

# 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 run a telephone case monitoring program for people in substance use recovery?
3. What is the cost and benefit of offering telehealth to non-acute patients when EMS responds to a call?

# 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

# Outline

1. Introduction
  - Perspective
2. Micro-costing methods
  - Direct Measurement
  - Cost Regression
3. Examples

# 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?

# Telehealth in Pre-Hospital Care

- Approximately 40% of EMS incidents in Houston are for non-urgent conditions
- Immediate, remote access to board-certified emergency medicine physicians for patients with non-acute conditions may reduce costs to the system
- What is the cost of providing telehealth to eligible patients?

# The answer

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



# Perspective

- Researchers may need to select and vary methods depending on the perspective of their analysis
- Perspective
  - Societal
  - Payer
  - Provider
  - Patient



# Perspective

TABLE 1 Cost Elements under Alternative Perspectives

<i>Cost Element</i>	<i>Societal</i>	<i>Veterans Affairs</i>	<i>Patient and Patient's Family</i>
Medical care (total cost)	All costs	All covered costs	Out-of-pocket payments
Patient time for treatment	All costs	None	Patient's opportunity cost
Paid caregiving	All costs	All covered costs	Out-of-pocket payments
Unpaid caregiving	All costs	None	Opportunity cost of caregiver time
Transportation and nonmedical services	All costs	All covered costs (if any)	All costs
Sick/disability leave, transfer payments	Administrative costs only	Amount paid + administrative costs	Amount received (negative cost)

Source: Adapted from Luce et al. (1996), Table 6.1.

Source: Smith MW, Barnett PG. Direct measurement of health care costs. Med Care Res Rev. 2003 Sep;60(3 Suppl):74S-91S.

# POLL

- In your work, which perspective(s) are you typically interested in?
  - Societal
  - Payer
  - Provider
  - Patient

# Micro-costing

- This term refers to a set of methods that researchers use to estimate costs
  - “direct enumeration and costing out of every input consumed in the treatment of a particular patient” (Gold et al, 1996)
- Methods are needed because costs\* are not readily observable

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\*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 data to identify the cost of the intervention
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# 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

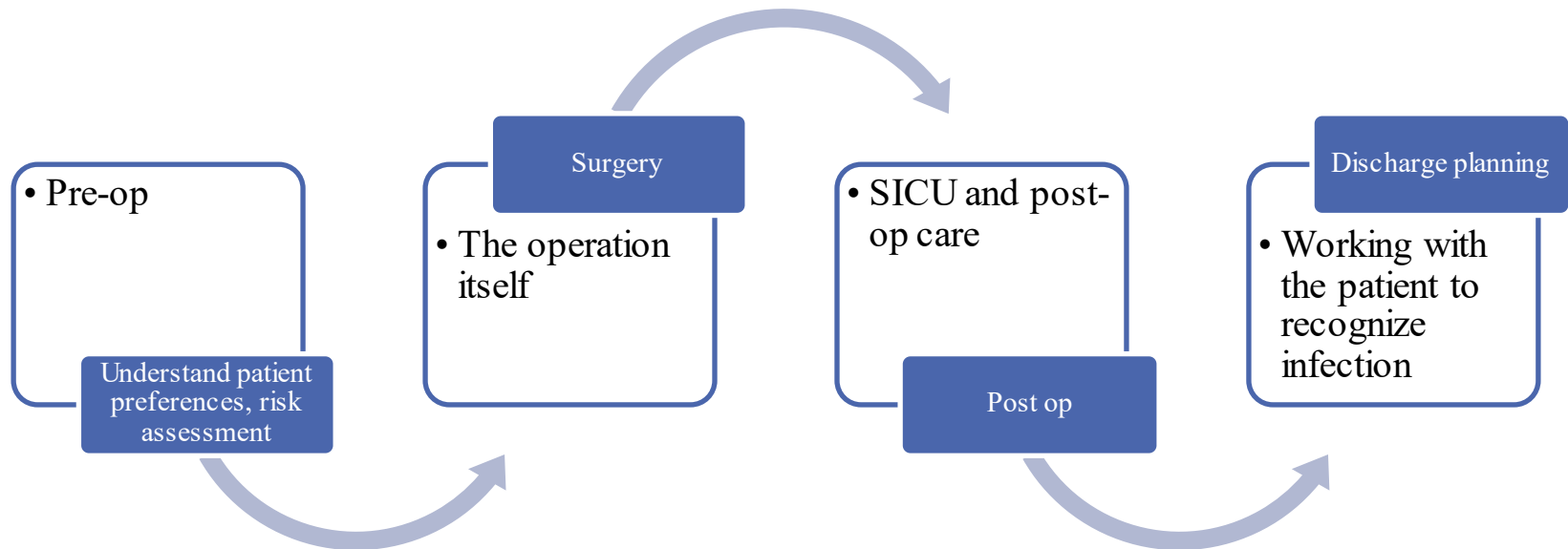
What is unique to health care is risk and uncertainty.

