Review

Decision analysis in patient care

Glyn Elwyn, Adrian Edwards, Martin Eccles, David Rovner

To help patients to fully participate in shared decision making is becoming an important goal in clinical practice and one which is receiving increasing attention in terms of the requisite skills and technological development. We discuss the potential application of decision analysis—a specific technology that has been introduced into clinical practice but to date only within research contexts—and examine the usefulness and feasibility of the technique for patients, particularly in settings where clinical presentations are diverse and characterised by uncertainty.

Decision analysis was founded on the work of von Neumann and Morganstern (1947) who described a model for human decision making known as the theory of expected utility.[1] Utility is an attribute that is said to motivate individuals to choose one action over another; it is quantified and usually scaled between 0 and 1. Expected utility is calculated when the probability of an outcome is multiplied by its utility (in this context by measurements of patient preference strengths). Decision analysis is therefore based on the premise that a rational decision-maker would do whichever plan of action results in the greatest expected utility (usefulness to the individual). Thus, a choice leading to an outcome with a 20% probability and associated utility of 0·9 would be chosen in favour of an action with an outcome probability of 50% but a utility of 0·2 (expected utilities of 0·18 and 0·10, respectively). Although developed in the discipline of economics, the technology has been applied (albeit in research contexts) to health-care decisions (figure 1).[2]

In a clinical decision analysis, choices and the potential outcomes need to be defined and ideally contextualised for the individual. The decision is laid out in a decision tree (figure 1) with decisions depicted as square nodes. Once a decision is taken, the outcome is a matter of chance. The chance of an outcome is depicted as a circular node. A line connecting nodes represents the passage of time. To populate the tree two types of data are needed—the probabilities of events occurring (usually from standard evidence sources) and the utilities placed on them by the patient. These can be measured by a number of methods (such as time-trade-off or the standard gamble). For example, treatment with warfarin or aspirin is advised to decrease stroke risk for patients with valvular atrial fibrillation. The incidence of stroke and treatment side-effects can be derived for the three management options from population studies: warfarin or aspirin or no treatment. The patient utilities for the possible health states (stroke or treatment side-effects) can be elicited. Arguably, this approach makes the decision making process more rigorous and tailored to the individual.

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Department of General Practice, University of Wales College of Medicine, Canolfan Iechyd Llanedeyrn Health Centre, Cardiff CF23 9PN, UK (G Elwyn MSc, A Edwards MPhil)**; Centre for Health Services Research, University of Newcastle upon Tyne, Newcastle upon Tyne, NE2 4AA, UK** (Prof M Eccles MD)**; and Michigan State University, East Lansing, MI, 48824-1316, USA** (Prof D Rovner MD)

Correspondence to: Dr Glyn Elwyn (e-mail:elwyng@cardiff.ac.uk)

Advantages of decision analysis

The strength of decision analysis is that the process offers an explicit and systematic approach to decision making based on the premise of rationality. Decision analysis can present and incorporate many factors. Crucially, the decision is based on a fuller range of information than would be the case in an unstructured approach. Thoughtful health-care professionals have always intended to do such tasks but health care is a clear example of a situation that outstrips human ability to integrate the range of relevant variables.

Decision analysis can help achieve the ethical principle of veracity because such analysis is explicit about the uncertainty within clinical practice and uncovers the complexity of decision making. The acknowledgment of choices and their associated uncertainties are positive steps towards improving the process of decision making between patients and professionals. Empirical data and patient values are acknowledged, quantified separately, and then integrated.[3] Decision analysis potentially enhances patient autonomy because the patients influence the decision-making process by contributing their own values.[3] Decision analysis has the advantage of being able

