Economic Evaluation: Making the case for diabetes self-management education

NACDD Webinar
September 27, 2012

Carsten Baumann, MA
Webinar 1: Learning the Language; Key Economic Concepts

Webinar 2: Applying the Skills; Critical Review of Diabetes-Related Econ Literature

Webinar 3: Tailoring the Points; Aligning Programs & Interest

Change
Economic Evaluation: Overview

- Part 1: Introduction
- Part 2: Main types of economic evaluation
- Part 3: Key concepts
  - Cost calculations (direct, indirect, opportunity)
  - Benefits (money, life years, etc.)
  - Perspectives (individual, group, society)
  - Time horizon (discounting)
  - Uncertainty
- Homework exercise: critical review of economic evaluations of DSME
Marooned on a Desert Island

- A physicist, an architect and an economist are marooned on a desert island with a can of beans
- How will they get the can open?
Learning Objectives

- Know the differences between types of economic evaluations: cost-inclusive, cost-benefit (return on investment), cost-effectiveness and cost-utility analysis

- Understand key terms in economic analysis

- Be able to use economic evaluation studies to justify and prioritize prevention and treatment strategies
Part 1: Introduction

- Selecting a program
  - Lowest cost; highest effectiveness
  - Allocating the budget
- What is economic evaluation?
- Why do it?
- What can it tell us?
- Is it evidence?
Which Program Has Greatest Benefit?

Benefit – only

- Physical Activity (PA) Program: 20 years of life gained
- Nutrition (Nutri) Program: 25 years gained
- Smoking Cessation Program: 15 years gained

Note: these examples are fictitious
Which Program Has Lowest Cost?

Cost – only

- Physical Activity (PA) Program: $400,000 per year
- Nutrition (Nutri) Program: $800,000 per year
- Smoking Cessation Program: $350,000 per year

Note: these examples are fictitious
Which Program to Implement? Lowest Cost or Greatest Benefit

Cost – only
- Physical Activity Program = $400,000
- Nutrition Program = $800,000
- Smoking Cessation Program = $350,000

Benefit – only
- Physical Activity = 20 years of life gained
- Nutrition = 25 years of life gained
- Cessation = 15 years of life gained

Note: these examples are fictitious
### Which Program to Implement?

<table>
<thead>
<tr>
<th>Ranked Interventions</th>
<th>Cost/Benefit ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physical activity ($400k)</td>
<td>$20,000/ YOL gained</td>
</tr>
<tr>
<td>2. Smoking cessation ($350k)</td>
<td>$23,333/ YOL gained</td>
</tr>
<tr>
<td>3. Nutrition ($800k)</td>
<td>$32,000/ YOL gained</td>
</tr>
</tbody>
</table>

- If we wanted lowest cost intervention?
- If targeted C/B ratio is: $25,000/ YOL gained
- If targeted C/B ratio is: $20,000/ YOL gained
- If we had $800,000 budget?
What is Economic Evaluation (EE)?

Definition:

- EE compares the outcomes (benefits) and costs of alternative interventions to inform decisions about the allocation of scarce resources using an established set of economic tools.
- It is one decision-making tool.
- It compares a new alternative vs. the base case (current approach; business as usual).
Why Use Economic Evaluation in Public Health Interventions?

- To determine whether an intervention alternative is both effective and efficient
- To make population-based decisions that take into account various cost perspectives
- To prevent waste of public resources
- To justify spending on public health interventions to funding agencies and policymakers
## What are possible EE results?

