An Overview of Methods in Cost-Benefit and Cost-Effectiveness Analysis

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Why Economic Evaluation?

• Some industries are insulated from competitive market forces.
  – Health care and education are two of them.

• As a result, some industries have intransigent allocation problems & inefficiencies.
  – Which services and products should be provided?
  – What level of access should be provided?
  – What prices should be paid? By whom?
Why Economic Evaluation?

• An economic evaluation provides a systematic assessment of costs and benefits.
  – Methods and assumptions can be made clear.
  – Costs in one program can be compared with costs in another program.
  – Uncertainty can be quantified.
Why Economic Evaluation?

- Economic evaluation makes explicit
  - the relevant alternatives – to what are we comparing a particular option?
  - the viewpoint or perspective being adopted
    - Payer/Budgetary
    - Societal
  - the basis for comparison
    - Costs and benefits associated with purchases
Why Economic Evaluation?

• Options are compared in relation to their relative costs and potential for beneficial effects.

• Resulting studies are of:
  – Cost or cost impact
  – Cost-effectiveness
  – Cost-benefit
What Gets Compared?

– Two medications, one new and one old
– Enhanced vs. usual care
– Screening and early intervention vs. no screening
– Specialized training vs. no training.
Which Outcomes are Assessed?

- More ambitious goals for assessing economic impact often imply more ambitious assessment plans.
  - Easy: Assess costs
  - More Difficult: Average net cost impact
  - Most Difficult: Net long-term impact on costs and health outcomes or economic benefits
Limitations of Economic Evaluation

- Based on assumptions
- Focus is on efficiency not necessarily equity
- Rarely if ever provides a definitive answer
  - must be used in conjunction with other information & value judgments.
Measuring Costs

- Notion of costs is the extra (or “incremental”) resources required for A vs. B.
  - Find measures of the cost of doing A vs. the cost of doing B, and take their difference.
Measuring Costs

– Challenge is in measuring things for which nothing was paid directly.
  • Free/donated/shared space, equipment, and resources
  • Training
  • The value of one’s time & effort.
  • Lost opportunities (because resources were committed to something and therefore not available for other uses)
Measuring Costs

• To be comprehensive, a cost inventory should be developed.
  – A list of all resources used, regardless of payment
  – Datcap is a free cost inventory software program that classifies costs.
<table>
<thead>
<tr>
<th><strong>Program Cost Inventory for School-Based Health Programs</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LABOR</strong></td>
<td>Salaries (Full and Part-Time) Stipends Fringe Benefits</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>OTHER OPERATING COSTS</strong></td>
<td>Supplies &amp; Materials Minor Equipment &amp; Furniture Contracted Services Postage Telephone Staff Training Local Travel</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SHARED AND OVERHEAD COSTS</strong></td>
<td>Custodial Services General Administrative Services</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>OTHER NON-PURCHASED COSTS</strong></td>
<td>School Space Capital Equipment Student Volunteers</td>
</tr>
</tbody>
</table>
## Example of Costs Calculation

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>Total Cost</th>
<th>Cost Per Client</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel</td>
<td>$8,277</td>
<td>$80</td>
<td>18%</td>
</tr>
<tr>
<td>Training and Setup</td>
<td>$5,231</td>
<td>$50</td>
<td>11%</td>
</tr>
<tr>
<td>Materials and Laboratory</td>
<td>$32,558</td>
<td>$313</td>
<td>69%</td>
</tr>
<tr>
<td>Equipment</td>
<td>$258</td>
<td>$3</td>
<td>1%</td>
</tr>
<tr>
<td>Clinic Fees (imputed)</td>
<td>$600</td>
<td>$6</td>
<td>1%</td>
</tr>
<tr>
<td>Grand Total</td>
<td>$46,900</td>
<td>$451</td>
<td>100%</td>
</tr>
</tbody>
</table>

**PARAMETERS**

- Fringe Rate: 34%
- Administrative Indirect Cost: 15%
- Number of Clients: 104
- Real interest rate: 3%
Time Costs

