

Use of Risk Assessment in Attaining and Maintaining Oral Health

CE X

Abstract: *The cost of health care is increasing rapidly. A transition from the “repair” to a “wellness” model of oral health care that minimizes the occurrence of disease and the need for complex treatment may reduce costs and improve oral health. Quantification of risk is essential for successful use of the wellness model. Subjective risk assessment by expert clinicians is too variable to be useful in clinical decision making. However, user-friendly Internet-based technology has been developed that provides a consistently accurate and valid quantified risk assessment for periodontitis, as well as a quantified measure of disease severity and extent. The numeric information helps clinicians and patients make diagnoses and generate individual, needs-based treatment plans. This technology enables successful application of the wellness model of care in day-to-day dental practice. Use of the wellness model may result in more uniform and accurate periodontal clinical decision making, improved oral health, less need for complex periodontal therapy, lower oral health care costs, and improved clinician productivity and income.*

Roy C Page, DDS, PhD
Professor Emeritus
Department of Periodontics
School of Dentistry
University of Washington
Seattle, Washington

John A Martin, DDS
Private Practice
State College, Pennsylvania

Carl F Loeb, BA
Previser Corporation
Mount Vernon, Washington

Health care in the United States is undergoing significant change. The current annual health care cost of \$1.7 trillion is projected to increase to \$3.4 trillion by 2013 and to consume more than 18% of the gross domestic product (GDP).¹ Currently, the total expenditure of the US federal government consumes only 20% to 21% of GDP. The total cost of dental care in the United States in 2003 was approximately \$68 billion, of which more than 75% was directed to caries and periodontal diseases.^{2,3} According to the American Dental Association, expenditures for periodontal services in 1999 totaled \$14.3 billion with \$9.8 billion expended on preventive procedures.⁴

The inability to consistently and accurately quantify risk in the diagnostic process and formulate treatment plans using risk information may contribute to the escalating cost of oral health care, especially periodontal care. Technology for standardized objective quantification of risk has not been available. Consequently, clinicians have assessed risk subjectively. Recent studies have shown that subjective risk assessments even by expert clinicians are too variable to be useful for clinical decision making and that the level of risk determined by clinicians may be lower than its real value.⁵ [Author: Better with comma.] Consequently, clinicians may be providing less intensive, preventive and reparative treatment interventions, especially to patients who are at risk but do not yet manifest signs and symptoms of periodontal disease or have early stage disease. Compared with 20 years ago, patients who are referred to periodontists today are older, have more severe disease, have more tooth loss, are treatment-planned for more extractions, and require more complex and, therefore, more costly treatment.⁶

This article describes the development and use of an Internet-based

Learning Objectives:

After reading this article, the reader should be able to:

- [Author: Learning Objectives will be provided.]



Figure 1A—Clinical and radiographic features of a case of generalized severe periodontitis having a risk score of 5 and a disease score of 82.

tool that provides a quantitative, accurate, and valid risk measurement for periodontitis and a disease score that quantifies severity and extent. The technology enables the successful application of the wellness model to the diagnosis and management of periodontal disease. A comparable tool for risk assessment for dental caries has been developed but has not yet been validated clinically. This new approach to dental care has the potential to improve oral health, reduce disease incidence and complexity of treatment, and control the escalating cost of care.

Disease Prevention and the Nature of Risk

From 1971 to 1972, Axelsson and colleagues⁷⁻⁹ began a 30-year study on a test group of 375 adult patients and 180 controls divided into 3 age groups of 20 to 35, 36 to 50, and 51 to 70 years. For the first 6 years, intensive preventive interventions were uniformly applied during highly frequent dental visits. This approach resulted in a decrease in new caries lesions by more than 98% and periodontitis by more than 95% at years 3 and 6. At year 6, risk was assessed based on patient response to the applied preventive interventions, and individual, needs-based care was provided through year 30. Essentially, the wellness model of care was instituted after risk levels were determined for individuals in the study group. At year 15, the average test subject had only 0.9 decayed or filled surfaces, and periodontitis (measured as attachment loss) was virtually eliminated. Reductions in caries and periodontal disease of this magnitude were maintained, and tooth

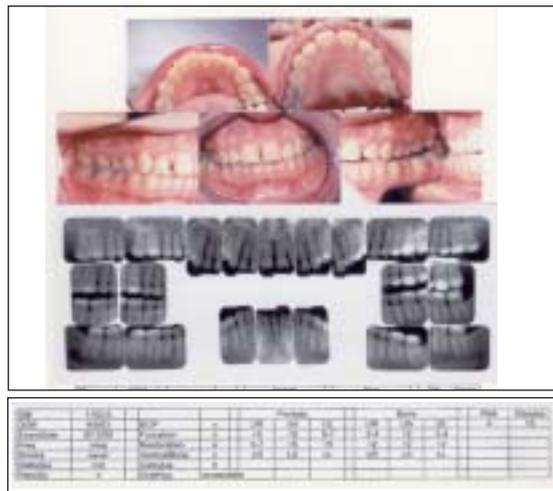


Figure 1B—Clinical and radiographic features of a case of generalized, beginning or moderate periodontitis having a risk score of 4 and a disease score of 15.

