Using Economic Evaluation to Understand the Value of Environmental Health Services

Glen P. Mays, University of Kentucky

Available at: https://works.bepress.com/glen_mays/334/
Using Economic Evaluation to Understand the Value of Environmental Health Services

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Glen Mays, PhD, MPH
Today’s Agenda

I. Fundamentals of economic evaluation
II. Tools for economic evaluation in public health
III. Examples of public health economic studies
IV. Interpretation, applications, limitations & caveats
I. Fundamentals of economic evaluation
Why economics in public health?

- Do outcomes achieved by public health interventions justify their costs?
- Where should new investments be directed to achieve their greatest impact?
Related questions of value...

- How much health can we produce through public health investments?
- Can public health investments help “bend the curve” to reduce medical costs or costs incurred by other stakeholders?
Transforming policy & practice with cost estimation

- Align resources with preventable disease burden
- Identify and address inequities in resources
- Improve productivity and efficiency
- Demonstrate value: linking costs to outcomes
- Strengthen fiscal policy: financing mechanisms
Uncertainty and Controversy

THE WALL STREET JOURNAL

JUNE 12, 2009

Prevention Efforts Provide No Panacea on Health Costs

By JANET ADAMY

Preventing Chronic Disease: An Important Investment, But Don’t Count On Cost Savings

An overwhelming percentage of preventive interventions add more to medical costs than they save.

by Louise B. Russell

HEALTH AFFAIRS - Volume 28, Number 1

Prevention for a Healthier America:

INVESTMENTS IN DISEASE PREVENTION YIELD SIGNIFICANT SAVINGS, STRONGER COMMUNITIES

Trust for America's Health
WWW.HEALTHYAMERICANS.ORG
Challenges in demonstrating economic value in public health

- **Time lag** between costs and benefits
- **Distribution** of costs and benefits: *concentrated* costs but *diffuse* benefits
- **Measurement** of costs and benefits requires good information systems
- **Attribution** of benefits to specific public health interventions
- **Estimating** the counterfactual
How public health activities relate to medical costs

Annual Growth Rate of Aggregate U.S. Medical Spending

Growth rate due to cost per case

Growth rate due to prevalence

Roehrig et al. Health Affairs 2011
Economic evaluation: key steps

1. Estimate resources used to implement intervention
2. Estimate effects attributable to the intervention
   - Health effects
   - Effects on resource use
3. Account for the timing of resources and effects
4. Account for uncertainty in resource and effect estimates
5. Compare intervention resource use to intervention effects
Economic evaluation: key issues

**Investments**
- Costs of implementing public health interventions
- Who pays: sources?
- Over what time frames?

**Benefits/Returns**
- Valuation of the outputs and outcomes attributable to public health interventions
- Who realizes returns?
- Over what time frames?
- Compared to what?
Setting and managing expectations

- **Cost savings** – a high bar
- **Cost effectiveness** – value for dollars spent
  - Compared to status quo
  - Compared to other possible investments
  - Compared to doing nothing

...Key concept: *opportunity costs*
Estimating value in public health: Key considerations

**Targets of study**
- Primary, secondary or tertiary prevention programs
- Quality improvement projects
- Cross-cutting infrastructure

**Perspective**
- Federal, state, agency, health system, or societal?

**Time Horizon**
- How long can you wait to realize a return?
Estimating value in public health: Key considerations - Costs

**Direct costs**
- Cost of implementing the activity
- Costs avoided or incurred due to the activity’s impact

**Indirect costs**
- Economic value of productivity gains/losses or time savings/costs attributable to the activity

**Intangibles**
- Quality of life, satisfaction, self-efficacy, social capital
Estimating value in public health: Key considerations - Benefits

**Health gains (captured in outcome measures)**
- Deaths averted
- Cases prevented
- Years of life gained (or QALYs)

**Efficiency gains (captured in cost measures)**
- Avoided medical care use (admissions, ED visits)
- Reduced labor costs
- Reduced material costs
- Reduced lost time from work, school, household production

