

## **Model of Evidence-Based Dental Decision Making**

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### **ABSTRACT**

Shared decision making empowers patients as informed consumers, helping them to make clinical decisions that optimize their personal oral health.

Evidence-based dentistry supports this process by providing best evidence that, when presented in visual and interactive formats, focuses consultation time on treatment or therapy options and their trade-offs. Currently, an explosion of evidence and technological advancements have necessitated a cooperation that translates into an interdisciplinary approach to care

delivery. For evidence-based dentistry, this interdisciplinary approach includes the interaction of researchers, clinicians, and patients in promoting individual patient care. To facilitate this interaction, a computerized model of evidence-based dental decision making is presented to manage knowledge in its application to clinical practice. This model includes the use of decision aids and a decision tree composed of multiple clinical practice guidelines. These aids allow for quantifying treatment options in terms of estimates using probability, utility, and cost data. With these estimates, decision analysis and the flexibility to manipulate data provide patients with increased control and acceptance of the decisions that they make about their personal oral health.

## INTRODUCTION

Treatment decisions and providing patient care using the best evidence and available technology supported by sound, rigorous research is fundamental to a state-of-the-art dental practice. On this, dentists, researchers, and other decision makers can agree. What is contentious is the process by which evidence-based decisions are made in current dental practice. To researchers and other decision makers, dentists make evidence-based decisions by loosely applying scientifically based and supported clinical standards or practice guidelines. To dentists, the process of making evidence-based decisions is impractical, authoritative, and not based on the conduct of routine dental practice, diminishing the value of clinical judgment.\*

Currently, researchers and facilitating organizations disseminate best evidence in forms perceived logical for clinical practice. These forms are standard to research reporting. Once reported, evidence must be read, analyzed, and accepted for its statistical significance. Then, findings need to be integrated with other types of evidence to provide statistically competent comparisons and measures for decision making. The clinician is required to perform these assessments, evaluate clinical significance, and combine evidence into usable options for presentation to their patients. Researchers see clinical practice as the laboratory to conduct these tasks.

Clinical practice, however, concentrates available time on shared decision making and services to individual patients. Dentists produce these services and monitor their outcomes over long periods of time. This clinical evidence becomes the dentist's judgment that may be altered when individual patients experience changes in their health and function, diminishing the value of research in advancing patient care. Both processes are

counterproductive in establishing an evidence-based practice, integrating best evidence from research into usable formats for shared decision making in advancing clinical practice and patient care. This article proposes a model of evidence-based dental decision-making (EBDDM) and decision analysis that supports evidence-based dental practice.

## MODEL OF EVIDENCE-BASED DENTAL DECISION MAKING

In private practice, dentists have an ethical responsibility to provide effective and appropriate therapies and treatments that meet the needs and desires of their patients. The clinical decision is the best choice among alternatives made within the scope of informed consent. While dentists quantify a patient's oral health status, patients qualify that status and may well contribute evidence derived from external resources including the Internet and other media. In addition, patients may wish to involve family members whose concerns and active participation in care services must be addressed. According to Coulter<sup>2</sup> and Price and Leaver,<sup>3</sup> motivating patient participation in decision making improves compliance and reduces errors that may lead to litigation.

### Goal

A model of evidence-based decision making manages knowledge, or, best evidence. Knowledge management integrates patient characteristics in a system that guides dentists and patients in maximizing decisions. A maximized decision reconciles best evidence of treatments or therapies with conditions and circumstances of individual patients. Access to knowledge in the 21st century has been facilitated by computer technology. This technology makes integration of multiple types of information, computation of complex mathematical measures and comparisons, and delivery of choices such that dentists and patients spend consultation time on discussing options and trade-offs rather than evidence in reaching a maximized decision.

### Decision Aids

Patient-centered and dentist-centered decision aids exist to augment and improve shared decision making during the consultation. Current decision aids are disseminated in numerous formats including workbooks, audio, video, and computer-based formats. However, instant decision trees are preferred when their formats provide "on-demand"<sup>4</sup> information, or content flexibly managed for real-time access or download by dentists.<sup>5</sup> According to O'Connor,<sup>6</sup> a decision tree must have certain requirements that provide competent information for advancing patient care (Figure 1). In addition, decision trees ought

\*Beutler LE: Empirically based decision making in clinical practice. *Prevention & Treatment*, 2000; 3(27): <http://journals.apa.org/prevention/volume3/pre0030027a.html#c9>. October 13, 2004.

