

# 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?
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# 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.
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# 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



Cost of Cooking



Cost of clean up

Good equipment (knives, stoves)  
Skilled labor  
Learning by doing (volume)  
Specialization (skills and foods)  
Proper preparation  
Understanding client flow

These issues transfer to medicine

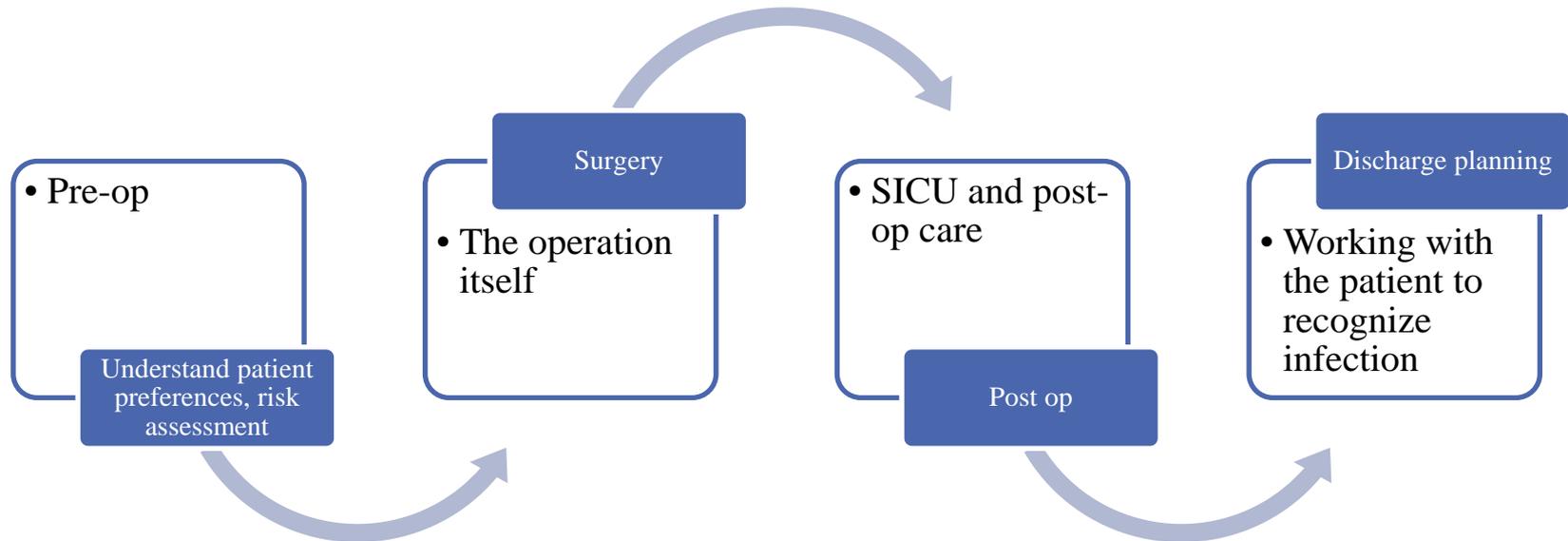
What is unique to health care is risk and uncertainty.

Arrow, Kenneth J. "Uncertainty and the welfare economics of medical care." *The American Economic Review* (1963): 941-973.

# 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
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# The Cost of Producing Health Care



