Costs I

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Cost-Effectiveness Analysis
HSMP 6609
2016
Cost definitions (lots of new terms that you need to learn)
Rules for thinking about which costs to include or exclude
Examples
More on perspective
The difficult parts (cost versus charges, opportunity costs versus prices, etc)
Discounting
Microeconomics 101

- **Total** cost, **average** costs, and **marginal** cost

\[ TC = p_1 \times q_1 + p_2 \times q_2 + \ldots + p_n \times q_n = \sum_{i=1}^{n} p_i \times q_i, \]

where \( TC \) is total cost and \( p \) is price and \( q \) is quantify for **inputs**

\[ AC = \frac{TC}{X}, \]

where \( AC \) is average costs and \( X \) is the level of **output**
The **marginal cost** is the cost associated with producing additional unit(s) of output

\[
MC = \frac{TC(X_2) - TC(X_1)}{X_2 - X_1},
\]

where \(TC(X_i)\) is the cost of producing \(X_i\) units.

- Usually, \(X_2 - X_1 = 1\) so MC is the extra cost of producing an additional unit, which usually depends on the number of units.

- Another way of saying the same (for a small change) is using calculus: 
  
  \[
  MC = \frac{dTC(X)}{dX}
  \]
**Fixed costs:** Do not vary with the level of output, \( X \) (i.e. rent)

**Variable costs:** Do vary with the level of output (i.e. medications in a hospital)

“Fixed” costs may change with time

**Sunk cost:** cost that has already been incurred and cannot be recovered

You signed up for a marathon but now you are not sure if you want to do it. Your friend tells you that you **should** because you already paid the $100 registration fee. What would a *normal* person say? What would an *abnormal* person (i.e. economist) say?
**Financial costs** are the money outlays for resources; **economic costs** are the opportunity costs of the resources used to implement an intervention.

**Opportunity costs**: the loss of potential gain from other alternatives when one alternative is chosen, or “the value of the forgone benefits because the resource is not available for its best alternative use”

**Examples:**
- What are the opportunity costs of getting an MPH?
- You had to do HSMP 6609 homework this past Sunday night. Your opportunity cost was missing the Superbowl (opportunity cost can be negative)
- For a hospital, the opportunity cost of spending $300,000 in a party are the 3 nurses that they won’t hire (and the profits they may lose)

**Transfer payments**: No resource utilization and from the point of view of the society they are not costs (e.g. welfare, social security, workers compensation)
Which costs should be considered in EEs

Direct costs: Changes in resource use attributable to the intervention

Indirect costs: Productivity gains or losses related to illness or death

Problem is that “direct” and “indirect” are not consistently used. In accounting indirect costs are overhead costs. People still use direct and indirect costs. When you encounter this term, think about the above figure.
By category

- **Health sector**: cost of therapy, hospital (inpatient and outpatient), medication, physician time, and so on...
- **Other sectors**: Social services, shelters, government services, or any cost of the intervention is not provided by the health care sector
- **Patient/family**: Transportation, accommodation, caregiver time
- **Productivity losses**: Days off, not working, or disable
What about cost savings?

- Cost savings are not benefits
- Cost studies are not cost-benefits studies
<table>
<thead>
<tr>
<th>Type of study</th>
<th>Measurement / valuation of costs in both alternatives</th>
<th>Identification of consequences</th>
<th>Measurement / valuation of consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost analysis</td>
<td>Monetary units</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Cost-effectiveness analysis</td>
<td>Monetary units</td>
<td>Single effect of interest, common to both alternatives, but achieved to different degrees</td>
<td>Natural units (e.g. life-years gained, disability days saved, points of blood pressure reduction, etc.)</td>
</tr>
<tr>
<td>Cost-utility analysis</td>
<td>Monetary units</td>
<td>Single or multiple effects, not necessarily common to both alternatives</td>
<td>Healthy years (typically measured as quality-adjusted life-years)</td>
</tr>
<tr>
<td>Cost-benefit analysis</td>
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<td>Monetary units</td>
</tr>
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</table>
Which costs should be considered in EEIs?

- Remember: key considerations are a) viewpoint of the analysis, b) time horizon, and c) relevance of cost item for the decision.

- Example adapted from Byford et al (2003)

- 480 patients with a history of recurrent deliberate self-harm randomized into cognitive-therapy (CBT) or usual treatment (UT). Time horizon: 1 year

- Patients were sent to several treatment sessions. Some of the patients were hospitalized or in prison or needed accommodations.

- What cost should be included? To simplify, let’s pretend they were veterans covered by the VA.