## Decision Aid Requirements

- Be evidence-based
- Provide options with estimates of probability and utility
- Identify the population characteristics attributed to the developed tree
- Be clinically significant
- Be current and updatable
- Be effective and efficacious for shared decision-making

**Figure 1.** The requirements of decision aids used in evidence-based dental practice.

to be made to guide patients in a step-wise fashion such that patient concerns and attitudes may be given the proper import at sensitive decision points. Decision trees are developed as expert systems that structure clinical problems, analyze decisions and options, and chose and implement clinical practice guidelines or CPGs. These systems may be developed by clinicians or groups of experts, representing institutional or patient interests, or with the assistance of computer software.<sup>7</sup>

### Infrastructure

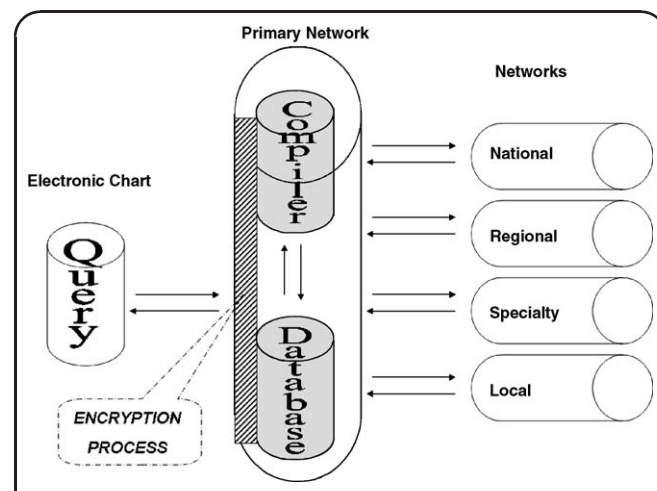
Creation of an infrastructure necessitates a centralized process that promotes shared decision making and manages knowledge. From a central database, best evidence is produced, stored, disseminated, and integrated into clinical practice for effective and efficacious decision making and quality assurance. The infrastructure for the EBDDM Model (Model) consists of the patient's electronic chart and primary, secondary, and local networks (Figure 2). Secondary networks include national, regional, and specialty networks producing, disseminating, and integrating best evidence within the primary network. Specialty networks focus on best evidence for specific populations or disciplines, for example, geriatric dentistry or oral maxillofacial surgery. Local networks act similarly to secondary ones and include local agencies and private practices.

The primary network is suggested as the American Dental Association (ADA). The ADA is the ethical, regulatory, and community advocate for patient oral health and personal self-care. As the primary network, the ADA controls all aspects of the central database. The ADA coordinates with other central databases internationally and those culturally based at the national,