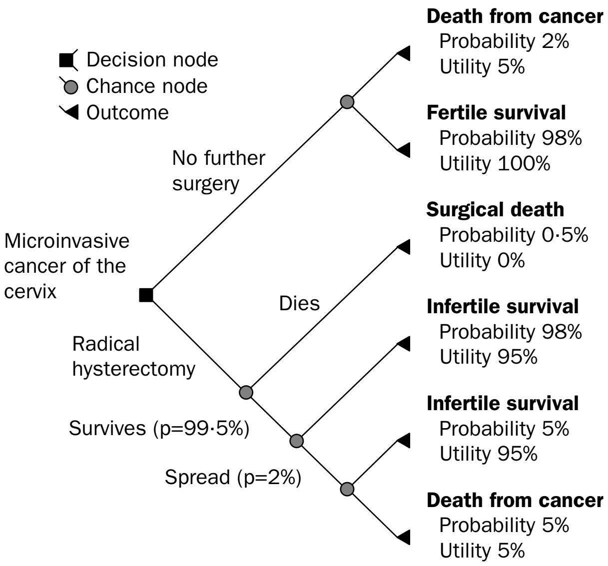

Figure 1: **Decision tree for microinvasive cancer of the cervix showing selected probabilities and possible utility calculations**
BMJ 1992; **304:** 1099–03.[2] With permission from the BMJ Publishing Group.

to calculate the balance of harms and benefits optimally in situations with complex outcomes, and reconciling both research evidence and patient preferences. Although decision analysis used with individual patients does not usually consider costs, they can also be built in to a similar process and can inform the economic aspects of clinical management.

Conceptual and practical issues

Despite the apparent advantages, an examination of the principles and practicalities of decision analysis highlights a number of issues, particularly if the technique is advocated for use by patients in clinical contexts.[4–6]

Calculating utilities

Patient utility is measured in terms of preference strengths that express an individual's assessment of an outcome in terms of moral, hedonic (pleasure or satisfaction), and personal values. These are naturally ranked in terms of ordinal values (first, fifth, &c) but their quantification involves the assignment of cardinal numerical values (one, three, seven, and so on). A critical issue therefore is whether cardinal values capture the phenomenon of preference strengths. To arrive at the utility for a future health state—a multidimensional and complex prospect—people have to assess the different dimensions of an outcome to arrive at a single index value usually expressed as a cardinal value between 0 (death) and 1·0 (perfect health). However, we weigh things up without using cardinal measures, just as, when considering the options on a restaurant menu, we end up with an order of preference, an ordinal measurement. Our ability, using the gambling techniques developed for decision analysis, to ascribe numerical units to preferences is an attempt to rationalise a more intuitive, heuristic approach to choice. Arguments for more pragmatic methods are appearing,[7] although there are differing views on the feasibility of making such measurements in human affairs.[8] An even more fundamental question arises about the validity of trying to calculate preference strengths about future health states on the basis of current knowledge and experience.

People may not be able to assess utilities that are divorced from their perceived probabilities and may also attach different weights (perhaps at a social or emotional level) to the various outcomes even after ascribing a numerical utility. Decision analysis assumes that the significance of outcome dimensions can be expressed solely in numerical values. Finally, patient utilities are quantified in terms of the consequences of choices. But not all values can perhaps be elicited in terms of consequences. Kant suggests that no moral values could be acquired in this way.[9] The decision whether or not to take an antenatal screening test (that presupposes a willingness to terminate pregnancy) is a prime example of this tension. Individuals might wish to be involved in decision making even if it did not affect the outcome because they valued the process per se. This puts a value on something that is not easily included in decision analysis.

Ethical considerations

The emphasis on involving patients in decisions is now well known[10,11] At first glance, decision analysis achieves many of the aims of involving patients in decision making but this view is debatable. The methods that promote shared decision making require a partial transfer of responsibility from the professional to the patient. Economists recognise that this agency relationship[12] can vary in the level of support given to patient decision making, ranging from paternalism (clinician decides) through partnership (shared decision), to delegation (patient decides). Decision analysis, at least in its current form, is an extension of professional expertise (paternalism); the technique generates a decision, and thereby prescribes the best course of action.[13] Decision analysis could thus compromise patient autonomy by its choice of probabilities, outcome descriptors, and calculation of utilities. Kassirer[14] counters this concern by listing the circumstances where the technology may be especially helpful; where, he argues, decisions are particularly sensitive to the calculation of utilities: when there are major differences in possible outcomes and impact of complications (for example, death versus disability); when choices involve a trade-off between near and long-term outcomes; when the apparent difference between options is marginal; when a patient is particularly averse to taking risks; and when a patient attaches unusual importance to certain possible outcomes.

