Estimating the Cost of an Intervention

Clara E. "Libby" Dismuke-Greer, PhD

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HEALTH SERVICES RESEARCH & DEVELOPMENT

Focusing Question

What is the cost of a new health care intervention?

Examples:

1. What is the cost of administering a COVID-19 vaccine to a country?
2. What is the cost of a COVID-19 related hospitalization from two different health system perspectives?

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. Examples

COVID-19 Vaccine

- COVID-19 vaccination has been shown to reduce hospitalization and deaths in the world-wide population.
- What is the cost of administering the COVID-19 vaccination in a country?

COVID Hospitalizations

- What are the costs of COVID-19 hospitalizations in two different health systems?

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 always 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 data to identify the cost of the intervention

Selecting a Method

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

Direct Measurement

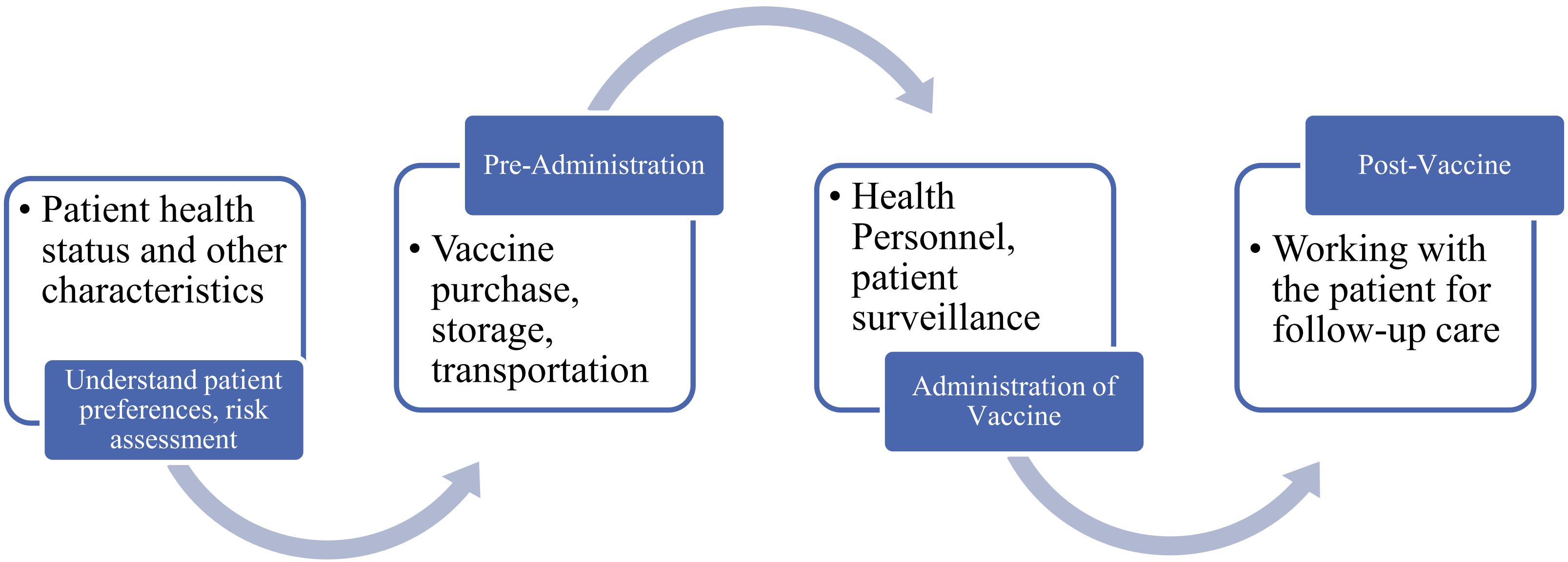
- Four steps
  1. Specify the production processes
  2. Enumerate the inputs for each process
  3. Identify price for the inputs
  4. Sum (quantity*price) across all inputs

- Level of precision is critical.