**Productivity gains (captured in output measures)**
- Services delivered
- Cases detected

**Revenue gains (captured in financial measures)**
Valuing Prevention & Public Health

Estimating value in public health:
Key considerations

**Participation/Adherence**
- What proportion of the population at risk engages in the program/intervention?

**Break even**
- How long does it take to recoup investment?

**Maintenance/Persistence**
- How long do the benefits last?
- Recurring costs?
Estimating value in public health: Key considerations

- **Evidence** of program effectiveness
- Ability to **reach** populations at greatest risk
- Ability to **implement and maintain** active ingredients of programs/policies
- **Efficiency** in program delivery
Estimating value in public health: Key considerations

- **Economies of scale**: many public health interventions can be delivered more efficiently across larger populations

- **Economies of scope**: efficiencies can be realized by using the same infrastructure to deliver an array of related programs and services
Estimating value in public health: common types of analyses

- Cost analysis
- Cost comparison/cost minimization
- Budget impact analysis
- Cost-effectiveness analysis
- Return-on-investment analysis
- Cost-benefit analysis
- Health impact assessment
“Poor costing systems have disastrous consequences. It is a well-known management axiom that what is not measured cannot be managed or improved. Since providers misunderstand their costs, they are unable to link cost to process improvements or outcomes, preventing them from making good decisions....Poor cost measurement [leads] to huge cross-subsidies across services...Finally, poor measurement of costs and outcomes also means that effective and efficient providers go unrewarded.”

Toward a deeper understanding of costs in public health

2012 Institute of Medicine Recommendations

- Identify the components and costs of a minimum package of public health services
  - Foundational capabilities
  - Basic programs
- Implement a national chart of accounts for tracking spending and flow of funds
- Expand research on costs and effects of public health delivery

Tools of the trade

- Prospective “expected cost” methods (micro-costing)
  - Vignettes
  - Surveys with staff and/or administrators
  - Delphi group processes

- Concurrent “implementation cost” methods (micro-costing)
  - Time studies with staff
  - Activity logs with staff
  - Direct observation

- Retrospective “cost accounting” methods (micro-costing or gross-costing)
  - Administrative records, financial reports, billing data
  - Decomposition, allocation or modeling
  - Surveys with staff and/or administrators
First Principles

Estimating total economic costs of an activity

Costs = value of resources used to produce activity

Resources = people, facilities, equipment, supplies

...Key concept: opportunity costs
Financial Costs

- **Expenditures** for resources to implement the activity – based on market prices
- Often reflected in expenditure reports, invoices
- Convenient, sometimes incomplete, measures
- **Examples:**
  - Salaries for project personnel
  - Supply costs
  - Computer purchases
  - Cost of curriculum materials
Economic Costs

Value of the lost benefit because the resource is not available for its next best use

Examples:

➢ Volunteer time
➢ Donated space

Shadow prices may be used when market price does not accurately reflect the value of the resource
Developing a cost classification system

- Perspective: who incurs cost
- Timeframe: over what period
- Type of resource
  - Labor, equipment, supplies, facilities, etc
- Activity domains/areas
  - Training, curriculum development, surveillance, recruitment, screening, administration
  - Pre-implementation vs. post-implementation
- “Direct” vs. “indirect” activities
- Capital vs. operating costs (& depreciation)
Developing a cost classification system

Common resource categories

- Noncontract labor
- Contract services
- Materials/supplies
- Building/facilities
- Donated labor and resources
- Other resources not funded directly
Developing a cost classification system

Don’t overlook...