Dowie,[3] an advocate of decision analysis, suggests that patients should be asked whether the expected utility calculation, once completed, is acceptable to them and recently some research groups suggest using decision analysis as only one of many inputs into a decision making process.[15]

Choosing and describing outcomes

Relevant outcomes have to be described to calculate their associated patient utilities. Biomedical outcomes are typically included. Other outcomes, such as the inconvenience of taking a tablet every day or the implicit imposition of the patient label on a previously fit individual, are usually excluded. Decision analysis will therefore tend to systematically limit the decision making scope by specifying a limited range of easily measured outcomes.[16,17] The decision tree in figure 2 portrays the choices of treatment for atrial fibrillation as either warfarin or no treatment, but another reasonable treatment choice would be to take aspirin. In decision analysis there is a limited ability for patients to say "this is what matters for me", thus standardisation of decision analysis trees goes against the individualisation of care.[17] However, standardisation is unavoidable and brief vignettes are typically used to portray a range of possible future health states. Choices have to be made, such as who to interview in order to formulate the descriptions and whether outcomes should be presented in terms of quality-of-life or specific health states.[18] Judgments are required at each

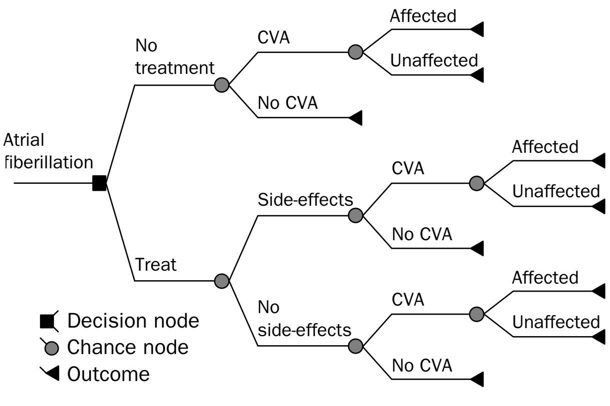

Figure 2: **Decision tree for atrial fibrillation**
The treatment is warfarin; the outcomes examined are side-effects of treatment (principally bleeding complications) and cerebrovascular accident (ie, stroke). Reproduced courtesy of Dr Tom Fahey, Bristol University.

stage about the framing of information, and bias is inevitable.[19] This problem is not unique to decision analysis, but generating utility measurements based on specific outcome descriptions should alert us to the potential systematic influences involved.[19]

Attitudes to risk

In the quantification of probability (usually into a percentage risk), and its insertion into a decision tree as if it were a mechanical factor, the patient's attitude to risk is not usually explored—an assumption is made that all patients approach risk in the same way—which over-rides the knowledge that some people are risk-averse while others are not. Perhaps this issue would be encompassed within utility measurement (the risk averse would assign low value to an unwelcome outcome), but this assumes that the choice of outcomes (and their descriptions) is appropriate.

Data accuracy

Schwartz[20] recognised the difficulties of populating decision trees with accurate and relevant data. Outcome data from systematic reviews are commonly derived from selected samples and may not accurately reflect an individual's risk or even generalise to a specific population. This problem is commonly encountered in decision analysis and indeed the method at least has the advantage of identifying areas where evidence is absent.

Heterogeneity of clinical conditions

Decision analysis might be helpful in clinical situations where there are legitimate treatment choices and high quality outcome data. But clinical presentations are seldom typical and the heterogeneity of clinical practice is likely to be a significant obstacle for this technology. For example, the attempt to improve diabetes control gives rise to many decision-making nodes that are dependent on the severity of the disease and the presence of co-morbidity such as obesity, hypertension, and ischaemic heart disease. These issues confound probability estimation. The undifferentiated nature of general practice presentations provides a particular challenge, thus decision analysis may prove easier to use in settings with limited variability, such as specialist clinics in secondary care.

Practical obstacles

Decision analysis has not been routinely incorporated into clinical practice. An editorial[21] (promoting the benefits of evidence-based practice) in 1996 commented: "we note from the outset that potentially more powerful decision making models exist, but must report that these models currently lack practical application for most clinical decisions". We must explore whether this reluctance to apply decision analysis is simply a lack of practical application or whether it reflects other concerns. There is little published about the acceptability to patients of using decision trees in clinical practice. Age, educational status, and social class are reported to have substantial effects on preferences for participation in decision making.[22] It is likely that these influences would be even greater if decision analysis was introduced. In general practice there is evidence that a marginal increase in consultation time has positive benefits, particularly in terms of the ability to cope with an illness (enablement).[23] Would this hold true for the extra time needed to use decision analysis? The current length of many primary care consultations in the UK is estimated to be 6 to 7 min. Professionals cite the lack of time as a reason for not exploring the reasons behind decision making in more depth.[24] But there are currently no studies that have measured the benefits of using decision analysis in routine consultations, in either secondary or primary care, outside research settings. Using current decision analysis techniques in clinical practice requires either rescheduled appointments or longer consultations.

