Introduction to Economic Evaluation in Healthcare
We all are (applied) economists!

- We evaluate costs and effects everyday
- We prioritize our choices
- We make resource allocation decisions with limited budgets
Comparative Analysis in Real Life
Economic Perspective on Health and Medical Care Production

- Health care production is complex: economists think of it as a “Health Production Function.”
  - General Production Function:
    - Output = f(Inputs)
  - Health Production Function:
    - Health = H(hospital stays, doctor visits, drugs, OTHER)
    - At a population level, OTHER (e.g., the social determinants of health, such as diet, lifestyle, income, etc., are important)

- Individuals trade off health versus other economic goods.
  - The physician acts as the “patient’s agent” in organizing and advising on this process.
  - The demand for medical care is “derived demand” from the demand for health.
Economics vs. Health Economics

- Economics is the study of how societies allocate their inherently scarce resources to satisfy the demands of their citizens.
- Health economics focuses on how these scarce resources are allocated to produce health and well-being, and, in particular, the roles that medical care and health insurance play.
- Economics posits that private markets are generally an “efficient” mechanism for allocating resources, maximizing the benefits received from the limited resources.
- However, in the case of health care markets, a number of special circumstances occur that require special interventions and adaptations to improve efficiency.
What is unique about the economics of health care?

• Healthcare markets have special features—very different from markets for other products

• The main difference is the pervasiveness of uncertainty
  – In terms of what works and doesn’t work
  – The demand for services difficult to predict

• Another key difference is “Informational asymmetry” between providers and patients and between insurers and subscribers

Special adaptations of healthcare markets?

• Interventions and institutions have arisen in response to this uncertainty:
  – Insurance and its regulation
  – Provider licensure
  – Drug and device regulation
  – Subsidized education
  – Health technology assessment

Defining Economic Evaluation

• **Comparison** of two or more alternative health interventions, treatments, or programs in terms of their **costs** and **effectiveness**—with effectiveness measured in the same units

• Costs refer to the value of resources involved in providing a treatment or intervention

• Consequences (health outcomes) are the health effects of the intervention

The Importance of Defining a Comparator

• Analysts need to define a comparator or “base case” and define both policy and specific interventions as changes from the base case

• For specific interventions e.g. clinical procedures, the natural base case is the status quo or standard of care

• The base case is less obvious for policy interventions

• Probably best to define policy base cases that are close to the current reality for policy makers—incremental CEAs from these bases provide more interpretable information

• Sometimes it is important to consider the impact of doing less than is being done in the base case thereby generating negative costs and effects.
  – Such negative intervention may prove to be highly cost-effective
Comparative Analysis in Healthcare

• Assuming **two** health interventions for comparison in an health economic evaluation
  
  – **Intervention A** is the existing intervention
  
  – **Intervention B** is the new or novel intervention

• As an analyst, you would like to compare the value of intervention B (the new intervention) to intervention A (the old intervention)
  
  – The **comparative analysis** considers the costs and health outcomes (effectiveness) of A and B
  
  – **Gold standard of effectiveness measures** is quality-adjusted life-year (QALY) or disability-adjusted life-year (DALY), both measure that combine length and quality of life
    
    • Cost per DALY averted
    
    • Cost per QALY gained
Trade-offs and Balance

VALUE

Cost

Health Outcome
Resources for Healthcare

• Monetary resources i.e., $, ¥, €, £, etc.

• Health system capacity e.g. human resources, infrastructure, etc.

• To implement an intervention, the system uses some of each resource
  – Some interventions need more of one or the other

• In poor countries with low health system capacity, it is important to select interventions that require relatively little health system capacity

Shaded box represents the traditional domain of **Value Assessment** in healthcare which do not include Financial Risk Protection and Health System Capacity in their calculations.
Rationale for Economic Evaluation in Healthcare

• Information on efficacy and effectiveness is necessary but not sufficient for making healthcare decisions
  – It is also necessary to consider the opportunity costs (benefits forgone) of alternative courses of action

• Healthcare does not have a typical market where supply and demand are brought together using a price mechanism
  – Governments intervene (to different extents) to deliver and finance healthcare

• Given scarce resources and the absence of a price signal, policy makers need a means to allocate resources between competing demands
  – Explicit consideration of the opportunity cost of alternative courses of action is necessary
Uses of Economic Evaluation in Healthcare

• To guide decision makers (usually public sector) on whether/when to change intervention mix or whether/when to change intervention coverage levels.

