Uncertainty-adjusted translation for preference-sensitive decision support

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Abstract. In Multi-Criteria Decision Analysis-based decision support for person-centred care, the person's quantitative preferences (as criterion weightings) are combined with quantified evidence and expert assessments (as option performance ratings on all criteria) to produce a personalised quantified *opinion* (as a set of expected value option scores). In our current decision support tools, we use the best available (central point) estimates for option performance ratings. The uncertainty surrounding the performance rating estimates, routinely reported by researchers as intervals around the means, are ignored. While defensible, this paper responds to questioning of this disregard. Apart from the inappropriate 'inverse variance' method, we find no attempt to integrate parameter uncertainty into decision analyses, simply an emphasis on reporting it fully, leaving decision makers unsupported in the burden of dealing with the separated outputs – e.g. Means and Credible Intervals. The paper suggests that uncertainty can be brought within Multi-Criteria Decision Analysis-based decision support by treating the means and uncertainties of all outcomes and process considerations as separate criteria, having them traded-off in an individually preference-sensitive manner at the point of decision. An empirical proof of method via an online example on bone health medications is provided, involving six options, two considerations and four criteria.

Keywords: Multi-Criteria Decision Analysis, decision support, uncertainty, preferences

Introduction

Uncertainty is the normal situation in decision making, in fact without it decision making - and therefore decision support - will often be unnecessary. How uncertainty - or rather uncertainties - *should* be dealt with varies with the paradigm within which the decision process, and hence decision support for it, is conceptualised. In the dominant paradigm in healthcare, researchers establish the expected average outcomes, along with the uncertainties, and hand over the burden of dealing with the separated outputs - e.g. Means and Credible Intervals (CIs) - to the decision maker. Considerable effort is rightly put into improving the estimates of uncertainty as well as the mean [1]. However, whether individual or group, the decision maker is expected to make the necessary trade-off between them as part of the final deliberative 'making up of their

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mind'. There is no attempt to synthesise, transparently and systematically, the joint means and uncertainties of the performance ratings for all options on all criteria.

In this paper we assume *structural* uncertainty has been dealt with appropriately and that *stochastic* uncertainty is simply the norm. We are therefore concerned here with the remaining parameter uncertainty (hereafter 'uncertainty'). The estimates for the effects/outcomes (e.g. on life expectancy, quality of life) of an intervention (e.g. medication, surgery, lifestyle change) are almost always uncertain. Our focus is on the situation in which the best estimate of the mean value of a parameter for an individual person is available, accompanied by the best estimate of the uncertainty surrounding it.

We note the much wider and open debate about how uncertainty *is* dealt with in decision making, and on whether and how decision makers should respect descriptive findings about this [2]. In confining ourselves to the specific and narrow issue above we are explicitly coming from a decision making, analysing, and supporting perspective which mandates a Bayesian position [3]. Here probabilities, which by definition relate to the future, or unknown present, are ontologically subjective, even if they are epistemologically based on 'objective' past frequencies. (We hence always refer to Credible rather than Confidence Intervals.)

Method

We take the view that computerised interactive decision support based on value-based, compensatory Multi-Criteria Decision Analysis (MCDA) is the best way to deliver preference-sensitive person-centred care that meets both ethical and legal requirements [4]. This involves the person's quantitative preferences for outcomes and process considerations (as criterion weightings) being combined with quantified evidence and expert assessments (of the option performance Ratings on all criteria) to produce a personalised preliminary *opinion* (as a set of expected value option scores) on what is best for this individual. Currently we use the Best central point Estimates Available Now – the 'mean BEANs' – as the option performance Ratings inputs and regard this as a defensible position, in line with the orthodox position for many health economists. However, one option might have a higher mean Score, but a wider CI, than another. It is therefore often suggested that the decision maker would benefit from knowing these CIs, because they may prefer the latter option because of 'uncertainty aversion'. We should therefore display the CI for each option Score.

We acknowledge the argument for doing so, but would not want to supply the decision maker with this additional CI information as such, alongside and separate from the mean. In our person-centred decision support tools (PDSTs) we are committed to producing a comprehensive preference-sensitive index Score - *one* number - for each option. The required criterion-specific mean-uncertainty preference trade-offs are to be those of the decision maker, but they are not to be left to tackle this task unsupported outside the tool. The Scores produced by the tool are to incorporate the mean-uncertainty trade-offs elicited from the decision maker *within* the tool. They can disregard uncertainty, on normative or any ground, simply by giving it zero weight.

An MCDA that propagates uncertainty through the analysis and leaves the output in the form of the means and variances of overall option scores may constitute current good practice in decision modelling [5], but it leaves the necessary value judgments to be made and processed in some non-analytical, intuitive, and/or deliberative way. That this is intentional is confirmed in the most relevant ISPOR Task Force report, where it is emphasised that uncertainty surrounding any central point estimate is to be '*responsibly reported'*, not further processed inside the model [6]. The recent ISPOR Task Force report on MCDA also suggests uncertainty is something to be explored within the presentation of the model, but there is no suggestion that the decision maker's trade-offs should be integrated within it [7].

> Parameter uncertainty (e.g., uncertainty in the performance of alternatives) can be addressed using techniques such as probabilistic sensitivity analysis techniques… The results from MCDA should not be taken as the "final decision" but rather the MCDA model should be used to explore the uncertainty in the decision problem. The decision makers can be presented with results from analyses exploring different types of uncertainty (e.g., parameter uncertainty, structural uncertainty, and heterogeneity) to support decision making. [7] (p12).

Personally, we question the assumptions made by mainstream decision modellers about a decision maker's competence to accomplish the implicit trade-off task accountably without analytical support. However, whether or not this rejection is justified is irrelevant. Our aim is simply to investigate the possibility of generating a preference-sensitive opinion on the decision that includes explicit trade-offs of means and uncertainties, based on a transparent analysis.