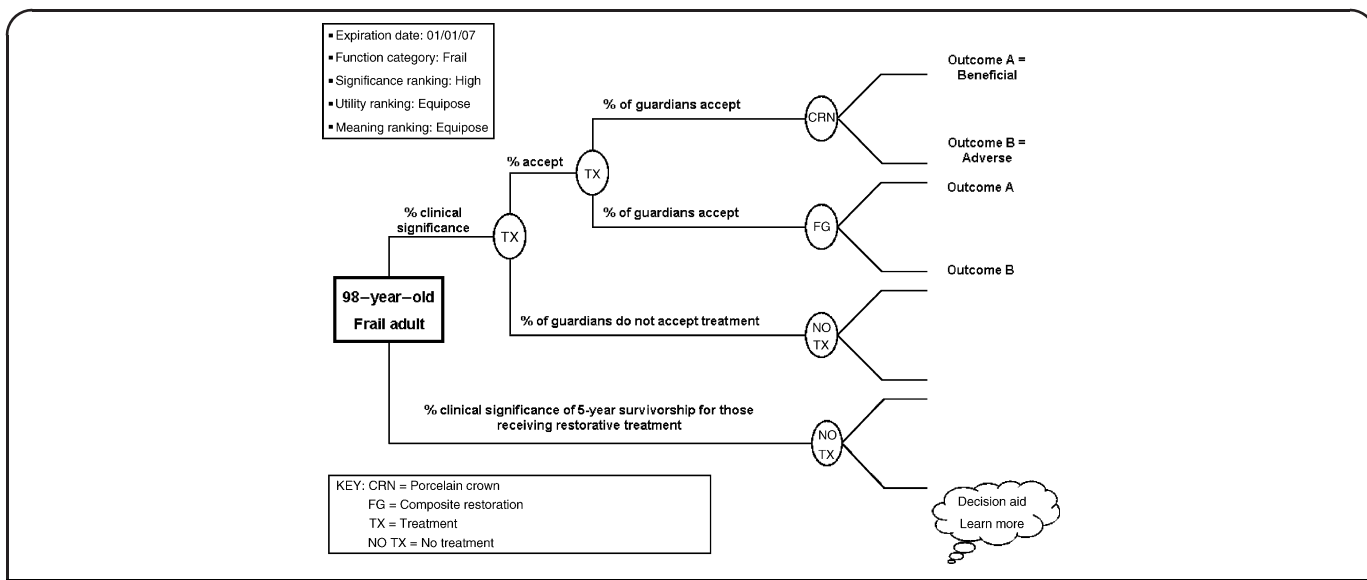
regional, local, and practice levels. Being the central processing agency, evaluating decision aids, new evidence, and conducting research are primary responsibilities in improving decision making for patients and dentists. The exchange of patient information in accomplishing these responsibilities must abide by The Health Insurance Portability and Accounting Act of 1996 (HIPAA) standards.<sup>8</sup> The data ought to be encrypted such that patient identification is protected. Databases, in particular, are obligated to be especially diligent in optimally safeguarding such information. Password protection and user access methods must be secured and security controls enforced. This has great import if researchers are to access information to further study changes in practice, behaviors, and oral health trends. Centralized-based information is knowledge that is independent of patient characteristics in developing choices. When information is dependent on patient characteristics, this information may be stored and managed for dissemination through national, regional, local, or practice databases. Here, new evidence and modification of probabilities using Bayesian statistics is conducted, managed, and disseminated.

### Decision Tree

The natural history of the Model follows the production, storage, management, dissemination, and integration of best evidence into clinical practice. The Model begins with the patient's electronic chart. The dentist performs the head and neck, oral cancer, and soft and hard tissue intraoral examinations. From these examinations, individual patient data are input into the patient's electronic chart. The amount and quality of data provided will determine the accuracy of the model in



**Figure 2.** The infrastructure of the process from the electronic chart to the centralized primary network.



**Figure 3.** Simulation dentist.

maximizing the clinical decision. Areas of uncertainty in determining treatments and their sequencing through shared decision making are determined. Through the patient's electronic chart, the dentist queries the need for a decision aid in meeting a complex decision process or specific condition. For a complex decision process, the query is for a decision tree, or algorithm.

#### Simulation Dentist

An emergency, new patient presents on the dentist schedule. The dentist learns from reception that the patient is a 98-year-old woman who has broken her 2 front teeth. She is coming in with her guardian who is the guarantor of any needed services. From the primary network, the dentist accesses a decision aid to assist the decision-making process with the guardian (Figure 3).