- Possible points of view: 1) Provider (VA), 2) Society.
Cost table (per person or average) adapted from paper:

<table>
<thead>
<tr>
<th>Cost item</th>
<th>Cognitive Therapy</th>
<th>Usual Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Hospital services</td>
<td>1,548</td>
<td>1,796</td>
</tr>
<tr>
<td>b) Outpatients services</td>
<td>678</td>
<td>566</td>
</tr>
<tr>
<td>c) Medication</td>
<td>169</td>
<td>140</td>
</tr>
<tr>
<td>d) Criminal justice</td>
<td>126</td>
<td>600</td>
</tr>
<tr>
<td>e) Social services</td>
<td>252</td>
<td>470</td>
</tr>
<tr>
<td>f) Living expenses</td>
<td>10,369</td>
<td>10,570</td>
</tr>
<tr>
<td>g) Productivity</td>
<td>294</td>
<td>450</td>
</tr>
</tbody>
</table>
Byford et al. (2003)

- Use categories to combine costs

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</table>

**Using textbook categories**

- Health sector (a+b+c): 2,395 (Cognitive Therapy) vs. 2,502 (Usual Treatment)
- Other sectors (d+e): 378 (Cognitive Therapy) vs. 1,070 (Usual Treatment)
- Patient/family (f): 10,369 (Cognitive Therapy) vs. 10,570 (Usual Treatment)
- Productivity (g): 294 (Cognitive Therapy) vs. 450 (Usual Treatment)

- Now, different perspectives

<table>
<thead>
<tr>
<th>Using textbook categories</th>
<th>Health sector (a+b+c)</th>
<th>Other sectors (d+e)</th>
<th>Patient/family (f)</th>
<th>Productivity (g)</th>
</tr>
</thead>
<tbody>
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<td>10,369</td>
<td>294</td>
</tr>
<tr>
<td></td>
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<td>1,070</td>
<td>10,570</td>
<td>450</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Perspective</th>
<th>Medical payer (a+b+c)</th>
<th>Society (a to g)</th>
<th>UT-CBT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2,395</td>
<td>13,436</td>
<td>2,502</td>
</tr>
<tr>
<td></td>
<td>107</td>
<td>1,156</td>
<td>14,592</td>
</tr>
</tbody>
</table>


Gold book: Who is affected? On whose behalf are decisions made? Who pays for it?

Muenning: The party interested in the study. “When a particular organization includes only costs and outcomes relevant to its needs, the analysis is said to have been conducted from that party’s perspective.”

Suppose the state of Colorado did the CB vs UT study. We would need to recalculate the costs to figure out what is paid (or saved) by the state of Colorado. If the participants were on Medicaid, some of the medical care is paid by the federal government.

One more time: perspective is not the point of view of the authors or the editor or the stakeholders...
But not a lot of agreement in the literature

The societal perspective can be fuzzy sometimes. Some studies measure costs from a party perspective but measure QALYs from a societal perspective (and argue that the study was from a societal perspective). This is how the CEA registry defines societal perspective (see Neumann, 2009)

<table>
<thead>
<tr>
<th>Perspective Used in Published CUAs, 1976 to 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>As Stated By Author</td>
</tr>
<tr>
<td>--------------------</td>
</tr>
<tr>
<td>Societal</td>
</tr>
<tr>
<td>Health care payer</td>
</tr>
<tr>
<td>Not stated/could not be determined</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

What are the cost components included in CUAs?

<table>
<thead>
<tr>
<th>Cost Components Included</th>
<th>n = 228</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct health care costs</td>
<td>226 (99.1%)</td>
</tr>
<tr>
<td>Intervention</td>
<td>222 (97.4%)</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>199 (87.3%)</td>
</tr>
<tr>
<td>Outpatient visits</td>
<td>167 (73.2%)</td>
</tr>
<tr>
<td>Long-term care</td>
<td>28 (12.3%)</td>
</tr>
<tr>
<td>Other health care</td>
<td>165 (72.4%)</td>
</tr>
<tr>
<td>Direct nonhealth care and time costs</td>
<td>38 (16.7%)</td>
</tr>
<tr>
<td>Patient time</td>
<td>22 (9.6%)</td>
</tr>
<tr>
<td>Transportation</td>
<td>11 (4.8%)</td>
</tr>
<tr>
<td>Family/caregiver time</td>
<td>13 (5.7%)</td>
</tr>
<tr>
<td>Social services</td>
<td>6 (2.6%)</td>
</tr>
<tr>
<td>Productivity costs</td>
<td>19 (8.3%)</td>
</tr>
<tr>
<td>Other</td>
<td>5 (2.2%)</td>
</tr>
</tbody>
</table>

Big picture

- In general, **identifying** costs and **measuring/counting** costs are **not** the difficult parts (**valuation** is)

- Where do we get data from?
  - In EEs that are performed along a clinical trial, there are **case report** forms
  - **Case notes** from clinical records or **claims** data or **electronic medical records**
  - **Interviews** of patients about other quantities (days off taken, assistance from family, etc)
  - **Diaries**
How precisely do cost need to be?