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

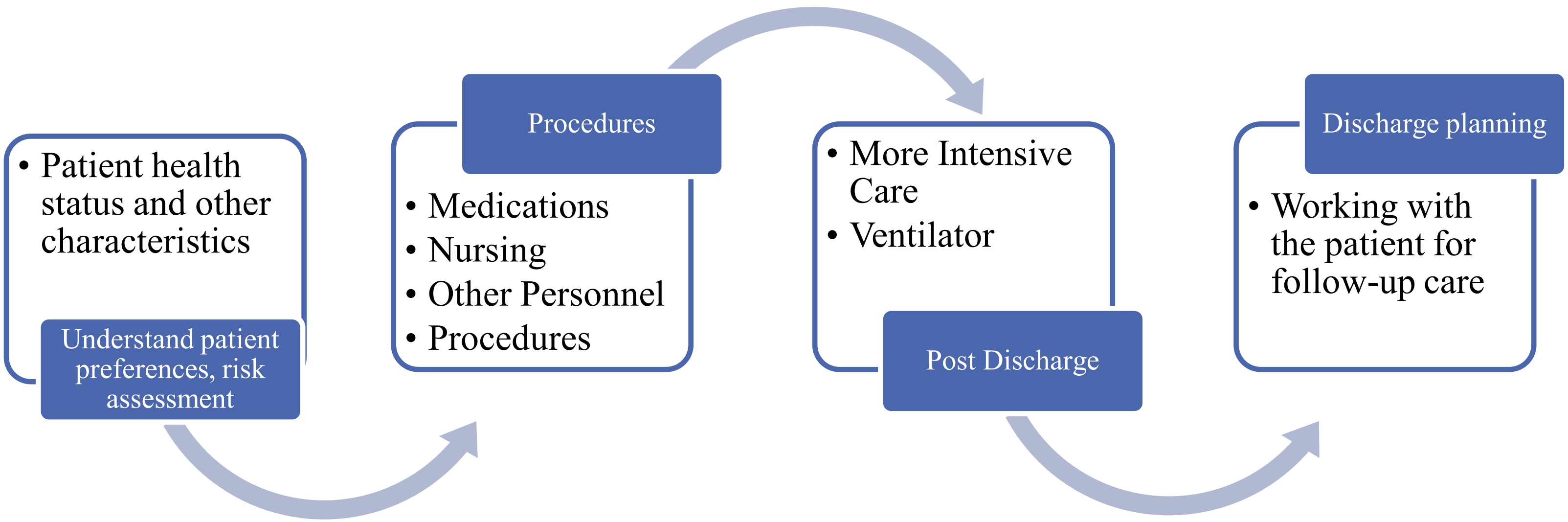
The Cost of COVID-19 Vaccination



- Cost types
  - Personnel
  - space
  - supplies
  - Training
  - contracts
- Time horizon
  - Fixed
  - Variable

Economists and accountants define differently

The Cost of Producing Hospitalization-



- Cost types
  - Personnel
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Precision