loss averaged only 0.6 teeth per patient, throughout the 30 years. These studies demonstrate clearly that both caries and periodontitis are preventable diseases. Identifying risk factors and undertaking measures that maximally reduce risk are the hallmarks of the wellness model. The model guides the clinician and patient toward a health care strategy based on risk reduction and disease prevention.

Application of this model helps clinicians diagnose periodontitis and generate needs-based treatment plans. Most practitioners equate risk of periodontitis with the extent and severity of periodontal disease, assuming that patients with little to no disease are at low risk of disease and those with severe disease at high risk. However, patients with severe disease at a prior time had less severe disease and, before that, were healthy. Risk was high for these patients before the onset of severe disease. Disease extent and severity (expressed as a periodontal diagnosis) and risk of periodontitis are entirely different. Diagnosis describes the current disease state, whereas risk predicts the disease state in the future if no intervention is undertaken. Severe disease logically implies high risk, but high risk can occur for patients with an initial stage of disease.

The patient in Figure 1A has generalized severe periodontitis. This diagnosis is based on deep periodontal pockets in 5 sextants and radiographic bone loss in all 6 sextants. Risk for this patient is 5 on a 5-point scale, indicating very high risk. A clinician might assign a lower risk score because few very deep pockets exist, bone loss does not appear to be severe,

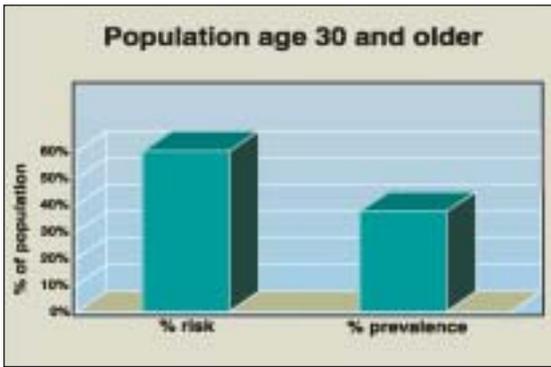


Figure 2—Prevalence of adults at risk of periodontitis and adults who actually manifest periodontal disease.

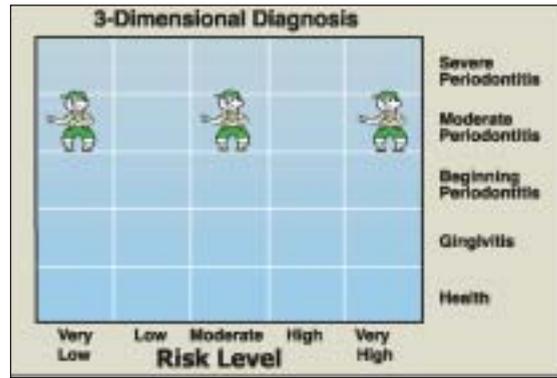


Figure 3A—Traditional 2-dimensional diagnosis of periodontitis based on clinical conditions and radiographs, as well as patient history, for 3 patients who have the same diagnosis and, therefore, will require the same treatment.

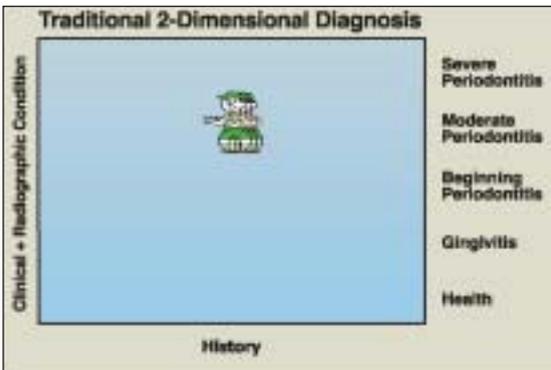


Figure 3B—Three-dimensional diagnosis when level of risk, along with clinical conditions and patient history, is included for the same 3 patients (Figure 4A) who still have the same diagnosis but require different treatments.

the patient does not smoke and is not diabetic, and no overt clinical signs of inflammation are present. Risk is very high because the upper right sextant has pockets that are deeper than 7 mm, along with bone loss, and because of the presence of calculus, an age of 38 years, and a history of periodontal surgery.

