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Overview of Multi Criteria Decision Analysis for Benefit Risk Analysis

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Outline of my talk

- Why do we need MCDA?
- What is MCDA and how can it support health care decision making?
- What are the key steps in implementing an MCDA?
  - illustrated using a simple case study
- Take home messages

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Why are we interested in MCDA?

- BRA decisions are challenging
  - Multiple endpoints, both benefits and risks
  - Difficult to process and evaluate all relevant information
  - Cognitive burden can lead to the use of heuristics
  - Confront trade-offs between criteria
  - Conflicting priorities between stakeholders

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What is MCDA?

- Belton and Stewart define as

"an umbrella term to describe a collection of formal approaches, which seek to take explicit account of multiple criteria in helping individuals or groups explore decisions that matter."

- Most health care applications use value measurement models (i.e. weighted sum approach), which is also our focus

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Weighted sum approach

- These types of models use following equation

$$V(a) = \sum v_i(a) \times w_i$$

where V(a) is the overall value is separated into v_i (a), the value of alternative *a* on *i*th criterion and weighted using w_i which represents the importance of *i*th criterion

- Scores v_i incorporate preferences for changes in performance within criteria and Weights w_i incorporate stakeholders' preferences between criteria

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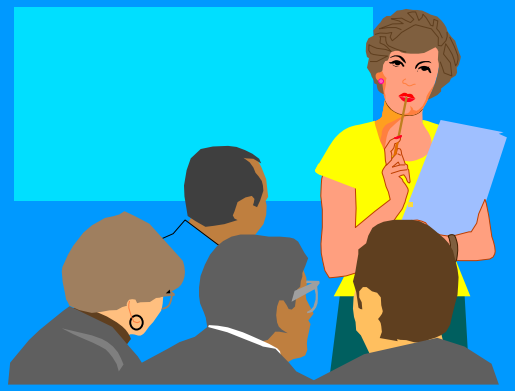
Socio-technical approach

SOCIAL DIMENSION

Decision conferencing



Facilitated workshops, participative process

TECHNICAL DIMENSION

Multi-Criteria Decision Analysis Modelling

Formal mathematical approaches

Decision support tool

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Steps in MCDA

Step	Description
Defining the decision problem	Identify objectives, type of decision, alternatives, stakeholders and output required
Selecting and structuring criteria	Identify criteria relevant for evaluating alternatives
Measuring performance	Gather data about the alternatives' performance on the criteria and summarize this in a 'performance matrix'
Scoring alternatives	Elicit stakeholders' preferences for changes within criteria
Weighting criteria	Elicit stakeholders' preferences between criteria
Calculating aggregate scores	Use the alternatives' scores on the criteria and the weights for the criteria to get 'total value' – to rank the alternatives
Dealing with uncertainty	Perform uncertainty analysis to understand the level of robustness of the MCDA results
Reporting and examination of findings	Interpret the MCDA outputs, including uncertainty analysis, to support decision-making

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Step 1: Defining the Decision Problem

- Goal: benefit-risk analysis of treatments
- The composition of the decision makers depends on the context
  - regulatory committee (approval)
  - Pharmaceutical companies (pre-launch)
  - Patients/clinicians (for shared decision making post-launch)
- Simple case study: Compare benefit risk balance of alternative 1 and alternative 2

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Step 2: selecting criteria

- Identify criteria (i.e. benefits and risks) by which the alternatives will be evaluated
- Criteria can be identified and selected in a number of ways ranging from
  - pivotal studies
  - previous decisions
  - focus groups/facilitated workshops
- Theoretical requirements for the criteria

