Value-of-Information Analysis for Patient-Centered Outcomes Research Prioritization

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VALUE OF INFORMATION: BASIC CONCEPTS

Value-of-Information (VOI) Analysis

- "Should I make a decision based on the information I currently have, or should I collect more data before I decide?"
- VOI is Bayesian approach to this question
  - Construct probabilistic decision model
  - Estimate both
    - Optimal decision given current information
    - Likelihood of that decision being wrong, along with consequences of wrong decision
  - If cost of obtaining more information less than costs/consequences of wrong decision, than collecting more data worthwhile

VOI – Example

- Two treatments, A and B, for fatal disease
- Costs of treatment equivalent, only cost differences due to complications
- Data on effectiveness from small studies (A, n=50; B, n=100)

Parameter	Treatment A (95% CI)	Treatment B (95% CI)
Cure rate	94% (86.0 to 98.6%)	90% (83.5 to 95.0%)
Life expectancy if cured	20 years	
Life expectancy if treatment fails	5 years	
Costs of managing treatment failure	$50,000	
Overall complication rate	20% (10.0 to 27.5%)	5% (2.1 to 10.1%)
Mortality rate after complication	10% (8.2 to 12.0%)	
Cost of complication	$10,000	
Costs associated with fatal complication	$50,000	

Expected Value with Current Information

- Estimates based on mean values (not incorporating uncertainty)
- Treatment A has better life expectancy but higher costs
  - Incremental cost-effectiveness $692
  - A is “optimal” if willingness-to-pay (WTP) for a QALY up to $692

Outcome	Treatment A	Treatment B
Mean life expectancy	18.72 years	18.40 years
Mean costs	$10,940	$10,725
Mortality from complications of treatment	2.0%	0.5%

Net Benefits

- Net benefits incorporate both incremental cost-effectiveness and willingness-to-pay (WTP) in single measure
  - Net monetary benefits
    *(WTP*Net quality-adjusted life expectancy)-Net costs*
  - Net health benefits
    Net quality-adjusted life expectancy – (Net costs/WTP)
- “Optimal” option is one with highest net benefit at any given WTP

Expected Value given Perfect Information (WTP=$750)

- Perform repeated simulations, drawing from distributions
- Calculate "optimal" choice for each simulation
- On average, B is optimal at WTP of $750

Simulation Number	Net Benefits Treatment A	Net Benefits Treatment B	Maximum Net Benefits	Preferred Strategy	Opportunity Cost
1	$4,180	$4,306	$4,306	B	$0
2	$2,273	$2,415	$2,415	B	$0
3	$7,095	$4,507	$7,095	A	$2,588
4	$3,186	$4,017	$4,017	B	$0
5	$3,504	$3,433	$3,504	A	$72
6	$5,698	$6,740	$6,740	B	$0
7	$4,762	$3,718	$4,762	A	$1,044
8	$3,960	$1,919	$3,960	A	$2,041
9	$5,071	$5,964	$5,964	B	$0
10	$1,904	$5,123	$5,123	B	$0
Expected value (mean of simulations 1–10)	$4,163	**$4,214**	$4,789		$575

Expected Value given Perfect Information (WTP=$750)

- In 4 individual simulations, A is optimal
- If we knew outcome of each simulation, would pick optimal choice each time

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Expected value (mean of simulations 1–10)	$4,163	$4,214	**$4,789**		$575

Expected Value given Perfect Information (WTP=$750)

- Expected value OF perfect information is difference between expected value based on highest mean and value if we knew results of each simulation ($575)

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Expected Value given Perfect Information (WTP=$750)

- Alternatively, opportunity cost of making wrong decision ($575)

