British Journal of Psychiatry (1995), **166**, 184–190

Review Article

Decision Analysis in Psychiatry

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Background. Decision analysis is an explicit, quantitative approach to examining difficult decisions about course of action. Its applicability to psychiatry is considered.
Method. An example of how decision analysis could be used in psychiatry is given, criticism of the technique is discussed, and previous attempts to apply it to mental illness problems (from a Medline search from 1966 onwards) are reviewed.
Conclusion. The future for decision analysis in psychiatry lies in teaching, audit and research, rather than clinical work.

"We believe that doctors in Europe may love it or hate it but cannot ignore it" was the conclusion of Thornton *et al* (1992) in an article on decision analysis. This paper aims to provide an example of how the technique could be useful in psychiatry, discusses criticism of decision analysis and reviews previous attempts to apply decision analysis to mental illness problems.

Decision analysis as a technique

Many everyday decisions entail little risk or uncertainty – they involve routine choices between tried and tested alternatives. There are situations where the 'correct' course of action is unclear, for example when should prophylactic medication begin in schizophrenia or bipolar disorder? In these circumstances clinicians may 'ask an expert' or delve into the literature to find a well designed study which matches the clinical problem, but these methods for seeking advice have limitations. Decision analysis, originally developed in the business world (Moore & Thomas, 1988), is an explicit, quantitative approach to examining such difficult decisions.

The widely quoted aim of decision analysis is to enable clinicians to make the best decision for individual or groups of patients (Littenberg & Sox, 1988). It may also help identify gaps in the research literature; produce protocols for patient management which doctors may use in audit and teaching; involve the patient in management; enable the clinician to ask hypothetical questions; and provide an alternative way of evaluating new treatments and investigations by incorporating widely dispersed research findings.

The technique involves several discrete steps (Weinstein & Fineberg, 1980; Pauker & Kassirer, 1987), which are described here using a psychiatric problem.

Application in psychiatry

A difficulty for psychiatrists is when to start prophylactic antipsychotic medication for schizophrenia. Psychiatrists and patients have to balance the benefits of preventing recurrence of the acute episode against the disadvantages of long-term, perhaps permanent, side-effects especially tardive dyskinesia (TD). The uncertainty is greatest with first-ever episodes of schizophrenia. Some patients, perhaps between 5% and 20%, will only have the single episode whereas the rest will have further illnesses. There is presently no way of reliably distinguishing between these two groups and there are no clear guidelines on whether to recommend prophylactic antipsychotic drugs or not. Decision analysis could be helpful in this situation.

Consider a 30-year-old man who presented with his first schizophrenic episode four weeks ago. He is now free of psychotic symptoms after in-patient treatment. What treatment should he have?

Defining the problem

The decision-maker identifies the choices to be made, and the possible outcomes of these choices. In this example the psychiatrist has to decide whether to prescribe a prophylactic antipsychotic drug or not. The main outcomes of interest are either recurrence of the schizophrenia or no recurrence, each of which may occur with or without tardive dyskinesia. Therefore there are four outcomes, *recurrence with tardive dyskinesia*; *recurrence no tardive dyskinesia*; *no recurrence with tardive dyskinesia* and *no recurrence no tardive dyskinesia*.

Structuring the problem

The clinician has to structure the components of the problem in a logical way which displays where choices must be made and where chance events occur. Such a structure is a decision tree (Fig. 1). In itself this process can be helpful by making clinicians pay attention to all the different outcomes – especially when it comes to the order in which they perform tests or treatment. By convention where there is a choice of action (a 'decision node') a square is used and where the outcome is decided by chance (a 'chance node') a circle is drawn. In this case the decision node represents a choice between prescribing and not prescribing antipsychotics. The first circle in the 'prescribe antipsychotic' pathway represents the probability of someone on