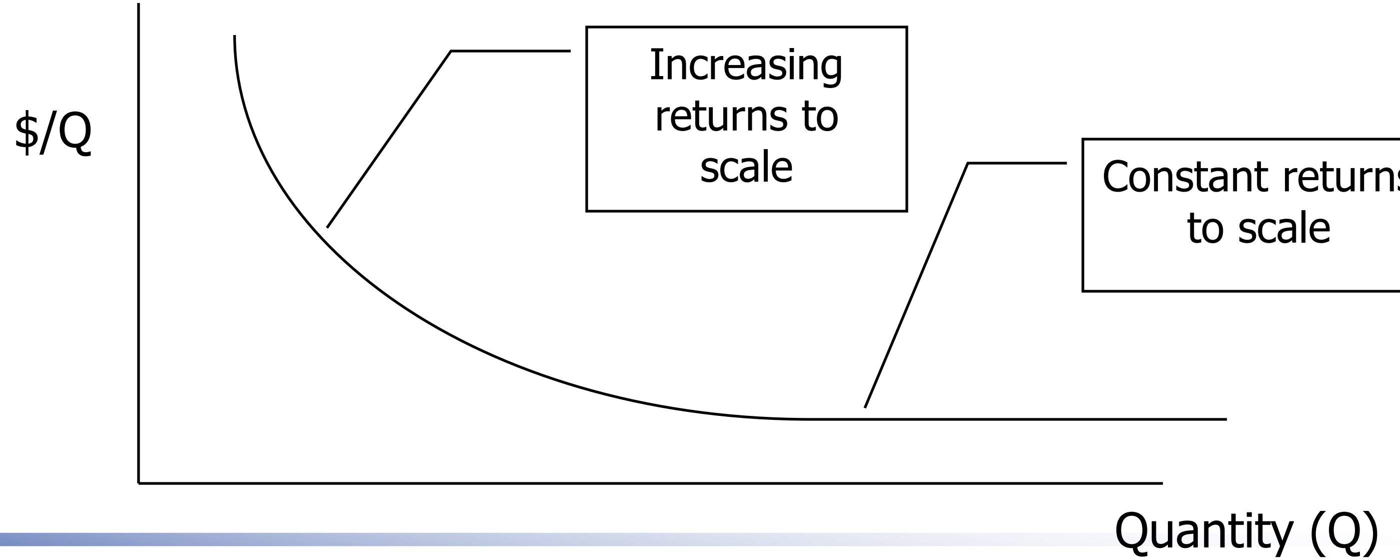
- Activity Based Costing
- Tracking activities of personnel involved in the intervention
- Tracking time spent in the activities
- Assigning costs based on salary and benefits paid to the personnel based on time and activities
- Can be very time consuming and burdensome on personnel to collect this type of information.

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

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.



Vaccines

- Costs of administering vaccines will decrease as more administered due to distribution of fixed costs over increasing numbers of vaccines.

Quality

- In this example, we make an assumption about efficient production
- Quality is also unobserved
- Changing assumptions about costs could affect quality (and outcomes).

Incremental Cost-Effectiveness Ratio (ICER)

- ICER represents the average incremental cost associated with 1 additional unit of the measure of effect.
- The ICER can be estimated as:
- ICER = (CA – CB) / (EA – AB)

ICER

- Where ICER is the incremental cost-effectiveness ratio ($/effect)
- CA is the cost of intervention A ($)
- CA is the cost of intervention B ($)
- EA is the effectiveness of intervention A
- EB is the effectiveness of intervention B

Example

- Water Project Plan A costs $50,000
- Water Project Plan B costs $30,000
- Plan A increases life expectancy by 3 years
- Plan B increases life expectancy by 1 year

Results

- ICER = ($50,000 – $30,000) / (3 – 1)
  ICER = $10,000 / year of life expectancy
- Source with calculator:
- https://calculator.academy/icer-incremental-cost-effectiveness-ratio-calculator/

Example: Estimating Costs by Direct Measurement: COVID-19 Vaccines:

Pearson CAB, Bozzani F, Procter SR, Davies NG, Huda M, Jensen HT, Keogh-Brown M, Khalid M, Sweeney S, Torres-Rueda S; CHiL COVID-19 Working Group; CMMID COVID-19 Working Group, Eggo RM, Vassall A, Jit M. COVID-19 vaccination in Sindh Province, Pakistan: A modelling study of health impact and cost-effectiveness. PLoS Med. 2021 Oct 4;18(10):e1003815. doi: 10.1371/journal.pmed.1003815. PMID: 34606520; PMCID: PMC8523052

Objective and Methods

- The authors modelled the impact of COVID-19 vaccination on cases, deaths, and disability-adjusted life years (DALYs) compared to counterfactual scenarios with no vaccination over a 10-year time horizon.

Methods

- For different vaccination scenarios, the averted DALYs were combined with the costs of the vaccination program and any reduction in COVID-19 case management costs from vaccination to calculate incremental cost-effectiveness ratios (ICERs).