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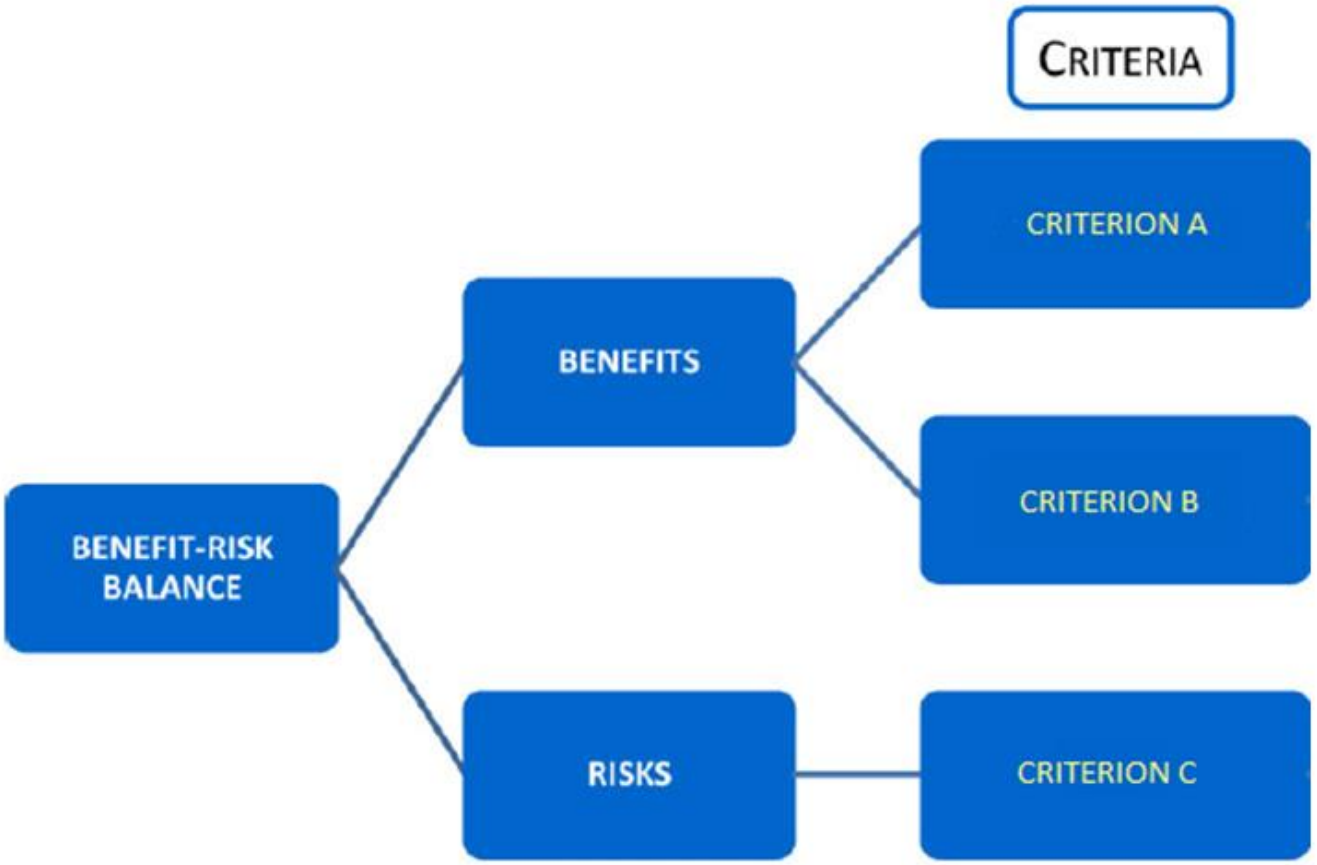
Simple case study



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Step 3: Measuring performance

- The performance of the alternatives on each of the criteria needs to be determined
- This can be gathered in a various ways, from
  - standard evidence synthesis techniques (e.g., clinical trials and meta-analysis)
  - to simulation modelling in early stages of drug development
- The alternatives' performance on criteria reported in a table is known as a "performance matrix"

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Performance matrix

	Alternative 1	Alternative 2
Criterion A	85 aa	73 aa
Criterion B	0.23 bb	0.15 bb
Criterion C	8 cc	6.5 cc

We can use this performance matrix to support deliberation, but all preferences are implicit

MCDA makes those preferences explicit. Both preferences within each criterion (scores) and between criteria (weights) need to be elicited

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Step 4: Scoring

- Scores are used to translate performance measures using different units for each criterion onto a common scale
- Scores also incorporate preferences for changes in performance within criteria, such that the same change along the scoring scale (e.g., 10–20 or 60–70) is equally preferred
- Number of different scoring approaches, in the next slide we illustrate “partial value functions”,