🌱 Resources that are hard to measure or value
🌱 Resources used in small amounts
🌱 Resources procured without money
  ➢ Volunteer time
  ➢ Parent/caregiver time
  ➢ Intervention recipient time
  ➢ In-kind contributions/donated materials
  ➢ Existing resources
Developing a cost classification system

Include measures of units of activity

➢ Unit costs

Fixed vs. variable costs

➢ Variable costs vary with activity level
➢ Fixed costs are constant despite volume of activity
➢ Long term, all costs are variable
Developing a cost classification system

- Handling resources that are shared by multiple programs, activities, or organizations

- Cost allocation methods
  - Time
  - Intensity of use
Conducting a cost study

- Define Purpose/Scope
- Literature Scan
- Solicitation of experts
- Development of Cost Categories
- Instrument Pilot Test/Validation
- Data Collection
- Cost Analysis
Conducting a cost study: focus

- Program/intervention
- Cross-cutting infrastructure (e.g. PHAB stds)
  - Assessment
  - Surveillance
  - Planning
  - Policy development
- Organization
- Industry/enterprise
Cost data collection methods

- Direct observation methods
- Time studies and time-and-motion methods
  - random moment time sampling
- Activity logs
- Analysis of administrative records
- Surveys
  - Program delivery staff
  - Program managers/directors
- Group process methods with vignettes
Examples: Survey methods

Three dimensions of work:
- Mental effort and judgment
- Technical skill and physical effort
- Stress
### Table 4

**Summary of Estimated Cost of Data Collection**

(in 1991 dollars)

<table>
<thead>
<tr>
<th>Collection Method</th>
<th>Total Cost&lt;sup&gt;a&lt;/sup&gt;</th>
<th>No. of Completes</th>
<th>Cost per Complete&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Cost per Rated Service&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telephone</td>
<td>$105,000</td>
<td>1200</td>
<td>$87.50</td>
<td>$175.00</td>
</tr>
<tr>
<td>1-Round Mail</td>
<td>$65,500</td>
<td>1200</td>
<td>$54.58</td>
<td>$109.17</td>
</tr>
<tr>
<td>2-Round Mail</td>
<td>$80,000</td>
<td>1267&lt;sup&gt;d&lt;/sup&gt;</td>
<td>$63.14</td>
<td>$133.33</td>
</tr>
<tr>
<td>Panel</td>
<td>$88,000</td>
<td>n/a</td>
<td>n/a</td>
<td>$146.67</td>
</tr>
</tbody>
</table>

<sup>a</sup>Total cost of data collection includes all field activities (e.g., interviewing, survey distribution, data reduction), supervision, management, and instrument/materials development.

<sup>b</sup>Cost per complete is derived by dividing the total cost of data collection by the number of completed cases. (This calculation is not applicable to the panel-rating methodology.)

<sup>c</sup>Cost per service is derived by dividing the total cost of data collection by the 600 rated services.

<sup>d</sup>667 completes for the first round and 600 completes for the second round.
Examples: Survey methods

- Surveys program managers
- Refers to expenditure records (not budgets)
- Explicit allocation of resources across multiple programs

Available at:


Analyzing costs

Average vs. marginal costs?

Compared to what?

- Doing nothing
- Status quo
- Other settings, implementation strategies
- Other activities/interventions

Quantifying variation in costs

- Scale and scope
- Context
Analyzing costs: example

WISEWOMAN Cost Analysis

Steps:
1. Calculate total costs for 6-month period
2. Divide by # women screened in same period

<table>
<thead>
<tr>
<th>Activity</th>
<th>Per capita costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outreach/follow-up</td>
<td>$22</td>
</tr>
<tr>
<td>Screening</td>
<td></td>
</tr>
<tr>
<td>WISEWOMAN screening</td>
<td>$98</td>
</tr>
<tr>
<td>Annual prescriptions</td>
<td>$26</td>
</tr>
<tr>
<td>Additional office visits</td>
<td>$3</td>
</tr>
<tr>
<td>Total screening</td>
<td>$127</td>
</tr>
<tr>
<td>Intervention</td>
<td>$121</td>
</tr>
<tr>
<td>Total</td>
<td>$270</td>
</tr>
</tbody>
</table>

Cost-Effectiveness of WISEWOMAN, a Program Aimed at Reducing Heart Disease Risk among Low-Income Women. Eric A. Finkelstein, PhD, Olga Khavjou, MA, and Julie C. Will, PhD
Analyzing costs across multiple settings