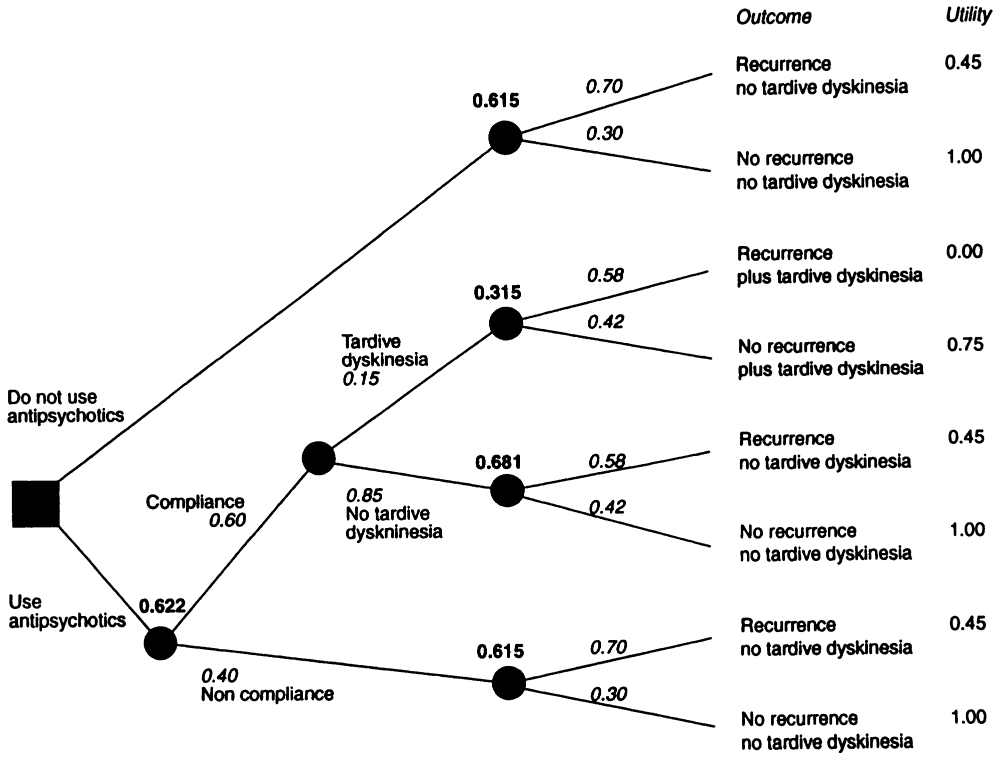

Fig. 1 Decision tree for using antipsychotics with probabilities (italic), utilities and expected utilities (bold) for each chance node.

these drugs being compliant or non-compliant with the medication.

Estimating the uncertainties and the value of the different outcomes

For each chance node the clinician estimates the probabilities of the different outcomes. A relative value is assigned to each outcome, this is called a 'utility'.

Estimating the uncertainties

The probabilities to be estimated are: the chance of recurrence with and without antipsychotics; the proportion of patients who comply and do not comply with prophylactic antipsychotics; and the probability of a patient getting tardive dyskinesia while taking these drugs.

Recurrence. The most relevant study here is by Crow *et al* (1986). Of the 120 first-episode British schizophrenic patients who entered this randomised placebo-controlled trial of maintenance antipsychotic medication, 58% relapsed on active medication (95% CI 42% to 74%) compared with 70% on placebo (95% CI 58% to 82%).

Compliance. There have been several treatment trials in non-first-episode schizophrenic patients (Crawford & Forest, 1974; Falloon *et al*, 1978; McCreadie *et al*, 1980) which have reported compliance rates of between 50% and 89%. Johnson & Freeman (1973) report that about one-third of patients fail to comply with depot medication. In this analysis I have assumed that 60% of patients will comply with treatment.

Tardive dyskinesia. Most authors quote a prevalence of 10% to 20% in patients exposed to major tranquillisers for more than a year (Task force on late neurological effects of antipsychotic drugs, 1980). A figure of 15% will be used in this analysis.