  – Often the questions asked pertain to specific health problems.

• To inform health policy.

  – Health policy can be defined as the "decisions, plans, and actions that are undertaken to achieve specific health care goals within a society. [WHO]

• To generate cost-effectiveness generalizations to support or undermine broad generalizations in healthcare policy options.

Use of Economic Evaluations by Policy Makers

• Policy makers need evidence
  – They don’t do stuff because of divine intervention but because evidence was generated and synthesized

• Estimates of costs, effectiveness and cost-effectiveness provide clear guidance to policy-makers when:
  – The effectiveness target is clear and the economic evaluation seeks to minimize the expenditure needed to achieve the target
  – The budget constraint is clear and the aim is to maximize health benefits within the given budget
  – The acceptable threshold cost-effectiveness is clear and explicitly stated
Value for Money in Healthcare is Important in Rich and Poor Countries

- Poor countries spend very little annually per capita on health and achieve poor outcomes
  - With a high burden of treatable and preventable diseases, a few extra dollars, used without formal assessment of value i.e. misspent, would mean a lost opportunity to postpone many deaths and prevent substantial disability.

- Rich countries spend large amounts annually per capita on health and achieve good outcomes.
  - With the high (and rising) cost of healthcare, an improved intervention mix might reduce healthcare spending (or at least reduce the rate of growth of healthcare spending).
  - Many new and expensive interventions are approved every year; which of these should payers reimburse?

Comparing A and B: The Cost-Effectiveness Plane

Higher Cost

Higher Effectiveness

Lower Effectiveness

Lower Cost

NE Quadrant
B is more costly and less effective
ADDITIONAL ANALYSIS NEEDED

SE Quadrant
A is less costly and more effective
[B is DOMINANT]
ADOPT B

NW Quadrant
B is more costly and less effective
DON’T ADOPT B

NE Quadrant
B is more costly and more effective
ADDITIONAL ANALYSIS NEEDED

NW Quadrant
B is more costly and less effective
DON’T ADOPT B

NE Quadrant
B is more costly and more effective
ADDITIONAL ANALYSIS NEEDED
NE Quadrant — The ICER

- Intervention B is both more costly and more effective than intervention A
- This situation is the most common
  - Innovative technologies tend to increase effectiveness relative to standard of care at an added cost (a premium on innovation)

\[
\text{ICER} = \frac{\text{Mean Cost (B)} - \text{Mean Cost (A)}}{\text{Mean Outcome (B)} - \text{Mean Outcome (A)}}
\]

Mean Outcome (A)

- Costs are always measured and presented in currency units ($, £, €, UGX, etc.)
- Outcomes are measured in a variety of ways but must be in the same units for comparators A and B
Some Examples of ICERs

Intensive care for seriously ill patients with multiple trauma (460'000 USD / LYG)

Home dialysis (vs. transplantation) for end-stage renal disease

Cervical cancer screening every five years for women age 35 + with 3+ kids

Lovastatin for men age 55-64 with heart disease and <250 mg/dl

Tengs T.O et al. Risk analysis 1995
ICERs and Cost-Effectiveness

- Three approaches to determine if an ICER ($/DALY averted or $/QALY saved) represents value for money in a given society
  - Thresholds
  - Benchmark interventions
  - League tables
Thresholds

- Most common threshold in LMICs is GDP-based
  - Highly cost-effective — ICER < GDP per capita
  - Cost-effective — ICER between GDP per capita and 3 X GDP per capita

- Limitations of GDP-based threshold
  - Obscures important comparisons
  - Thresholds are easily attained
  - Based on untested assumptions and no empirical data
  - Affordability not adequately appraised

