Decision Analysis: A Prescriptive Method for Decision and Cost-Effectiveness Research

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It has been almost 20 years since decision analysis was transposed from operations research and applied to the medical environment. Although it has emerged as a powerful tool for both clinical decision making and research, decision analysis has not gained wide acceptance, and its uses remain narrowly defined.[1] Within the discipline of family medicine, the dissemination and application of formal decision theory has been especially hindered by two problems: first, lack of trained faculty, and second, misconceptions resulting from lack of understanding about the applicability of decision analysis in primary care practice and research. Circumstances appear to be changing, however. Recent efforts to introduce formal decision analysis to interested faculty, fellows, and residents at the annual meetings of the Society of Teachers of Family Medicine and elsewhere have been rewarding. Further, increasing numbers of family physicians have become active participants in the Society for Medical Decision Making, a rapidly growing organization whose members are committed to recognition of decision analysis as a basic clinical skill and research method.[2,3]

What is decision analysis? And does it indeed deserve recognition within family medicine as an important clinical and research tool? In short, decision analysis principles dictate a logical and probability-based pathway to assess the merits of clinical decisions in situations of uncertainty.[4] Given the nature of primary care practice, family physicians are especially likely to confront clinical problems in which decisions to treat or not to treat must be made in the face of a high degree of uncertainty. Decision analysis is an aid to, not a replacement for, clinical judgment in identifying the "best" decision.

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Three steps are essential in any decision analysis. First, a decision tree of alternative choices and their consequences must be elaborated. Second, probabilities must be assigned to events that affect decision outcomes; these probabilities are based on current knowledge from published data or the physician's own clinical judgment to tailor the literature to a particular patient or setting. Finally, patient preferences for the alternatives and their potential outcomes must be quantified. These ingredients are then combined mathematically, thus permitting a comparison of the merits of each alternative treatment option to assist in guiding the final decision. A less formal, and certainly less overtly mathematical, method of reasoning is used by each of us when confronting, for example, a patient in the emergency room with acute chest pain.[5] Decision analytic methods coupled with clinical judgment in this setting, however, can optimize patient outcomes.[6]

Where does decision analysis fit into the research agenda within family medicine? A major emphasis of recent research in primary care has centered on the efficacy, or the tradeoffs between quality and cost, of specific clinical strategies.[1,7,8] Three general approaches to such issues emerge: the medical model of cumulative experience, the controlled clinical trial, and nonexperimental methods such as decision analysis.

First, the medical model of cumulative practice may dictate standards of care that become generally accepted and are often codified through standards development or descriptive studies. Second, medicine is currently preoccupied with the controlled clinical trial as the "gold standard" research design for solving all clinical questions. Indeed, when asking well-focused basic biological or factual questions, controlled trials are ideally appropriate; but often clinicians and researchers alike may find the results of such studies narrowly responsive. Clinical trials, by definition, attempt to answer a specific question while controlling for all other variables, thereby leaving other aspects of the clinical problem to be addressed by future studies. Third, we can confront clinical research questions using logic or reasoning. This research is prescriptive, seeking to

answer clinically relevant questions under real-world constraints making the best use as practically possible of data available in the literature.[9–11] A careful review of the medical literature reveals pieces of data, much like the pieces of a puzzle, that might answer the question if assembled appropriately. Decision analysis clearly falls into this third domain and provides the methodology for joining such pieces.

The study by Wadland and Plante in this issue of the Journal is an excellent example of the decision-analysis approach.[12] The clinical problem, screening for asymptomatic bacteriuria in pregnancy, has been the subject of basic research and numerous studies examining different aspects of the issue. As cost constraints mount and new treatment options emerge, however, reexamination of standard practices is both inevitable and healthy. This decision analysis is well developed and the decision tree noncomplex. Is screening for asymptomatic bacteriuria in pregnancy cost effective given current knowledge and alternative approaches to treatment? The answer to the clinical question appears to be "yes." The assumptions presented by the authors are reasonable and well justified. The analysis has laid out a coherent strategy for relating all the pieces of the puzzle. The end result is a model of the alternative decision points and their logical outcome based on existing literature, clinical experience, and cost data to determine whether the procedure is justified or should be discarded.