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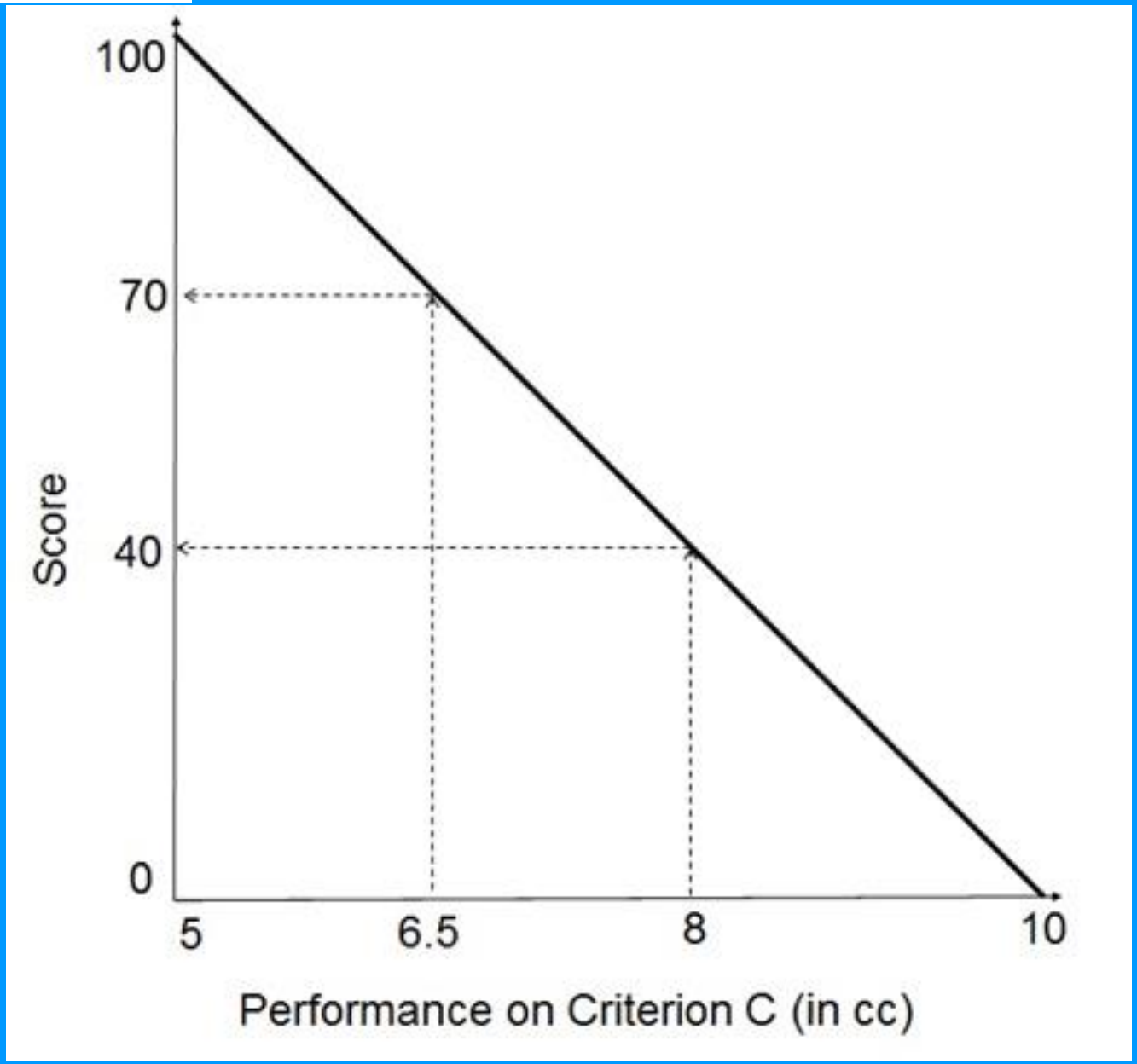
Step 4: Scoring



