical

● Time horizon
  ○ Timeline of new intervention
    ■ costs
    ■ effects
  ○ choice of timeline
    ■ current intervention remains same?
  ○ longer horizon
    ■ uncertainty increases
Discounting

Present value = (Future cost at year $t$) / $(1 + \text{discount rate})^t$

Fig. 15.2 Present value of € 1 or 1 life year
Uncertainty & sensitivity analysis

- Deterministic sensitivity analysis
- Probabilistic sensitivity analysis

https://www.bmj.com/content/342/bmj.d1672/F3
Economic Evaluation Process:
Planning, Implementation/Analysis & Presentation/Advocacy

Steps to Performing an Economic Evaluation

1. Planning
   - Define the problem
   - Define the options
   - Define the audience
   - Define the perspective
   - Define the time frame
   - Define the analytic horizon

2. Implementation/Analysis
   - Choose a research design
   - Estimate costs
   - Estimate outcomes/benefits
   - Conduct a sensitivity analysis

3. Presentation/Advocacy
   - Determine methods of presentation of findings
   - Present findings from evaluation
   - Advocate for evidence-based decision-making as a result of the findings
Assume that a single hypothetical randomized controlled trial (RCT) has recently reported on the clinical effectiveness of two drug regimens, drug A on its own and a regimen consisting of drugs A and Y, for the treatment of chronic hepatitis C infection (HCV). The main RCT outcomes after a 52-week follow-up period are reported in Table 10.2.

**Table 10.2** RCT results at one year

<table>
<thead>
<tr>
<th></th>
<th>Drug A</th>
<th>Drugs A+Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual mean cost of Drug A</td>
<td>£2500</td>
<td>—</td>
</tr>
<tr>
<td>Annual mean cost of Drugs A + Y</td>
<td>—</td>
<td>£6438</td>
</tr>
<tr>
<td>Annual mean cost of all other health care resources related to HCV infection</td>
<td>£764</td>
<td>£650</td>
</tr>
<tr>
<td>Mean utility over months 1 to 6 inclusive</td>
<td>0.80</td>
<td>0.81</td>
</tr>
<tr>
<td>Mean utility over months 7 to 8 inclusive</td>
<td>0.80</td>
<td>0.90</td>
</tr>
<tr>
<td>Mean utility over months 9 to 12 inclusive</td>
<td>0.805</td>
<td>0.95</td>
</tr>
<tr>
<td>Percentage of patients alive at study end</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Percentage of patients achieving a sustained virological response at study end</td>
<td>87%</td>
<td>90%</td>
</tr>
</tbody>
</table>

Note that the aim of treating people with chronic HCV is to completely eradicate detectable levels of the virus – this is known as having a ‘sustained virological response’ (SVR). Assume that if people achieve a SVR, they are no longer likely to develop any longer-term problems associated with the infection. Assume that all costs are to the health service. Your task is to calculate the ICER per additional QALY.
Costs over a year for A = £2500 + £764 = £3264

Costs over a year for A + Y = £6438 + £650 = £7088

QALYs for A = ((6/12)*0.8) + ((2/12)*0.8) + ((4/12)*0.805) = 0.8017

QALYs for A + Y = ((6/12)*0.81) + ((2/12)*0.9) + ((4/12)*0.95) = 0.8717

ICER = (£7,088 - £3,264) / (0.8717 - 0.8017) ≈ £54,629 per additional QALY

In other words, for every year of perfect health that is generated (1 QALY being 1 year of perfect health), it costs an additional £54,629 if treatment A + Y is used instead of A alone.

Note: The 6/12 (or 0.5) is used here because the time period is 6 months (or 0.5 of a year). Similar adjustments are made for the other time periods to standardize them to a year period.
Activity 10.2

Given the answer to Activity 10.1, is the introduction of A + Y a cost-effective use of resources? What other information would you (ideally) need to answer this question?
To answer this question, the most critical piece of missing information is an idea about the willingness to pay for an additional QALY. In the UK, NICE suggests a value of up to £30,000 per additional QALY (in most circumstances at least). Thus, as the ICER is above this level, A + Y is not a cost-effective use of resources – more QALYs would be lost than gained if money were taken from elsewhere in the health economy to fund it.