<table>
<thead>
<tr>
<th>Increased Costs</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Costs more; Worsens health relative to control</td>
<td>B: Costs more; No health difference</td>
<td>C: Costs more; Improves health relative to control</td>
</tr>
<tr>
<td>D: Costs the same; Worsens health relative to control</td>
<td>E: Costs the same; No health difference</td>
<td>F: Costs the same; Improves health relative to control</td>
</tr>
<tr>
<td>G: Costs less; Worsens health relative to control</td>
<td>H: Costs less; No health difference</td>
<td>I: Costs less; Improves health relative to control</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost Savings</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No Change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worse Outcomes</td>
<td>No Change</td>
<td>Improved Outcomes</td>
</tr>
</tbody>
</table>

13
Should intervention be adopted?

<table>
<thead>
<tr>
<th>Cost Changes</th>
<th>Better Outcomes</th>
<th>No Change</th>
<th>Worse Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased Costs</td>
<td>Definitely reject new alternative (base case preferred)</td>
<td>Decision: Are the benefits worth the costs?</td>
<td></td>
</tr>
<tr>
<td>No Change</td>
<td>Indifferent</td>
<td>No Change</td>
<td>Definitely accept new alternative (base case rejected)</td>
</tr>
<tr>
<td>Cost Savings</td>
<td>Decision: Is the health loss worth the savings?</td>
<td>No Change</td>
<td>Definitely accept new alternative (base case rejected)</td>
</tr>
</tbody>
</table>
Need for Evidence

- Without proven strategies, we do not know whether our planned intervention will work
  - If not effective, cannot be cost-effective

- **Must do research to find out whether:**
  - A) An unproven intervention is effective
  - B) An effective intervention is cost effective

⇒ In case it got lost: If something is not effective, it cannot be cost-effective!
Part 2: Main Types of Economic Evaluation

- Cost-inclusive evaluation (CIE)
- Cost-benefit analysis (CBA)
  - Cost-minimiziation
- Cost-effectiveness analysis (CEA)
  - Cost-utility analysis (CUA)
Cost-Inclusive Evaluation

- Definition: Any evaluation that looks at both effectiveness (intended outcomes) and costs
- Outcomes: Monetary & non-monetary units
- Answers: Did it work and at what cost?
- Decision: Accept if effectiveness is better or cost is lower than alternative
## Previewing EE Types

<table>
<thead>
<tr>
<th>Type of Analysis</th>
<th>Outcome (Benefit)</th>
<th>Measurement of Benefits</th>
</tr>
</thead>
</table>
| **Cost Minimization** (CMA) | $\$\rightarrow\$\$  
Identical, but costs are different  
*Can we do it for less?* | None  
(or kept constant) |
| **Cost Effectiveness** (CEA) | $\$\leftrightarrow\$\$  
Single common benefit (or outcome)  
*Are the (natural) outcomes worth the cost?* | Natural units e.g. life years gained, A1C levels, blood pressure, improved nutrition/physical activity |
| **Cost Utility** (CUA) | $\$\leftrightarrow\$\$  
1 or more benefits (outcomes) standardized into a single value  
*Are standardized outcomes worth the cost?* | QALYS  
DALYS  
(discounted) |
| **Cost Benefit** (CBA) | $\$\leftrightarrow\$\$  
Single, or multiple benefits (outcomes) standardized into a single monetary value (in present dollars)  
*Do we save more than we spend?* | Present value of $$; Monetary value of a YOLS or QALY |
Cost-Benefit Analysis

- **Definition:** CBA compares the costs and benefits of the same (or different) program using monetary outcomes.

- **Outcomes:** Monetary units.

- **Answers:** Are the net benefits greater than net costs?

- **Decision:** Accept if the effects are worth more than the cost; select the intervention that has a cost/benefit ratio < 1.

- Most common form of EE in business:
  - AKA return-on-investment (ROI) analysis.
Cost-Minimization (Saving) Analysis

- Definition: CMA compares the costs of different programs that produce the same health related outcomes (cell H)

- Outcomes: Monetary units*

- Answers: While keeping outcomes constant, are the costs lower?