Methods

- Their analysis followed the Consolidated Health Economic Evaluation Reporting Standards (CHEERS)

Micro-Costing

- Vaccine procurement price per dose $3 with sensitivity analysis of $6 and $10
- Wastage 15% of vaccine procurement price per dose,
- 10% of immunization supplies procurement price per dose

Microcosting

- Freight 10% of vaccine procurement price per dose
- Syringes and safety boxes 0.04
- Cold chain costs per dose (national level) $0.133
- Cold chain costs per dose (service level) $0.029

Microcosting

- Human resources per dose $0.38
- Transport per dose Transport to facility: $0.04
- Transport from facility to vaccination site: $0.001
- Social mobilization per dose $0.16

Micro-Costing

- Health system markup 31% of cost per dose excluding procurement price per dose, immunization supplies, wastage, and freight
- Perspective: Health system & Society
- Discount rate 3% costs, 3% DALYs for health system and 3% costs, 0% DALYS for society.

Conclusions

The authors project that 1 year of vaccine distribution, at delivery rates consistent with COVAX projections, using a vaccine at $3/dose with 70% efficacy and 2.5-year protection is likely to avert around 0.9 million cases, 10.1 thousand deaths, and 70.1 thousand DALYs with an ICER of $27.9 per DALY averted from the health system perspective.

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.

No.	Description	Impact compared to no vaccination				
		Cases Averted (millions)	Deaths Averted (thousands)	Difference in Cost ($ millions)	DALYs Averted (thousands)	Cost per DALY Averted ($)
Base case						
1	Vaccine base case	0.9 (0.8, 0.9)	10.1 (10.1, 10.3)	2.0 (0.1, 2.9)	70.1 (69.9, 70.6)	27.9 (1.7, 40.9)
Economic assumptions						
2	DALYs discounted at 0%	0.9 (0.8, 0.9)	10.1 (10.1, 10.3)	2.0 (0.1, 2.9)	97.0 (96.8, 97.3)	20.1 (1.3, 29.5)
3	DALYs based on higher comorbidities				54.9 (54.8, 55.4)	35.5 (2.2, 52.2)
4	Societal perspective			−20.2 (−22.5, −19.1)	70.1 (69.9, 70.6)	cs (cs, cs)
5	$6 price per dose			54.7 (52.8, 55.6)		780.5 (749.0, 793.0)
6	$10 price per dose			124.8 (123.0, 125.8)		1,781.9 (1,744.2, 1,795.7)
Vaccine and immunity assumptions						
7	Target 15+ from outset	1.0 (0.9, 1.0)	6.4 (6.4, 6.5)	2.7 (−1.1, 4.3)	55.9 (55.1, 57.9)	48.4 (cs, 78.0)
8	5-year campaign	6.0 (6.0, 6.0)	40.7 (40.2, 41.3)	85.6 (84.5, 87.3)	344.8 (341.8, 347.7)	248.1 (243.6, 255.1)
9	10-year campaign	10.9 (10.9, 11.0)	67.0 (66.2, 67.9)	270.3 (267.9, 271.8)	560.7 (556.9, 565.5)	482.1 (473.8, 488.1)
10	Slow rollout: 4K courses per day (no scale-up) for 10 years	0.7 (0.6, 0.7)	32.5 (31.7, 33.5)	38.2 (35.8, 40.1)	154.0 (150.3, 158.5)	247.9 (225.9, 267.1)
11	Fast rollout: 184K courses per day (no scale-up) for 6 months	3.2 (3.0, 3.3)	20.1 (20.0, 20.2)	102.8 (97.2, 112.4)	181.8 (178.4, 183.2)	565.6 (530.9, 629.5)
12	1-year vaccine and natural immunity waning	0.9 (0.9, 0.9)	11.9 (11.7, 12.2)	−5.1 (−6.1, −4.7)	81.9 (81.0, 83.8)	cs (cs, cs)
13	5-year vaccine and 2.5-year natural immunity waning	1.6 (1.6, 1.7)	18.4 (18.2, 18.8)	−53.8 (−54.5, −53.4)	126.8 (125.8, 127.9)	cs (cs, cs)
14	1-dose regimen (twice rate of people vaccinated)	1.7 (1.6, 1.7)	12.9 (12.9, 13.1)	−48.1 (−53.0, −46.7)	105.8 (104.8, 108.0)	cs (cs, cs)
15	30% vaccine efficacy	0.4 (0.4, 0.4)	5.0 (5.0, 5.1)	36.4 (35.8, 36.9)	33.8 (33.7, 33.9)	1,080.7 (1,056.8, 1,091.2)
16	90% vaccine efficacy	1.1 (1.0, 1.1)	12.2 (12.1, 12.4)	−13.4 (−15.8, −12.3)	85.5 (85.3, 86.2)	cs (cs, cs)
17	Vaccine protects against disease-only	0.6 (0.6, 0.6)	9.1 (8.9, 9.3)	14.2 (13.9, 14.4)	60.1 (59.5, 61.1)	236.8 (227.3, 242.3)
18	Vaccine protection is leaky	0.6 (0.6, 0.7)	8.2 (8.2, 8.3)	18.0 (15.8, 19.3)	55.0 (54.6, 56.0)	327.4 (281.4, 353.4)