Figure 1 displays the probability of each outcome at each chance node as a number between 0 (will not occur) to 1 (will occur). At each chance node the probabilities always add up to 1.

Estimating the value of different outcomes

The best way of assigning a value to the different outcomes is to use a 'basic reference gamble' which involves the relative value or utility of three different health states. In this example there are four different outcomes – *recurrence plus tardive dyskinesia* is the worst outcome (with a utility of 0) and *no recurrence no tardive dyskinesia* the best (with a utility of 1). The other two outcomes – *recurrence without tardive dyskinesia* and *no recurrence with tardive dyskinesia* – are somewhere between these.

To assess the value of these two outcomes I asked three clinicians, two doctors and a senior nurse in a multidisciplinary team to perform the 'gamble'. I explained the case to them and they were asked to imagine two doors, A and B, one of which they had to choose to go through (Fig. 2). Through door B there was a 50% chance the patient would get a *recurrence of the schizophrenia and tardive dyskinesia* and a 50% chance he would get *no recurrence and no tardive dyskinesia* – that is, there was a 50% chance of getting the best or worst outcome. If they chose door A the patient would definitely *not get a recurrence but he would get tardive dyskinesia*. All three chose door A. I then changed the odds behind door B. I decreased the chances of the worst outcome, *recurrence plus tardive dyskinesia* until they could no longer choose between the two doors. This is the 'point of indifference' and for all three occurred when the chances of *recurrence plus tardive dyskinesia* was 25% and the chance of *no recurrence and no tardive dyskinesia* was 75%. Therefore on a scale of 0 to 1 they valued *no recurrence plus tardive dyskinesia* at 0.75. A similar process took place for the fourth outcome *recurrence but no tardive dyskinesia*. Both doctors produced utilities of 0.45 whereas the nurse produced one of 0.55. Both values were used in this analysis.

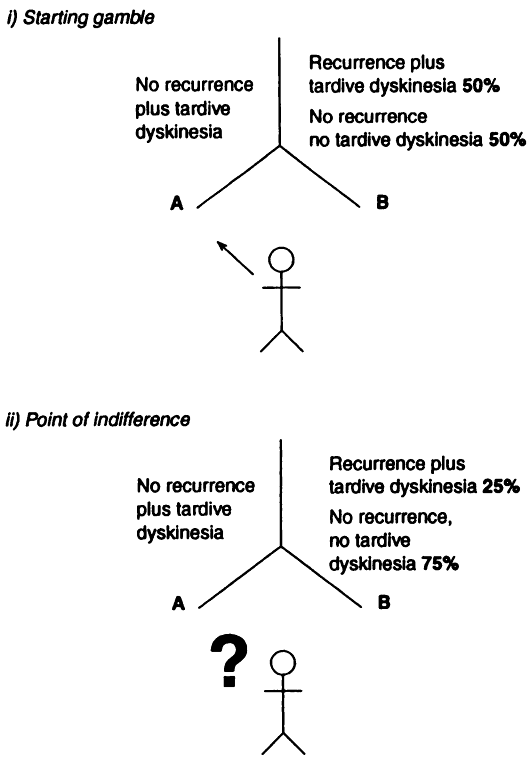

Fig. 2 Basic reference gamble: (i) Starting gamble and (ii) point of indifference.

Analysing the decision tree

The utility values and the probabilities are now added to the decision tree (Fig. 1), and the utilities for each chance node calculated. The utility of each final outcome is multiplied by the probability which immediately precedes it, and at each chance node these new utilities are added together. If a chance node branches into one or more other chance nodes the utility at the next chance node on the right is used in the sum. For example the utility of the chance node 'tardive dyskinesia or no tardive dyskinesia' is $0.15((0.58\times 0)+(0.42\times 0.75))$ plus $0.85((0.58\times 0.45)+(0.42\times 1))$. This process is called folding back the decision tree. For a decision node the best choice is that with the highest utility at its first chance node. Figure 1 shows the decision tree with outcome utilities and the expected utilities for each branch and for each chance node. In this example the best decision with *recurrence no tardive dyskinesia* having a utility of 0.45 is to prescribe the major tranquilliser. This has a utility of 0.622 compared with 0.615 for not prescribing the medication. If *recurrence no tardive dyskinesia* had a 'better' utility of 0.55 then the best choice would be not to prescribe the medication (0.685 for no medication v. 0.679 for medication).

