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Commentary

A Convenient Framework for Health and Medical Decision-Making Processes

Reflections on S.G. Pauker's paper:
Therapeutic Decision Making

Several approaches may be proposed for decision making. People usually base their judgments on common sense and the vast amount of knowledge they have accumulated through experience. One might also proceed by analogy or look for a more general problem with a known solution and then apply this general solution to the particular case to be solved, or one might use the language of a formal decision-making method and then use the algorithms proposed by the model to solve the problem.

The early Seventies was a period of intense research to develop decision support models to help clinicians making decisions in view of the uncertainty with which they are frequently confronted. Many authors turned towards decision analysis methods proposing an explicit framework and logic to create a model of these decision-making situations [1]. Many outstanding articles began appearing on the subject at that time. These articles opened the way to research and thinking on how to formalize diagnostic and therapeutic reasoning. The article by Pauker and Kassirer [2], published in 1975 in the *New England Journal of Medicine*, is one of these.

Rereading it now, 25 years later, along with some of the other important essays of the period, allows us to assess their contribution, the lasting concepts they introduced or upheld and the seeds of progress they contained and concretized. This rereading also allows us to review the issues that these concepts continue to raise today.

The Development of a Useful Formal Framework

The central points underlying a formal decision-making method are the following:

- The decision maker must make choices based on successive steps of consistent reasoning. He is, therefore, led to examine the downstream consequences of his decisions and not only those of the next step [3].
- The rationality of the proposition is not enough for the decision maker to adopt it. It is unreasonable to think that the decision maker will adopt the decision merely because it is logical.

The article by Pauker and Kassirer upholds the principle of the need for a relatively simple formal framework to help a physician in making therapeutic choices. The framework provided by the probability of the occurrence of events relevant for the decision, the utilities related to the results and to the costs and benefits they represent, is a suitable framework for such a formalization.

When the article was first published, the notion of utility, on which the costs and benefits are based, was already familiar. It had been introduced in fields other than medicine. It developed out of the work of Bernoulli in the 18th century and Laplace in the 19th century. The work of von Neuman and Morgenstern in the Forties contributed significantly to the development of this model: choices are functions of probabilities and utilities. During the last 50 years, the dominant theory of decision making, involving uncertainty, has been the theory of expected utility. The concept of utility has become a basic concept in decision-making theory to determine the best course of action starting from a description of a decision problem. This idea is at the root of various methods and techniques, including *cost-effectiveness analysis* and *cost-benefit analysis*.

The applicability of expected utility theory in clinical medicine is subject to debate. Nevertheless, the techniques that it underpins have been the subject of numerous applications in medical journals. This is clear from the large number of articles published in the medical scientific literature since 1975 on this topic (Table 1). These articles

Table 1. Number of articles found in MEDLINE on "cost-benefit analysis" by period

Period	1975 – 80	1981 - 85	1986 – 90	1991 - 95	1996 - 98
Number of articles	1,638	2,059	2,535	5,373	4,808

were found in MEDLINE, in response to a query concerning the keywords "cost-benefit analysis". It should also be noted that the number of such articles has increased steadily.

Finally, we wish to remark that this work is not always concerned with computer-assisted decision-support applications in clinical medicine but also very frequently with applications for evaluating public health programs.

Another example of the current interest in these methods can be found in the journal *Medical Decision Making* which often publishes articles that rely on the use of these tools. Fifteen months ago, it published a series of tutorial articles on the practice of decision making [4]. This shows that the research area is dynamic, stimulated by these techniques, dominated by the decision making in risk situations. This interest is visible not only in medicine but also in other fields, such as economics, finance, insurance, etc.

The Analysis Model Proposed by Pauker and Kassirer

In medicine, cost-benefit analysis, presented by Pauker and Kassirer is applicable to numerous problems encountered by clinicians in a wide variety of disciplines and clinical situations. The model decision problem is based on the following hypotheses:

- The patient presents (or does not present) only one illness
- There is a well-defined, effective treatment for the illness
- The physician must decide on prescribing this treatment in a situation of diagnostic uncertainty for a given case
- The patient who presents the illness loses a finite benefit by not being treated
- The patient who does not present the illness is affected by a finite cost (risk of complication, for example) by being treated.
- The patient who presents the illness is also affected by the same finite cost by being treated but has a benefit linked to the treatment.

In this model, the cost is defined for patients who do not have the illness as the difference between the utility of not treating patients who do not have the illness and the utility of treating these same patients.

The benefit is defined as the difference between the utility of administering a treatment to patients who have the illness and the utility of not administering the treatment to patients who have the illness.

The proposed cost-benefit analysis is formulated in a very general way.

Sometimes, in the literature that came later, the benefits are broken down into direct and indirect benefits [5]. Direct benefits are rather easy to estimate (the money saved), whereas indirect benefits, such as the value of prolonging life expectancy, are much more difficult to evaluate. None of the methods used to express costs and benefits is exempt from criticism.

The article considers various ways of quantifying utility and asserts that the model can be used even if it is impossible to carry out an exact validation of the benefits, costs and probability of the illness. Furthermore, "cost-benefit" analysis has an important advantage: the benefits and costs are expressed in identical units. Hence, various actions can be compared.

The proposed sensibility analysis makes it possible to judge the soundness of the conclusions with regard to the evaluation of benefits, costs and probabilities, thereby raising a fundamental problem underlying the debate which has grown up around this topic and which is not over yet.