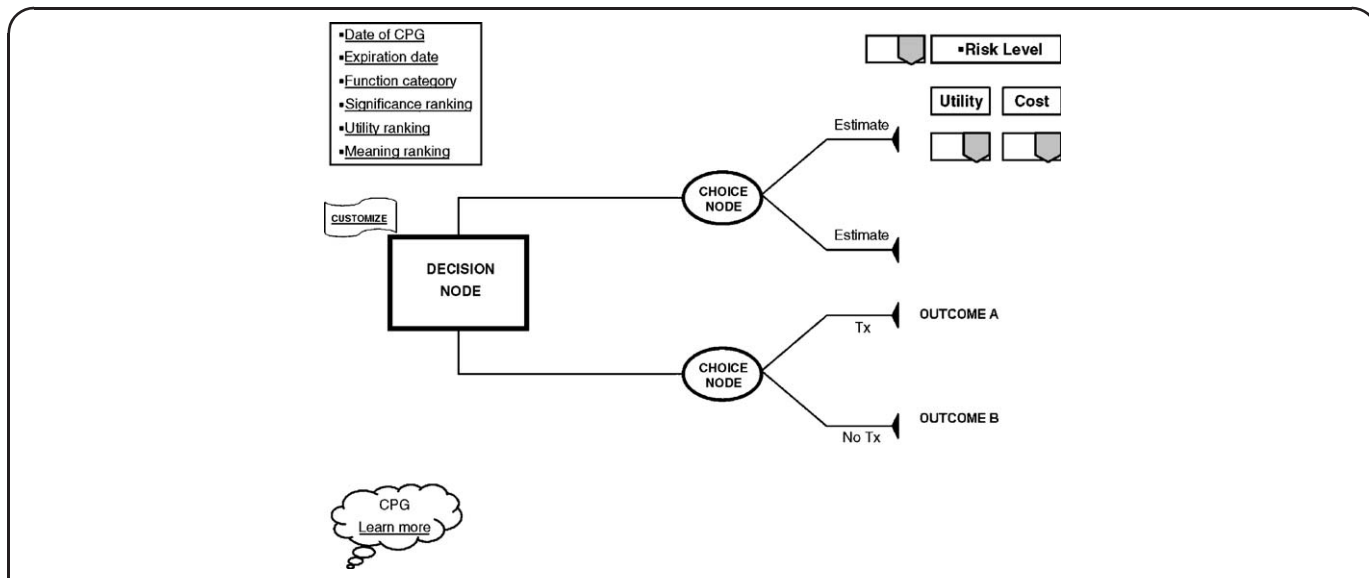
This decision aid is a visual representation of instructions to approach a complex decision process. The process ends with health care outcomes quantified by probabilities, utilities, and costs (Figure 4). The data may provide probabilities of events, or comparisons. For a specific condition or intervention, the query is for a CPG. The CPG is a specific decision node within a decision tree. Decision trees cover multiple CPGs and organize them into pathways for shared decision making and mutually agreed upon treatment plans (Figure 5).

If the query is for a decision tree, it begins by electronically sending the patient's assessment information or data through the primary network's encryption process. During encryption, a random identifier is assigned to the patient's data entry. This identifier is secured within the primary network. After encryption, the query is managed and completed through a compiler-database

processing system. The resultant outcome or outcomes return through the encryption process to the point of origin of the query. Depending on the specificity of the query, a standard decision tree may be returned. Other possible outcomes may be single or multiple decision trees developed from the primary or other networks. The supplied decision trees are identified by their expiration date, the patient's functional status,<sup>6</sup> and their ranking (high, equipose, low) in terms of statistical significance, dentist-determined utility, and their meaning in practice. This ranking system is important because best evidence is by definition temporal and may be of varying quality. Thus, researcher weighting or grading of the evidence will indicate to the dentist the strength of the data<sup>9</sup> and areas of needed research. Dentist weighting of the evidence provides evaluation of the clinical significance of the evidence. This evaluation may expose differences that may be quantified by researchers on a local, regional, national, or international basis. Both weightings may have the added benefit of exposing gaps in knowledge or differences between statistical and clinical significance in the application of evidence. Finally, patient's weighting of the evidence is demonstrated in patient compliance and provides the meaning that can be associated to the decision tree's overall usefulness in treating patients.

A link is also provided for access to the decision aid's original data, published articles, abstracts, or other user-defined formats. Dentists may access this link for their own interests.