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!

# The Cost of Producing Health Care



## ■ Cost types

- Personnel
- Space
- Supplies
- Training
- Contracts

## ■ Time horizon

- Fixed
- Variable

# 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 and Accuracy

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



# 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:  Phone **Contact to** (CHA, client, other): \_\_\_\_\_  
 In person **Contact from** (CHA, client, other): \_\_\_\_\_  
 Where: \_\_\_\_\_

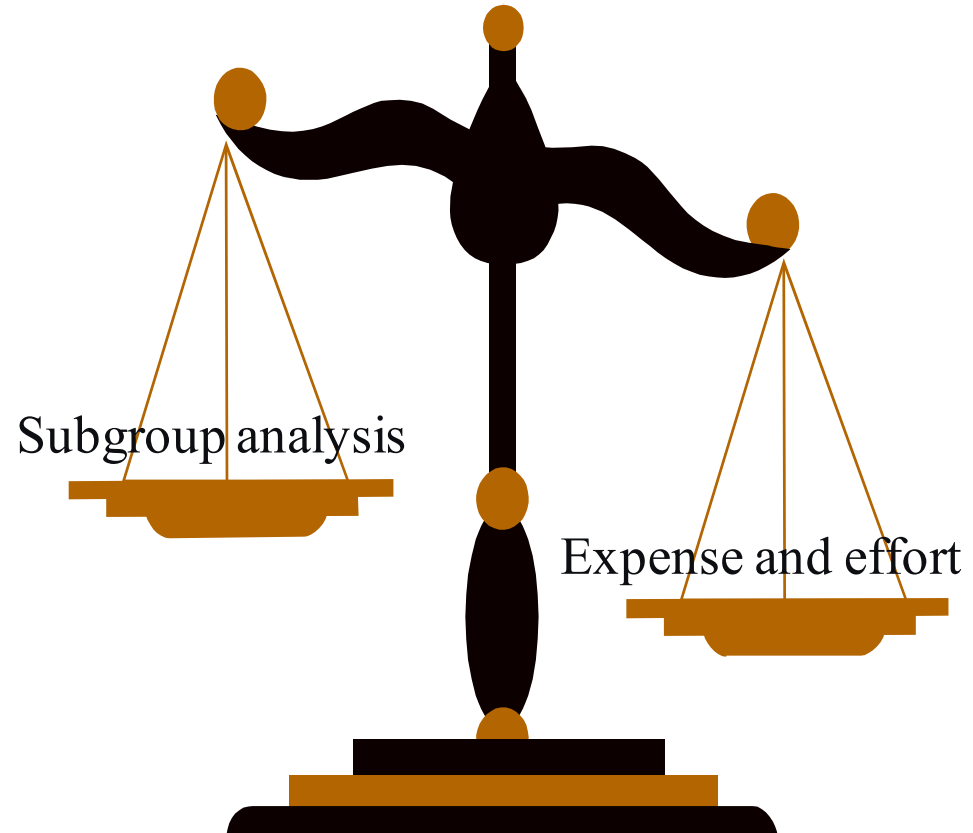
Total Time with Client:		Travel Time:		Expenses:		<input type="checkbox"/> County vehicle <input type="checkbox"/> Own vehicle
Hours	Minutes	Hours	Minutes	Mileage	Parking	