Other recent examples of such analyses are worth commentary. Arevalo and Washington[13] reported on their findings comparing the cost effectiveness of routine screening for hepatitis B during pregnancy with targeted screening of identified high-risk patients. They combined a decision analysis and cost-effectiveness analysis using literature and data from the United States and Southeast Asian sources to construct a model. Additionally, where accurate information was lacking for certain decision points, expert panel judgments were obtained through use of a delphi technique to provide probability and other data. Their decision and cost analysis determined that routine screening is, in fact, cost effective and improves patient outcomes, thus providing the evidence necessary to justify its inclusion as an integral part of prenatal care. An editorial responding to the study cited the important contribution of the cost-savings data, especially when it was derived in a way that allowed favorable cost comparisons to other routinely accepted prenatal screening tests such as the Rh antigen.[14]

Not all decision-analysis studies resolve controversies, but they may shed new light on issues. A recent cost-justification analysis of prenatal screening for maternal serum α-fetoprotein reported that screening was not cost saving given the current reimbursement structure in the clinical environment.[15] Although this study was constructed from the perspective of the cost benefit to the insurer rather than society, the cost justification demonstrated that the maneuver would be cost saving only if the incidence of neural tube defects in the underlying population were significantly higher than currently reported in the United States. This study represented a rigorous decision and cost analysis, utilizing data from the literature and from actual clinical experience at the Group Health Cooperative of Puget Sound. The availability of pertinent literature, as well as clinical and cost data from actual experience, provided the elements prerequisite to completing the analysis. The finding that screening is not cost saving (ie, does not pay for itself in later monetary savings) focuses attention on how willing we as individuals and a society are to pay for nonmonetary health benefits at the rate determined by the study.

Several issues arise when discussing studies that utilize decision analysis or draw conclusions about cost effectiveness. First, there is a nearly automatic reaction to find fault with specific quality or cost data utilized at key decision points. To counteract this reaction, each of the above studies performed tests of robustness of the model under study, demonstrating that wide alterations in their quality and cost assumptions would have little effect on their final results. For example, in the study by Wadland and Plante in this issue, the only variable likely to change the conclusions of this decision analysis would be the hospital day rate if it were to fall below $77. Although such a finding would be lauded as a revolutionary development in health care financing, the likelihood that hospital rates would ever return to such low levels is remote.

Second, ethical concerns are often raised when challenging the results of decision analytic or cost-effectiveness analyses. These concerns are well articulated elsewhere.[16–18] One commonly cited ethical or value issue, however, is relevant to family medicine research: the lack of adequate quality of life or health status measures necessary to accomplish meaningful decision or cost analyses.[19,20] The interrelationship of health and illness as it affects the individual and the family is clearly within the domain of family medicine research, and this topic provides an opportunity for family medicine researchers to improve upon current approaches to these values and outcome measurement issues.

Finally, when does one consider not using decision analysis and decide instead to turn to clinical trials to answer complex problems? There is no quick or comprehensive rule, but there are guidelines that may assist in making this decision.[10] If estimates or guesses of critical quantities at many or most decision points are not based on *empirical* data, the results of the decision analysis may be justifiably questioned. Under these conditions, our models may drift further and further from reality and need stabilization with empirical studies. The exercise of applying decision analysis to a complex clinical problem may resolve a controver-

sial issue, provide decision trees useful in everyday medical practice, or reveal the need for very specific data absent from current literature. Decision analyses that identify critical gaps in knowledge may encourage targeted studies to collect the missing data necessary to answer complex questions, thus obviating the need for larger and often more costly empirical trials.

The study by Wadland and Plante revisits a common problem, screening for asymptomatic bacteriuria in pregnant women. There is a vast array of similar, common clinical problems in family medicine, whose standard management is based on the medical model of cumulative experience, that have not been subjected to such rigorous analyses. Probably an equal number of vague and ill-defined clinical problems also confront us in routine practice whose management might be understood through use of formal decision analysis. It is hoped that, through more frequent publication of studies such as that by Wadland and Plante, more and more family physicians will become at least conversant enough with decision analysis to begin to catalog types of problems that may be addressed by this method and thus help to build a reasonable research agenda for the field. Certainly, the recent contributions by Wadland and Plante, Taplin et al, and Arevalo and Washington justify the utility of this method and further contribute to the credibility of family medicine research efforts in areas of concern to our discipline.

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