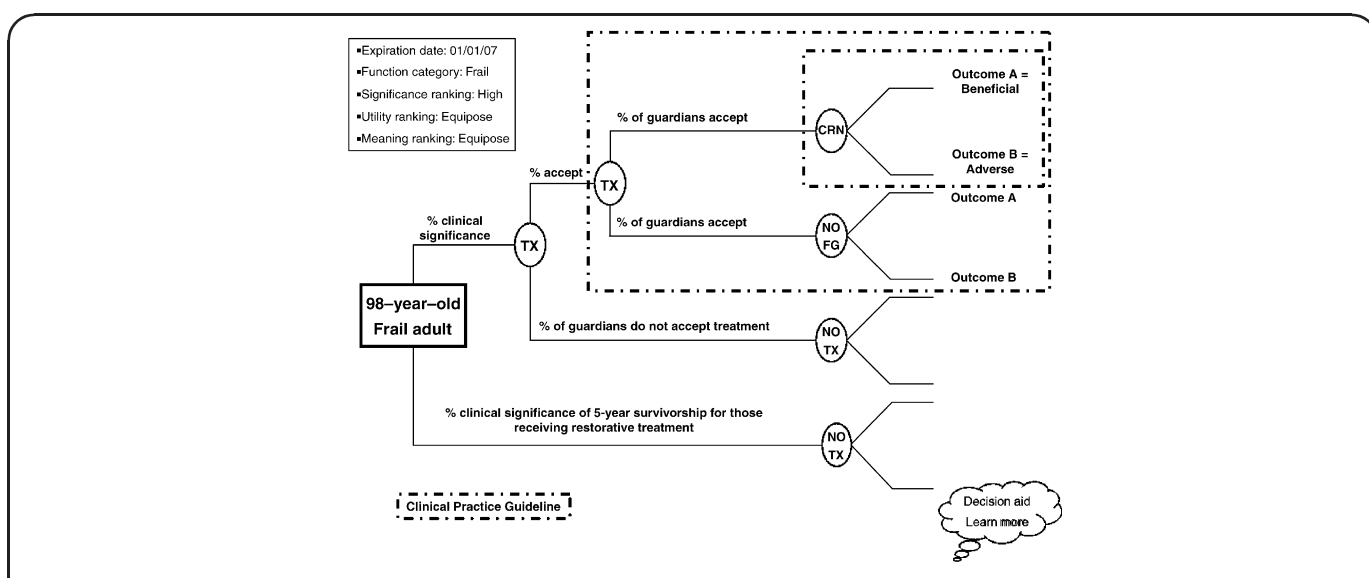
The dentist has the option to peruse and accept, input additional information for a regenerative search, or reject



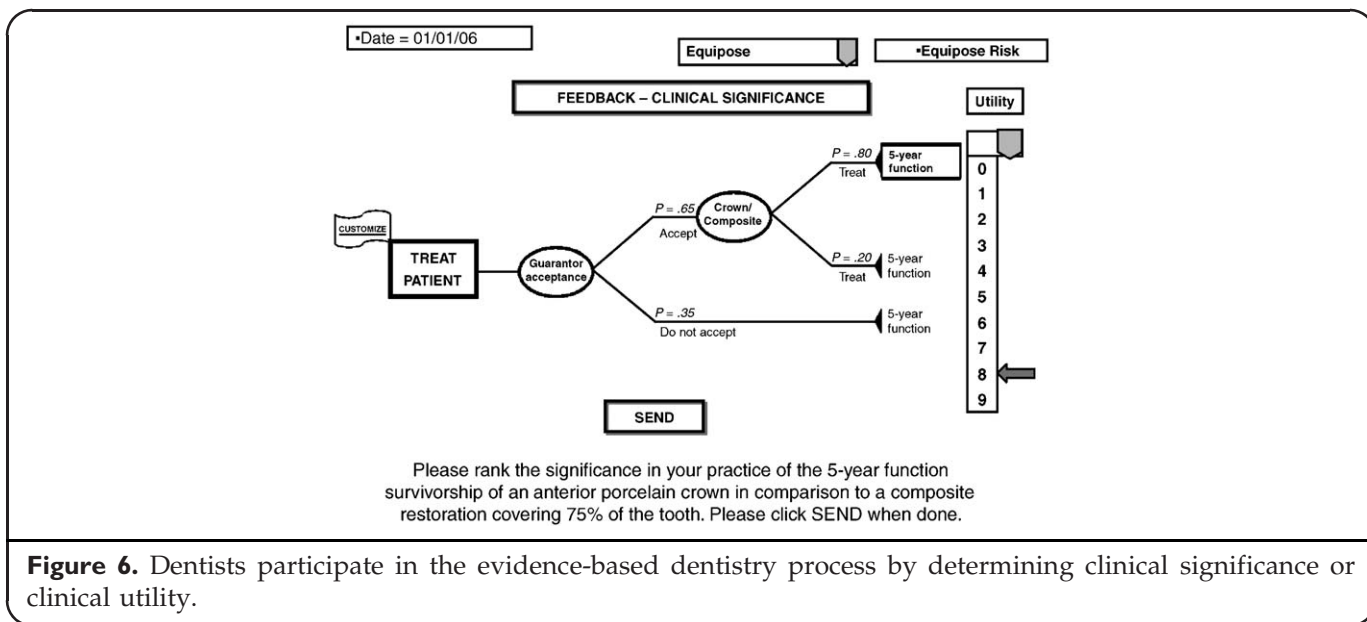
**Figure 4.** Health outcomes are quantified by probability, utility, and cost estimates.

