A note on cost-value analysis

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Summary


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Introduction

A health planning authority’s decisions regarding the allocation of health care resources are literally fateful for the individuals involved. It has long been recognized that health planning authorities need explicitly formulated tools for dealing with fairness/equity concerns. Several procedures have been proposed in recent literature. Among others, Bleichrodt [1], Dolan [2], and Williams [3] suggest procedures founded in traditional welfare economics. In this note, we discuss ‘cost-value analysis’, an alternative method for evaluating health care programmes suggested by Nord et al. [4]. We argue that cost-value analysis is likely to give less intuitive allocations of health care resources. Our concerns are illustrated by a numerical example using a set of fictitious weights given by Nord et al. Besides what is illustrated in the example, we put forward other related difficulties, and issues for future research are pointed out.

Cost-value analysis

In this section we review the mechanics of cost-value analysis, and provide some discussion of the interpretation of its components. The ‘societal value’ obtained by improving individual utility from initial level $u_i$ to level $u'_i$ is given by

$$V_i(u_i, u'_i) = (u'_i - u_i) \times S(u_i) \times P((u'_i - u_i)/(1 - u_i))$$

where $u_i, u'_i \in [0, 1], u'_i \geq u_i$. $S : [0, 1] \rightarrow [0, 1]$ is a severity weight, a decreasing function aiming to reduce the societal value of an improvement in health state for individuals already in good health. $P : [0, 1] \rightarrow R_+$ is a potential weight, a decreasing function serving the purpose of reducing the societal value of large gains in health index value relative to the maximum possible gain. One may normalize $S$ and $P$ so that $S(0) = P(1) = 1$. The overall societal value by taking a population $N = \{1, \ldots, n\}$ of individuals with initial utilities $u = (u_1, \ldots, u_n)$ to utilities $u' = (u'_1, \ldots, u'_n)$ can be stated as

$$V(u, u') = V_1(u_1, u'_1) + \cdots + V_n(u_n, u'_n)$$

for $u, u' \in [0, 1]^N, u' \geq u$. The individual utility $u_i$ may be interpreted as a health status index measuring the immediate utility of life,$$u_i = h_i(a_i)$$

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where \( h(a_i) \) is the utility enjoyed at health state \( a_i \), for example constructed by time trade-off or standard gamble procedures. However, such construction would not explicitly give us a way to bring the time perspective into consideration. In much related work on health state measurement, individual utility is a separable function of a health status index and prospective lifetime of the form

\[ u_i = h_i(a_i)t_i \tag{4} \]

where \( h(a_i) \) is the utility enjoyed at health state \( a_i \), and \( t_i \) is the lifetime. However, such an interpretation is not unproblematic in cost-value analysis, since it is then not clear how the individual utility \( u_i \) should be normalized to the unit interval keeping the weights attached to the different values between 0 and 1 in mind. Another way of dealing with the time aspect could therefore be to weight the societal value \( V \) of a gain in the immediate utility of life with the number of years for which this improvement in utility is enjoyed, \( t'_i - t_i \). Then the (modified) societal value would be given by

\[
V(u, u', t, t') = V_1(u_1, u'_1)(t'_1 - t_1) + \cdots + V_n(u_n, u'_n)(t'_n - t_n) \tag{5}
\]

Using this criterion, the health planning authority weights gains in utility but does not weight gains in lifetimes. But the health planning authority would then attach too much (or too little) importance to improvements in the individuals’ lifetimes compared to improvements in the utility of life, thereby suppressing the individuals’ preferences for their own health. That is, the health planning authority is likely to extend a persons life, even if he/she himself would have preferred a quality improvement instead. Thus, we would have a conflict with the Pareto principle.d

Nord et al. do not give an explicit treatment of the time aspect. With the considerations above in mind, neither shall we in this note attempt to incorporate the time aspect in cost-value analysis. If the health planning authority does only have concerns for immediate improvements in health state utilities (and has no explicitly formulated concerns for the duration and permanence of treatments), it may seem reasonable to leave explicit measures of lifetime out of account. Yet, even if all prospective lifetimes are assumed to be identical and normalized to one, difficulties still remain, as we shall illustrate by the following numerical example.

**An example**

In this section, we will argue that using the societal value \( V \) give less intuitive (and from our point of view, unappealing) social orderings of health care allocations. For illustrative purposes, we analyse a simple example using the fictitious weights given by Nord et al. (for ease of reference, the weights are depicted in the appendix).

Assume that there are two individuals (or groups of individuals) denoted individual 1 and individual 2, facing the same life expectancy. The status quo utilities are \( u_1 = 0 \) for individual 1, and \( u_2 = 0.5 \) for individual 2. Moreover, assume that the health planning authority can implement one of the following two programmes. Programme \( A \) brings individual 1 to utility 0.5 \( (u_1^A = 0.5) \) and individual 2 to utility 1 \( (u_2^A = 1) \). Programme \( B \) brings instead individual 1 to utility 1 \( (u_1^B = 1) \) and leaves individual 2 at status quo utility 0.5 \( (u_2^B = 0.5) \). The societal value of Programme \( A \) is

\[
V^A = (0.5 - 0) \times S(0) \times P((0.5 - 0)/(1 - 0)) \]

\[
+ (1 - 0.5) \times S(0.5) \times P((1 - 0.5)/(1 - 0.5))
\]

\[
= (0.5) \times S(0) \times P(0.5) + (0.5) \times S(0.5) \times P(1)
\]

\[
= (0.5) \times (1) \times (1.6) + (0.5) \times (0.3) \times (1)
\]

\[
= 0.95
\]

Programme \( B \) has the societal value

\[
V^B = (1 - 0) \times S(0) \times P((1 - 0)/(1 - 0))
\]

\[
= (1) \times (1)
\]

\[
= 1
\]

Thus, Programme \( B \) is preferred to Programme \( A \) according to the societal value \( V \). Since the final outcomes of the two programmes are identical, except for a permutation of individuals, it seems difficult to find a justification for such priority. If cost-value analysis were motivated by an aversion to unequal health gains, we cannot find any justification for this bias against individual 2. Programme \( A \) admits a fair compromise with respect to the allocation of health care. At least, both individuals are admitted some treatment under Programme \( A \).