Other information, however, would also be useful. For example, no confidence intervals are presented in Table 10.2, meaning we have no idea as to how certain or not these results are, although sensitivity analysis would help somewhat in addressing this issue. Moreover, the benefits of treatment if a SVR is achieved are likely to extend beyond the one year period. Thus there is a strong argument that the treatment benefits, as they stand, have been underestimated and that decision modelling should be undertaken. Finally, treatment A is defined as the comparator – it would be useful to know how frequently it is used to treat HCV in the UK. If, for example, it too is an experimental drug, then the ICER becomes difficult to interpret, as it is unclear whether it is clinically and cost-effective in the first instance.
Learning outcomes

● Describe the role of economic evaluation in health care.

● Differentiate between the different forms of economic evaluation.

● Explain how an incremental cost-effectiveness ratio is estimated and its meaning in relation to willingness-to-pay threshold.

● Identify the key steps in designing an economic evaluation.
Additional resources
Consolidated Health Economic Evaluation Reporting Standards (CHEERS) statement

Don Husereau senior associate; adjunct professor of medicine; senior scientist, Michael Drummond co-editor-in-chief, Value in Health; professor of health economics, Stavros Petrou professor of health economics, Chris Carswell editor, David Moher senior scientist, Dan Greenberg associate professor and chairman; visiting assistant professor, Federico Augustovski director; professor of public health, Andrew H Briggs William R Lindsay chair of health economics, health economics and health technology assessment, Josephine Mauskopf vice president of health economics, Elizabeth Loder chief of division; clinical epidemiology editor, BMJ, on behalf of the CHEERS Task Force.

Cost-effectiveness analysis (CEA) & Budget impact analysis (BIA)

When cost-effective interventions are unaffordable: Integrating cost-effectiveness and budget impact in priority setting for global health programs

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Global Health Economics Centre
https://www.lshtm.ac.uk/research/centres/global-health-economics-centre

- Economic evaluation and priority setting theme
Modelling and Economic Evaluation of Vaccines

http://meev.lshtm.ac.uk/
Economic evaluation for health

- Disease control priorities project
  - http://www.dcp-3.org
WHO-CHOICE (CHOosing Interventions that are Cost Effective)
https://www.who.int/choice/en/

Cost effectiveness and strategic planning (WHO-CHOICE)

The WHO-CHOICE team works with policy makers at the country level, providing information on cost-effectiveness, costs and strategic planning which can help guide policy decisions. We assist countries to ensure that money spent on health is allocated in a way that the greatest possible health outcomes are achieved in the most feasible manner. We also collaborate with international agencies contributing to resource allocation decisions.

Member States, countries and organizations use the CHOICE tools to undertake cost-effectiveness analysis, whilst the OneHealth Tool assists in costing and measuring the feasibility of strategic plans.

OHT OneHealth Tool

The OneHealth Tool is a model to be used for supporting national strategic health planning in low- and middle-income countries. The tool facilitates an assessment of resource needs associated with key strategic activities and their associated costs, with a focus on integrated planning and strengthening health systems.

https://www.avenirhealth.org/software-onehealth
Health Technology Assessment (HTA)

- International Network of Agencies for Health Technology Assessment
  - [http://www.inahta.org/](http://www.inahta.org/)

**HTA: Informing Decisions About Technologies:**
Efficiency, effectiveness, and ethical, social & legal aspects
Decision support for priority setting in health

- International Decision Support Initiative
  - [https://www.idsihealth.org/](https://www.idsihealth.org/)

**Better decisions. Better health.**

iDSI is a global network working to increase the value and impact of health spending. We believe everyone should have fair access to health, receiving the right treatment and the right medicines at the right time.

[https://www.youtube.com/watch?v=pxHdTVfLlxE](https://www.youtube.com/watch?v=pxHdTVfLlxE)