- No clear answer except to say that it should not bias the comparison
- Two extremes
  - **Micro costing**: count every unit and price it
  - **Gross costing**: aggregate (DRG, cost per day, or from medical literature)
- In the CFPI, we are getting average cost per person from the different agencies
- Trivia: In 2015, food assistance in Colorado is $1,751 per person (for those who get assistance) or $4.4 per day
### Examples: CDC Communicable disease cost log and survey

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Time</th>
<th>Activity Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1/2014</td>
<td></td>
<td></td>
<td>Check CEDRS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Routine Investigations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phone/email communication to/from Regional Epi, Infection Control Practitioner, Provider or someone else related to Communicable Disease Surveillance outside of Routine Investigation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tabulate Data</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Assess community risks and trends</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Learning and research (NOT training)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Travel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Please insert ‘other’ here</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>Please insert ‘other’ here</td>
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<td></td>
<td>Please insert ‘other’ here</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total Minutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Number of Cases (report in cases/day in LAST CELL in this row) (Routine Investigation)</td>
</tr>
</tbody>
</table>

Enter ‘X’ for every 15 minutes an activity is done.
### Examples: CDC Communicable Disease Cost Log and Survey

<table>
<thead>
<tr>
<th>Total FTE</th>
<th>Total Lower End of Annual Salary Range</th>
<th>Total Higher End of Annual Salary Range</th>
<th>Average Fringe Rate</th>
<th>Total FTE Dedicated per Communicable Disease Surveillance Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>$-</td>
<td>$-</td>
<td>0%</td>
<td>0.00</td>
</tr>
</tbody>
</table>

- Please enter each person's TOTAL FTE based on 40 hour work week.
- Please enter whether each person is paid hourly or salary.
- Please enter the LOWER END of the salary range for each position.
- Please enter the HIGHER END of the salary range for each position.
- Please enter FRINGE DATE, in percent, for each position. If NOT KNOWN, please enter 0%.
- Please enter your best estimate of the NUMBER OF HOURS FOR THE TOTAL 2 WEEKS dedicated to these activities during the time they logged their time (see dates on the left column). For minutes, please enter as fractions of time (15 minutes = 0.25).
Relevance of cost for the decision

- **Reminder:** this is an important tool to figure out what to include
  1. If both alternatives have the same costs, then they can be ignored (it may be a problem in the future)
  2. If some costs are not going to change the decision and are complicated to obtain, they could be ignored. Should provide some justification

- Each case is different; determining which costs are relevant requires some thinking. Sometimes you know that they are not relevant after you measure them
Now the complicated parts

1. The importance of opportunity costs
2. How to value items: charges or costs?
3. How do we value things for which there is no market?
4. Should health care costs unrelated to the program or intervention be included?
5. Should related or unrelated non-health care costs be included?
6. How should overhead costs be calculated?
7. How do we discount costs and why?
8. How do we measure productivity losses?

(Some of these issues are complicated in theory but not in practice, while others are clear in theory but complicated in practice)
Opportunity costs

- In EEs we want to compare the resources consumed to the benefits obtained.
- In markets resembling **perfectly competitive markets**, prices would be a good guide for costs.
- Perfectly Competitive markets: 1) Firms sell identical products, 2) firms are price takers, 3) small market share, 4) perfect information, 5) no barriers to entry.
- In equilibrium, firms produce until marginal cost equals marginal revenue, which equals price. In the long run, profits are zero (remember, no barriers to entry).
- In real life, there is no perfectly competitive market. Easy example: monopoly. Their price is higher than MC and have profits in the long run.
Opportunity costs

- The health care sector looks nothing like a perfectly competitive market; prices are not a good guide for opportunity costs.
- Think of the five characteristics and how they don’t apply to the health care sector.
- See Arrow (1963). Health economics is all about market failure (technical term, nothing to do with communism).
- Example: What is the cost of a CAT scan? A private payer (uninsured) may pay $4,000, an insurance company may give just $1,000 to the hospital (relatively true story).
Another example from Muenning (2008): In a NYT article, a gynecologist in NYC said that he charges $175 for a routine visit for uninsured patients but accepts $25 from insurance company.