The patient in Figure 1B has generalized, beginning to moderate periodontitis with 5-mm to 7-mm pockets in 2 sextants and moderate bone loss in 2 other sextants. One of the sextants with bone loss does not have deep pockets, so 3 sextants have experienced periodontitis. Risk for this patient is 4, indicating high risk. A clinician might assign a lower risk because the severity and extent of periodontitis is low. However, risk is high because the patient at 35 years of age has severe disease, deep periodontal pockets, and a vertical bone lesion at the upper left sextant.

[Author: Use “at risk of” per Medline.]

More adults are at risk of periodontitis compared with adults that actually have periodontitis. As determined in the NHANES-III national study, about 35% of adults in the United States have

periodontitis (Figure 2); approximately 22% have mild disease; and 13% have moderate to severe disease.¹⁰ When this data set is examined by age cohort, a different picture emerges. At the youngest age cohort (30 to 34 years), 75% to 80% or more of the population did not have periodontal disease. This percentage decreased linearly with increasing age. By age 85 to 90 years, about 40% still did not have periodontal disease and, therefore, were never at risk of the disease. The remaining 60% who developed periodontal disease, therefore, must have been at risk before disease onset could be observed (Figure 2).

In the youngest age cohorts, only a few would manifest and be diagnosed with periodontitis, yet 60% are at risk of the disease. With increasing age cohort, the percentage at risk decreases and the percentage manifesting disease proportionately increases to a maximum of 60% for the oldest age cohorts. With traditional diagnostics, dentists often cannot distinguish between patients who will develop or have worsening periodontitis (or dental caries) and those who will not. However, new technology permits identifying high-risk patients who would benefit from preventive interventions to maintain health or inhibit the progression of disease.

Traditionally, dentists diagnose periodontitis based on the dimensions of clinical and radiographic status and patient history without considering risk level, which is distinct from disease severity and extent. Under these circumstances, dentists would presume that 3 patients with comparable periodontal status and histories have the same diagnosis, and all 3 would appear to require the same

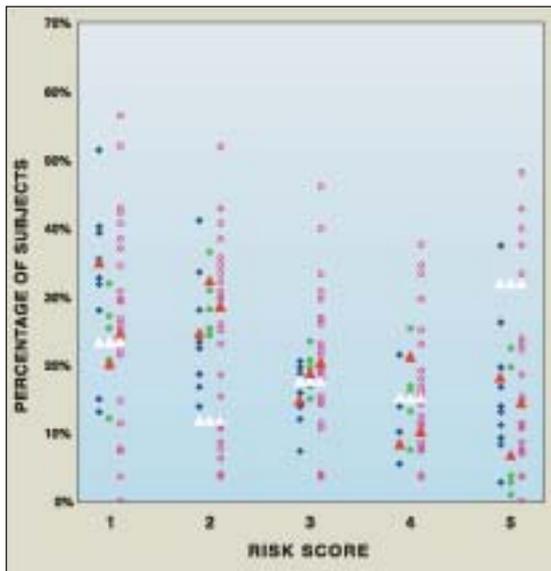


Figure 4—Percentages of subjects assigned to risk score groups 1 (low risk) through 5 (high risk) in year 2 by the risk calculator (white triangles); percentages of total subjects assigned by each expert evaluator in Group A (10 periodontists; blue), Group B (6 periodontists; green), and Group C (36 general dentists; red); and the evaluator group consensus scores (average scores) (colored triangles). [Author: Per AMA. Written permission needed from copyright holder (usually publisher).] Reprinted with permission from J AM Dent Assoc.⁵ Copyright 2003. American Dental Association.

treatment (Figure 3A). When risk level is considered as a third dimension in the diagnostic equation (Figure 3B), these 3 patients appear at different positions on the grid. They still have the same diagnosis, but they probably require 3 different treatment plans. Although they present with the same clinical signs and symptoms, the patient with the lowest risk may require only scaling and root planing with recalls at 6-month or longer intervals; the patient at moderate risk may require scaling and root planing with surgery in some areas followed by 4-month recalls; and the high-risk patient may require referral to a periodontist for scaling and root planing, more extensive surgery, and shorter recall intervals. Thus, disease extent and severity are not the same as risk when treatment planning. Although consideration of risk does not change the diagnosis, diagnosis and treatment planning in the absence of risk information may result in overtreatment or undertreatment of a significant proportion of patients.⁵ As demonstrated in the research conducted by Axelsson and colleagues,⁷⁻⁹ matching the intensity of intervention with the risk profile of the patient can significantly reduce disease incidence across the entire population.