At this stage it could be argued decision analysis has not helped because it simply produces two incompatible outcomes, either to prescribe or not to prescribe depending on what utilities are used. No decision has actually been reached. However this ignores two points: decision analysis has many aims apart from finding out what the 'correct' decision should be; and there are other variables which affect the final decision apart from the utility of *recurrence no tardive dyskinesia*. It may be that the final decision is relatively insensitive to this utility and that other variables have far greater effects. Because of this the final part of the process is a sensitivity analysis. This shows how the final decision is affected by varying the different probabilities and utilities.

To examine the effects of varying more then one variable at a time I performed a type of sensitivity analysis called a threshold analysis. (The term threshold comes from 'decisions threshold' which is where two variables produce identical expected utilities i.e. where both courses of action are equal.) A threshold analysis plots the decision thresholds of two variables against each other while a third is varied. Figure 3 shows a threshold analysis which displays the effect of altering the utility of *recurrence no tardive dyskinesia*, the probability of recurrence while taking medication and the probability of recurrence while not taking medication. I determined the decision thresholds by using utility values between 0.4 and 0.6 for *recurrence no tardive dyskinesia*. I then calculated the probability of recurrence with medication which produces identical expected utilities for prescribing or not prescribing medication. This probability is plotted against the utility value of probability for recurrence while not on medication at probabilities of 60%, 70% and 80%. (These figures reflect the 95% confidence limits in Crow *et al* (1986).) The calculations are easily transferred to a spreadsheet making calculation of this or other threshold analyses simple and rapid. Points below the lines at different probabilities of recurrence without medication show that psychiatrists should prescribe antipsychotics. Above these lines antipsychotics should be withheld. For example if a patient places a utility of 0.45 on *recurrence no tardive dyskinesia* and the risk of recurrence when not on medication is 80% or more then the best decision would be to prescribe prophylactic anti-psychotics. This applies as long as the risk of recurrence while taking them was less than 69%.

The decision whether to prescribe or not prescribe medication is not very sensitive to the utility of *recurrence no tardive dyskinesia*. It does however seem much more sensitive to the probability of recurrence while not on medication. It would seem from this analysis that it is important that different units audit their relapse rates. Extra threshold analyses would show the relative importance of other variables.

Criticisms of decision analysis

Traditional clinic decision-making, using clinical 'rules' and intuition, can be criticised because of its often unrecognised *implicit* assumptions (Tversky & Kahneman, 1974). Decision analysis however is often criticised because of its *explicit* assumptions (Feinstein, 1977). The criticisms follow the basic stages of decision analysis.

Defining and structuring the problem

A common critique of decision analysis is that problems are defined too narrowly and don't replicate clinical practice – there are not enough choices and not all the possible outcomes are considered (Dolan, 1990). While this may be true of some analyses it is not insurmountable. Indeed defining the problem, and deciding upon the important outcomes and where the clinician has to make choices, can be sufficient in itself to solve it.