- High-income country thresholds vary but tend to be higher
  - UK (NICE) — £20,000 to £30,000 per QALY
    - Recent study suggests that this is too high and that £13,000/ QALY is more accurate (£13,000 of NHS resources adds one QALY to the lives of NHS patients)
  - US — $50,000 to $200,000 per QALY
Benchmark Interventions

• Citation of the cost-effectiveness of a benchmark intervention that has already been adopted
  – Example is dialysis as the basis of (traditional) $50,000 per QALY in the US

• Suggests that willingness to pay has already been decided

• Therefore overall health benefits will increase by transferring funds from interventions that cost more to interventions that cost less than benchmark

• Approach exhibits better local relevance

• Limitations of benchmark interventions
  – ICER for benchmark may be a high or low outlier
  – Benchmarks don’t take affordability into account
  – There might be available options that have a better ICER than either the benchmark intervention or the intervention under evaluation
League Tables

• With league table approach, no need for thresholds; all interventions that have potential for scale are ranked in league table according to ICERs

• Assumes that health outcomes are maximized if implementation starts with interventions with the smallest ICER (at top of league table)

• Different kinds of league tables, big and small
  – WHO league tables
  – TUFTs CEA registry

• Limitation of league tables
  – ICERs may not be available for many relevant options or settings

• Advantages of league tables
  – Consider affordability
  – need not be comprehensive to support improved resource allocation
    • Can indicate benefit of cancelling some programs and funding new ones
## League Table Example

Marseille et al. (Bull World Health Organ 2015)

<table>
<thead>
<tr>
<th>Intervention (description)</th>
<th>Annual cost (million I$) per million people</th>
<th>Annual no. of DALYs averted per million people</th>
<th>Incremental no. of DALYs averted per million people</th>
<th>Incremental cost (Million I$ per million people, I$ per DALY averted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAL-27 (case management with ACT, 80% coverage)(^b)</td>
<td>0.25</td>
<td>26426</td>
<td>26426</td>
<td>0.25 (9)</td>
</tr>
<tr>
<td>MAL-7 (MAL-27 but 95% coverage)</td>
<td>0.33</td>
<td>31470</td>
<td>5044</td>
<td>0.08 (16)</td>
</tr>
<tr>
<td>MAL-17 (combination of ACT, IPTP and ITNs, 95% coverage)</td>
<td>1.07</td>
<td>44115</td>
<td>12645</td>
<td>0.74 (59)</td>
</tr>
<tr>
<td>MAL-20 (MAL-17 plus IRS)</td>
<td>1.59</td>
<td>49518</td>
<td>5403</td>
<td>0.52 (96)</td>
</tr>
</tbody>
</table>

*ACT*: artemisinin-based combination therapy; *DALY*: disability-adjusted life-year; *I$: international dollars; *IPTP*: intermittent preventive therapy for pregnant women; *IRS*: indoor residual spraying; *ITNs*: insecticide-treated nets.

\(^a\) A list of countries in the Africa D region is available from: [http://www.who.int/choice/demography/african_region](http://www.who.int/choice/demography/african_region).

\(^b\) The costs and DALYs averted by MAL-27 were compared with no intervention. Each of the other three options was compared with the next cheapest intervention, i.e. the intervention in the row above.

Data source: World Health Organization.\(^6\)
**SW Quadrant — The “Decremental” CER (DCER)**

- In theory, limited benefits could be sacrificed for substantial resource savings, permitting reallocation of resources to higher-value alternative.

- In the SW quadrant, the CER is a measure of savings per outcome loss:
  - A higher DCER is better.

- Decrementally cost-effective innovations have potential for maximizing health benefits while minimizing costs.
  - May be especially attractive in poor countries.