- Identifying determinants of costs
- Cost function estimation
- Examining cost heterogeneity and efficiency
- Stochastic frontier analysis
- Data envelopment analysis
Analyzing costs: example

Explaining the efficiency of local health departments in the U.S.: an exploratory analysis

Kankana Mukherjee · Rexford E. Santerre · Ning Jackie Zhang

DOI 10.1007/s10729-010-9136-5

Fig. 4 Relative efficiency of 771 LHDs with nonzero inputs and outputs
Resources


Cost-effectiveness analyses

Cost-Effectiveness Ratio ($ per QALY)

ROI analyses

Estimating value in public health: levels of analyses

- Macro-level analysis
- Infrastructure-level analysis
- Intervention-level analysis
- Process-level analysis
Example:
Macro-level Analysis

<table>
<thead>
<tr>
<th></th>
<th>1-2 Years</th>
<th>5 Years</th>
<th>10-20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Total</td>
<td>$2,848,000,000</td>
<td>$16,543,000,000</td>
<td>$18,451,000,000</td>
</tr>
<tr>
<td>ROI</td>
<td>0.96:1</td>
<td>5.6:1</td>
<td>6.2:1</td>
</tr>
</tbody>
</table>

Source: Trust for America’s Health, 2009
Example: Intervention-level analysis

- Smoking cessation interventions cost an estimated $2,587 for each life-year gained
- $1 spent on STD and pregnancy prevention produces $2.65 in medical cost savings
- $1 spent on preconception care for diabetic women produces $5.19 in medical cost savings
- $1 spent on childhood immunization produces $6.30 in medical cost savings

Source: Centers for Disease Control and Prevention 2011
Examples:
Environmental Health Interventions

- $1 investment in lead paint hazard control saves $12-155 per household (Gould 2009)
- $1 spent on asthma control programs yields $71 in savings (CDC 2013)
- $1 spent on federal disaster mitigation yields $6 in savings (National Institute of Building Sciences 2017)
II. Tools for economic evaluation in public health
Existing public use tools

AHRQ Asthma ROI calculator
http://statesnapshots.ahrq.gov/asthma/Required.jsp

CDC Smoking-Attributable Mortality, Morbidity, and Economic Costs (SAMMEC)
http://apps.nccd.cdc.gov/sammec/

CDC LeanWorks Obesity Cost Calculator
http://www.cdc.gov/leanworks/costcalculator/index.html

RWJF Diabetes Self-Management ROI Calculator
http://www.diabetesinitiative.org

HIMSS Electronic Health Record ROI
http://www.himss.org/ASP/ROI_Calc.asp
Existing public use tools

County Health Calculator: impact of education and income
http://countyhealthcalculator.org/

OSHA Safety Pays Cost Calculator for Occupational Health

Economic Impact Analysis Tool
https://www.raconline.org/econtool/

CommunityFlu 2.0
http://www.cdc.gov/flu/pandemic-resources/tools/index.htm

Integrated Disease Surveillance and Response Cost Calculator
http://www.cdc.gov/globalhealth/healthprotection/ghsb(idsr/default.htm
Estimating value in public health:
ASTHO Public Health ROI Template

- **Goal**: Develop approaches to assess value of improvements in public health capacity, infrastructure, administrative processes

- **Near-term**: capture effects on labor costs, time costs, productivity

- **Longer-term**: capture effects on program delivery (reach, effectiveness), population health
The Public Health ROI Calculator

Requires data on:

- Operating costs before and after implementation of your public health strategy
- Revenues (if any) before and after implementation of your public health strategy
- Measures of outputs/services before and after
- Measures of health and economic outcomes (if available) before and after

astho™
III. Examples of economic evaluation in public health
Economies of scope and scale

Institutional and Economic Determinants of Public Health System Performance

Glen P. Mays, PhD, MPH, Megan C. McHugh, MPA, Kyumin Shim, PhD, Natalie Perry, DrPH, MPH, DrPH, MHSA, and Ramal Moonesinghe, PhD