the decision tree. The issue of the amount and quality of decision aids is important to emphasize. Query criteria and input must facilitate only those results that are most pertinent to the patient's data. Otherwise, this part of the process will not meet dentist utilities in a service-intensive practice. Upon acceptance of the decision tree, it becomes attached to the patient's electronic chart. Options are provided to the dentist for automatic updates of the decision aid. These options include reminders or alerts delivered by e-mail to the patient's chart, or other ways specified by the dentist end user.

For long-term monitoring, the dentist is expected to provide through a survey mechanism the clinical significance or usefulness of the decision aid. The dentist is also expected to provide the decision aid's meaning in practice from within the electronic chart. Using the CPG, the dentist ranks its clinical significance, or clinical utility, by a ranking system from 0 to 9. The results are quantified as 0 to 3, a low ranking; 4 to 6 equi- pose; and 7 to 9 high (Figure 6). This evaluation of the decision aid is expected within a period of 6 months. Similarly, the CPG's meaning in practice may typically be



**Figure 5.** A decision tree is a compilation of single or multiple CPGs.



completed at annual intervals. The rankings are provided through the same mechanism from within the patient's electronic chart. The survey process is expected to be short and noninvasive to the daily conduct of practice. From this long-term monitoring process, additional primary network alerts provide evaluation of the changes in the effectiveness and efficiency of the decision aid for both the dentist and patient. This evaluation is called a sensitivity analysis.

### Clinical Practice Guidelines

Similarly, the CPG production, storage, management, dissemination, integration of best evidence, and query process occurs. However, a CPG organizes and sequences care outcomes for specific conditions that are included within a decision tree. Searching CPG decision aids allows the dentist to address specific and narrowly defined patient care issues. CPGs may be accessed for evaluation from within the attached decision tree or singularly, all from the patient's electronic chart. The CPG provides for viewing and modification of health care outcomes. The CPG may be customized through the Customize button. The CPG also provides the probabilities, utilities, and costs of these outcomes.