## ■ 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.

# 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

Client Contact Form					
Your Name: _____		Today's Date: _____		Time: _____	
Client's Name: _____			ID#: _____		
Type of Contact:	<input type="checkbox"/> Phone	Contact to (CHA, client, other): _____			
	<input type="checkbox"/> In person	Contact from (CHA, client, other): _____			
Where: _____					
<b>Total Time with Client:</b>		<b>Travel Time:</b>		<b>Expenses:</b>	
Hours	Minutes	Hours	Minutes	Mileage	Parking
				<input type="checkbox"/> County vehicle	
				<input type="checkbox"/> Own vehicle	
Reason for call/visit			Outcome		
<input type="checkbox"/> Administer pre-survey			<input type="checkbox"/> Next appt date: _____		
<input type="checkbox"/> Administer survey			Date to give reminder call: _____		
<input type="checkbox"/> Provide information			Date to check if appointment kept: _____		
<input type="checkbox"/> Check to see if she scheduled appointment			Appointment kept?		
<input type="checkbox"/> Schedule an appointment for her			<input type="checkbox"/> Yes <input type="checkbox"/> Cancelled		
<input type="checkbox"/> Remind her of appointment			<input type="checkbox"/> No, why?		
<input type="checkbox"/> Check if she kept appointment			Resched - New appt date/time _____		
<input type="checkbox"/> Other: _____					
Consultation/Intervention			Referrals		
<input type="checkbox"/> A. Consumer skills (blue/green/pink/yellow)			<input type="checkbox"/> B. Transportation		
<input type="checkbox"/> D. Calendar			<input type="checkbox"/> AC Transit Voucher		
Coping:			<input type="checkbox"/> C. Child care		
<input type="checkbox"/> E. Distancing			<input type="checkbox"/> I. Mental Health		
<input type="checkbox"/> F. Seeking Social Support			<input type="checkbox"/> J. Alcohol abuse		
<input type="checkbox"/> G. Escape Avoidance			<input type="checkbox"/> K. Substance abuse		
<input type="checkbox"/> H. Playful Problem Solving			<input type="checkbox"/> L. Domestic violence		
<input type="checkbox"/> Education about abnormal Paps			<input type="checkbox"/> M. Sexual abuse		
<input type="checkbox"/> Other (specify): _____			<input type="checkbox"/> V. HIV/AIDS		
Attempts to contact:					
1	<input type="checkbox"/>	Date and time of day:	10	<input type="checkbox"/>	Date and time of day:
2	<input type="checkbox"/>	Date and time of day:	11	<input type="checkbox"/>	Date and time of day:
3	<input type="checkbox"/>	Date and time of day:	12	<input type="checkbox"/>	Date and time of day:
4	<input type="checkbox"/>	Date and time of day:	13	<input type="checkbox"/>	Date and time of day:
5	<input type="checkbox"/>	Date and time of day:	14	<input type="checkbox"/>	Date and time of day:
6	<input type="checkbox"/>	Date and time of day:	15	<input type="checkbox"/>	Date and time of day:
7	<input type="checkbox"/>	Date and time of day:	16	<input type="checkbox"/>	Date and time of day:
8	<input type="checkbox"/>	Date and time of day:	17	<input type="checkbox"/>	Date and time of day:
9	<input type="checkbox"/>	Date and time of day:	18	<input type="checkbox"/>	Date and time of day:

# Precision and Accuracy

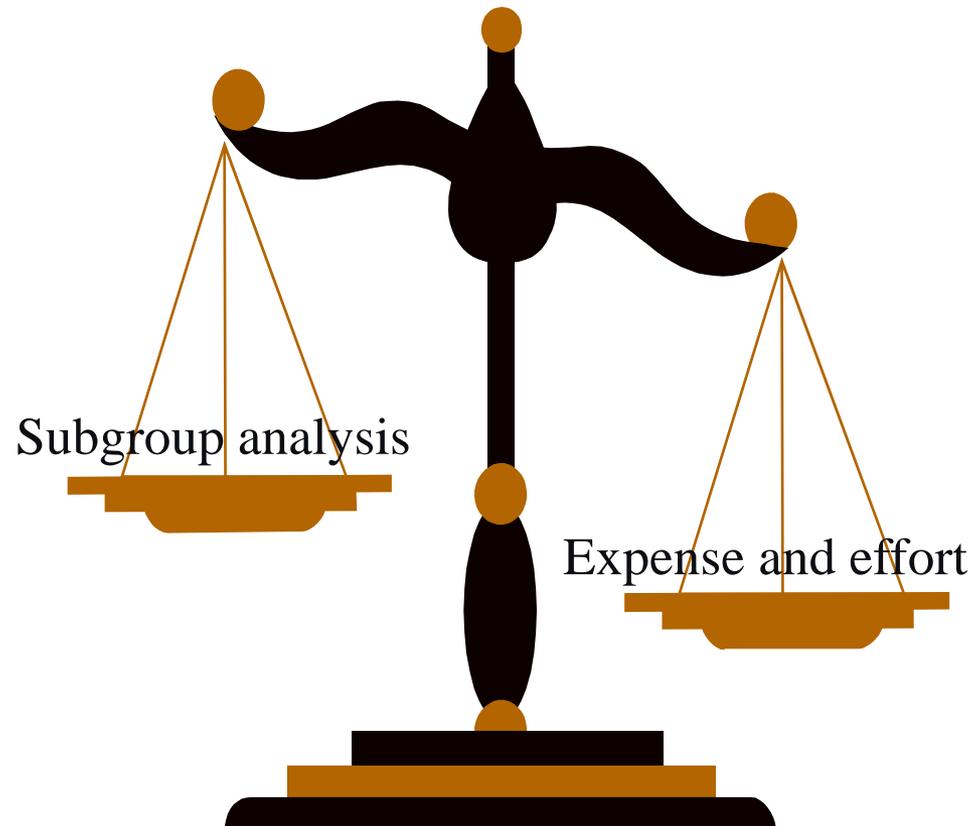
- The center of the target represents perfect accuracy
- A and B are equally accurate
- A is more precise than B



# 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
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# 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
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# 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

# Regression

	Linear Regression
Number of phone calls	10.53 [2.32]**
Female	-4.14 [22.47]
Site 1	-2.92 [14.73]
Age	0.87 [0.86]
<i>other covariates omitted for brevity</i>	
Observations	667

Robust standard errors in brackets

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

Duan, N. (1983) Smearing estimate: a nonparametric retransformation method, *Journal of the American Statistical Association*, 78, 605-610.  
Manning WG, Mullahy J. Estimating log models: to transform or not to transform? *J Health Econ* 2001 Jul;20(4):461-94.  
Basu A, Manning WG, Mullahy J. Comparing alternative models: log vs Cox proportional hazard? *Health Economics* 2004 Aug;13(8):749-65.

# Important Assumptions: Scale Economies

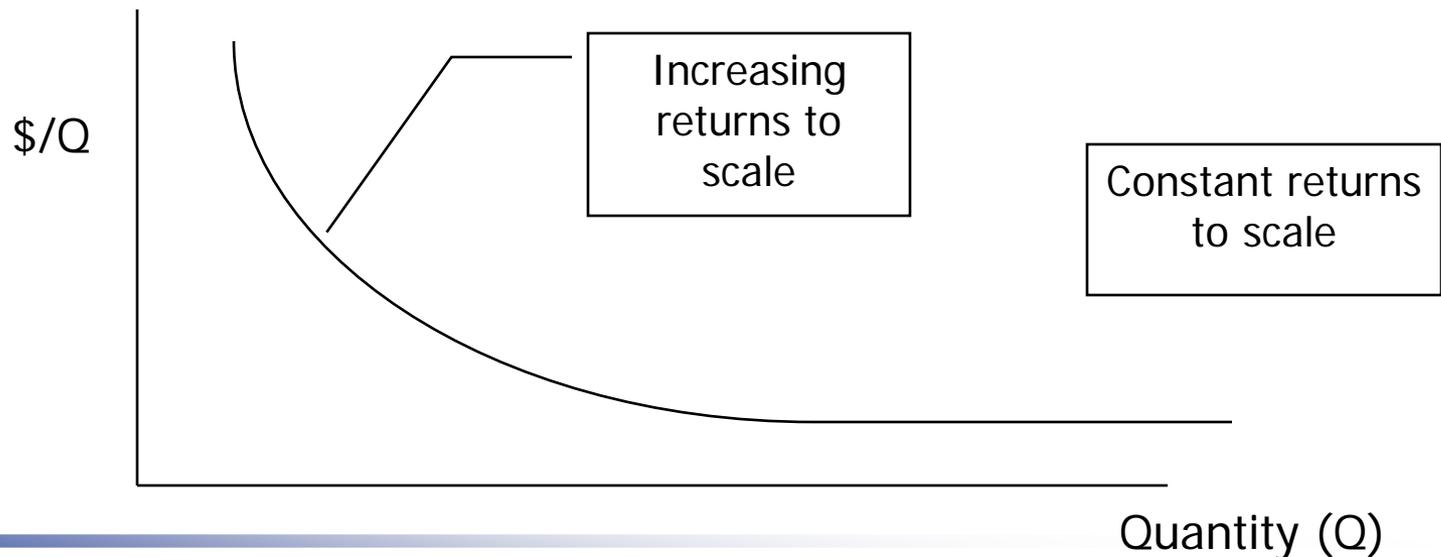
- We created a health guide for a RCT
- We paid \$14 per guide for 1000 guides
- If we ordered more, the cost per guide would decrease, eventually reaching \$3
- Which cost estimate should you use for the CEA?

