Cost-Effectiveness Using Decision-Analytic Models

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Overview

• This presentation will focused on the decision-making process and fundamental models used in cost-effectiveness analysis.
• Examples of Cost-Effectiveness Analysis
• Limitations and strengths will be discussed.
• Resources for further discussion.
Learning Objectives

• At the end of the presentation, you will learn the following for your own study design:
  – the decision-making process.
    the framework used in decision-analytic model.
  – the application in cost-effectiveness analysis.
Outline of Presentation

1. Concept of “PROACTIVE” in Modeling.
2. Structure of Decision Analysis
3. Components of Cost-Effectiveness Analysis
4. Research Studies
5. Limitation and Strengths
6. Resources
Decision Analysis

“A good decision is a logical decision – one based on uncertainties, values, and preferences of a decision-maker.”

Ronald Howard
Professor, Stanford University
PROactive

Step 1: Defining the problem

P: Problem
R: Reframe the perspective
O: Objectives of interest
proACTive

Step 2: What are the alternatives, consequences and trade-offs?

A: Consider Alternatives.
C: Model Consequences
T: Identify Trade-offs.
proactive

Step 3: Integration and exploration

I: Integrate evidence
V: Optimize Expected Value
E: Evaluate Uncertainty.
PROACTIVE

P: Problem
R: Reframe
O: Objectives
A: Alternatives
C: Consequences
T: Trade-offs
I: Integrate
V: Value
E: Evaluate
A Decision Tree

A visual representation of all the possible options and the consequence that may follow each option.
Decision Analysis Tree

Step 1: **PROactive**

Step 2: **proACTive**

Step 3: **proactIVE**

**Chance node**

- Treatment A
  - live
    - Cost per Health Benefit
  - die
    - Cost per Health Benefit

**Decision node**

- No Treatment
  - Cost per Health Benefit

**Terminal node**
Cost-Effectiveness

• Using decision-analytic models to consider the economics costs of health care.

• Health resources are consumed in order to produce health benefits.
Research Questions

• What is the most efficient use of this health resources, given the alternative uses?
  – Time
  – Resources
  – Cost
Time-effectiveness

An hour of a physician’s time spent with one patient is unavailable for another patient.
Resource-effectiveness

• Health resources are consumed in order to produce health benefits.
• Resources used for one program cannot be spent to increase the program use of another or invest in new program.
Cost-Effectiveness Graph

- Superior
- Trade-Off
- Effect
- Costs

Superior vs. inferior
Trade-Off vs. ?
Cost-effectiveness

- Common measure of costs & health effectiveness.
- Measure can be expressed as
  - Cost
  - Case of disease prevented
  - Lives saved
  - Years of life saved
  - Quality adjusted life year
Perspective

• A range of decision-makers confront these decisions.
  – Societal perspective
    Patient
  – Provider
  – Organizational
Different Types of Cost

• *Total Resource Use* includes different types of cost
  – Health care resource
    Nonhealth care resource
Cost Calculation

• Laying out the cost
• Categorize the cost in term health vs. non-
• Organize the sequence of event
  – Initial cost
  – Induced cost
  – Adverted cost
• Consider short or long-run resource cost
Probabilities

- Probability is the chance of the event.
- Range in 0 to 1.0
- 0 = event is impossible
- 1 = event is certain
- 0.5 = the event is equally as likely to occur as not to occur
Preferences

• Preference-based measures reflect the values an individual has for a particular health states or the relative desirability of health outcome.
Effectiveness

• Health benefits in CEA can be expressed as
  – Single measure of health outcome
    • Number of Cases Prevented
    • Number of Cases of Cancer Detected
    • Number of Hospital Days Reduced
  – Combined measures
    • Quality Adjusted Life Years (QALYs)
Using cost-effectiveness analysis

- Cost-effectiveness using decision-analytic modeling
  - summarize large amount of information.
  - clarify the decision-making process.
  - compare the different scenarios in complex system.
Incremental Cost-effectiveness ratio (ICER)

Incremental cost-effectiveness ratio (ICER)
-- costs to benefits and is expressed as $ per life saved or the cost per QALY saved.

\[
\frac{\text{Cost}_{\text{intervention A}} - \text{Cost}_{\text{intervention B}}}{\text{Effectiveness}_{\text{intervention A}} - \text{Effectiveness}_{\text{intervention B}}}
\]
Decision Analysis Tree

Decision node

Chance node

Treatment A

live

0.9

$400K/10 life years

0K/0 life years

0K/8 life years

Decision node

No Treatment

Terminal node

$50K/0 life years

$0K/0 life years

Components of CEA
Incremental Cost-Effectiveness Ratio (ICER)

Question: Is the extra health benefit worth the extra cost?

\[
\frac{\$400K_{\text{intervention A}} - \$100K_{\text{intervention B}}}{10 \text{ life years}_{\text{intervention A}} - 8 \text{ life years}_{\text{intervention B}}}
\]

\[\text{ICER} = \frac{\$300 \text{ K per 2 life years}}{} = \frac{\$150K}{\text{life year}}\]

Answer: If intervention A is chosen, the additional investment of $150K results in one additional life year, relative to Intervention B.
Handling Uncertainty

Parameter and Model structure uncertainty addressed using sensitivity analyses.

- One-Way
  - Two-Way
- Multi-way
- Probabilistic
Examples
Cost-effectiveness Studies Registry

https://research.tufts-nemc.org/cear4/
Limitations

• Availability of Data
• Modeling vs. Real-time Experiment
• Assumption
• Uncertainty
Strengths

- Illustrate a Visual Aid.
- Formulate Objective.
- Evaluate Complex System.
- Inform Policy and Guidelines.
- Guide Research.
References and Resources

- Software: TreeAge
HERC resources

http://www.herc.research.va.gov/home/default.asp
Research Societies

- SMDM (Society for Medical Decision Making)
- ISPOR (International Society for Pharmacoeconomics and Outcomes Research)
- Decision Sciences Institute
- INFORMS (Institute for Operations Research and the Management Sciences)
Summary

• Use “PROACTIVE” modeling in your design.
• Construct a decision analysis tree.
• Use cost-effectiveness analysis.
• Compare research studies.
• Understand the limitations and strengths.
• Find resources and references.
Contact Information

If you have any questions or would like to collaborate, please contact me:

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