So which price should we use for CEA? Ideally, neither.

We should figure out the **actual costs** of a routine visit (doctor time, tests, receptionist time, medications use).

But then you may ask yourself, where do I get, say, the medication price that reflects an opportunity cost?

Some conventions to the rescue...
Drug costs

- What is the cost of a drug (not the price charged)?
- We would need manufacturing and distribution costs (hard to obtain)
- Usual solution: **average wholesale price** (AWP)
- Not perfect solution: AWP does not reflect the actual costs. Some argue that CE ratios of drugs are overestimated (Garrison et al, 2008)
- But for the Nth time: **perspective matters a lot**!! If you are conducting a study from the point of view of a provider with the objective of informing the provider about the cost of an intervention, *what matters is the price that the provider pays*
- From the societal perspective, we want opportunity costs
Adjusting costs

- Your textbook suggests two guidelines for when to modify prices:
  1. To leave prices unadjusted would introduce substantial biases
  2. There is a clear and objective way of making adjustments

- Typical case: **costs** versus **charges** for hospitalizations
Cost to charges

- Studies assessing the effects of costs versus charges in hospitals found that using one or the other does not change CEA conclusions.
- Remember that we are comparing alternatives.
- In the US, there are cost-to-charge ratios published so researchers tend to adjust hospital charges.
- Cost to charge ratios vary by setting and years, about 0.4 or 0.67 (or the inverse, 2.5 or 1.5).
Just to make things a bit more confusing: costs, charges, and expenditures

Expenditure is the amount that the patient or the insurance company actually paid

The Medical Expenditure Panel Survey (MEPS) has great data on expenditures (http://meps.ahrq.gov/mepsweb/)

Healthcare Cost and Utilization Project (HCUP) has hospitalization data and cost and charges (http://hcupnet.ahrq.gov/)

Medicare also has cost to charge data (Medpar files)
How do we value non-market items?

- Typical cases: volunteer time and patient and family time
- This could be $C_3$ (patient/family) (rarely, $C_1$ or health care sector)
- Remember that the objective of EEs is to inform decisions that are applicable to other settings
- One intervention may have used volunteer time to do something that normally would be done by employees
- One simple approach: use wages for similar activities. The Bureau of Labor Statistics has this information (http://www.bls.gov/bls/blswage.htm)
- For interventions that require family time, could use same approach (some argue for extra time wage rates)
Discounting

- Not all costs happen at the same time but we want to compare costs of different interventions at the same time
- You need to learn how to move costs in time
- The basic formula is fairly easy to derive
- Imagine that you deposit $100 at the beginning of the year and you earn 3% of interest. How much do you have at end of the year?
- One way: $100 \times 0.03 = 3$, so at the end of the year $100 + 3 = 103$
- Same as $100 \times (1 + 0.03)$ because $100 + (100 \times 0.03)$
What about if you deposit the $100 for three years?

1st year: $100 \times (1 + 0.03)$
2nd year: $[100 \times (1 + 0.03)](1 + 0.03) = 100 \times (1 + 0.03)^2$
3rd year: $[100 \times (1 + 0.03)(1 + 0.03)](1 + 0.03) = 100 \times (1 + 0.03)^3$

So looks like we can write: $100 \times (1 + 0.03)^n$, where $n$ is the number of years.

Now call the $100$ the present value or $PV$ and call the money that we have after depositing the $PV$ in the bank the future value (or $FV$) of the $100$. $r$ is the interest rate.

$FV = PV(1 + r)^n$. Solving for $PV$:

$PV = \frac{FV}{(1+r)^n}$
Discounting

- From your textbook:
  \[ PV = \sum_{n=1}^{3} FV_n (1 + r)^{-n} = \frac{FV_1}{(1+r)} + \frac{FV_2}{(1+r)^2} + \frac{FV_3}{(1+r)^3} \]

- Just an application of the general formula \( PV = \frac{FV}{(1+r)^n} \). Now we are bringing three different values to the present and adding them up. That’s all

- We will work on this next class
Three steps for dealing the cost side of EEs

1. Figure out the items that you need to include, which depend on perspective, time horizon and relevance of the costs
2. Count units
3. Value units

For those of you who are going to be in management and want to do EEs from a provider perspective, make friends in the accounting department

For physicians who are going to do EEs using interventions, treat RAs and project managers nicely (you may need friends in the accounting department too)

For those of you who will read EEs, think about the cost categories and whether things were left out that should be included (no need to make friends)

Next class: more on the thorny issues plus discounting and overhead costs