– Time logs can provide a wealth of information.
  • e.g., Nurse time in a screening program
Shared and Overhead Costs

• Resources that serve many different departments and programs, such as general administrative services (payroll, billing), cleaning services

• Shared and overhead costs need to be allocated to interventions

• No “right” method – costs may be allocated based on a measure that is logically related to usage of the item (e.g. square footage)
Other Non-Purchased Costs

- **Donated labor** – value according to what these workers would have been paid.
- **Donated space** – value according to what the space would have cost.
- **Capital Equipment** – two cost components
  - Depreciation: wear and tear on capital equipment
  - Opportunity cost of funds tied up in capital: rate of return these funds would have earned had they been invested elsewhere
Measuring Benefits

• Main problem is that benefits are often subjective, or are objective but intermediary to outcomes
  – Satisfaction/health utility
  – Symptoms (intermediary to functioning)
    • Blood pressure
    • Depression
Measuring Benefits

• Three major approaches:
  – willingness to pay
    • contingent market evaluation (CME), and
    • market-based equivalents (MBEs)
  – health utility assessment
    • Measure directly the perceived value of health using a standardized assessment tool.
  – effectiveness analysis
    • Select a critical indicator of health outcome.
Measuring Benefits

• CMEs use respondents’ reported willingness to pay.
• MBE’s use the prices people pay for the benefits produced by a good or service.
  – e.g., the benefits of flu shots could be quantified based on the market value of work days gained.
  – e.g., benefit of prevention interventions for youth could be future public savings.
Measuring Benefits

• In a **cost-utility analysis (CUA)**, benefit is measured by improvement in health utility.
  - As measured by Quality Adjusted Life Years, QALYs, a “preference weighted” health index, with values between 0 (Death) and 1 (Perfect Health).

• In a **cost-effectiveness analysis (CEA)**, benefit is measured by improvement in health outcome.
Measuring Benefits

• In CEAs and CUAs the key estimate is the Incremental Cost Effectiveness Ratio (ICER)
  – the incremental cost incurred per incremental unit of effectiveness achieved.
The CE Ratio (Gold et al. 1996, p.176)

**A** Intervention

**DENOMINATOR**
"Health Effects"

**B** Changes in Health Status

**NUMERATOR**
"Costs"

- **E** Changes in Use of Health Care Resources
- **F** Changes in Use of Non-Health Care Resources
- **G** Changes in Use of Informal Caregiver Time
- **H** Changes in Use of Patient Time (for Treatment)

- **C** Intrinsic Value
- **D** Production Output
Cost difference

IV
Intervention less effective and more costly than O

+  

Intervention more effective and more costly than O

B

-  

Intervention less effective and less costly than O

III

-  

Intervention more effective and less costly than O

II

Effect difference
Measuring QALYs

• **Direct health utility measures**
  – Visual analog scale (VAS)
  – Standard Gamble (SG)
  – Time Tradeoff (TTO)

• **Indirect health utility measures**
  – Combine data from direct health utility measures with ratings of components of health to impute overall utility values
**VAS**

Example of VAS provided with the EQ-5D

- Easy to administer
- Good psychometric properties
- However, not tied to axioms expected utility theory

To help people say how good or bad a health state is, we have drawn a scale (rather like a thermometer) on which the best state you can imagine is marked 100 and the worst state you can imagine is marked 0.

We would like you to indicate on this scale how good or bad your own health is today, in your opinion. Please do this by drawing a line from the box below to whichever point on the scale indicates how good or bad your health state is.
Standard Gamble

Live rest of life in current health state

OR

take a pill that could kill you

What $\Pr(\text{Death})$ makes you indifferent between taking the gamble or remaining in current situation?