# 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.



# 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

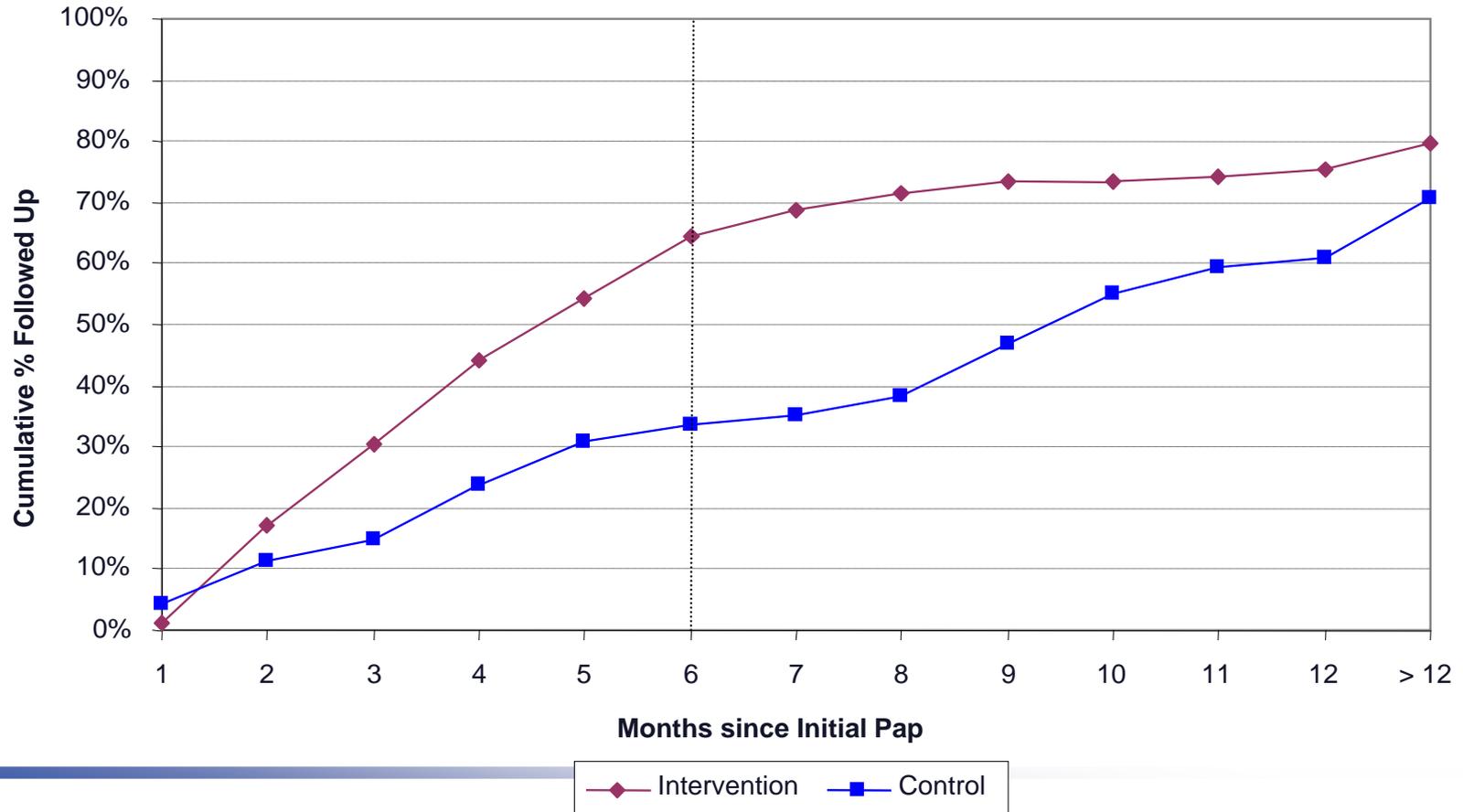
- Method 1: Sum all the intervention costs and divide by number of participants (easy)
- Method 2: Estimate the cost of the intervention for each patient (hard)
- If you want to ask, “was the intervention more cost-effective for subgroups?”, then you need to use method 2?

