Cost Analyses for Public Health Interventions

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Hang in there...we're checking all the vital signs...
Association of Changes in Local Health Department Resources with Changes in State-Level Health Outcomes

Purpose

• Investigation of association between LHD inputs & health outcomes
  • State-level analyses

• Underlying theory (conceptual or logic model)
  • Increase inputs → increased public health activities → improved community health

• Measures of community health (how do you ascertain effectiveness?)
  • Amenable to public health interventions
    • E.g., physical activity → cardiovascular health
    • E.g., immunizations → preventable diseases
Methods

• National data sets
  • National Associate of County and City Health Officials (NACCHO)
    • LHD expenditures, staffing, population data
    • Expenditures adjusted to 2005 dollars
    • Field surveys from 1997 & 2005
  • America’s Health Rankings (United Health Foundation)
    • State-level health measures
      • Smoking & obesity prevalence
      • Infectious disease morbidity (AIDs, TB, hepatitis A & B)
      • Infant mortality
      • CVD mortality
      • Cancer
      • Years of potential life lost (YPLL)

• 1997 → 2005 data
  • Changes in LHD expenditures per capita = predictors (independent variables)
  • Changes in 7 health measures = outcomes (dependent variables)
LHD expenditures & FTEs per capita declined slightly
<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
<th>Minimum^a</th>
<th>Maximum^b</th>
<th>IQR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportional change (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking prevalence</td>
<td>-14.58</td>
<td>-14.31</td>
<td>7.83</td>
<td>-29.41</td>
<td>4.87</td>
<td>11.95</td>
</tr>
<tr>
<td>Obesity prevalence</td>
<td>57.65</td>
<td>54.53</td>
<td>16.55</td>
<td>29.24</td>
<td>108.06</td>
<td>15.71</td>
</tr>
<tr>
<td>Infectious diseases</td>
<td>-58.76</td>
<td>-57.68</td>
<td>17.47</td>
<td>-96.41</td>
<td>-29.23</td>
<td>25.05</td>
</tr>
<tr>
<td>Infant mortality</td>
<td>-9.05</td>
<td>-10.13</td>
<td>10.87</td>
<td>-34.21</td>
<td>20.00</td>
<td>13.17</td>
</tr>
<tr>
<td>Cardiovascular disease deaths</td>
<td>-17.72</td>
<td>-18.16</td>
<td>4.49</td>
<td>-28.25</td>
<td>-4.66</td>
<td>5.36</td>
</tr>
<tr>
<td>Cancer deaths</td>
<td>-7.06</td>
<td>-7.17</td>
<td>13.26</td>
<td>-13.26</td>
<td>2.22</td>
<td>5.45</td>
</tr>
<tr>
<td>Years of potential life lost</td>
<td>-5.08</td>
<td>-4.86</td>
<td>8.29</td>
<td>-28.34</td>
<td>14.02</td>
<td>11.59</td>
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<tr>
<td>Absolute change</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking prevalence</td>
<td>-3.41</td>
<td>-3.25</td>
<td>1.90</td>
<td>-7.70</td>
<td>1.20</td>
<td>2.20</td>
</tr>
<tr>
<td>Obesity prevalence</td>
<td>9.50</td>
<td>9.45</td>
<td>2.11</td>
<td>6.00</td>
<td>14.30</td>
<td>2.50</td>
</tr>
<tr>
<td>Infectious diseases</td>
<td>-24.96</td>
<td>-21.02</td>
<td>16.60</td>
<td>-67.05</td>
<td>-4.79</td>
<td>26.30</td>
</tr>
<tr>
<td>Infant mortality</td>
<td>-0.68</td>
<td>-0.80</td>
<td>0.83</td>
<td>-2.60</td>
<td>1.50</td>
<td>1.00</td>
</tr>
<tr>
<td>Cardiovascular disease deaths</td>
<td>-62.83</td>
<td>-62.30</td>
<td>14.59</td>
<td>-100.70</td>
<td>-17.90</td>
<td>12.80</td>
</tr>
<tr>
<td>Years of potential life lost</td>
<td>-385.80</td>
<td>-370.95</td>
<td>684.85</td>
<td>-2462.70</td>
<td>1160.40</td>
<td>806.70</td>
</tr>
</tbody>
</table>

Note: IQR = interquartile range.
^aFor negative numbers, greatest decrease, 1998-2008.
^bGreatest increase.
E.g., a 10% increase in expenditures $\rightarrow$ 1.8% decrease in infectious disease morbidity
E.g., a 10% increase in FTEs $\rightarrow$ 0.65% decrease in CVD deaths
Conclusion