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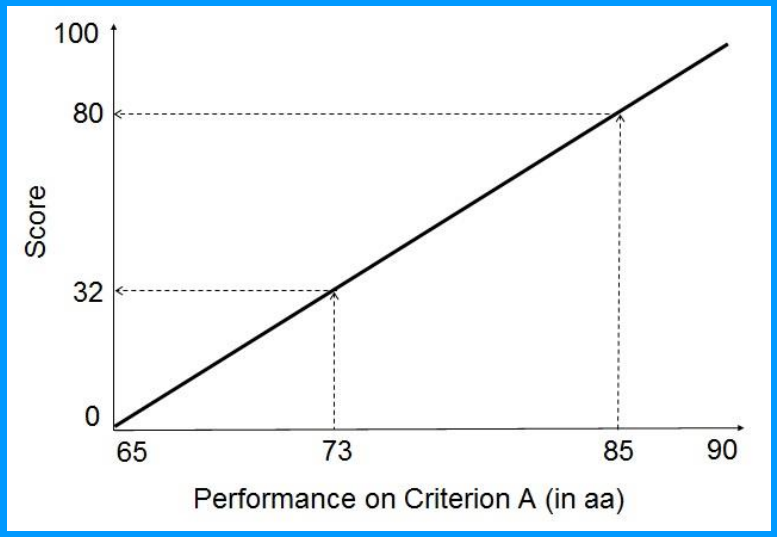
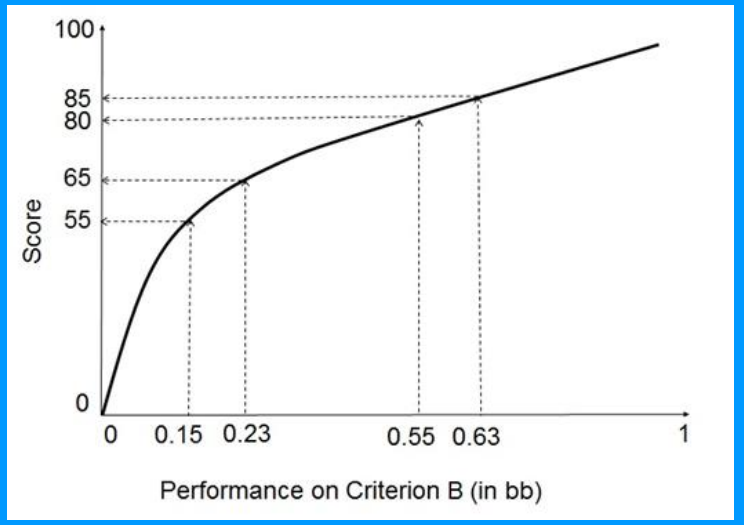
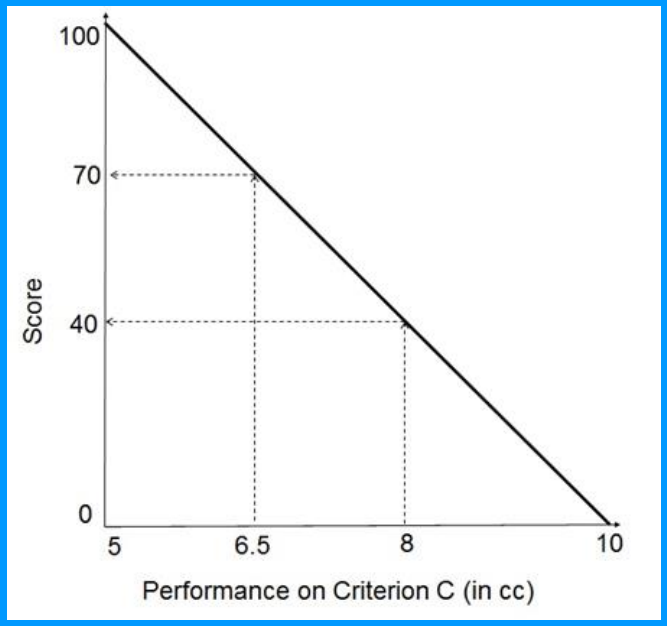
Step 4: Scoring







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Step 4: Scoring

	Alternative 1	Alternative 2	Scores for Alternative 1	Scores for Alternative 2
Criterion A	85 aa	73 aa	80	32
Criterion B	0.23 bb	0.15 bb	65	55
Criterion C	8 cc	6.5 cc	40	70