We do not assert that Programme \( A \) necessarily is superior to Programme \( B \). Neither do we suggest that the two programmes are equally desirable from a societal point of view, as prescribed by traditional cost-utility analysis. What we assert is that it appears not perfectly clear whether the bias
against individual 2 is motivated by an underlying principle of fairness or if it merely is the undesirable result of an ad hoc formula defining societal value. Our concern is whether the latter could be the case.

Discussion

Nord et al. state (p. 37) that ‘a multifactorial valuation model that encapsulates societal concerns for severity and realization of potential can be translated into a corresponding set of health state values with strong upper end compression’. The example in the previous section shows that strictly speaking this is incorrect. As the societal values of Programme A and B are different, there exists no ‘upper end compression’ \( F : [0,1] \rightarrow [0,1] \) of individual utility such that the societal value \( V_i \) is given by \( F(u_i) - F(u_t) \). Specifically, the societal value (2) cannot be represented by any social welfare function defined on the set of conceivable end state utilities \([0,1]^N\) (except for trivial weights \( S \) and \( P \)).

We saw in the previous section, that the combined effects of the severity- and potential weights are difficult to see through. Aside from this difficulty, we will address a more fundamental problem inherited in the cost-value method. As outlined by Nord et al., the functional form of the severity weight \( S \) and the potential weight \( P \) may be estimated by two separate procedures. For this purpose, representative individuals are questioned about their valuations (in terms of person trade-off) of different health programmes. The severity weights are estimated by asking representative individuals to make person trade-offs between movements that are equal in terms of utility gains but different in terms of starting points. For example: How many persons moved from utility 0.3 to 0.6 would be just as good as 10 persons moved from utility 0.0 to 0.3? If the median answer is 20, the severity weight for utility level \( u_l = 0.3 \) is \( S(0.3) = 20/0.3 = 66.67 \) (just as the severity weight for \( u_l = 0.3 \) depicted in the appendix). In a similar way, the potential weights are estimated by asking representative individuals to make person trade-offs between movements that are now different in terms of utility gains but equal in terms of starting points.

The representative individuals are not, however, meaningfully able to estimate severity- and potential weights without knowing exactly what these weights ultimately mean for the allocation of health. Otherwise, the health planning authority could make all sorts of manipulations with the representatives’ preferences for health care allocation by changing the functional form of the societal value. For example, using the severity- and potential weights depicted in the appendix, the societal value (2) of bringing 21 persons from utility 0.3 to 0.6 is lower than the societal value of bringing 10 persons from utility level 0 to 0.3. Thus, a health planning authority using the societal value with a set of severity- and potential weights estimated as outlined by Nord et al. would systematically set aside the person trade-offs elicited from the representative individuals. Why should the health planning authority want to overrule the representative individuals’ distributional concerns? As the preferences expressed for severity- and potential are not mutually exclusive, overruling the person trade-offs elicited from the public is by no means necessary, nor desirable. But, on the other hand, if we give up the natural interpretation of the specific components defining the societal value formula and the simple estimation procedures associated to them, the connection between the cost-value formula (2) and the underlying concepts of fairness that initially motivated its construction is then no longer perfectly clear.

The cost-value method puts societal value on a process bringing the individuals from initial health utilities to new improved health utilities. As such, we find the basic ideas behind cost-value analysis attractive, and we shall certainly not generally refuse methods that attribute value to other factors than end states (see e.g. Loomes [9]). For example, a status quo reference point does matter in many contexts. Nord et al. have initiated an interesting and necessary discussion. But at its present form, the cost-value method is not free of difficulties. We find that more research into the welfare theoretic foundations of non-consequentialist solutions to the health care resource allocation problem would be desirable.

Acknowledgements

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Notes

a. Cost-value analysis was introduced by Nord [5].
b. Our notation differ from that used by Nord et al.
c. Following Nord et al., we restrict attention to improvements in individual utility level.
d. I thank a referee for pointing out that a related critique of the violation of the Pareto principle has been raised by Johannesson [6] in a recent issue of this journal. See also Nord [7] and Williams [8] for other views.
e. The weights estimated as outlined reflect trade-offs in different situations: Either we compare movements that are equal in terms of utility gains but different in terms of starting points (severity weights), or we compare movements different in terms of utility of gains but equal in terms of starting points (potential weights).

Appendix

This appendix contains the fictitious weights given by Nord et al. [4].
Severity weights \( S(u_i) \) for different levels of initial utility \( u_i \).

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<th>( u_i )</th>
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Potential weights \( P(r_i) \) for different levels of relative potential ratios, \( r_i = (u'_i - u_i)/(1 - u_i) \).

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References