An Introduction to Economic Evaluation

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Agenda

• Key concepts
  • Study design
  • Perspective
  • Outcomes
  • Time horizon and discounting

• Examples
“The first lesson of economics is scarcity: there is never enough of anything to fully satisfy all those who want it. The first lesson of politics is to disregard the first lesson of economics.” (Thomas Sowell 1993)

“Sustaining the health care system is the most pressing public policy challenge the province will face this decade.” (Don Drummond 2010)
Economic evaluation

Economic Evaluation is a “comparative analysis of alternative courses of action in terms of both their costs and consequences” (Drummond 1997)

Translation:

• “bang for the buck”
• Efficiency
• Value

In a nutshell:
$$\frac{\Delta C}{\Delta B} = \frac{(C_1 - C_2)}{(B_1 - B_2)}$$
Approaches

• Cost minimization analysis
  • Compares costs only
  • Options are assumed to have same effectiveness

• Cost-benefit analysis
  • All effects are valued in monetary terms

• Cost-effectiveness / cost-utility analysis
  • Compares costs and health outcome
  • Health outcome measured as
    • Clinical effectiveness (e.g. life years gained, cases avoided) - CEA
    • Utility (QALYs) - CUA

$$\frac{\Delta C}{\Delta B} = \frac{(C_1 - C_2)}{(B_1 - B_2)}$$
Perspective

- Society
- Government
- Healthcare payer (MOHLTC)/Third party payer
- PHU, hospital
- Patient

\[ \frac{\Delta C}{\Delta B} = \frac{(C1-C2)}{(B1-B2)} \]
Health Outcome

• “Natural units” (clinical outcomes)
  • Cases, life years, deaths
  • Change in BMI, other clinical outcomes

• Standardized units (health indexes)
  • Quality-adjusted life years (QALYs)
  • Disability-adjusted life years (DALYs)

\[ \Delta C/\Delta B = (C_1-C_2)/(B_1-B_2) \]
QALYs

QALYs:
- Capture both dimensions of health: quantity and quality
- Utilities/patient preferences (0=death, 1=perfect health) of health states are applied to time spent in health states to determine QALYs
Cost

- **Definition**: the value of resources required to deliver a product, service, or intervention

- **Types of cost**:
  - **Health-care resources**
    - Supplies, pharmaceuticals, equipment, facilities, tests, time of health-care personnel
  - **Nonhealth-care resource**
    - Transportation, dietary change, exercise
  - **Time costs / caregiver costs**
    - Time for transportation, waiting in a clinician’s office, receiving the service
    - Time for unpaid caregivers (volunteers, family members)
  - **Productivity costs**
    - Value of lost or impaired ability to do work
    - Value of lost leisure

\[
\frac{\Delta C}{\Delta B} = \frac{(C_1-C_2)}{(B_1-B_2)}
\]
Time Horizon and Discounting

- **Time horizon:**
  - Should be long enough to capture all relevant differences in future costs and outcomes of the alternatives being analyzed.

- **Discounting: Allowance for differential timing of costs and consequences**
  - Positive time preference: advantage to receive a benefit earlier or to incur a cost later
  - Costs yes, health effects controversial but most agree to discount at same rate as cost
  - Recommended in Canada: 5%
Summary Measure of Cost-Effectiveness

Incremental Cost-Effectiveness Ratio (ICER):

\[ ICER = \frac{\Delta C}{\Delta B} = \frac{(C1-C2)}{(B1-B2)} \]
Example: H1N1

Cost of vaccinating nation hits $1.5-billion and climbing

The flu-shot program is costing Canada almost double what was expected. Some doctors argue it's not worth it.
Objective

To estimate the effectiveness and cost-effectiveness of Ontario’s mass immunization program in response to the 2009 pandemic H1N1 influenza outbreak compared to no immunization from the health care payer perspective.
Findings

