Estimating the Cost of an Intervention

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Focusing Question

What is the cost of a new health care intervention?

Examples:

1. What does it cost to use outreach workers to improve cancer screening?
2. What does it cost to use a robot for stroke rehabilitation?
3. What does it cost to run a telephone case monitoring program for people in substance use recovery?
Objectives

At the end of the seminar, you should

– Understand what micro-costing means
– Be familiar with different micro-costing methods
– Understand that the method you use will affect your future analyses
Perspective

- Researchers may need to vary these methods depending on the perspective of their analysis

- Perspective
  - Societal
  - Payer
  - Provider
  - Patient
POLL

What kinds of economic analysis interest you?

- Cost identification
- Cost-effectiveness analysis
- Implementation (e.g., budget impact)
Outline

1. Introduction
2. Micro-costing methods
   - Direct Measurement
   - Cost Regression
3. Efficient production and economies of scale
4. Example
Outreach workers

- A local hospital routinely performed Pap smears in the ED (when clinically indicated).

- Problem: Low rates of follow-up among abnormal Pap smears (~30% follow-up)

- Potential solution: employ outreach workers to improve follow up

- Question: what is the added cost of using an outreach worker to improve follow-up?
Robots

- Engineers have developed robotic devices to facilitate arm rehabilitation after stroke
- Robots offer precise, repetitive actions to help the patient with impairment
  - Direction
  - Speed
  - Control
- What is the cost of robotic-enhanced rehab?
The answer

- To answer these questions, we need to use micro-costing methods.
Micro-costing

- This term refers to a set of methods that researchers use to estimate costs.

- Methods are needed because costs* are not readily observable.

*cost resulting from a competitive market
Micro-cost Methods

Three commonly-used methods

- Direct measure: measure activities and assign prices to them
- Pseudo-bill: capture services using billing codes. Assign costs to billing codes
- Cost regression: use statistical techniques with existing to identify the cost of the intervention
Selecting a Method

- Data availability
- Method feasibility
- Appropriate assumptions
- Precision and Accuracy
Direct Measurement

Four steps

1. Specify the production processes
2. Enumerate the inputs for each process
3. Identify price for the inputs
4. Sum (quantity*price) across all inputs

Level of precision is critical.
An example outside of health

What is the process of producing a meal?

Get ingredients  Use equipment  Cook the meal  Clean up

A natural sequence of events in the production process
Cost of Cooking

- Buy ingredients
- Buy/rent equipment and space
- Cost of Cooking
- Cost of clean up
The Production Process: two critical issues

- **Efficiency**
  - Use fewer resources to produce more outputs, or
  - Use the same resources to produce more outputs

- **Quality**
  - Services that increase the likelihood of desired health outcomes and are consistent with current professional knowledge
Efficiency and Quality in Cooking

- Buy ingredients
- Buy/rent equipment and space
- Good equipment (knives, stoves)
- Skilled labor
- Learning by doing (volume)
- Specialization (skills and foods)
- Proper preparation
- Understanding client flow

Cost of Cooking
Cost of clean up

These issues transfer to medicine

What is unique to health care is risk and uncertainty.

Returning to Health Care...

- Efficiency and quality are important in health care.
- They are often unobserved in health care production and yet they are correlated with costs!
- We will return to these issues later.
The Cost of Producing Health Care

- Pre-op
  - Understand patient preferences, risk assessment
- Surgery
  - The operation itself
- SICU and post-op care
- Post op
- Discharge planning
  - Working with the patient to recognize infection

Cost types
- Personnel
- Space
- Supplies
- Training
- Contracts

Time horizon
- Fixed
- Variable

Economists and accountants define differently
Precision

- Intervention used 2 FTE for 1000 participants
- Total labor cost is $100,000 for a year

**Less Precise Method:** Labor cost per participant is $100,000/1,000 or $100

**More Precise Method:** Track intervention time per participant. Use time estimates to apportion labor costs.
Micro-Cost Methods: Direct Measurement

Precision is Expensive

- It is time consuming to track staff activities
- Form was created with input from outreach workers
- Manager reviewed them for accuracy each week
Precision and Accuracy

- The center of the target represents perfect accuracy.
- A and B are equally accurate.
- A is more precise than B.
Accuracy

- SCI-VIP program developed an app built into the medical record so that time spent providing supportive employment was gathered as part of the documentation in VISTA.