There is no place in PCDS for the most frequent way uncertainty adjustment is undertaken, inside or outside MCDA, by the 'inverse variance' procedure. This ignores the fact that the individual decision-maker's trade-offs may vary by criterion (e.g. life expectancy vs. adverse effects) and by option (e.g. medication vs. surgery). Sensitivity analysis, whether deterministic or probabilistic, does not meet the PCDS requirement, merely re-presenting the problem for the decision maker in a different form. Because of their complexity, Bayesian Networks, Dempster-Shafer theory, Fuzzy Set Theory and Grey [8] theory all fail most tests of feasibility and practicality in the context of PCDS. More important for the present argument, none is relevant to the situation in which the results of research comes in the form of means and uncertainties.

Result: Preference-sensitive uncertainty adjustment

In our experience, committees, such as NICE Technology Appraisal ones, look at the CIs by 'eyeballing' them. They are not explicit or systematically processed. Decision makers may not be Expected Value (EV) maximisers, but they will still need some procedure for integrating the means and CIs produced by researchers. In our view that should be a systematic and transparent algorithm.

The contemplated answer, advanced for debate, is to treat the mean and uncertainty of a criterion as separate attributes. This suggestion is not new, except in

PCDS. Durbach and Stewart introduce it in their comprehensive review (9). ‘Given the aim of taking external uncertainty about outcomes on an attribute into account, one possible approach is to use some measure of the consequences of this uncertainty as an attribute in its own right.’ (p.6)

To follow three illustrative examples fully and interactively, the reader is invited to go to https://ale.rsyd.dk, enter 1406 as survey ID. (Note that no data security is offered.) The examples are in the Annalisa implementation of MCDA, embedded in the survey program Elicia. In the example below, the data are from a Network Meta-Analysis on medications to reduce fracture risk [10]. We use the absolute CI as our uncertainty indicator and with positively-oriented criteria the indicator is actually (1- absolute CI).

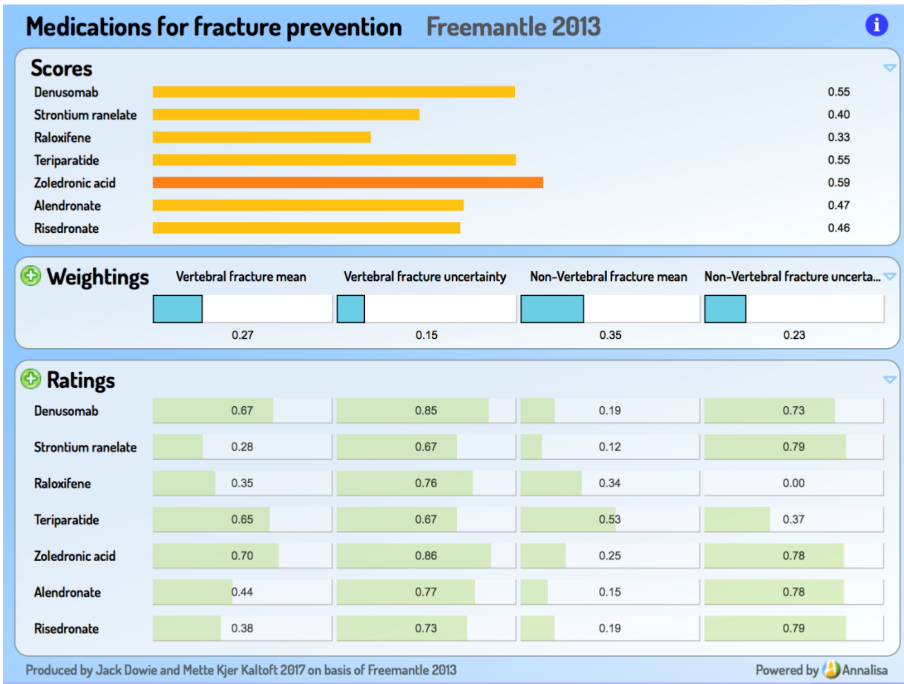

Figure 1: Screen capture showing uncertainty-adjusted MCDA

The decision maker has their importance weights for mean and uncertainty elicited for each criterion separately, so the trade-offs are criterion-specific, permitting that for Vertebral fracture to be different from that for Non-vertebral fracture. In our tools, this elicitation is done on a 0-10 slider ratio scale, with the responses being normalized to add to 100%. We do not see swing weighting, pairwise comparisons, or discrete choice experiments [11] as remotely practical in a direct-to-citizen, apomediative [12-13], approach to clinical decision support. Moreover, the Visual Analog Scale approach is defensible on grounds other than its practicality [14]. The decision maker has the ability to vary the criterion weightings in the interactive display.

The result is a personalised evaluation of each option sensitive to the preferences of the decision owner – the person/patient – as captured in their criterion Weightings. These evaluations can be a valuable input into the subsequent decision deliberation.

Conclusion

In one view the setting up of mean and uncertainty as separate criteria involves double counting, in that the calculation of the Expected Value has already 'synthesised' the uncertainty in the distribution. In the alternative view, the calculation of the mean, has left the uncertainty surrounding it to be addressed by the decision maker, alongside the mean. Their relative weighting of the two can be entered into a new EV calculation. In this view the trade-off between mean and uncertainty for each criterion is a preference-based value judgment and the opportunity to make it should be offered to all decision makers at or near the point of decision. The aim here is limited to providing proof of method for the latter possibility, as a basis for the debate and research we hope ensue.

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Conflict of Interest

Jack Dowie has a financial interest in Annalisa but does not benefit from its non-commercial use.

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