Mays et al. 2006
Variations in policy design, implementation, enforcement

Estimated Effects of Smoke-free Policies on AMI admissions

Glantz 2008

NOTE: Weights are from random effects analysis
Example: comparison of alternative implementation strategies

- Limited adoption of DPP: cost, staffing
- Non-inferiority trial comparing standard intervention to CHW-delivered intervention
- Clinical and cost-effectiveness estimates
Estimating the aggregate value of public health spending

Change in Local Public Health Spending, 1993-2005

Fraction of Agencies

35%
65%

Change in Per Capita Spending (Current Dollars)
Example: Mortality reductions attributable to local public health spending, 1993-2008

Mays et al. Health Affairs, 2011
## Aggregate value of spending

<table>
<thead>
<tr>
<th>Source</th>
<th>Cost per Life-Year Gained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical care spending, 1990-2000</td>
<td>$36,300</td>
</tr>
<tr>
<td>(Cutler et al. NEJM, 2006)</td>
<td></td>
</tr>
<tr>
<td>Public health spending, 1993-2005</td>
<td>$12,200-$25,600</td>
</tr>
</tbody>
</table>
Example: Medical Care Offsets Attributable to Local Public Health Spending, 1993-2008

Medical Cost Offset = 0.088%

Mays et al. Health Services Research, 2009
Example: Projecting effects of new public health spending

1.2% increase in public health spending in average community over 10 years:

- Public health cost: $7.2M
- Medical cost offset: -$6.3M (Medicare only)
- Deaths averted: 175.8
- Life years gained: 1758
- Net cost/LY: $546

Mays et al. 2017
Examples: Program ROI
Arkansas Community Connector Program

- Use community health workers & public health infrastructure to identify people with unmet social support needs
- Connect people to home and community-based services & supports
- Link to hospitals and nursing homes for transition planning
- Use Medicaid and SIM financing, savings reinvestment
- Costing with electronic time logs

Felix, Mays et al. 2011
http://content.healthaffairs.org/content/30/7/1366.abstract
Example: Program ROI

- Quasi-experimental research design
- Three year demonstration period + 1 year extension
- Measured expenditures for CCP participants one year before participation and up to 3 years after participation
- Constructed a statistically-matched comparison group of Medicaid recipients not served by CCP
- Use difference-in-difference models to estimate impact, controlling for time-varying covariates
Examples: Program ROI

By Holly C. Felix, Glen P. Mays, M. Kathryn Stewart, Naomi Cottoms, and Mary Olson

THE CARE SPAN

Medicaid Savings Resulted When Community Health Workers Matched Those With Needs To Home And Community Care

Felix, Mays et al. 2011
http://content.healthaffairs.org/content/30/7/1366.abstract
Examples: Program ROI

Three Year Aggregate Estimates

- Combined Medicaid spending reductions: $3.515 M
- Program implementation costs: $0.896 M
- Net savings: $2.629 M
- ROI: $2.92

Felix, Mays et al. 2011
http://content.healthaffairs.org/content/30/7/1366.abstract
IV. Interpretation, Limitations and Caveats
Interpreting & using results: Key considerations

- Uncertainty and sensitivity analysis
- Measurement error
- Attribution and threats to validity
- Scenario analysis
- Upper-bound and lower-bound estimates
Advancing Economic Analysis in Public Health

- Enhanced tracking of public health expenditures
- Enhanced monitoring of program performance
  - Reach/targeting
  - Effectiveness
  - Efficiency
  - Equity
- Analysis of cross-cutting infrastructure needed to implement/maintain programs
For More Information

Systems for Action
National Coordinating Center
Systems and Services Research to Build a Culture of Health

Supported by The Robert Wood Johnson Foundation

Glen P. Mays, Ph.D., M.P.H.
glen.mays@uky.edu
@GlenMays

Email: systemsforaction@uky.edu
Web: www.systemsforaction.org
www.publichealthsystems.org
Archive: works.bepress.com/glen_mays
Blog: publichealtheconomics.org