- This improved data accuracy.
The Precision Payoff

Example at end of lecture
About subgroup analysis
Direct Measurement: Personnel Activities

- Research staff can produce several “products”
  - Exclude development cost
  - Exclude research-related costs
  - Should measure activities when program fully implemented (efforts during start up period is likely odd)
Personnel Costs

- May need to include benefits
- Need to include direct/productive and indirect/non-productive costs (e.g., meeting times)

- VA Labor costs
  http://www.herc.research.va.gov/include/page.asp?id=labor
Cost Regression

- Use a regression model to estimate the marginal cost of an activity

- Caveats
  - Only works when there are existing cost data
  - Not a good method for a new technology (e.g., secure messaging) where cost accounting may be underdeveloped
Ex: Cost of Telephone Care

- We conducted a RCT to examine whether telephone case monitoring improves substance use care relative to usual care.
- Intervention averaged 9.1, control averaged 1.9 calls (difference=7.2, p<.001)
- MCA tracks SUD telephone care costs in clinic stops (543, 544, 545)
- We summarized the cost data per person
Each additional call cost an average of $10.53
Assumptions

- Cost and workload data are accurately captured
- Accuracy could vary by location
- Costs are biased toward 0 if the workload is not being captured
Cost Regression

- Large literature on analyzing cost data
- Cost data are frequently skewed
  - Skewed errors violates assumptions of Ordinary Least Squares
  - Error terms not normally distributed with identical means and variance
  - Transformation
    - Typical method: log of cost
    - Can make OLS assumptions more tenable

Important Assumptions: Scale Economies

- We created a health guide for a RCT
- We paid $14 per guide for 1000 guides
- If we ordered more, the cost per guide would decrease, eventually reaching $3
- Which cost estimate should you use for the CEA?
Poll

- For a CEA (societal perspective), which estimate should you use?
  - $14 per guide
  - $3 per guide
  - Somewhere in between
Economies of Scale

If the unit costs ($/Q) of producing a good decrease as the quantity (Q) of goods increase, use the unit cost when there are constant returns to scale.

\[
\text{$/Q} \quad \text{Increasing returns to scale} \\
\text{Quantity (Q)} \quad \text{Constant returns to scale}
\]
Quality

- In this example, we make an assumption about efficient production
- Quality is also unobserved
- Changing assumptions about costs could affect quality (and outcomes).
Example: Estimating Labor Costs by Direct Measurement
Outreach workers

- A local county hospital routinely performs Pap smears in the ED.

- Problem: Low rates of follow-up among abnormal Pap smears (~30% follow-up)

- Question: what is the cost of using an outreach worker to improve follow-up?
Objective

- We evaluated the cost-effectiveness of usual care (a mailed postal reminder) with a tailored outreach intervention compared to usual care alone.

- Does CEA vary by disease risk?
Study Overview

- Randomized, controlled trial
- Usual care: notified by telephone or mail, depending on the degree of abnormality. Provided intervention after 6 months.
- Intervention: Usual care plus outreach and tailored individual counseling
- Estimated costs using direct measurement
Methods

- Method 1: Sum all the intervention costs and divide by number of participants (easy)
- Method 2: Estimate the cost of the intervention for each patient (hard)

If you want to ask, “was the intervention more cost-effective for subgroups?”, then you need to use method 2?
# Unit Costs (2002 dollars)

<table>
<thead>
<tr>
<th></th>
<th>Intervention (n=178)</th>
<th>Usual care (n=170)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outreach worker costs</td>
<td>$142</td>
<td>$0</td>
</tr>
<tr>
<td>Travel costs at $.365 per mile</td>
<td>$4</td>
<td>$0</td>
</tr>
<tr>
<td>Office space and supplies</td>
<td>$28</td>
<td>$0</td>
</tr>
<tr>
<td>Outreach worker quality assurance</td>
<td>$19</td>
<td>$0</td>
</tr>
<tr>
<td>Usual care</td>
<td>$1</td>
<td>$1.00</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>$47</strong></td>
<td><strong>$0</strong></td>
</tr>
<tr>
<td>Patient Travel Costs for Follow-up</td>
<td>$19</td>
<td>$9.9</td>
</tr>
<tr>
<td><strong>Total unit cost from societal perspective</strong></td>
<td><strong>$214</strong></td>
<td><strong>$10.9</strong></td>
</tr>
<tr>
<td><strong>Cost to add intervention from provider perspective</strong></td>
<td><strong>$194</strong></td>
<td><strong>$0</strong></td>
</tr>
</tbody>
</table>