The base case vaccination scenario assumes the following: a 1-year campaign using a 2-dose vaccine regimen with 70% efficacy at a price of $3 per dose; 2.5-year duration of natural and vaccine induced immunity; and costing from a healthcare perspective.

Example: Estimating Costs Using Administrative Data in VA and DoD

Operations Data for DoD and VA

- We used operations databases from DaVINCI for inpatient MTF (SIDR).
- We used operations databases from VA containing hospital costs (hdisch20)
- We identified hospitalizations with a primary diagnosis of U071-COVID-19 which was approved for use by CDC in FY2020 DoD and VA databases.
- We tried to match cost between DoD and VA as closely as possible.
- We used totcost from hdisch20 from VINCI.

Operations Data for DOD and VA

- We created a DoD MTF total cost variable for the hospitalization from SIDR, total cost=FCANCLAB+FCANCRAD+FCCLNSAL+FCICU+FCOTHANC+FCOTHSAL+FCSUPPRT+FCSURG.
- We also obtained common variables for diagnosis related group (MSDRG) fiscal month, age and sex,and length of stay common in both DoD and VA databases.
- We also created a variable for both DoD and VA databases, cost per day per hospitalization =total cost of hospitalization/length of stay of hospitalization

Analyses in Merged databases

- After conducting the analyses in the separate DoD and VA databases, we merged the data based on creating the same variable names for the common variables in both databases.
- We then estimated models for total cost, length of stay and cost per day.
- We adjusted for being a DoD hospitalization relative to VA in all models to test for differences in costs and length of stay.

Primary ICD U071 FY2020 MTF and VA Hospitalizations

FY 2020 ICD10 U071- COVID-19 as Primary Diagnosis	DOD N=773	VA N=7,818
Total Cost of the Hospitalization	Mean=$28,396 Median=$13,640	Mean=$61,268 Median=$31,587
Length of Stay	Mean=6.53 Median=4	Mean=12.99 Median=7
Cost Per Day	Mean=$4,633 Median=$4,276	Mean=$5,155 Median=$4,474
DRG 177	N=536	N=5,877
Total Cost of the Hospitalization	Mean=$21,846 Median=$13,688	Mean=$61,858 Median=$32,850
Length of Stay	Mean=5.87 Median=4	Mean=13.36 Median=7
Cost Per Day	Mean=$4,523 Median=$4,219	Mean=$5,150 Median=$4,523

Combined DOD and VA Total Cost and LOS Models

Total Cost	Total Cohort N=8,951	DRG 177 N=6,143
Age>=50	$240	$807*
Female relative to Male	-$267	$73
Length of Stay	$5,078*	$5,082*
DRG 177 relative to other DRGs	-$157	N/A
DOD	$329	$736*
Length of Stay		
Age>=50	4.53*	4.22*
Female relative to Male	-1.75*	-1.70*
DRG 177 relative to other DRGs	0.80	N/A
DOD	-2.83*	-3.70*
* P<0.05		
Note: Both Models Adjusted for Fiscal Month		

Combined DOD and VA Databases GLM Cost Per Day

Cost Per Day	Total Cohort N=8,951	DRG 177 N=6,413
Age>=50	-$11	$172
Female relative to Male	-$10	-$1
DRG 177 relative to other DRGs	-$64	N/A
DOD	-$520*	-$572*
*P<0.05		
Note: Both Models Adjusted for Fiscal Month		

Resources

- HERC resources
  - 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