- Examples in the literature:
  - Watchful waiting in inguinal hernia (Stroupe et al, 2006)—DCER=$194,300/QALY
  - Percutaneous coronary intervention for multi-vessel coronary artery disease (Weintraub et al, 2004)—DCER=$3,210,000/QALY
  - Pharmacy refill compared to physician follow-up for HIV care (Babigumira et al, 2011)—DCER=$13,500/favorable immune response
Importance of Incremental Analysis

• Classic example – the “sixth stool guaiac” (Neuhauser and Lewicki, 1975)
• In mid-1970s, when colon cancer was suspected, each stool sample was tested 6 times
  – Test 1 part of the sample and if positive, do additional tests
  – If negative, test 2nd part of sample and if positive, do additional tests
  – On up to 6th part of sample to declare individual negative
### Average Analysis — Average CE Ratio (ACER)

Cases of colon cancer detected per 10,000 population with six sequential tests

<table>
<thead>
<tr>
<th>No. of tests</th>
<th>Total cases detected</th>
<th>Total costs</th>
<th>Calculation</th>
<th>ACER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>65.0465</td>
<td>$77,511</td>
<td>$77,511/65.0456</td>
<td>$1,192</td>
</tr>
<tr>
<td>2</td>
<td>71.4424</td>
<td>$107,690</td>
<td>$107,690/71.4424</td>
<td>$1,507</td>
</tr>
<tr>
<td>3</td>
<td>71.9003</td>
<td>$130,199</td>
<td>$130,199/71.9003</td>
<td>$1,811</td>
</tr>
<tr>
<td>4</td>
<td>71.9385</td>
<td>$148,116</td>
<td>$148,116/71.9385</td>
<td>$2,059</td>
</tr>
<tr>
<td>5</td>
<td>71.9417</td>
<td>$163,141</td>
<td>$163,141/71.9417</td>
<td>$2,268</td>
</tr>
<tr>
<td>6</td>
<td>71.9420</td>
<td>$176,331</td>
<td>$176,331/71.9420</td>
<td>$2,451</td>
</tr>
</tbody>
</table>
### Incremental Analysis — Incremental CE Ratio (ICER)

Incremental cases detected and incremental costs with six sequential tests

<table>
<thead>
<tr>
<th>No. of tests</th>
<th>Total cases detected</th>
<th>Inc. cases</th>
<th>Costs</th>
<th>Inc. costs</th>
<th>ICER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>65.0465</td>
<td></td>
<td>$77,511</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>71.4424</td>
<td>6.3959</td>
<td>$107,690</td>
<td>$30,179</td>
<td>$4,718</td>
</tr>
<tr>
<td>3</td>
<td>71.9003</td>
<td>0.4579</td>
<td>$130,199</td>
<td>$22,509</td>
<td>$49,157</td>
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<tr>
<td>4</td>
<td>71.9385</td>
<td>0.0382</td>
<td>$148,116</td>
<td>$17,917</td>
<td>$469,031</td>
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<tr>
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<td>71.9417</td>
<td>0.0032</td>
<td>$163,141</td>
<td>$15,025</td>
<td>$4,695,313</td>
</tr>
<tr>
<td>6</td>
<td>71.9420</td>
<td>0.0003</td>
<td>$176,331</td>
<td>$13,190</td>
<td>$43,966,667</td>
</tr>
</tbody>
</table>
## Types of (Full) Economic Evaluations

<table>
<thead>
<tr>
<th>Method of Analysis</th>
<th>Cost Measurement</th>
<th>Outcome Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost-Consequences Analysis</td>
<td>$</td>
<td>Multi-dimensional listing of outcomes</td>
</tr>
<tr>
<td>Cost-Minimization Analysis</td>
<td>$</td>
<td>Equivalence demonstrated or assumed in comparative groups</td>
</tr>
<tr>
<td>Cost-Effectiveness Analysis</td>
<td>$</td>
<td>Single “natural” unit outcome measure</td>
</tr>
<tr>
<td>Cost-Utility Analysis</td>
<td>$</td>
<td>Multiple outcomes—life-years adjusted for quality-of-life</td>
</tr>
<tr>
<td>Cost-benefit Analysis</td>
<td>$</td>
<td>$</td>
</tr>
</tbody>
</table>
Thanks very much

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