# Unit Costs (2002 dollars)

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

# Effectiveness

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



# Cost per follow-up

	Cost	Incremental cost	Probability of follow-up	Incremental follow-up	Incremental cost per follow-up
<b>Overall</b>					
Control	\$77		0.32		
Intervention	\$355	\$278	0.61	0.29	\$959
Bootstrapped 95% CI					(787-1367)
<b>By severity</b>					
ASCUS/AGUS	\$75		0.32		
	\$347	\$272	0.57	0.25	\$1,090
LGSIL	\$74		0.30		(813-1658)
	\$374	\$300	0.64	0.34	\$882
HGSIL	\$105		0.43		(579-4584)
	\$405	\$300	0.87	0.44	\$681
					(486-1989)

# 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](http://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

	Robot (n=49)		ICT (n=50)		UC (n=28)	
	Average	SD	Average	SD	Average	SD
<b>Intervention costs</b>						
Per session	\$140		\$218			
Robot cost per session	\$20	--	--	--	--	--
Therapist cost per session	\$120	--	\$218	--	--	--
Average number of completed sessions	32.8	8.2	32.1	8.0	0	0
Travel costs	\$561	\$596	\$389	\$372	0	0
Average intervention cost	\$5,152	\$1,421	\$7,382	\$1,845	0	0

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

ICT is intensive comparison therapy

# Resources

- HERC resources
  - [www.research.herc.va.gov/include/page.asp?id=micro](http://www.research.herc.va.gov/include/page.asp?id=micro)
  
- Converting travel distance into money.
  - Phibbs CS, Luft HS. Correlation of travel time on roads versus straight line distance. Med Care Res Rev. 1995;52(4):532-542.
  - 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)
  - US Bureau of Labor Statistics <http://www.bls.gov/news.release/elcare.toc.htm>
  - Russell LB. Completing costs: patients' time. Med Care. Jul 2009;47(7 Suppl 1):S89-93.

# Resources

- 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
    - Barnett PG, Berger M. Indirect Costs of Specialized VA Mental Health Treatment. Technical Report 6. Menlo Park: Health Economics Resource Center; 2003.
    - Barnett P, Berger M. Cost of Positron Emission Tomography: Method for Determining Indirect Cost. Technical Report 5. Menlo Park: Health Economics Resource Center; 2003.

# Questions