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 <span style="margin-left: 100px;"><input type="checkbox"/> Cancelled</span>
<input type="checkbox"/> Remind her of appointment	<input type="checkbox"/> No, why? Resched - New appt date/time _____
<input type="checkbox"/> Check if she kept appointment	
<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. Planful 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: _____

# The Precision Payoff



Example at end of lecture  
About subgroup analysis



# 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

# 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

- Researchers 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)
- 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

Each additional call cost an average of \$10.53



Robust standard errors in brackets

# 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

# Ex: Cost of Hospital Adverse Patient Safety Events

- Dependent variable: Total cost of hospital stay
- Key independent variable: Indicator whether an adverse event occurred
- Analyses: Generalized linear models for each of 9 patient safety indicators
- Results:
  - Excess costs excess costs range from \$9448 per hospitalization for accidental puncture or laceration to \$42309 for infection due to medical care
  - \$165.5 million dollars (FY07) in excess cost to the VA

# 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

<https://www.herc.research.va.gov/include/page.asp?id=seminars-archived>

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.

# Example 1: 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

- Researchers 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

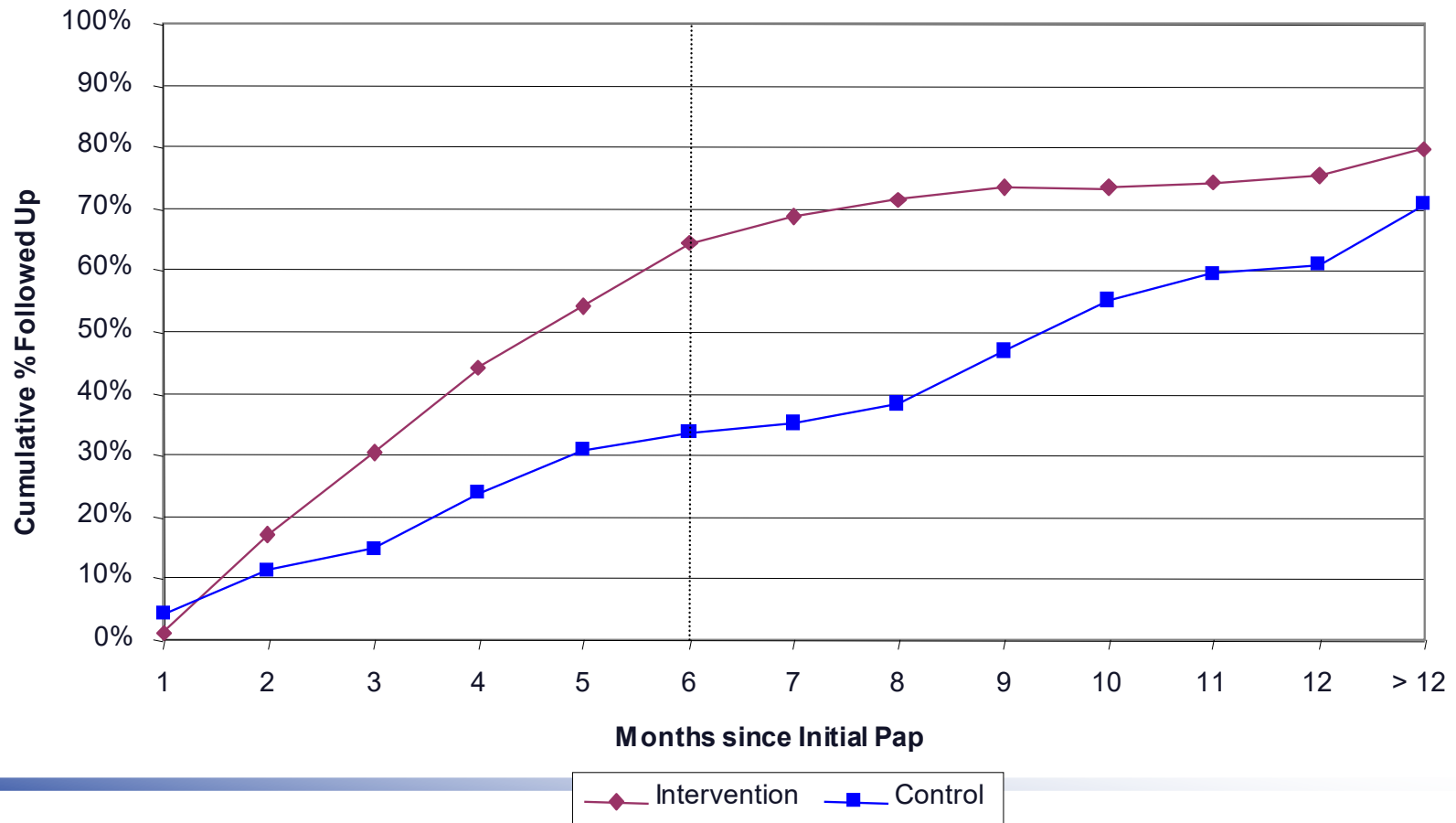
**Table 2. Comparison of Average Payer and Societal Costs per Woman (U.S. Dollars in 2005) in Intervention Group (Community Health Advisors Plus Usual Care) and in Control Group (Usual Care), Alameda County, California, 2000–2002<sup>a</sup>**