Assigning probabilities

The probabilities drawn from the published literature or from clinicians 'best guesses' may be inappropriate or non-existent. However intuitive decision-making

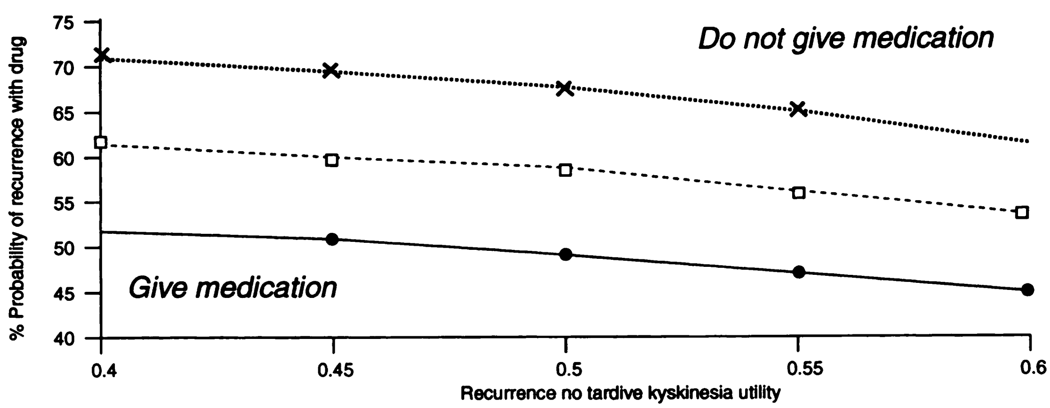

Fig. 3 Threshold analysis of using antipsychotics. The effect of varying the utility of *recurrence no TD* and the probability of recurrence with and without medication. Recurrence no drug: —— Probability 60%; --□-- Probability 70%; ···•··· Probability 80%.

faces the same problem when the database is inadequate. Clinicians may find it difficult to quantify their estimates of probability – one doctor's 'very likely' may be 90%, another doctor's 75%. An advantage of decision analysis is that sensitivity analysis allows change of these estimates to judge how important individual differences are. Also, clinicians' personal probability estimates may explain why they make different decisions in similar circumstances (Schwartz, 1979).

Assessing relative values or utilities

There are three main difficulties with this (Ransohoff & Feinstein, 1976). The first is the process of quantifying imprecise outcomes – for example the value of being pain free. Converting these into numbers may be difficult but no more so than when psychiatrists convert emotions such as depression into numbers using standardised rating scales.

Second is that most outcomes have multiple attributes. An outcome such as 'recurrence but no side-effects' is made up of many different factors including the severity of any symptoms, the time off work, economic cost, the stigma of psychiatric contact and effects on family functioning. Ransohoff & Feinstein (1976) argue that all these different outcomes should be given separate utility values which are then expressed on a single scale. The objection to this view is that people can assign relative values to outcomes without doing the same for their individual parts. For example most people would be able to decide on the relative merits of travelling by train or car without also having to list the relative merits of the economic and environmental costs, convenience and comfort. Decision analysis may be criticised for making this process explicit but any other model of decision-making – including 'normal clinical practice' – also has to find a way of ranking different outcomes.

The third objection to assigning utilities to outcomes is who should do it – the patient, doctor or society? Each of these decision-makers could place different values on the same outcome. Rather than being a drawback this is an advantage of decision analysis. It helps to highlight ethical dilemmas where the needs of the individual have to be balanced against the needs of society and the duties of professionals.

There are other difficulties in obtaining utilities. The way in which doctors frame questions affects the response of the patient (McNeil *et al*, 1982). The effect depends on whether the patient views a particular outcome as a loss or a gain – for example whether the question is about survival or mortality. In addition utility values may not be consistent over time or changing circumstances. How patients' utility values change when they are ill is not known. However an advantage of decision analysis is that sensitivity analysis may answer such 'what if' questions.

Analysing the decision tree

A problem here is how to interpret differences between the final expected utilities. Should clinicians give the same weight to the difference between 0.1 and 0.2 as they do to 0.5 and 0.6. Brett (1981) has pointed out the ethical dilemmas of decision analyses designed for groups of patients that produce small differences in the final utilities. Such analyses by seeking the greatest good for the population may 'sacrifice' individuals who were destined to do well without treatment.