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Step 5: Weighting

- Weighting involves eliciting stakeholders' preferences between criteria
- Weights can be thought of 'scaling factors' (e.g. setting exchange rates to combine €, $, and £ into a single overall value)
- Number of different weighting approaches, in the next slide we illustrate "swing weighting"

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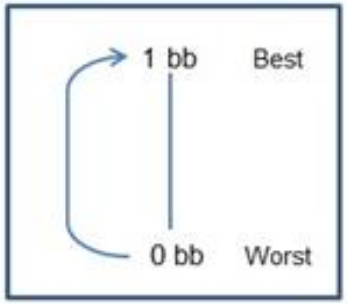
Step 5: Weighting

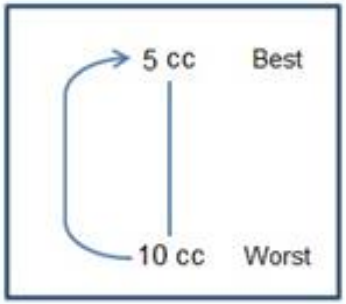
Imagine the starting point is at the worst level for each criterion. Identify which criterion you would like to improve first to its best level

Criterion A

Criterion B



Criterion C



Give that criterion 100 points. Then, assign points to the swings in other criteria relative to the swing in most important criterion.

Points for Criterion A

Points for Criterion B

Points for Criterion C

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Step 5: Weighting

Criteria	**Weights**
Criterion A	0.25
Criterion B	0.33
Criterion C	0.42

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Step 6: Aggregation

- After eliciting the scores and the weights, the aggregation is frequently performed using an additive model

$$V(a) = \sum v_i(a) \times w_i$$

$$V(b) = \sum v_i(b) \times w_i$$

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Step 6: Aggregation

Criteria	Scores for Alternative 1	Scores for Alternative 2	Weights	Alternative 1 Total Value	Alternative 2 Total Value
Criterion A	80	32	0.25	80x0.25 = 20	32 x 0.25 = 8
Criterion B	65	55	0.33	65 x 0.33 = 21.45	55 x 0.33 = 18.15
Criterion C	40	70	0.42	40 x 0.42 = 16.8	70 x 0.42 = 29.4
Overall Value of the Alternatives				58.25	55.55

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Step 7: Dealing with Uncertainty

- Parameter uncertainty (e.g., uncertainty in the performance of alternatives) can be addressed using techniques such as deterministic or probabilistic sensitivity analysis techniques
- Heterogeneity in preferences among subgroups can be studied by using weights and scores obtained from different stakeholder groups in the MCDA model

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Step 8: Interpretation/ Reporting

- The decision makers/stakeholders can be presented with the MCDA results either in tabular or graphical form
- The MCDA model allows them to explore the results for different scenarios
- MCDA is intended to serve as a tool to help decision makers reach a decision - their decision, not the tool's decision