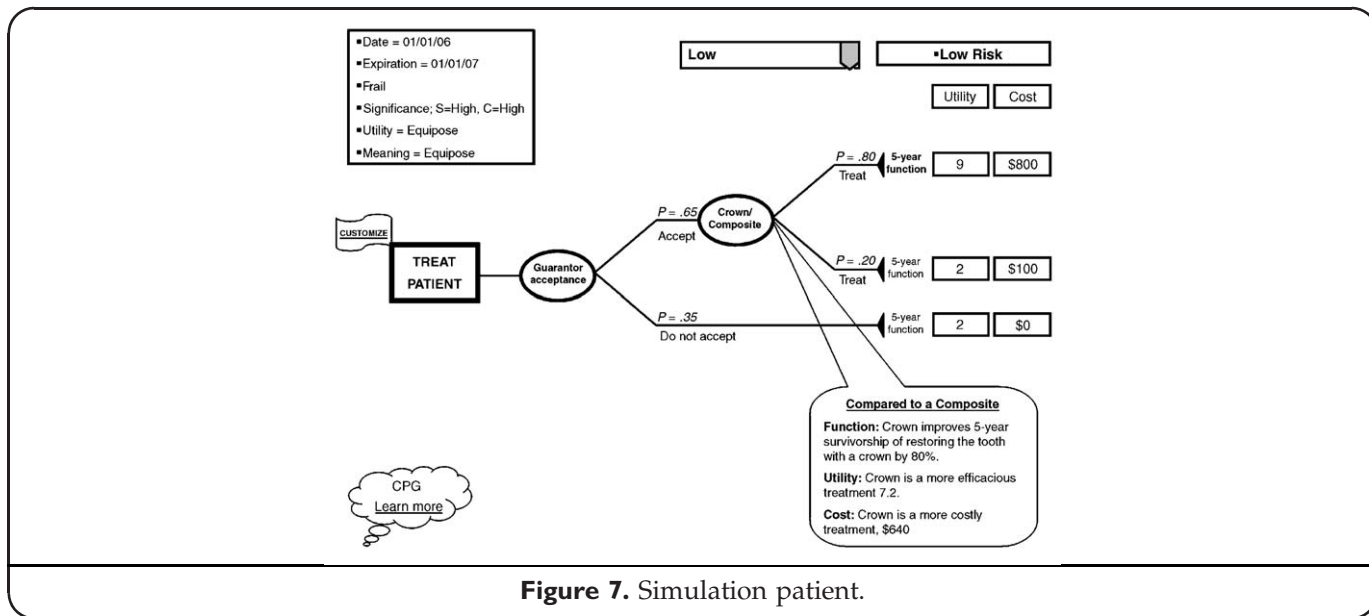
#### Simulation Patient

The guardian is a low risk taker, making the acceptance of treatment and restoring maximum function a high priority. The guardian gives the ranking of the restoration of the tooth with a crown the highest utility, composite restoration a low ranking (2), and denying treatment a 2. In discussing all options, the dentist provides, in visual format, all outcomes of each possible decision. The clinical decision becomes the most effective and efficacious decision at that time (Figure 7).

The probabilities that are initially assigned are baseline probabilities and are those derived from best evidence based on the "average patient." The use of probability data is to show which choice is better. Individualizing these probabilities to the patient is done here. Thus, inputs for new information are entered through drop-down menus. The advantages of this approach are dentists may change input data (for example, utilities) and regenerate choices, the calculation and analyses of which takes place in the background. The results are displayed within the CPG along with the original data. Patients benefit by comparing their choices with that of the "average patient" in choosing what is best for their personal circumstances. This is important because patients may vary in their risk-taking behaviors. Thus, utility data are initially categorized by risk-taking levels. The categories include those patients who are more cautious, or risk adverse, those who are more freethinking, or risk tolerant, and those who are equiposed, or risk neutral.<sup>10</sup> Accordingly, flexibility is incorporated into the CPG because patients may vary in their risk-taking behaviors over time.

Few tests are external to the dental assessment. When they are, a computer-generated, test-cost-effectiveness threshold<sup>1</sup> may be calculated. Using assessment data, these thresholds may be integrated into and augment decision data.

The resultant, combined data inform patients of their options and allow them to weigh evidence with personal utilities and costs to come up with a decision, to treat or not to treat, that is best and sensitive to their desires and needs. Utility and economic data modify baseline values by integrating personal realities. Thus,