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Cost</th>
<th>Incremental Cost</th>
<th>Effectiveness (QALYs)</th>
<th>Incremental Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>No immunization</td>
<td>$90,050,623</td>
<td></td>
<td>185,343,522</td>
<td></td>
</tr>
<tr>
<td>Immunization</td>
<td>$249,972,384</td>
<td>$159,921,760</td>
<td>185,360,556</td>
<td>17,035</td>
</tr>
</tbody>
</table>

ICER = $159,921,760 / 17,035 QALYs
= $9,388 per QALY gained

- ICER (Incremental Cost-Effectiveness Ratio): cost per additional QALY
- However
  - Is this value for money?
  - Can we afford it?
Incremental cost-effectiveness ratio (ICER)

$$\text{ICER} = \frac{\text{Cost of } B - \text{Cost of } A}{\text{QALYs of } B - \text{QALYs of } A}$$
Value for money?

- $/QALY gained thresholds
  - Laupacis 1992:
    - <$20,000/QALY
    - $20,000-$100,000/QALY
    - >100,000/QALY
  - 1990s: $50,000/QALY
  - WHO CHOICE 2003:
    - 1xGDP/capita/DALY
    - 3xGDP/capita/DALY
  - Claxton 2013: displacement

- Value for money ≠ affordability
Recap

- Study design
- Perspective
- Outcomes
- Time horizon and discounting
- Value for money
EXAMPLES
Example 1

• AIM: Clinical trials have shown prophylactic human papillomavirus (HPV) vaccines to be effective against infection and disease. We examined whether HPV vaccination has the potential to be cost-effective.

• METHODS: A cohort model of the natural history of HPV was developed, which fits simultaneously Canadian age and type-specific data for infection, cervical intraepithelial neoplasia, cervical cancer (CC) and genital warts (GW). Quality-Adjusted Life-Years (QALYs) lost and costs were estimated using data from the literature.

• RESULTS: Vaccinating 12-year-old girls (efficacy=95%, no waning, cost/course=CAN$ 400) against HPV-16/18 and HPV-6/11/16/18 is estimated to cost the health provider CAN$ 31,000 (80%Crl: 15,000-55,000) and CAN$ 21,000 (80%Crl: 11,000-33,000) per QALY-gained, respectively. Results were most sensitive to age at vaccination, duration of vaccine protection, vaccine cost and QALY-lost due to GW, and were least sensitive to the medical costs.

• CONCLUSION: Vaccinating adolescent girls against HPV is likely to be cost-effective. The main benefit of vaccination will be in reducing CC mortality. However, unless screening is modified, the treatment costs saved through vaccination will be insignificant compared to the cost of HPV immunization.
Example 2

In 2005, an outbreak of West Nile virus (WNV) disease occurred in Sacramento County, California; 163 human cases were reported. In response to WNV surveillance indicating increased WNV activity, the Sacramento-Yolo Mosquito and Vector Control District conducted an emergency aerial spray.

We determined the economic impact of the outbreak, including the vector control event and the medical cost to treat WNV disease.

WNV disease in Sacramento County cost approximately $2.28 million for medical treatment and patients' productivity loss for both West Nile fever and West Nile neuroinvasive disease. Vector control cost approximately $701,790, including spray procedures and overtime hours. The total economic impact of WNV was $2.98 million. A cost-benefit analysis indicated that only 15 cases of West Nile neuroinvasive disease would need to be prevented to make the emergency spray cost-effective.

- What was the study design?
- How were outcomes measured?
- What was the time horizon?
- What was the perspective?
- What are the findings?
- Limitation?
Air pollution and premature death are important public health concerns. Analyses have repeatedly demonstrated that airborne particles are associated with increased mortality and estimates have been used to forecast the impact on life expectancy.

In this analysis, we draw upon data from the American Cancer Society (ACS) cohort and literature on utility-based measures of quality of life in relation to health status to more fully quantify the effects of air pollution on mortality in terms of quality-adjusted life expectancy.

The analysis was conducted within a decision analytic model using Monte Carlo simulation techniques. Outcomes were estimated based on projections of the Canadian population.