• While on average, states had very slight declines in LHD expenditures and FTEs
  • Those who invested more, saw significant decreases in infectious diseases & cardiovascular deaths

• Convert our thinking to how to decide what types of investments we should make
Health Economic Evaluations

CHOICE

ALTERNATIVE “A”

ALTERNATIVE “B”

COSTS OF “A”

COSTS OF “B”

CONSEQUENCES “A”

CONSEQUENCES “B”
## Full vs. Partial Economic Evaluations

<table>
<thead>
<tr>
<th>Are there two or more alternatives being considered?</th>
<th>Are you considering costs &amp; consequences of the alternatives?</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>Consequences only</td>
</tr>
<tr>
<td></td>
<td>PARTIAL EVALUATION</td>
</tr>
<tr>
<td></td>
<td>Outcome study</td>
</tr>
<tr>
<td>YES</td>
<td>PARTIAL EVALUATION</td>
</tr>
<tr>
<td></td>
<td>Efficacy or effectiveness study</td>
</tr>
</tbody>
</table>
Cost-of-Illness Analysis

• Purpose: Measure economic burden of disease & illness on society
  • Assess how & where resources are being used
  • Identify & set priorities for policy makers
    • E.g., NIH funding examples
  • Information for other cost analyses
  • Does NOT indicate efficient use of resources
<table>
<thead>
<tr>
<th>Type of Analysis</th>
<th>Cost Measures</th>
<th>Outcome Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost-Minimization Analysis (CMA)</td>
<td>Monetary units, e.g., dollars</td>
<td>Natural units, but proven to be equivalent</td>
</tr>
<tr>
<td>Cost-Benefit Analysis (CBA)</td>
<td>Monetary units, e.g., dollars</td>
<td>Monetary units, e.g., dollars</td>
</tr>
<tr>
<td>Cost-Effectiveness Analysis (CEA)</td>
<td>Monetary units, e.g., dollars</td>
<td>Biological or natural units (e.g., years of life, blood pressure, blood sugar levels)</td>
</tr>
<tr>
<td>Cost-Utility Analysis (CUA)</td>
<td>Monetary units, e.g., dollars</td>
<td>Quality-adjusted life years or other utility measures</td>
</tr>
</tbody>
</table>
Cost-Benefit Analysis (CBA)

• Outcomes valued in monetary units
• Outcomes are NOT equivalent between alternatives
• Allows for comparison of different types of programs:
  • Programs that affect different natural units
  • Blood pressure screens vs. immunizations
• Allocation of funds
  • Investment costs & returns
  • Often public money
Cost-Effectiveness Analysis (CEA)

• Alternatives have common outcome
  • Same natural unit of effectiveness
    • E.g., change in quit rates (smoking), changes in life expectancy
  • If outcome incorporate quality of life assessment = Cost-utility analysis (CUA)
    • E.g., quality-adjusted life years (QALYs)

• Equivalent outcomes
  • Cost-minimization analysis (CMA)
Steps for conducting a cost analysis

1. State problem/objective
   Explicitly establish a viewpoint (perspective)
2. Consider relevant alternatives
3. Create a framework
4. Identify, measure, and value inputs & outcomes
5. Analyze:
   Identify most efficient way to achieve outcome
6. Account for uncertainty
   Sensitivity analysis
State the Problem/Objective

- What problem needs to be solved?
  - What are the trade-offs involved?

- What do you intend to accomplish?
  - How will you evaluate effectiveness?

**Example:** Goal is to reduce morbidity & mortality from myocardial infarctions (MIs).

- To reduce mortality → focus on emergency treatment
- To reduce morbidity → focus on prevention
Identify Perspective

• Who is affected (who pays)?
• On whose behalf is decision being made (who gains)?

*Dictates what resources, costs & outcomes are included*
# Selected Perspectives & Their Scope

<table>
<thead>
<tr>
<th><strong>Perspective</strong></th>
<th><strong>Scope of Interest</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Society</td>
<td>Most comprehensive &amp; broadest; includes total economic (direct &amp; indirect) costs</td>
</tr>
<tr>
<td></td>
<td>regardless of who bears those costs</td>
</tr>
<tr>
<td>Payer (employer, insurer,</td>
<td>Interested in direct costs that pertain to</td>
</tr>
<tr>
<td>government)</td>
<td>reimbursement of providers or caregivers</td>
</tr>
<tr>
<td>Patients/Family</td>
<td>Direct &amp; indirect costs that they must bear:</td>
</tr>
<tr>
<td></td>
<td>i.e., intervention costs, lost income</td>
</tr>
<tr>
<td>Provider (HMO, hospital, pharmacy)</td>
<td>Direct medical costs that affect their budget</td>
</tr>
</tbody>
</table>
### Costs & perspectives