- Decision: Select the effective intervention with the lower cost (cost saving strategy)
Cost-Minimization Analysis: Example

A. Participants walk 4 days per week
   - Lowers Cardiovascular Disease (CVD) risk by 10%
   - Costs $3000 per participant per year

B. Participants reduce fat from 40% to 30% of calories
   - Lowers CVD risk by 10%
   - Costs $2500 per participant per year

Outcome: Compare data on outcome only
   - Both equally effective in lowering CVD risk

Analysis: Compare data on costs only
   - Reduced fat intake intervention costs less

Decision: Choose the fat reduction intervention
   - Cost saving strategy

Note: these examples are fictitious
Cost-Effectiveness Analysis

- Definition: CEA compares the **costs** and **benefits** of different programs using the same **outcome measure**

- Outcomes: Non-monetary, natural units

- Answers: Are the net effects worth the net costs?

- Decision: Accept if effects are worth the cost; select the intervention that has a lowest cost/benefit ratio

→ Most common form of EE in health:
  - Cells C, F, and I
## Which Program to Implement?

<table>
<thead>
<tr>
<th>Ranked Interventions</th>
<th>Cost/Benefit ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physical activity ($400k)</td>
<td>$20,000/ YOL gained</td>
</tr>
<tr>
<td>2. Smoking cessation ($350k)</td>
<td>$23,333/ YOL gained</td>
</tr>
<tr>
<td>3. Nutrition ($800k)</td>
<td>$32,000/ YOL gained</td>
</tr>
</tbody>
</table>

- If we wanted lowest cost intervention?
- If targeted C/B ratio is: $25,000/ YOL gained
- If targeted C/B ratio is: $20,000/ YOL gained
- If we had $800,000 budget?
Question on Part 2: Main Types of Economic Evaluation

Any questions on what was covered so far:

- Cost-inclusive evaluation (CIE)
- Cost-benefit analysis (CBA)
  - Cost-minimization
- Cost-effectiveness analysis (CEA)
  - Cost-utility analysis (CUA)
Part 3: Key Concepts

- Cost (direct, indirect, opportunity*)
- Benefits (money, life years, etc.)
- Perspectives (individual, group, society)
- Time horizon (discounting)
- Uncertainty (sensitivity)
Key Concept: Cost Types

- Intervention program (or direct) costs
- Indirect program costs on client and others
- Averted health care costs
  - A negative cost (i.e. a benefit?)
- Averted productivity losses
  - A negative cost (i.e. a benefit?)
- Future health costs incurred due to increased longevity from intervention
  - Controversial cost
Key Concept: Program (Direct) Costs

Direct Costs (costs attributable to program)

- **Variable Costs**
  - Costs that vary with number of participants
    - Labor
    - Supplies
    - Some variable costs (labor) may be fixed, especially within a budget cycle

- **Fixed Costs**
  - Cost that do not change with number of participants
    - Management
    - Equipment, rent
Key Concept: Indirect Costs

- Costs to participants
  - Time costs (lost wages)
  - Travel costs
  - Supplies and equipment client buys

- Costs borne by external agents
  - Other family members, individuals, agencies
  - Value of any free or donated inputs

- Opportunity costs
Down the Rabbit Hole: Costs
Plus Costs of Treating Adverse Side Effects

- If the intervention has potential adverse health side effects, the cost of treating these must be included
  - Vaccine-related illness
  - Smoking cessation and weight gain
  - Vigorous exercise and injury
  - Spraying for mosquitoes and health risk

- Most public health interventions have low risk of adverse side effects
Beneficial Side Effects?

- If the intervention has potential positive health side effects, those cost savings should be included if they can be estimated.

- Smoking cessation program reduces cancer and CVD risk to smoker and to others who are no longer exposed to secondhand smoke:
  - Not always included in averted treatment costs
  - Analysis will understate the cost effectiveness of the program
Averted Treatment Costs

- Reduced health care treatment costs due to successful diabetes self-management program
  - A negative cost rather than a benefit
    - Subtracted from total costs of intervention
  - Lowers the total health care budget for individual/payer/society in the short (or long) run.
Increased Life Expectancy = Added Health Care Costs?

“The cost of additional healthcare caused by extended years of life should NOT be included in the costs of preventive services…

Note: Although there is no clear consensus in the field on this point, these additional costs should not be included for comparative purposes only.”