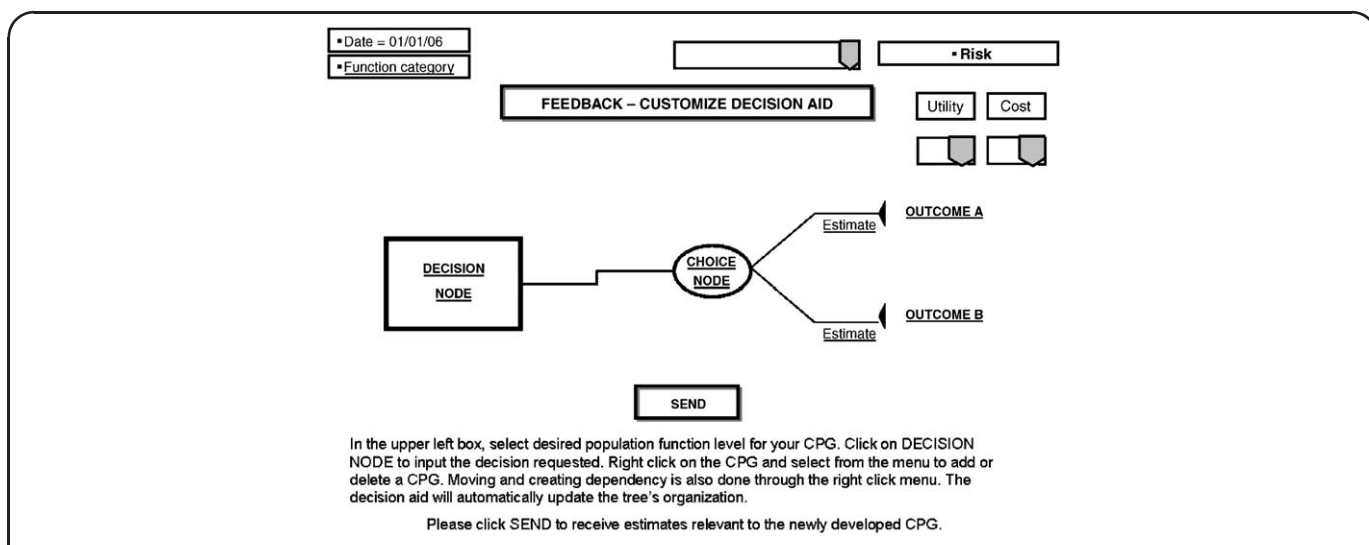


dentists, and the patient, may identify and compare over time sensitive aspects of particular importance in patient decision making. Negotiation time based on this approach is set at approximately 10 minutes. The results are printable for patient retrieval and study.

### Customization

Decision aids ought to allow dentists to customize decision trees and CPGs for use in their practices (Figure 8). Once developed, they may be transferred

to the primary network for evaluation and possible inclusion in the central database. The process begins with decision-making software and templates to guide the construction of the decision aid. Drop-down menus are accessed to input best evidence in the form of probabilities, comparisons, utilities, and practice cost schedules. All evidence except costs are obtained and updated from the primary central database. When evidence does not exist, then the deficiency is noted in terms of a clinical question. The clinical question is sent to the research



development department in charge of the central database. Intramural or extramural researchers may interact with the clinician in producing best evidence from systematic reviews and determining their statistical and clinical significance.

Customized decision aids may also apply to dental practices as well. Decisions regarding the introduction and use of new technology and equipment follow similar evidence-based dental decision-making processes. This approach is most needed in maintaining quality assurance for patient care and care delivery in an evidence-based dental practice.

### Implementation

The Model supports a primary network database that is developed and subsequently updated with best evidence within best decision aids. The database is segregated first by the patient's functioning: independent, frail, or dependent, and uses the physical, mental, and social as well disease criteria that make up these functional categories. Second, the database is organized by fields of other criteria pertinent to the quantitative and qualitative evidence gathered from systematic reviews conducted by researchers.

Within the central database, probabilities and values are updated every 6 months.

### CLINICIAN ACCEPTANCE

Previous attempts to apply evidence-based processes in shared decision making have noted clinician apprehensions. These apprehensions include excessive time in accomplishing negotiations that involve patient disclosures needed to make shared decision making, conflicts in patient expectations that may undermine best evidence for unproven yet provocative cures, and circumstances in which patients, who freely relinquish their role, defer to the clinician. However, studies<sup>3,11</sup> have shown that shared decision making takes no more time than traditional consultations, about 10 minutes.

### PATIENT ACCEPTANCE

A disadvantage to EBDDM is that patients do not make maximizing decisions in all situations and circumstances. The reasoning behind this is that patients are poor Bayesians.<sup>12</sup> Patients tend to be conservative; they don't change when analysis suggest that they should. Patients tend to stick to existing knowledge, being influenced more by prior opinions. Change may not be based solely on reason but rationalization. Rationalization takes into account peripheral issues that may include conforming to social or cultural mores. Thus, clinical decisions are not maximized, but optimized in reconciling best evidence with patient characteristics.

### CONCLUSION

A model of evidence-based dental decision making requires a centralized database that stores, manages, and disseminates best evidence. Best evidence is made available from the centralized database, or primary network, to private practices and other networks that compile evidence into culturally sensitive estimates. This primary network also exists to revise and update information by facilitating the participation of researchers and clinicians working in cooperation to develop best evidence for patient care. A computerized, knowledge management system manages best evidence used in clinical practice to improve and advance shared decision making. This system presents evidence in visual and interactive formats so that researchers, dentists, and patients work to produce optimum clinical and practice decisions. Formats allow for flexibility in decision analysis for determining best options from "average patient" data. Decision aids are categorized by patients' risk and functional levels. "Average patient" data are ranked as to their statistical significance, and clinical utility rankings provided by dentists indicate their clinical significance. Individual patients contribute estimate adjustments by their choices and long-term compliance. The reciprocation of best evidence and its application to clinical practice produces a dynamic model in advancing knowledge for patient care.

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