A one-unit reduction in sulfate air pollution would yield a mean annual increase in Quality-Adjusted Life Years (QALYs) of 20,960, with gains being greater for individuals with lower educational status and for males compared to females. This suggests that the impact of reductions in sulfate air pollution on quality-adjusted life expectancy is substantial.

Interpretation of the results is unclear. However, the potential gains in QALYs from reduced air pollutants can be contrasted to the costs of policies to bring about such reductions. Based on a tentative threshold for the value of health benefits, analysis suggests that an investment in Canada of over $1 billion per annum would be an efficient use of resources if it could be demonstrated that this would reduce sulfate concentrations in ambient air by 1 μg/m3. Further analysis can assess the efficiency of targeting such initiatives to communities that are most likely to benefit.
Example 4

BACKGROUND: To assess from a societal perspective the incremental cost-effectiveness of the Walking School Bus (WSB) program for Australian primary school children as an obesity prevention measure. The intervention was modelled as part of the ACE-Obesity study, which evaluated, using consistent methods, thirteen interventions targeting unhealthy weight gain in Australian children and adolescents.

METHODS: A logic pathway was used to model the effects on body mass index [BMI] and disability-adjusted life years [DALYs] of the Victorian WSB program if applied throughout Australia. Cost offsets and DALY benefits were modelled until the eligible cohort reached 100 years of age or death. The reference year was 2001. Second stage filter criteria ('equity', 'strength of evidence', 'acceptability', feasibility', sustainability' and 'side-effects') were assessed to incorporate additional factors that impact on resource allocation decisions.

RESULTS: The modelled intervention reached 7,840 children aged 5 to 7 years and cost $AUD22.8M ($16.6M; $30.9M). This resulted in an incremental saving of 30 DALYs (7;104) and a net cost per DALY saved of $AUD0.76M ($0.23M; $3.32M). The evidence base was judged as 'weak' as there are no data available documenting the increase in the number of children walking due to the intervention. The high costs of the current approach may limit sustainability.

CONCLUSION: Under current modelling assumptions, the WSB program is not an effective or cost-effective measure to reduce childhood obesity. The attribution of some costs to non-obesity objectives (reduced traffic congestion and air pollution etc.) is justified to emphasise the other possible benefits. The program's cost-effectiveness would be improved by more comprehensive implementation within current infrastructure arrangements. The importance of active transport to school suggests that improvements in WSB or its variants need to be developed and fully evaluated.

• What was the study design?
• What are the comparators?
• How were outcomes measured?
• Whose perspective was chosen?
• What are the findings?
• Limitations?
Challenges in PH Economic Evaluations

• Complexity of interventions
• Measurement of effectiveness
• Measurement of benefits and costs
• Time horizon
• Equity considerations
Take home message

“In an era when most societies must cope with increasing demand for health resources, they will inevitably have to make choices about the provision of health services, even if those choices are, by default, to continue current practices.” (Alan Lopez 2006)
Help

- Basics (in lay language)
  Drummond, Sculpher, Torrance, O’Brien, Stoddart:
  Methods for the economic evaluation of health care programmes

- Advanced/specific topics

- Guidelines
  CADTH: Guidelines for the Economic Evaluation of Health Technologies: Canada
  http://www.cadth.ca/media/pdf/186_EconomicGuidelines_e.pdf

- Assessment tools
  Some... based on checklist in Drummond et al, e.g., Huserau 2013 BMJ
  Also consider checklists for decision-analytic models (most economic evaluations are model based), e.g. Philips 2004 HTAi, MDM Modeling Good Research Practices 2012 (http://mdm.sagepub.com/content/32/5.toc)

- Registries
  Tufts CEA Registry: https://research.tufts-nemc.org/cear4/
  NHS (University of York, UK): http://www.crd.york.ac.uk/crdweb/
  PEDE (Pediatric economic evaluations, SickKids): http://pede.ccb.sickkids.ca/pede/

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