--The Community Guide

Key Concept: Benefits (Health Outcomes)

In monetary units (currency)
- Monetary value of years of life saved (gained)

In physical units – global health outcomes
- Years of life saved (YOLS)
- Health Related Quality of Life (HRQL) Units
- Quality Adjusted Life Years Saved (QALYS)

In physical units - intermediate outcomes
- % lowered blood pressure, cholesterol
- Increased hours of exercise
- Smoking cessation
Societal Decisions

- **Goal:** Balance spending on different health programs to maximize net benefits to society as a whole.
  - Who benefits from the intervention? Is it equitable?

- **Investments based on societal values**
  - Political system determines whose values are represented in the outcome chosen
    - e.g. Diabetes self-management education vs. well baby visits
Use of Intermediate Outcomes (Benefits)

Prevention poses special problems:
- It may take a long time for benefits to be felt
- Annual benefits may be small and cumulative
- The benefits may be complex and interrelated
  - Some benefits may be omitted or overlooked
- So often focus on intermediate outcomes
Intermediate Outcomes in CEA

- Intermediate outcomes (CEA)
  - Reduced A1c among targeted group
  - Lower BMI among targeted group
  - Increased hours of weekly exercise
  - Number of target group that stops smoking

- Related to final outcomes (CEA)
  - If A1c maintained in normal range, then less likely to have complications
  - If normal BMI maintained, then XX years of life gained
  - Outcomes depend on validity of assumptions
  - Expected outcomes
What are Expected Outcomes?

Create a Decision Tree

- % of population targeted for intervention
- Adjust for % who participate
- Adjust for % effectively treated
  - % adherence to intervention, relapse
- Adjust for % with improved health status from intervention
- Expected benefit from successful intervention
  - Number of years of life gained * successful cases
What are Expected Outcomes?

Create a Decision Tree

- Percentage population targeted for intervention (17%)
  - 250,000 people living in Lincoln, NE and 17% smoke = 42,500
- Adjusted for percentage who participate (10%) = 4,250
- Adjusted for percentage effectively treated (15%) = 638
  - Adherence to intervention versus relapse

\[ 250,000 \times 0.17 \times 0.10 \times 0.15 = 638 \] successful participants

Assumed benefit: Increase life expectancy by 40 years on average if new behavior is maintained over lifetime

\[ 40 \times 638 = 25,520 \text{ YOLS} \]

- Note YOLS based only on those who succeed, not larger groups
Cost Utility Analysis Outcomes

When is CUA used?

- When quality of life is important
- When the program affects both morbidity and mortality of participants
- When the programs being compared have a wide range of outcomes but all have an effect on healthy years of life
  - Diabetes self-management education versus violence prevention
  - Reducing secondhand smoke exposure versus increasing prenatal care
Down the Rabbit Hole: QALYS
Adjust YOLS for Quality of Life (QALYS)

- QALYS take into account morbidity occurring in additional years of life
- Time spent in a particular health state multiplied by a preference weight for that state
- Q of L adjustment to YOLS ranges from 0 – 1
  - 0 = dead
  - 1 = perfect health
- If Q of L adjustment is .80 (80 percent)
  - 5 years (in poor health) = .8(5)
  - 5 years (in poor health) = 4 years in good health
Problems With QALYs

- Subjective and difficult to measure
- Whose QALY values should be used?
  - A representative sample of the population
  - The affected group only
- QALY scales will differ depending upon:
  - Age group represented
  - Health status represented
- Limited applicability in primary prevention, high applicability in secondary & tertiary prevention
  - Captures disease progression
Cost/Benefit: Depends on Perspective

LOST

Human; no hair; 6’ 0”
Responds to “Bark, bark”
Key Concept: Perspective of Analysis

- **Narrow**: Includes benefits and costs to the individual
- **Intermediate**: Includes benefits and costs to
  - Public Health Agency
  - Medical Care Provider
  - Payer: Health Plan or Government
  - Consumer Group
- **Broad (Societal)**: Includes the benefits and costs to the entire population
Optional Exercise on Perspectives:

Based on the different costs identified earlier when we talked about direct & indirect costs:

- Which fall into costs borne by the individual?
- By an intermediary or organization?
- By society?
Key Concept: Time Horizon

- Over what period will you observe and include outcomes and costs of intervention?
- Benefits and costs from the intervention
  - Short term (1 year or less)
  - Longer term (more than 1 year)
  - Lifetime benefits or costs
- The longer the time horizon the greater the uncertainty about outcome and cost
- The preference is for something now
Discount Rate Used

- If you include costs and benefits over more than one year, you must discount them to their present values
  - Otherwise adding apples and oranges
- Use Low Social Rate of Discount: 3%-5%
- Benefits and costs are lower in present value the further in the future they occur
Discounting Common Monetary Units

$60,000 in benefits received (or expenses paid) in one year at 5% rate
- $60,000/(1.05) 1 = $57,142.86

$60,000 in benefits received (or expenses paid) in 50 years at 5% rate.
- $60,000/(1.05)50 = $5,232.22

→ Present value is lower the farther in the future the benefits or costs occur
Key Concept: Uncertainty

- Effect of intervention on outcomes and costs is not known with certainty
  - We make assumptions
    - We can manage participant enrollment, adherence
    - Avoided costs (side effects) are correct
    - We have used the proper discount rate
    - Our budgeted costs are correct

- How to deal with uncertainty?
  - Sensitivity analysis (best, base and worst case scenarios)
Accounting for Uncertainty: Sensitivity Analysis

- Identifies critical variables

- Variables in sensitivity analysis
  - Risk of disease or injury
  - Discount rate (0-5%)
  - Direct costs of program
  - Value of estimated benefits
  - Patient compliance, adherence
    - Successful quitters = 5% or 50% of participants
# Summarizing EE Types

<table>
<thead>
<tr>
<th>Type of Analysis</th>
<th>Outcome (Benefit)</th>
<th>Measurement of Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost Minimization</td>
<td>Identical, but costs are different</td>
<td>None (or kept constant)</td>
</tr>
<tr>
<td>(CMA) $\Rightarrow$ $\Rightarrow$</td>
<td><em>Can we do it for less?</em></td>
<td>Natural units e.g. life years gained, A1C levels, blood pressure, improved nutrition/physical activity</td>
</tr>
<tr>
<td>Cost Effectiveness</td>
<td>Single common benefit (or outcome)</td>
<td>QALYS, DALYS (discounted)</td>
</tr>
<tr>
<td>(CEA) $\Leftrightarrow$</td>
<td><em>Are the (natural) outcomes worth the cost?</em></td>
<td></td>
</tr>
<tr>
<td>Cost Utility</td>
<td>1 or more benefits (outcomes) standardized into a single value</td>
<td>Present value of $$; Monetary value of a YOLS or QALY</td>
</tr>
<tr>
<td>(CUA) $\Leftrightarrow$</td>
<td><em>Are standardized outcomes worth the cost?</em></td>
<td></td>
</tr>
<tr>
<td>Cost Benefit</td>
<td>Single, or multiple benefits (outcomes) standardized into a single monetary value (in present dollars)</td>
<td></td>
</tr>
</tbody>
</table>
Summary

- Economic evaluation is the comparison of costs and benefits of alternative interventions to determine the most efficient and effective allocation of scarce resources.