A final criticism of decision analysis is that it is not clinically useful. Sackett quotes a figure of 1 : 80 routine admissions where he uses decision analysis (Sackett *et al*, 1991). Plante *et al* (1986) performed between 14 and 40 consultations a year over seven years, three-quarters of which were formal decision analyses by a clinical decision consultation service. They do not present any data on the impact the service had on patient care, an area for future research.

Difficulties and advantages in using decision analysis in psychiatry

A Medline search from 1966 to the present using decision analysis or decision making combined with either mental disorders, depressive disorder, schizophrenia or bipolar disorder found three papers. The references of these papers were screened for other relevant items, and the Science Citation Index was searched using the first authors names alone and combined with the title of the article. I also discussed the subject with an expert in the field (Mr J. G. Thornton, Institute of Epidemiology and Health Services Research, Leeds). This produced the papers shown in Table 1.

Why is there a rarity of psychiatric applications of decision analysis? Many of the applications of decision analysis in other fields have focused on the importance of either choosing a test, the sequence in which doctors should perform tests, or the context in which a test would be helpful (Kassirer *et al*, 1987). A positive or negative test decides the diagnosis and the diagnosis determines treatment. In psychiatry there are few routine useful tests, and diagnosis is relatively less important in deciding treatment.

One difficulty is the poor quality of the psychiatric database (Schulberg *et al*, 1989). However this problem also applies to intuitive 'clinical' decision

Table 1
Applications of decision analysis in psychiatry

Method	Clinical topic	Type of problem	Level of application	Utility
Decision tree (Worrall, 1989)	Resistant depression	Treatment	Generic	Not applicable
Decision analysis (Schulberg *et al*, 1989)	Treating depression in primary care	Treatment/referral	Generic	Remission rates
Markov process[1] (Zarin & Pass, 1987)	Lithium	Prophylaxis	Generic	Costs, recurrence, death, months on lithium

1. The Markov process is a variant of decision analysis which follows a hypothetical cohort of patients over a specified period of time.

making. In fact using decision analysis helps identify important gaps in knowledge.

In psychiatry many situations are unique to one patient, so any analysis may be difficult to 'export' to other patients. Hamm *et al* (1984) suggest other problems. Structuring the decision tree is difficult when patients may not always make rational choices and where the doctors' actions may be constrained by the law. The probabilities that apply in unique situations may be difficult to measure, especially when the decision-maker affects the actions of the patient. In these circumstances the probabilities of events are not independent of the choices made by the clinician.

There are situations where these objections don't apply and decision analysis may prove useful, for example in a conflict over management in a multidisciplinary team. Worrall (1989) describes his use of a decision tree in resolving conflicts between doctors over the use of electroconvulsive therapy as well as in teaching junior doctors and social workers.

The future and decision analysis

Decision analysis has been applied to clinical problems for over 20 years but still has the status of an esoteric academic discipline (Detsky, 1987). Each medical speciality discovers decision analysis and promptly forgets it again (Nettleman, 1988; Webb, 1988; Greep & Siezenis, 1989). It seems unlikely that decision analysis will ever be a routine part of clinic work. The instances when it is useful are too infrequent for clinicians to become skilled at using it and even with powerful pocket computers it is too time consuming.

The future for decision analysis in psychiatry lies in teaching, audit and research. It clarifies why doctors make decisions and encourages a comprehensive review of the literature. It also helps clinicians communicate where there are management conflicts. Its use in audit lies in defining standards and suggesting areas where audit would be useful. The sensitivity analyses should indicate clearly at what point of the decision audit activity should be focused or where more research is needed. Setting standards based on decision analysis should also ensure that patients are more involved in management if crucial outcomes and their relative values are explicitly discussed. In psychiatry, perhaps more so than in other disciplines, the treatment you get depends on who you see rather than what your problem is. Using decision analysis in teaching, audit and research may make going to the psychiatrist less of a 'lucky dip' (Prior, 1987).

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(First received 2 August 1993, final revision 17 January 1994, accepted 8 February 1994)