Applications of Decision Analysis[1]

David F. Kallmes, MD

Decision analysis represents a formal, quantifiable approach to complex clinical situations. Such analyses can be used to aid decision making under conditions of uncertainty. Originally developed in the field of economics in the early 1970s, in the early 1980s decision analysis gained popularity in clinical applications for addressing individual patient decision making. Recent concerns about health-care economics have generated widespread interest in the use of decision analysis, as evidenced by the presence of greater than 250 citations each year focusing on decision analysis. This paper discusses the use of decision analysis as an adjunct to cost-effectiveness evaluation.

CONSTRUCTION OF A DECISION TREE

Definition of Patient Population

Performing a cost-effectiveness analysis with decision trees requires strict definition of the expected patient population. Clearly defined populations are mandatory because disease prevalence and spectrum may vary in different populations. Patient age, sex, and presenting symptoms must all be clearly defined. In addition, potential bias from previous work-ups, including selection bias and work-up bias, should be clearly stated, or eliminated, if possible. In addition, the spectrum of disease within a given patient population is also important. For example, in a decision analysis for confirmatory magnetic resonance angiography (MRA) after screening ultrasound for suspected carotid occlusive disease, results are highly dependent on the screening criteria used in the initial evaluation. A highly sensitive but nonspecific screening examination leads to a patient population with relatively mild stenosis, whereas an insensitive screening examination leads to a patient population with a spectrum of disease that is strongly biased toward severe stenosis. This previous bias can affect the specificity of the imaging examination under consideration.

Decision-Analysis Software

Historically, most decision analyses were performed with either customized software or with small SMTREE software. However, a user-friendly, flexible, and detailed program called Decision Analysis by TreeAge is now available (DATA; TreeAge Software, Williamstown, Mass). With this decision-analysis software, automated calculation of outputs is performed, and the only tasks remaining for the operator are definition of the decision tree and determination of input variables for parameters such as test specificity, disease prevalence, and costs.

Identifying Branch Points (Nodes)

Construction of a decision tree requires the use of three types of branch points or nodes: (*a*) choice nodes, (*b*) chance nodes, (*c*) terminal nodes. The choice node is one in which the person constructing the decision tree is faced with an imaging decision, for example, choosing ultrasound or MRA for evaluating carotid stenosis. The chance node uses input data, such as test specificity and sensitivity, to define probabilities. The terminal node is one where outcomes are defined or quantified. The utility of a given node, such as a chance node, is calculated using the weighted average of the utilities of all of its possible outcomes. In other words, the calculations required in decision trees are simply those of the Bayes theorem, well known to most medical practitioners.

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[1] From the Department of Radiology, University of Virginia HSC, Charlottesville, VA 22908. **Address reprint requests to** the author.

SENSITIVITY ANALYSIS

The sensitivity analysis is otherwise known as a "what if" analysis. A sensitivity analysis tracks change in an output variable as a result of change in a given input variable. Sensitivity analysis is highly useful when input data are incompletely or poorly defined. Sensitivity analyses may be either one-way or multivaried. The greatest strength of the sensitivity analysis is that it can be used to identify the most relevant input parameters. For example, if small changes in a given input variable lead to large changes in a given output parameter, that input variable may be identified using sensitivity analysis as an important parameter. Conversely, if large changes in a given input variable result in small changes in output, this parameter may be relatively less important.