Does decision analysis lead to better decisions?

Doing decision analysis requires time for utility calculation and thereby extends the consultation length. This could be acceptable if there was evidence that the technology leads to improved decisions. Little research exists that compares the quality of patients' decisions arrived at via decision analysis with those arrived at by untutored choice.[25] A decision tree presenting large amounts of information claims to enable the comparison of multiple options and would seem to guard therefore against the oversimplification of complex decisions. But studies that attempt to define a gold standard have found that a systematic approach to decision making does not always lead to better decisions. When decisions are analysed by their component parts, issues are identified that conflict with intuition leading to lower satisfaction with the choices made.[26] Attempts to identify any gold standard best decision pre-suppose opinions on such matters. Assessments of interventions designed to improve decision making in clinical practice must grapple with the issue about which outcomes should be measured for evidence of making a good decision.[27] Uptake of treatments or tests would certainly be an oversimplistic proxy measure of good decisions. For example, it is not necessarily a bad decision for an individual to decline the offer of cholesterol lowering therapy on the grounds that the evidence of benefit does not justify the personal and family impact of being categorised as a life-long patient. O'Connor[28] defines effective decisions as informed, consistent with personal values, and acted upon. This is an important guide to the assessment of decision making approaches, but it is still doubtful whether decisions and their associated actions are stable enough for longitudinal assessments.

Conclusions

Although there are important technological developments that have made decision tree and utility calculations easier,[29,30] fundamental concerns remain. We should not suppose that current clinical practice is superior, but should draw attention to the obstacles that need overcoming for decision making technologies to become useful in service settings. One approach is to place substantial parts of decision-making processes outside the face-to-face consultation and ensure that patients are at least aware of information about the choices and their associated harms and benefits. There is evidence that decision aids (a generic term for a wide range of different methods) are becoming more widely available. Most decision aids do not attempt to calculate utilities but use metaphors such as "weigh scales" to gauge preference strengths. As their interfaces improve they may provide the correct degree of pragmatism for day-to-day practice.[31]

There is, however, a much more fundamental issue at the heart of this debate that could lead to a paradigm shift in the way that decisions are managed in professional encounters. Gigerenza and Todd,[32] propose that we replace our image of an omniscient mind computing intricate probabilities and utilities with that of a bounded mind reaching into an adaptive toolbox filled with fast and frugal heuristics (rules of thumb). Figure 3 outlines this vision.

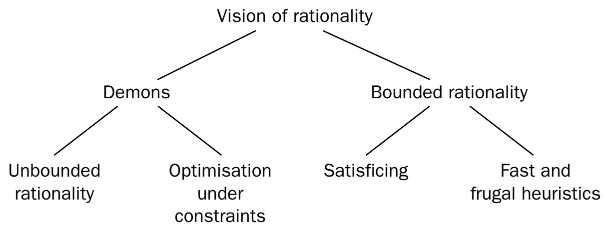

Figure 3: **Vision of rationality**

The left hand categories point to unbounded rationality models that assume unlimited reasoning power, minds that work hard to provide the basis for expected utility theory and Bayesian models. The other side points to forms of bounded rationality, a recent conceptualisation of decision making that is seeing increased interest. Satisficing[32] is the term that describes a form of searching through a sequence of available alternatives; fast and frugal heuristics use little information and computation to make various types of decisions. The application of such new concepts and the notion of analysing the trade-off between accuracy and frugality could be central to the practice of evidence-based medicine in the real world of busy professionals with limited time. Although it is important to explore how patients and clinicians might have used decision analysis, there is general agreement that technology does not provide a way forward. We are now witnessing the introduction of decision aids to clinical practice, tools that are essentially means of sharing information. The next frontier will involve fast and frugal heuristics; rules for patients and clinicians alike.

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