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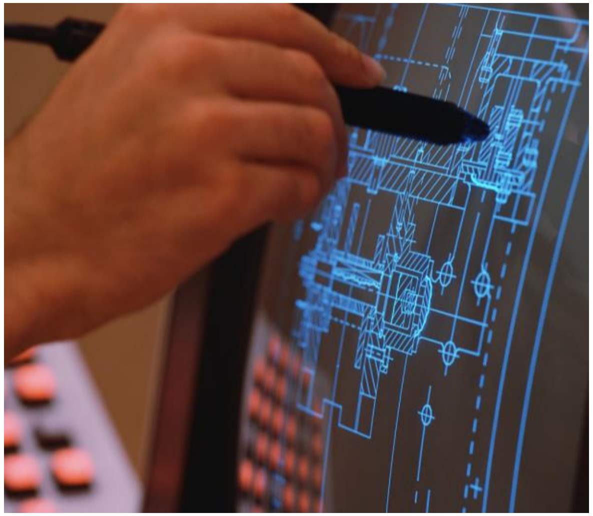
Value of Information to Inform Decision Making Under Uncertainty







Value of Information to Inform Decision Making Under Uncertainty

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Applications for Value of Information

- Prioritize where additional investment will lead to maximal benefits
- Identify research areas with the greatest likelihood of influencing clinical practice and patient outcomes
- Quantify the expected opportunity loss from decision making under uncertainty by estimating the value of obtaining additional information through research

Approach Relies on Bayesian Statistics

- Based on Bayes Rule: $P(A|B) = P(B|A)P(A)/P(B)$
- Traditional hypothesis testing (e.g., clinical trial) gives you p(data|hypothesis) but what you want is p(hypothesis|data)
- There is a 90% chance that the net benefit of protocol a exceeds that of protocol b
- p(expected benefit of future study|existing [clinical trial] data)

Decision Making Under Uncertainty

- Goal is to make the decision offering the greatest net benefit given constraints
- There is uncertainty in the inputs to the decision
- Expected cost of uncertainty is determined by the probability that a decision based on existing information will be wrong and the consequences if the wrong decision is made
- Expected value of (im)perfect information

Expected Value of Information is determined by:

- The estimated mean net benefit of the new technology/drug/intervention
- The amount and results of existing data
- The value placed on opportunity losses when they occur
- The size of the patient population who could benefit from the new technology/drug/intervention

General Form of the Approach

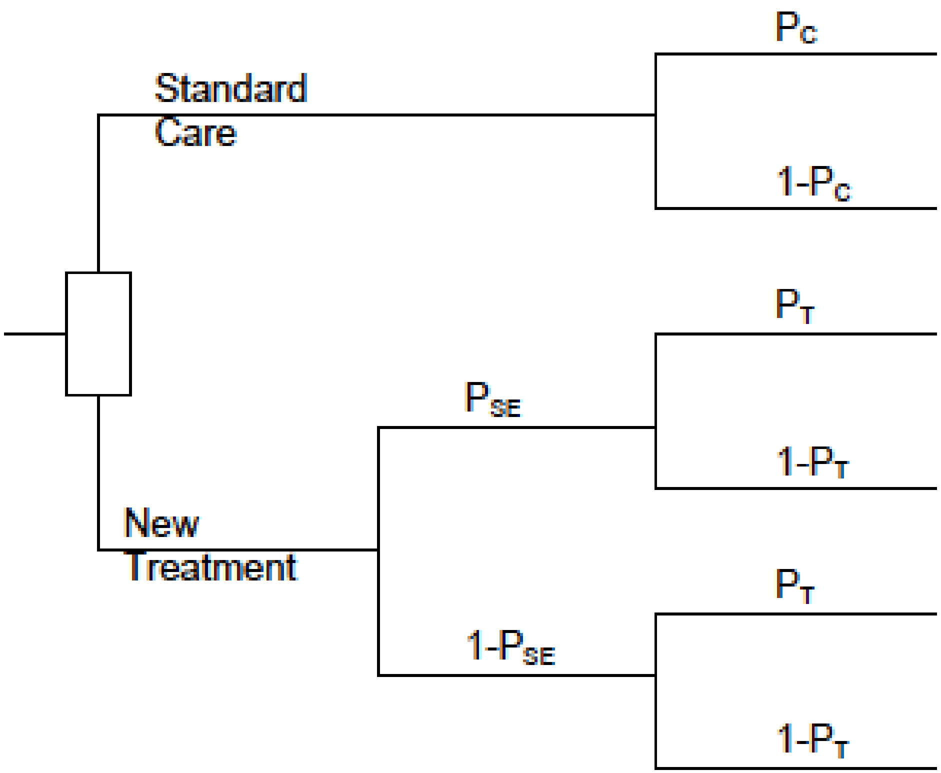
$EVPI = E\{\max_a NMB(a,s)\} – \max_a \{NMB(a,s)\}$

- where $E\{\max_a NMB(a,s)\}$ represents the expected net monetary benefits under perfect information
- $\max_a E\{NMB(a,s)\}$ represents the expected net monetary benefits under prior information
- Assess the optimal action for all possible values of *s* and then determine the weighted average of the resulting values over the prior belief about the likelihood of each event

Costs and Benefits of the Decision

- Benefits described in terms of utilities, QALYs, DALYs
- $/QALY or other cost-effectiveness ratios
- Predicted costs as compared to monetized benefits
- Number of patients impacted is essential for population VOI

Example Decision Tree



Quality	Cost
$L(1 + Q_E)/2$	C_E
L	0
$[L(1 + Q_E)/2] - Q_{SE}$	$C_T + C_{SE} + C_E$
$L - Q_{SE}$	$C_T + C_{SE}$
$L(1 + Q_E)/2$	$C_T + C_E$
L	C_T

Examples of VOI

- What would it be worth to conduct an observational study on $n = 60$ patients who are on the new treatment?
- EVSI = $5,550 per patient; compare to cost
- What would be the EVSI for a study allocating $nT = 200$ patients to new treatment and another $nC = 200$ to standard care?
- EVSI = $3,260 per patient

Conclusions

- Value of information techniques are used to evaluate research priorities based on reducing uncertainty
- Builds on existing cost-effectiveness studies using Bayesian statistics
- No “off the shelf” software – requires linking models, software platforms

Further Reading

- Thorn et al. 2015 Interpretation of the Expected Value of Perfect Information and Research Recommendations: A Systematic Review and Empirical Investigation, *Medical Decision Making*, DOI: 10.1177/0272989X15586552
- Steuten et al. 2013 A Systematic and Critical Review of the Evolving Methods and Applications of Value of Information in Academia and Practice, *PharmacoEconomics*, 31:25–48
- Carlson et al. 2013 Value-of-Information Analysis within a Stakeholder-Driven Research Prioritization Process in a US Setting: An Application in Cancer Genomics, *Medical Decision Making*, 33:463–471.
- Andronis et al. 2015 A Practical Application of Value of Information and Prospective Payback of Research to Prioritize Evaluative Research, *Medical Decision Making*, DOI: 10.1177/0272989X15594369