Effectiveness

Abnormal Pap Follow-up at Highland Hospital
non-OB Patients

- Cumulative % Followed Up
- Months since Initial Pap

Graph shows the percentage of patients followed up over time, comparing Intervention (red dots) and Control (blue squares) groups.
## Cost per follow-up

<table>
<thead>
<tr>
<th></th>
<th>Cost</th>
<th>Incremental cost</th>
<th>Probability of follow-up</th>
<th>Incremental follow-up</th>
<th>Incremental cost per follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>$77</td>
<td></td>
<td>0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>$355</td>
<td>$278</td>
<td>0.61</td>
<td>0.29</td>
<td>$959</td>
</tr>
<tr>
<td>Bootstrapped 95% CI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(787-1367)</td>
</tr>
<tr>
<td><strong>By severity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASCUS/AGUS</td>
<td>$75</td>
<td></td>
<td>0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$347</td>
<td>$272</td>
<td>0.57</td>
<td>0.25</td>
<td>$1,090</td>
</tr>
<tr>
<td>LGSIL</td>
<td>$74</td>
<td></td>
<td>0.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$374</td>
<td>$300</td>
<td>0.64</td>
<td>0.34</td>
<td>$882</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(813-1658)</td>
</tr>
<tr>
<td>HGSIL</td>
<td>$105</td>
<td></td>
<td>0.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$405</td>
<td>$300</td>
<td>0.87</td>
<td>0.44</td>
<td>$681</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(579-4584)</td>
</tr>
</tbody>
</table>

Example 2: Estimating cost of using robots for stroke rehab

- The MIT robot can assist the patient to initiate movement towards the target.
- The robot can “guide” the movement, making certain that the patient is practicing the movement the correct way.
- As the patient gains movement control, the robot provides less assistance and continually challenges the patient.
- The robot provides quantifiable feedback on progress and performance.


www.interactive-motion.com/technology.htm
Robot Costs

- **Robot**
  - $230,750 purchase price
  - Need to include financing (6.015%)
  - Robot needs overhead— a room, separate circuit
  - Annual maintenance contract ($15,000 in yrs 2-5)
  - Depreciates over a 5 year-life span

- **Net present cost for 5 years of robot therapy**
  $422,532
Costs per Rehab Unit

- A site could offer 7 session per robot
  - Each session lasts 75 minutes
  - 2 patients per session (using different components)

- Number of slots over five years: 21,500
- Robot cost per session: $19.65
- Therapists run the robot: $120 per session
- Total cost per robot session: ~$140
## Results

<table>
<thead>
<tr>
<th>Intervention costs</th>
<th>Robot (n=49)</th>
<th>ICT (n=50)</th>
<th>UC (n=28)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per session</td>
<td>$140</td>
<td>$218</td>
<td></td>
</tr>
<tr>
<td>Robot cost per session</td>
<td>$20</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Therapist cost per session</td>
<td>$120</td>
<td>$218</td>
<td>--</td>
</tr>
<tr>
<td>Average number of completed sessions</td>
<td>32.8</td>
<td>32.1</td>
<td>0</td>
</tr>
<tr>
<td>Travel costs</td>
<td>$561</td>
<td>$389</td>
<td></td>
</tr>
<tr>
<td>Average intervention cost</td>
<td>$5,152</td>
<td>$7,382</td>
<td>$1,845</td>
</tr>
</tbody>
</table>

Note: Robot therapy is significant less expensive than ICT (p<0.001)

ICT is intensive comparison therapy
Resources

- HERC resources
  - [HERC resource link](http://www.research.herc.va.gov/include/page.asp?id=micro)

- Converting travel distance into money.
  - Eligible Veterans receive $0.415 per mile
  - The IRS standard mileage rate allowed for operating expenses for a car when you use it for medical reasons is $.17 per mile
  - GIS and many statistical programs have built in functions for estimating travel distance or drive times

- Caregiver costs (if needed)
When we estimate the cost of labor, we need to add employee benefits (30%) and overhead (the “back office” components of an organization that keep it running such as HR and IT)

Calculating overhead costs

- 33%-- Arthur Andersen. The costs of research: examining patterns of expenditures across research sectors. This report has seemingly vanished

Estimating overhead costs empirically

Questions