What is the balance between certainty and uncertainty?

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Overview

• Decision analysis
  – Objective function
  – The decision to invest/disinvest in health care programmes
  – The decision to require further evidence

• Characterising uncertainty
  – Epistemic uncertainty, quality of evidence, modelling uncertainty

• Possibility for research
Theory
Objective function

• Methods can be applied to any decision problem
  – Objective
  – Quantitative index measure of outcome

• Maximise health subject to budget constraint
  – Value improvement in quality of life in terms of equivalent improvement in length of life → QALYs

• Maximise health and equity s.t budget constraint
  – Value improvement in equity in terms of equivalent improvement in health
The decision to invest

• Maximise health subject to budget constraint
  – Constrained optimisation problem
  – Given costs and health outcomes of all available programmes, identify optimal set

• Marginal approach
  – Introducing new programme displaces existing activities
  – Compare health gained to health forgone
Slope gives rate at which resources converted to health gains with currently funded programmes.

(resources, health)

$C_A$

$HG_A$

$HD_A$
Slope gives rate at which resources converted to health gains with currently funded programmes.
Requiring more evidence

• Costs and health outcomes estimated with uncertainty

• Cost of uncertainty: programme funded on basis of estimated costs and outcomes might turn out not to be that which maximises health gains
  – Likelihood of wrong decision
    • I.e. probability that programme selected did not maximise health
  – Consequences of wrong decision
    • Amount of health forgone
Value of information

• Additional information has value
  – Allows avoidance of wrong decision and associated health losses
  – Better decisions → better health gains

• Compare cost of uncertainty to cost of obtaining additional evidence
  – Gather additional evidence if cost of uncertainty > cost of research
  – If cost of uncertainty < cost of research then may conclude current evidence is sufficient
Putting theory into practice
Estimating costs and effects

• Gather available evidence on costs and health outcomes
  – Rare to have single source of evidence that provides all required
• Use decision-analytic model to combine evidence from a range of sources
  – Synthesise data from multiple trials, e.g. meta-analysis
  – Extrapolate to relevant time horizon, e.g. survival analysis
  – Estimate overall costs and health outcomes, e.g. Markov model
Costs and health outcomes of programmes
Characterising uncertainty I

• Epistemic uncertainty
  – Uncertainty related to incomplete or inadequate information

• If information is incomplete, exists a range of plausible values for each parameter

• Specify range of values to use in decision model
  – Sampling error → standard error, confidence interval
  – Lack of data → elicit expert opinion
Assign distribution

Repeatedly take random draws from assigned distributions and calculate expected costs and outcomes for each

Generate distribution of expected costs and outcomes
Characterising uncertainty II

• Inadequate information
  – Poor quality evidence, suspicion of bias
  – Generalisability of evidence to practice

• To incorporate formally must assess impact on range of values for parameters
Characterising uncertainty III

• Modelling uncertainty
  – Assumptions required to synthesise data from multiple sources
  – Assumptions required to extrapolate
  – Structure of decision model
    • E.g. health states in a Markov model

• To incorporate formally must assess probability that each assumption is appropriate
Cost of uncertainty = \text{Probability(wrong)} \times \text{Consequences(if wrong)}
Costs of uncertainty

• Total cost of uncertainty can be broken down into uncertainty associated with each parameter

• Estimate cost of uncertainty that is attributable to:
  – Uncertainty in costs, effectiveness, in quality of life, and so on...

• For each parameter there will be a different potential for research and appropriate research design
Possibility of research

• Some research designs unfeasible
  – Unethical (e.g. smoking, pregnancy), impractical

• Type of research will determine
  – Amount by which uncertainty reduced, costs

• Possibility of research affected by decision to invest
  – RCT may be impossible once programme in use
  – Prospective observational design initiated before investment decision may provide better quality data than retrospective
Summary

• Compare health gained with new programme or further evidence to health forgone to fund investment

• Estimate costs and effects of programmes and cost of decision uncertainty
  – Search for available data, use expert opinion and appropriate methods of elicitation
  – Characterise uncertainty, impact of poor quality, other sources of uncertainty

• Engage with decision makers
  – Characterise objectives, appropriateness of model and assumptions
    • Accurately represent assumptions that must underlie informal analysis
  – Provide explicit, transparent, consistent framework on which to base decisions