- Economic evaluation provides information for rational decision-making by public health professionals and policy makers.
Key Take Away: Match EE Type with Question of Interest

- Do we know all our costs?
- What outcomes are we comparing?
- What is the time horizon for incurring both costs and benefits?
- What level of (or perspective on)
  - Cost, benefits, effectiveness do we need?
Reflection
1) What was the intervention/program?
2) In what setting? What population?
3) What type of economic analysis?
4) From whose perspective?
5) What were the cost & types of costs?
6) What were the benefits?
7) How do findings support case for DSME?
More Economic Evaluation Slides; Drinking from the Fire Hose

Photo source: Massachusetts Institute of Technology, Alumni Newsletter; http://alum.mit.edu/news/QuickTake/Archive/200908/
Key Concept: Opportunity Cost

- Opportunity Cost of a decision:
  - The value (net benefit) of what is given up to produce more health.
    - Net benefit lost from more health versus producing more education, better roads and streets, national defense, law enforcement
  - To produce more chronic disease prevention programs, what other public health programs (and other public programs) must be given up and at what cost to society when we do so?
Lowest Opportunity Cost: Example

Cost per year of life saved (C/B ratio):

- **Pneumonia vaccine**
  - $2 million/100 YOLS = $20,000

- **Influenza vaccine**
  - $2 million/11,100 YOLS = $180

- Which has lower C/B ratio?

*Note: these examples are fictitious*
Lowest Opportunity Cost: Example

Same Resource Cost: Budget = $2 Million
Same Population Served: Denver citizens

<table>
<thead>
<tr>
<th>INTERVENTION</th>
<th>NET BENEFITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia vaccine</td>
<td>100 life-years gained</td>
</tr>
<tr>
<td>Influenza vaccine</td>
<td>11,100 life-years gained</td>
</tr>
</tbody>
</table>

- What is opportunity cost of influenza vaccinations?
  100 LIFE YEARS
- What is the opportunity cost of pneumonia vaccination?
  11,100 LIFE YEARS
- Which has the higher opportunity cost?
  PNEUMONIA VACCINE

Note: these examples are fictitious
Averted Productivity Losses

- Present value of higher future wages earned because of disease prevention
  - Intervention increases worker life expectancy
  - Intervention reduces disability so can earn more

- Benefits to employers/society
  - Intervention makes workers more productive
  - Produce more output; pay more taxes

- Not used in cost-utility analyses (CUA)
  - Utility measure implicitly includes the value of additional working life years gained
Comparing QALYS: Example

- **Intervention A:**
  - Saves 5 years of life but with disability
  - Quality adjustment for disability = 0.7
  - QALY: \(0.7 \times 5 = 3.5\) QALYs

- **Intervention B:**
  - Saves 4 years of life with no disability
  - Quality adjustment: 1.0
  - QALY: \(1 \times 4 = 4\) QALYs

- **Intervention B** is preferred to **A**
Alternative to QALYs: DALYs

- Disability Adjusted Years of Life
- DALYs are a cost or burden to society
- Definition: Years of healthy life lost through premature death and disability

- DALYS and QALYS not comparable
- Goal: reduce DALYs; increase QALYs
Converting QALYs to Dollars

- Monetary Valuation (Human Capital Approach)
- Value of a year of life saved based on average annual (hourly) earnings
  - Average worker earns $50,000 per year, working 40 hours per week
  - Value of a year of life saved = $50,000

- What is the value if person does not work?
  - What if the person is a doctor or a farmer?
Discounting Benefits: YOLS and QALYs

- Is an added year of life less valuable to you, the further into the future that it is received and enjoyed?
  - Do younger people value increased years of life more or less than older people who are closer to the end of life?
  - Discounting reflects this difference in the value of an additional year of life by age
Converting to Common Temporal Monetary Units

- Future Benefits (and Costs) measured in monetary units must be discounted to reflect PRESENT VALUES

- Money received tomorrow is worth less than money received today
  - \( \frac{10.00}{(1.10)^1} = 9.09 = \text{value today @ 10\%} \)
  - Future Value of year of life in 20 yrs = $50,000
  - Present Value of a year of life $27,683
    - \( \frac{50,000}{(1.03)^{20}} \)
Sensitivity Analysis

- Vary the values of key variables over a given range, e.g., adherence from 5% to 50%
- Use these values to calculate different costs and/or benefits
- Variables with the greatest impact on C/B and C/E ratios create greatest risk to program success
- These need to be monitored and well managed