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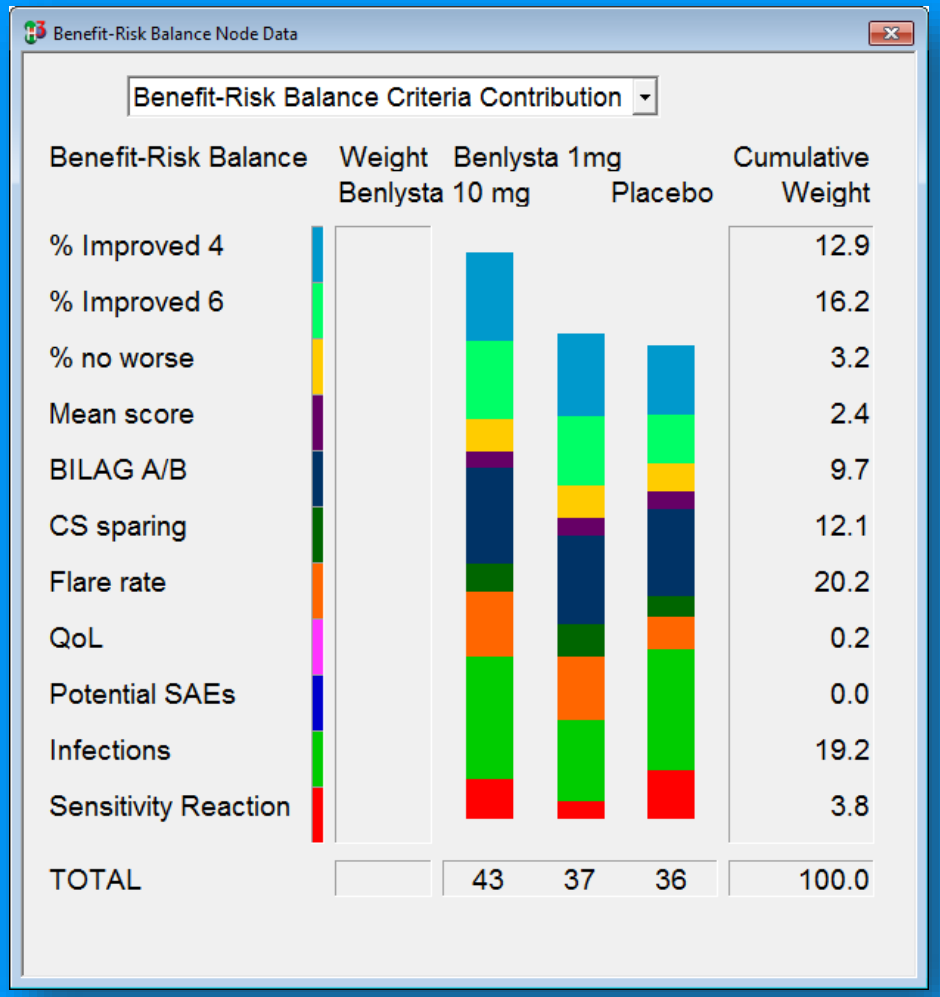
Results visualisation

For example, stacked bar graphs showing how the total value is a combination of the value from each criterion.



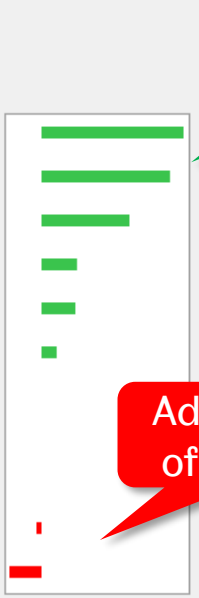
Zafiropoulos, Nikolaos and Phillips, Lawrence D. and Pignatti, Francesco and Luria, Xavier (2012) *Evaluating benefit-risk: an Agency perspective.* Regulatory rapporteur, 9 (6). pp. 5-8. ISSN 1742-8955

Show results—difference display

Sorts

Compare Benlysta 10 mg minus Placebo

	Model Order	Cum Wt	Diff	Wtd Diff	Sum
FE	Flare rate	20.2	12	2.5	2.5
SLEDAI	% Improved 6	16.2	14	2.3	4.8
SLEDAI	% Improved 4	12.9	12	1.6	6.3
FE	CS sparing	12.1	5	0.6	6.9
SRI	BILAG A/B	9.7	6	0.6	7.5
PGA	% no worse	3.2	9	0.3	7.8
UFE	Potential SAEs	0.0	-100	0.0	7.8
UFE	Infections	19.2	0	0.0	7.8
FE	QoL	0.2	-0	-0.000	7.8
PGA	Mean score	2.4	-4	-0.1	7.7
UFE	Sensitivity Reaction	3.8	-15	-0.6	7.2
		100.0		7.2	



Advantages of 10mg

Advantages of Placebo

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Preference elicitation

- Source of value judgements
  - regulatory committees, internal decision making bodies, patients/clinicians
- Elicitation setting
  - workshop using deliberation (or anonymous rating using surveys etc)
- Issues with group dynamics
  - conflicts, sharing and consensus
  - aggregation of the anonymous scores, mean and standard deviations

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Take home messages

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Take home messages

- The theory of MCDA modelling is simple, the complexity is in the implementation (elicitation of the preferences is a tricky task, more with issues of group dynamics)
- MCDA can be used throughout the product life cycle (early stage to post launch)
- MCDA is great for visualisation of BRA
- Uncertainty analysis is currently work in progress within health care MCDA field