#### Table 6.1 Costs Under Alternative Perspectives

<table>
<thead>
<tr>
<th>Cost Element</th>
<th>Societal</th>
<th>Patient and Patient Family</th>
<th>Self-Insured Employer</th>
<th>Public or Private Insurer*</th>
<th>Managed-Care Plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical care (aggregate)</td>
<td>All medical care costs</td>
<td>Out-of-pocket expenses</td>
<td>Covered expenses(^a)</td>
<td>Covered payments</td>
<td>Covered services</td>
</tr>
<tr>
<td>&quot;Units&quot;</td>
<td>All units</td>
<td>Those paid out-of-pocket</td>
<td>Those covered</td>
<td>Those covered</td>
<td>Those covered</td>
</tr>
<tr>
<td>&quot;Price&quot;</td>
<td>Opportunity cost (including admin. cost)</td>
<td>Amount paid out-of-pocket</td>
<td>Amount paid + admin. cost</td>
<td>Amount paid + admin. cost</td>
<td>Marginal cost</td>
</tr>
<tr>
<td>Patient time cost for treatment or intervention</td>
<td>Cost of all time used</td>
<td>Opportunity cost to patient</td>
<td>Only if affects productivity, paid sick time, admin. costs</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Marketed caregiving</td>
<td>All costs</td>
<td>Out-of-pocket expenses</td>
<td>Covered payments</td>
<td>Covered payments</td>
<td>Covered payments</td>
</tr>
<tr>
<td>Unmarketed, informal care giving</td>
<td>All costs</td>
<td>Opportunity cost to caregiver</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Transportation and other nonmedical services</td>
<td>All costs</td>
<td>All costs</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Sick leave, disability, other transfers, (taxes?)</td>
<td>Admin. costs only</td>
<td>Amount received</td>
<td>Amount paid by employer + own admin.</td>
<td>Amount paid by insurer + own admin.</td>
<td>If any paid</td>
</tr>
</tbody>
</table>

a. Third-party insurers.
c. If high, this could lead to a loss of enrollment and business.

Establish the Scope

- Identify all relevant alternative courses of action
  - therapeutic products
  - non-drug alternatives
  - may include doing nothing
- Determine appropriate time horizon
  - Acute vs. chronic condition
  - Affects choice of cost modeling
  - Affects need for discounting
Framework: Modeling Alternatives

- Help make explicit all alternatives and subsequent courses of action
  - flow charts
  - treatment models
  - decision trees/analysis
  - Markov chain models
  - regression analysis

- Natural history of disease or natural course of action
  - If do something, what happens next...until reach outcome
Specifying Inputs...What is used?

- Relevant to perspective & alternatives under consideration
  - Health care sector resources
  - Patient & family resources
  - Other relevant sectors
    e.g., home assistance
Micro- vs. Gross-Costing

• **Micro-costing**
  • Enumeration and costing of every input consumed in the treatment of each patient/participant
    • E.g., physician time spent with patient, individual supplies used

• **Gross-costing**
  • Average costs of events that include multiple components
    • E.g., hospitalizations → consists of room & board, nursing time/effort, laundry, housekeeping, etc.
Micro- vs. Gross-Costing

- **MICROCOSTING**
  - New intervention & unknown inputs
  - Examine within intervention variability
  - Include nonmarket goods without standardized cost estimates

- **GROSS COSTING**
  - Estimates already exist for inputs & their values
  - Payment system already in place for services
  - Large cost items where within event costs are not likely to change overall costs
Variable vs. Fixed Costs

- Relationship to production process
- Fixed costs
  - Total remains constant regardless of the volume of activity or numbers of patients served
  - E.g., special piece of equipment used for all interventions
- Variable costs
  - Costs that increase or decrease with changes in volume of activity
  - E.g., if include more patients, do you need more units of the item
How do we know how much is used/produced?