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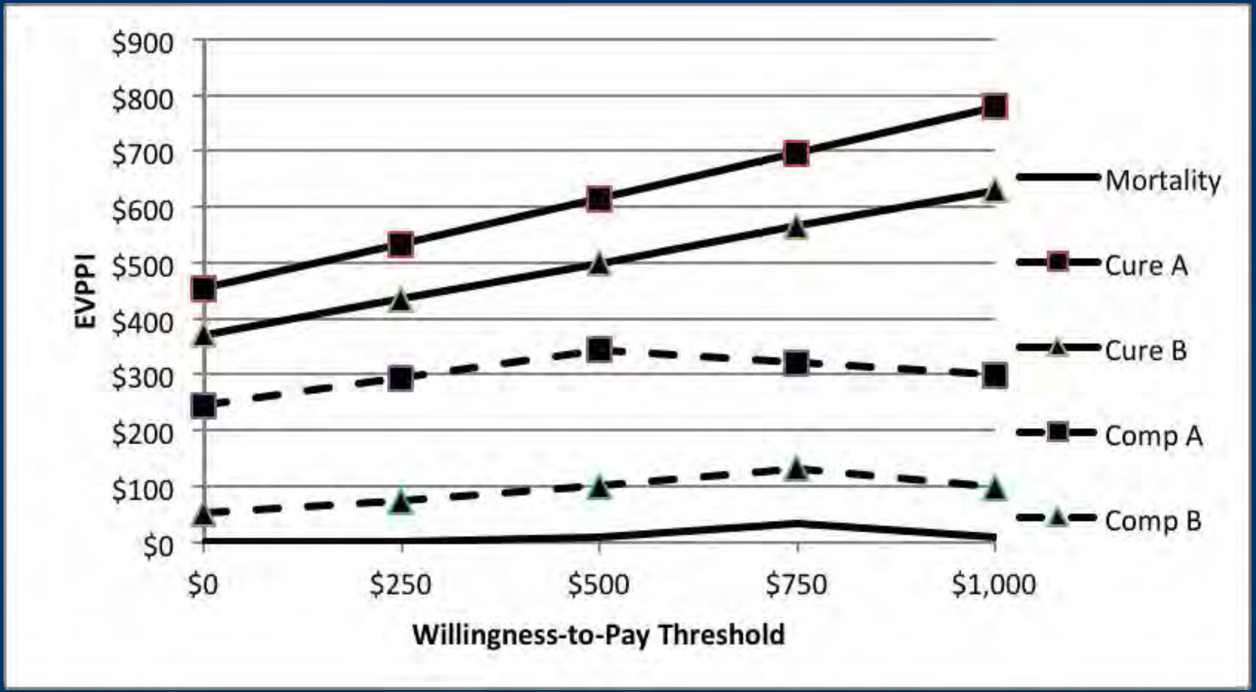
Expected Value of Perfect Information (EVPI)

- Results vary in simulation because of uncertainty around parameter estimates (e.g., wide confidence intervals)
- Reducing uncertainty (e.g., by narrowing confidence intervals with larger study) increases probability of "optimal" decision
- If cost of reducing uncertainty is less than expected value of perfect information, then further research is worthwhile

Expected Value of Partial Perfect Information (EVPPI)

- Can estimate impact of individual parameters
- Higher the EVPPI, greater contribution to uncertainty
- Helps prioritize specific research areas



CHALLENGES TO VOI FOR PATIENT-CENTERED OUTCOMES RESEARCH

Information vs. Implementation

- Implicit assumption behind VOI in health care: resolving uncertainty about outcomes will lead to greater use of effective treatments
  - Multiple examples of persistent use of ineffective or inefficient interventions despite evidence, or resistance to recommendations based on new evidence
    - *Cancer screening*
    - *Treatment of low back pain*
- If further research reduces uncertainty but does not result in changes in patient and/or provider behavior, then value of research is overestimated

Information vs. Implementation

- Can include assumptions/estimates about patient and provider responses to new evidence in model
  - Estimate “value of **implementation**” along with value of information
  - Research into understanding issues behind variable patient/provider use, or methods for improving adherence, may have higher priority than studies of clinical effectiveness

Addressing Heterogeneity

- "Classic" application of VOI in health care in UK:
  - Perform VOI analysis
  - Estimate per-patient EVPI
  - Estimate population-level EVPI by multiplying
    - *Estimated number of patients eligible for intervention*
    - *Expected time horizon for use of intervention*
    - *Discount rate*
- Population-level EVPI sets upper bound of reasonable research budget

Addressing Heterogeneity

- Heterogeneity in probabilities of outcomes
  - Per-patient EVPI may differ within subgroups (e.g., fibroids and African-American women)
  - Depending on relative sizes of subgroups, overall EVPI might be lower
- Heterogeneity in patient preferences for outcomes
  - Population-level preference distributions may underestimate values for individual subjects
  - May be value to individualizing care (e.g., early stage prostate cancer)
- Heterogeneity in patient preferences for other attributes of process of care
  - May be difficult to capture with QALYs

Limitations of QALYs for PCOR

- Standard methods for eliciting utilities for QALYs may not be appropriate for many situations
  - Conditions affecting infants and children
  - Conditions where there are outcomes for more than one patient
    - *Obstetrics*
    - *Infertility*
      - Parental utilities for chronic disability resulting from preterm birth approximately 0.95, permanent infertility 0.7
  - Decisions where outcomes are similar but other attributes of the process of care are important
    - *Obstetrics*
    - *End-of-life care*
    - *Choice of surgical approach*