A Normative Method, the Importance of Axioms

This formal decision-making method belongs to the category called normative decision making. In addition to the method presented, the advantages of formal decision-making methods in medicine are clearly apparent in reading the article. The formal framework is open to discussion, indeed it is debatable. It nevertheless offers the advantage of providing a common reference point enabling discussion on the basis of shared decision-making and it may permit the evaluation of the rules we use in practice. The method imposes a structuring of the problem that avoids bias to which the intuitive approach to decision-making is liable. These points are far from negligible in the current framework in which medicine is becoming increasingly complex and many decisions are no longer made by a single physician but by a team.

According to Baron's definition [6], a normative theory is an idealized abstraction, an analytical framework in which we place the phenomena of life with a view to defining a standard. Building a normative theory of decision making has important advantages, for it rests on axioms that give validity and coherence to the theory as a whole. There is one question: what is the validity of such a method? Its validity depends greatly upon the field in which it is applied. In particular, it must satisfy two specific conditions of the field. It

st be [7]:
locally correct. This implies that it is applicable to simple problems in the field and provides correct solutions. This condition, achieved or discussed in the articles presenting the use of the method, does not suffice to validate the formal method.
- capable of being extrapolated, i.e., a significant increase in the size and complexity of the problem does not affect the nature of the problem or make it inapplicable.
- Expected Utility (EU) is a normative standard that has taken on great importance in medical decision making. It is based on the axioms of ordering, continuity, independence, and transitivity. These axioms lead to the consistency sought in the decision-making process, but are difficult to satisfy in the medical field in particular. The following can be concluded:
- The axiom of decomposition implies that the decision maker can break down an uncertain event into several components. Together they represent a recomposed event with a probability of occurrence identical to that of the initial event.
- The axiom of total order presupposes that the decision maker can order all possible situations resulting from his decision. This axiom is not always easy to satisfy.
- The axiom of continuity is also a matter of controversy. The perception of uncertainty presents particular features that have been studied by numerous authors, including Tversky and Kahneman in their work on the study of heuristics and biases [8].

The quality of a decision depends on the correctness of the action taken by the decision maker in view of a given model and the degree to which it represents the reality perceived by the decision maker. The theoretical debate concerns the model and its appropriateness to the area of application.

Further Considerations

In addition to theoretical considerations, the behavior of the clinicians who are supposed to use these methods in practice must also be taken into account. According to medical culture, clinicians are always reluctant to include costs as a factor influencing therapeutic decision making. This reluctance is certainly linked to the idea that a less-than-optimal treatment may be chosen strictly for reasons of cost.

This decision-making approach also raises practical problems. Thus, aside from the difficulty of accepting the axioms underlying the decision-making rules, it turns out that individuals have a poor grasp of probabilities and have difficulty measuring utilities.

Many paths have been explored in attempting to solve the problems of poor interpretation of probabilities on the part of human beings. This continues to be a problem.

A philosophical consideration has often been put forth by practitioners who are critical of the use of normative methods: good decisions may have good or bad results, just as the results of bad decisions may also vary in quality. There is no way of knowing whether a better decision would have been made using a normative decision-making procedure than not using one. The quality will depend on preferences of the decision maker and is, therefore, connected to a given decision only in a probabilistic way.

In this decision-making approach, the role of experts in the field is also called into question. The role of experts is different in decision-making analysis than in knowledge engineering. Initially, in order to assist in the decision-making situation, the development of expert systems sought:
- to propose models of concepts and knowledge. The contribution of knowledge engineering has provided solutions in the field of software engineering.
- models for reasoning in uncertain situations to assist medical decision-making.

The knowledge used by these systems was established by "expert opinion". In this case, the experts were viewed as decision makers who explain the rules of decision making without making explicit the formal model of the decision-making method. Contrary to the decision-analysis approach, this procedure introduces confusion between the area of decision making and the decision-making situation and makes it difficult to analyze the source of preferences in the choices made.

Conclusion

The article by Pauker and Kassirer deserves much credit for helping to introduce cost-benefit analysis and, more generally, methods of decision making in medicine. Today, the methods are used for clinical decision making as well as in public health to carry out comparative financial assessments of actions or prevention programs.

Published articles usually make use of the method for decisions concerning health programs or medical-financial problems. Since this method is based on the notion of expected utility, one intuitively understands why it is more readily accepted for formalizing problems affecting populations rather than for decisions affecting individuals. In the case of health program or medical-financial decision making, the cost and clinical results of new programs must be expressed in standardized units to facilitate comparison between programs. Cost-utility analyses meet this need, by calculating, for example, the incremental cost by QALY, achieved when one strategy is used rather than another. Software has been developed and is now on the market to implement these decision-making methods.

The theory has strength as well as limits of applicability in the field of medical decision making. It cannot be applied directly, a fact that has given rise to a debate which has not yet been settled. This debate is situated at the outer limits of the search for trade-offs between quality of life and quantity of life, between cost and effectiveness, between the short term and the long term.

It allows us to evaluate the rules that we use in practice by identifying those that are better than others in the sense of being standard. One might also say with Baron [6] that Expected Utility is normative but not prescriptive. The limits of the underlying theory must be recognized and the results of analyses interpreted accordingly.

Using these methods makes it easier for clinicians to understand and grasp decision-making conflicts. In this sense it is extremely useful to teach them in medical school programs. Weinstein and Fineberg [5] state three reasons for teaching physicians how to use formal decision-analysis methods. Decision analysis provides a more rigorous and less ambiguous vocabulary than the current vocabulary used to talk about uncertainty. It also provides a systematic method for structuring problems. Finally, it can help clarify medical controversy by bringing to light the points of disagreement.

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