• Prospective or retrospective studies
  • Primary data collection
    • Track use of resources prospectively
    • Time & motion studies
    • Surveys, diaries, interviews
    • Chart review
    • Logs
  • Secondary data analysis, e.g., administrative data
  • Piggy-back studies
    • Count resources from data collected for other purposes, e.g., RCTs
    • Single facility data, e.g., KUH data

• Expert panel
Valuing Resources

• **Opportunity cost**
  Value of foregone benefits because resource not available for its best alternative use
  1) Approximated by *Market Value*:
     What you would pay for the good or service
     - may not hold for all health care goods/services
  2) People’s Time = wages + benefits = human capital approach
     • Wage valuation
       • Local (internal) wages
       • Benefits: add 25-30% to base wage rate
Types of Costs

For any type of health economic evaluation, consider the following:

- Direct medical costs
- Direct non-medical costs
- Indirect (productivity) costs
- Intangible costs (pain & suffering)
Types of Costs: Direct Medical Costs

• Medical resources used to treat or conduct the intervention
  • incurred in the course of therapy
  • treat adverse effects
  • used during added years of life
Assigning Dollar Values: Direct Medical Costs

• Drug products
  • Drug ingredient costs + pharmacist labor
  • Retail prices
  • Reimbursement rate from payer

• Physician Services & institutional services (e.g., hospitals)
  • Usual & customary charge
  • Reimbursement rates
    • RBRVS (physicians-Medicare) or DRG (hospitals-Medicare)
Direct non-medical costs

- Transportation
  - Mode of transportation
  - Fares
  - Mileage estimates

- Home modifications
  - Retail prices or reimbursed amts (direct costs: don’t double count) + out of pocket

- Formal care
  - Often part of direct costs
  - Home health aides, personal assistance services
Informal care definition

• “...nonmarket composite commodity...produced by (paid or unpaid) ...members of the social environment of the care recipient as a result of the care demands...” (van den Berg, et al., 2004)
  • Home keeping
  • Personal care
  • Support with mobility
  • Administrative tasks
  • Socializing
Patients’ time

• Scarcity of human time
  • Choices between activities

• Patient time...
  • Seeking care
  • Participating in an intervention
  • Recovery
  • Self-management
  • Helping others (family, friends)

• Too often excluded, though can be substantial
  • Can impact willingness to undergo medical care

Source: Russell, Med Care 2009
Productivity losses

• Premature death
  • Foregone earnings

• Absenteeism
  • Lost days of work/school

• Presenteeism
  • Present at work but working at a reduced capacity

• May be several fold higher than direct costs
  • Bank One estimated presenteeism to be as much as 84% of their productivity costs vs. 16% for absenteeism & disability!!
  • American Productivity Audit (2001-2002)
    • 38% of respondents reported presenteeism in last 2 weeks due to health problems
Discounting is the process for calculating the present value of money to be spent in the future.

- Dollar today is worth more than a dollar tomorrow

- Costs & benefits may accrue in different years
  - Use when costs & benefits occur beyond the first year
Incremental Analysis

- Program gives better effect but costs more
- Incremental Cost-Effectiveness Ratio
  - \[(\text{Cost A} - \text{Cost B})/(\text{Effect A} - \text{Effect B})\]
  - cost per unit of switching from one program to another

- If a program costs less and produces better effects = dominant strategy
Sensitivity Analysis: Accounting for Uncertainty

• Reasons for Sensitivity Analysis
  • No data may be available
  • Estimates available but imprecise
  • Methodological controversy or value judgments used
  • Generalizability to other settings

• Tests robustness of assumptions
  • One or more variables tested over the range of likely values
    • one-way
    • multiple-way
Example
Time Costs Associated with telemedicine counseling for smoking cessation (R01 Richter)

• Rural participants in smoking cessation intervention
  • Attend clinic for videoconferencing with smoking cessation counselor vs. phone-based counseling

• Distance from home → clinic
  • Google maps to calculate
    • Mileage between addresses
    • Time to travel between addresses

• KS mileage reimbursement = $0.50/mile (2010)

• Self-reported hourly wages → we added 25%
  • If missing, used age/gender rates from BLS
Travel costs for telemedicine

• Distance in miles ➔ home to clinic
  • Mean: 12.06 +/- 19.3
  • Median: 2.9
  • Range: 0-103
  • @ $0.50 per mile:
    • Avg cost = $6.09 x 2 = $12.18
    • Med cost = $1.45 x 2 = $2.90
    • Range = $0.00-$51.50 = $0 - $103
Time costs for telemedicine

- Travel time ➔ home to clinic
  - Avg driving time = 19.9 minutes
  - Avg wage + 25% benefits = $20.18
  - Travel time costs = 19.9 x 2 x 20.18/60 = $13.39

- Sum of mileage & time costs for participants
  - $12.18 + $13.39 = $25.57 per telemedicine visit
Back to public health articles
Local Public Health Cost Study in Georgia

CL HADLEY, L FELDMAN, KE TOOMEY

J PUBLIC HEALTH MANAGEMENT PRACTICE

2004, 10(5), 400-5
Brief Review of paper

• Purpose:
  • What does it cost to provide public health services?
  • Shift to identifying the cost of providing services rather than revenues generated by services

• Perspective:
  • Provider of services (public health agency)

• Components of public health
  • Clinical services
  • Population-based services
  • Environmental health
  • Non-clinical WIC services
Brief review of Hadley, cont.