$Q \text{ of } L = 1 - \Pr(\text{Death})$
Time Tradeoff

Live Full Duration of Life with Current Health

- You will live with your current health for 34 years

Take the Pill

- You will live in perfect health for 29 years
- AND
- You will give up 5 years of life
Indirect Health Utility Measures

• HUI and EuroQol
  – Clients rate a condition or health outcome along component attributes of health using a direct measure.
    • E.g., mobility, physical pain, emotional well-being
  – Responses are then combined using an index, which has predetermined weights
Scoring indirect health utility measures

Health Utilities Index (HUI®) Components

- Subjects
- Proxy
- Questionnaire
- Classification
- Attribute Levels (Health Status)
- Single-Attribute Utilities
- Multi-Attribute Utilities (HRQL)
- Utility formula: Based on General Population
- QALYs
Health Utility Index

- **8 domains of health**
  - vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain
- **Basis of domain weights**:  
  - Canadian community sample  
  - Used VAS and SG to rate hypothetical health states
EuroQol

- **5 domains of health**
  - Mobility, self-care, usual activity, pain/discomfort, or anxiety/depression

- **Basis of domain weights:**
  - Past studies have been based on British community sample that used TTO to rate states
Adjusting for Timing

• Prevention/intervention programs often incur costs in the present to achieve benefits in the future.
• Are the future benefits of prevention comparable to the present-time costs, without any adjustment for differences in the timing of costs and benefits?
• No!
  – If future benefits are not adjusted for timing, it would always pay to delay intervention.
  – Having to wait for benefits implies we are foregoing current opportunities that increase in value over time.
Adjusting for Timing

• What if we treated future and current costs as being equivalent in a CBA?
• Instead of spending on preventive interventions, we could save our money and receive a real (i.e., inflation adjusted) positive rate of return (say at 3 percent per year).
Adjusting for Timing

• Then we would have 3% more resources available for a prevention program next year.
Adjusting for Timing

• The process of adjusting for timing is called discounting.

• In the simplest case, for each year that costs or benefits are delayed into the future, we discount them by a factor of $1/(1+r)$, where $r$ is the discount rate.
  – In future year $t>0$, the discount factor is $1/(1+r)^t$
  – a 3% rate is the standard convention.
Adjusting for Timing

• Example - a program that costs $100 in the present and generates $100 in benefits in 12 mos., 24 mos. And 36 mos.

• **Discounted present value** of NB = -$100 + $100/ (1+r) + $100/(1+r)^2 + $100/(1+r)^3

• Note that if r > 0 result is less than $300 - $100.
Adjusting for Timing

• Why should \( r \) be > 0?

• Assuming 0 inflation (or that all costs and benefits are expressed in $’s of constant purchasing power) -
  – Market returns; $1 invested by a company in new equipment yields more than $1 in future revenues so companies will borrow money at interest.

  – Consumers can therefore lend $1 today to earn >$1 tomorrow so $1 today is worth more to them than $1 tomorrow.
Adjusting for Timing

• What discount rate should we use?

• Real vs. Nominal Rates -
  – Nominal rates are approximately equal to real rate plus the rate of inflation.
  – Real rates are adjusted for inflation. Use real rates if your costs and benefits are in constant purchasing power $’s. (This is usually the case.)
  – Nominal rates are not adjusted for inflation. Same as published interest rates (e.g., rates on bonds).
Adjusting for Timing

• Usual practice - use a rate of about 3 % \( (r = 0.03) \) and do sensitivity analyses with higher and lower rates.

• Other complications - taxes, adjusting nominal rates for risks, etc.
Sensitivity Analysis

• Provides a set of alternatives estimates that show how the findings would change if key assumptions were changed.

• At minimum, 1-way sensitivity analysis necessary for key assumptions

• 1-way sensitivity analysis can understate overall uncertainty; should also conduct multivariate sensitivity analysis.
Sensitivity Analysis

• Results often reported using “best/worse case” contrasts.
  – Better to be too conservative (i.e., understate the benefits and overstate the costs) than too optimistic.
  – Better studies recognize the potential flaws, and discuss their significance to the results.
Summary

• Economic evaluations should provide greater accuracy and transparency than informed guesses.

• Comprehensive analyses of costs should take into account all opportunity costs, whether paid for directly or not.

• Economic benefits are difficult to measure and compare across interventions.
  – Unclear what to do about it.