Alternatives to Cost-Effectiveness

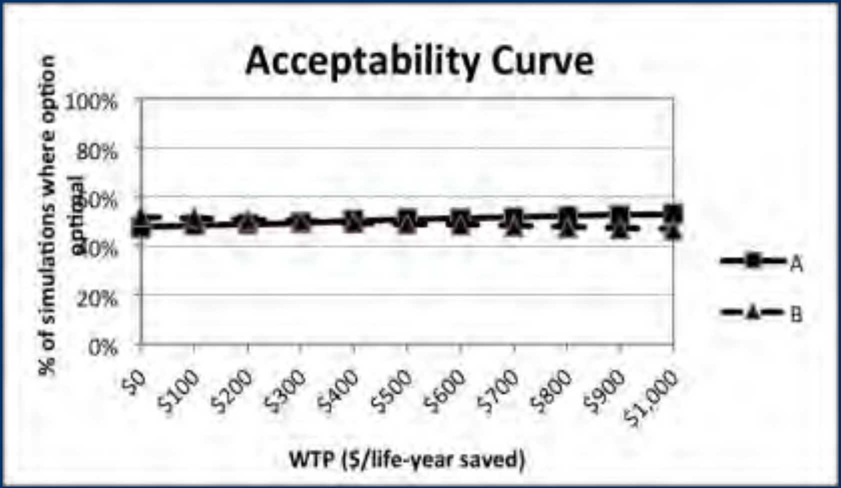
- Statutory limitations on use of cost-effectiveness and QALYs
- QALYs may not always be best option anyway

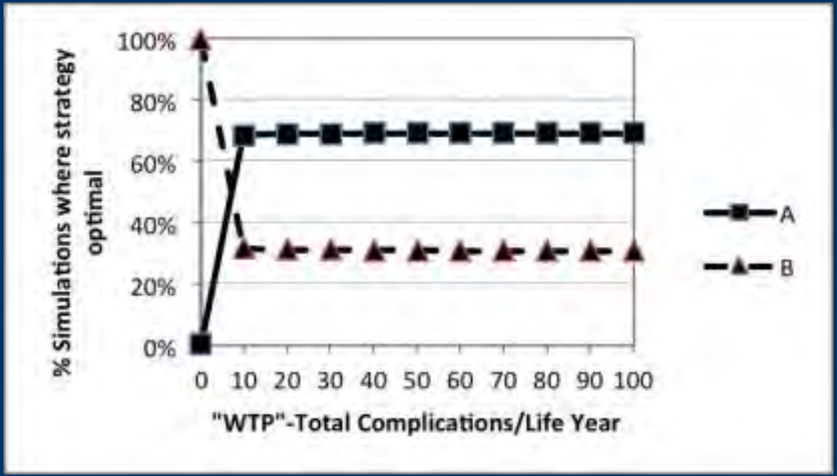
Alternatives to Cost-effectiveness Framework

- Cost-benefit analysis
  - Experience in environmental and regulatory economics (including at federal level)
  - Alternative methods for capturing patient preferences
    - *Revealed preferences (e.g., travel costs for appointments)*
    - *Stated preferences*
      - Discrete choice
        - Able to incorporate preferences for both outcomes and process
        - Can generate estimates of population distribution of preferences

Alternatives to Cost-effectiveness Framework

- “Harm/benefit” or other multicriteria decision analysis
  - Can consider adverse outcomes as “costs”
  - Can express trade-offs between these “costs” and outcomes in same way one expresses trade-offs between costs and effectiveness
  - Can illustrate uncertainty at different thresholds of “willingness-to-pay”
  - Might be particularly useful for developing guidelines, especially in conjunction with formal framework such as GRADE


Acceptability Curve
% of simulations where option optimal
100%
80%
60%
40%
20%
0%
$0
$100
$200
$300
$400
$500
$600
$700
$800
$900
$1,000
WTP ($/life-year saved)
A
B


% Simulations where strategy optimal
100%
80%
60%
40%
20%
0%
0 10 20 30 40 50 60 70 80 90 100
"WTP"-Total Complications/Life Year
A
B


% simulations where stragy optimal
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0 1 2 3 4 5 6 7 8 9 10
"WTP"-Fatal complication/life-year saved
A
B

Other Challenges

- Resources required to develop models
  - Limited expertise in both disease modeling and VOI—almost 40% of all papers identified in lit search from one of 3 groups
- Lack of stakeholder familiarity with concepts
- Lack of published experience on actual use of VOI for research prioritization
- Lack of coordination within US funding agencies about role, scope of VOI