- RMSS = Random Moment Statistical Sample
  - Select random points in time and ask employees what they are working on
  - Approach to allocate staff time costs

- Cost teams → cost centers
  - What expenses incurred to conduct activities

- Task analyses
  - Surveys of staff organizing their time across cost centers

- Collected data during one year, sampling first week of each month
Brief review of Hadley, cont.

• Cost Study Methodology
  • 1. Public health clinical services
  • 2. Cost allocation to each county
  • 3. Allocation of administrative costs
  • 4. Allocation of costs of clinical services to programs
  • 5. Results per relative value unit
  • 6. Results: cost per procedure
Direct Cost Associated with the Development and Implementation of a Local Syndromic Surveillance System

Purpose

• Syndromic surveillance system
  • Detect potential outbreaks using automated, prediagnostic data sources
    • E.g., ED chief complaints, OTC med purchases

• How much does it cost to roll one of these out and maintain it?
  • NYC = $130,000-$150,000 per year
  • England & Wales = $280,000 per year

• So, let’s take a look at Boston’s ED-based system
  • Development & implementation
  • Operation including upgrades
Methods

• ED-data from 10 hospitals are submitted electronically every 24 hours to BPHC (Boston Public Health Commission)
  • Patient ID, chief complaint, age, sex, race/ethnicity, zip code
  • Chief complaints analyzed using Early Aberration Reporting System
  • Reports from system reviewed daily by epidemiologists at BPHC
    • Looking for clusters or significant events
    • If one noted → get medical records
      • Follow-up with standard public health protocols
    • Additional data:
      • Death certificates, EMS calls, poison center calls

• Analysis → calculate direct costs of the system!
• CDC costs – external consultants

• Data sources:
  • Fiscal records
  • Internal interviews
  • Time studies (time & motion studies)
Direct costs

Fixed costs

• Travel & equipment
  • Development
  • Operating
  • Upgrades

Variable costs

• Personnel
  • Development
  • Operating
  • Upgrades
**Table 1** Itemized costs for developing, implementing, and upgrading a local syndromic surveillance system from December 2003 to July 2005

<table>
<thead>
<tr>
<th>Phase</th>
<th>Cost type</th>
<th>BPHC</th>
<th>CDC</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development</td>
<td>Personnel (variable)</td>
<td>$103,885</td>
<td>$8,540</td>
<td>$112,425</td>
</tr>
<tr>
<td></td>
<td>Travel (fixed)</td>
<td></td>
<td>$6,662</td>
<td>$6,662</td>
</tr>
<tr>
<td></td>
<td>Equipment (fixed)</td>
<td>$22,140</td>
<td></td>
<td>$22,140</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$126,025</td>
<td>$15,202</td>
<td>$141,227</td>
</tr>
<tr>
<td>Operating</td>
<td>Personnel (variable)</td>
<td>$73,891</td>
<td>$3,952</td>
<td>$77,843</td>
</tr>
<tr>
<td></td>
<td>Travel (fixed)</td>
<td></td>
<td>$4,503</td>
<td>$4,503</td>
</tr>
<tr>
<td></td>
<td>Equipment (fixed)</td>
<td>$65,146</td>
<td></td>
<td>$65,146</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$139,037</td>
<td>$8,455</td>
<td>$147,492</td>
</tr>
<tr>
<td>Upgrades</td>
<td>Personnel (variable)</td>
<td>$57,265</td>
<td>$486</td>
<td>$57,751</td>
</tr>
<tr>
<td></td>
<td>Travel (fixed)</td>
<td></td>
<td>$2,040</td>
<td>$2,040</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$59,716</td>
<td>$2,526</td>
<td>$62,242</td>
</tr>
<tr>
<td>Enhancements</td>
<td></td>
<td>$74,389</td>
<td></td>
<td>$74,389</td>
</tr>
<tr>
<td>Grand total</td>
<td></td>
<td>$396,716</td>
<td>$26,183</td>
<td>$422,899</td>
</tr>
</tbody>
</table>

BPHC 12-month operating costs = $196,302
We’re firm believers in preventive medicine...