<b>Cost</b>	<b>Intervention Group Mean (SD) (n = 178)</b>	<b>Usual Care Mean (SD) (n = 170)</b>
Payer costs		
Outreach worker costs	155 (115)	0 (0)
Travel costs at .365 per mile	4 (7)	0 (0)
Office space and supplies	31 (0)	0 (0)
Outreach worker quality assurance	21 (0)	0 (0)
Usual care	1 (1)	1 (1)
Follow-up visit	123 (99)	65 (95)
Patient travel costs for follow-up visit	20 (21)	11 (20)
Total average unit cost from societal perspective <sup>b</sup>	355 (182)	77 (111)
Total average unit cost from payer perspective <sup>c</sup>	335 (169)	67 (95)

Source: Wagner, T. H., Engelstad, L. P., Mcphee, S. J. & Pasick, R. J. (2007) The costs of an outreach intervention for low-income women with abnormal Pap smears, *Prev Chronic Dis*, 4, A11.

# 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: Telehealth in pre-hospital care

- Objective: cost–benefit analysis (CBA) comparing costs with potential savings associated with patients treated through a telehealth-enabled intervention
- Intervention:
  - EMS personnel assesses patient and determines if they need acute or primary care
  - If patient needs are non-urgent and patient meets inclusion criteria, EMS personnel can initiate telehealth intervention
  - EMS personnel uses a tablet connect the patient to an emergency physician
  - Dispositions: transport to ED via ambulance, appointment with primary care clinic with prepaid taxi ride, or ED referral with prepaid taxi



# Example 2: Telehealth in pre-hospital care

- Analysis: Cost-benefit
  - Perspective: Societal
- Micro costs:
  - EMS personnel time: time from patient call to end of care for patient x average hourly personnel cost per minute x # personnel on the scene
  - EMS physician time: same method
  - Transportation costs: fuel, taxi transportation

# Example 2: Telehealth in pre-hospital care

Table 2. Average unit cost by resource type.

	Telehealth EMS mean (SD)	Control mean (SD)
Paramedic/EMT salaries and benefits	82 (30.1)	209 (72.4)
EMS physician salaries and benefits	19 (4.3)	2 (.5)
Vehicle (ambulance) costs	27 (2.0)	59 (4.8)
Telemedicine technology	17 (1.3)	–
Alternative transportation (taxi)	12 (4.4)	–
Programme administration and other	10 (.6)	–
Average unit cost per patient	167 (42.7)	270 (77.7)

- Average \$103 cost reduction per patient, which translated to \$570,913 savings to the agency in the first year of operation.
- Adding reduction in ED visits, \$928,113 community savings.

# 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.
  - The 2021 rate is \$0.56/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