SMAA-CEA: a new method for representing decision uncertainty in cost-effectiveness analysis when three or more alternatives are being compared

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Abstract

In cost-effectiveness analysis (CEA), two or more alternatives (e.g. medical devices, drug therapies, screening strategies) are evaluated in terms of their costs (C) and effects (E). It is assumed that the decision maker's preference structure can be represented by a linear value function $u(E,C) = \lambda \cdot E - C$, which maps the costs and effects of the different alternatives to real values by using a weight λ to quantify the decision maker's willingness-to-pay for a unit of health gain. The resulting indices of preferability or value are generally referred to as the alternatives` net monetary benefit (NMB).

When the costs and effects of the different alternatives are known with certainty, the most preferred treatment strategy is simply the one with the highest NMB. In reality, however, this is hardly ever the case, so the current state-of-the-art in CEA is to assume that the costs and effects of the different alternatives are stochastic variables. Information on decision uncertainty is provided by calculating for each possible value of λ the probability $p(\lambda)$ that an alternative has the highest NMB. The plot of $p(\lambda)$ against λ shows how the alternative's likelihood of being the most preferred treatment strategy varies with λ and is known as the cost-effectiveness acceptability curve (CEAC).

CEACs offer a useful way of representing decision uncertainty when there are only two alternatives, say an intervention and a control, as in such a situation only the CEAC of the intervention

has to be provided. However, when three or more alternatives are considered, multiple CEACs have to be presented (i.e. one for each alternative). Since these CEACs usually intersect at several places (i.e. different alternatives are generally preferred at different ranges of λ), it becomes less clear how they could be used to discern favourable treatment strategies from less favourable ones.

To provide increased decision support in situations where a decision maker has to choose among three or more alternatives, we use Stochastic Multicriteria Acceptability Analysis (SMAA) as a new method for representing decision uncertainty in CEA. SMAA is a general method for aiding multicriteria decision making in situations where the criteria measurements and/or the preference information is missing, imprecise, or uncertain. It is based on inverse weight space analysis to describe for each alternative the share of all possible weights and criteria measurements that grant the alternative a particular rank and has already been successfully applied in a variety of real-life cases, including harbour citing, forest planning, and drug benefit-risk analysis. To demonstrate its applicability in the context of CEA, we will use data from the COACH study[1]—a multicenter, randomized, controlled trial in which 1023 patients were enrolled after hospitalization because of heart failure (HF)—to illustrate how SMAA can be used to assess the cost-effectiveness of three different disease management programs in HF: (i) usual routine management by a cardiologist, (ii) additional support by a HF nurse, and (iii) more intensive support by the HF nurse. We also present an open-source software implementation of the proposed method to allow for convenient application of SMAA-CEA in practice.

Keywords: Cost-effectiveness acceptability curve, stochastic multicriteria acceptability analysis, decision uncertainty, Monte Carlo simulation

[1] T. Jaarsma, M.H.L. van der Wal, I. Lesman-Leegte, et al., Effect of moderate or intensive disease management program on outcome in patients with heart failure: coordinating study evaluating outcomes of advising and counseling in heart failure (COACH), Archives of Internal Medicine 168 (2008) 316-324.