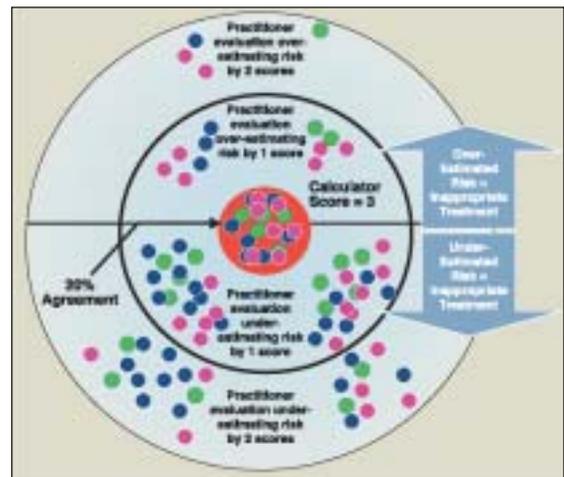


Figure 5—The extent of agreement for subjects assigned a risk score of 3 by the risk calculator and risk scores assigned by expert evaluator Groups A (blue), B (green), and C (red). Each circle represents 5 risk assessments. For agreement, circles are located on the bull's eye; when scores of 4 or 2 instead of 3 were assigned, circles are located in the inner circle; when 1 or 5 were assigned instead of 3, circles are located in the outer circle. Data from Persson et al.⁵

Traditional Risk Assessment for Periodontitis

The major factors that enhance risk of periodontitis have been identified.¹¹ Practitioners generally are aware of these, and they know that their patients differ greatly in susceptibility to periodontitis. Furthermore, during the performance of a standard periodontal examination, dentists generally collect the information required for risk assessment.¹² However, subjective, qualitative risk assessment is not an easy task; risk factors are interactive and synergistic, not additive. They vary greatly in importance generally and among patients.

In a study designed and conducted by Persson and colleagues,⁵ examination records for 107 patients who were assembled to manifest a wide range of risk of periodontitis were evaluated by 1 group of general dentists and 2 groups of periodontists, who assigned a risk score from 1 (lowest risk) to 5 (highest risk) for each. The examination data were entered into a computer-based Previser Risk Calculator^a, and a risk score was calculated for each subject. The scores assigned by the expert evaluator groups were compared with one another and with risk scores calculated using the risk calculator, and interevaluator and intergroup variations were determined.

A large interevaluator variation was observed in all 3 expert evaluator groups, the

^aPreviser Corporation, Mount Vernon, WA 98273; (360) 661-5763

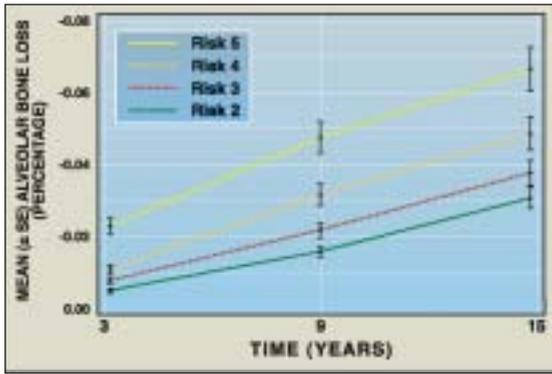


Figure 6—Mean (+ standard error) alveolar bone loss from baseline for risk groups 2 through 5 at sites exceeding the threshold of 2% loss of alveolar bone height that could be compared. [Author: Per AMA. Written permission needed.] Reprinted with permission from J AM Dent Assoc.13 Copyright 2002. American Dental Association.

greatest being in the general dentists' group (Figure 4). For both groups of periodontal experts, the percentage of patients placed in risk groups 3 and 4 clustered around the scores assigned by the risk calculator. The same was true of risk group 1, but the range was somewhat greater. Of 15 periodontists, 14 placed fewer patients in risk group 5 compared with the risk calculator, and all 15 placed more patients in risk group 2 compared with the risk calculator. These data suggest that both periodontist groups significantly underestimated risk, especially high risk. Percentages of subjects assigned to each of the risk groups by general dentists were spread throughout the scale.

Patients for whom expert evaluators were in agreement and for whom the risk calculator assigned a score of 3 are shown on the red circle, those that were assigned a score of 2 or 4 are shown in the circle outside of the red circle, and those that were scored 1 or 5 are shown in the outermost circle (Figure 5). Only a 20% agreement existed between scores assigned by the expert clinicians and the Previser Risk Calculator. In other words, compared with the risk calculator, 80% of the patients were scored either too low (1 or 2 instead of 3; the majority) or too high (4 or 5 instead of 3). Thus, overtreatment or undertreatment probably would have been prescribed for about 80% of the risk group 3 patients. Similar variation from validated risk scores was evident in risk groups 1, 2, 4, and 5. Risk assessment by expert clinician opinion is too variable to be clinically useful in diagnosis and treatment planning for periodontitis. These observations clearly demonstrate the

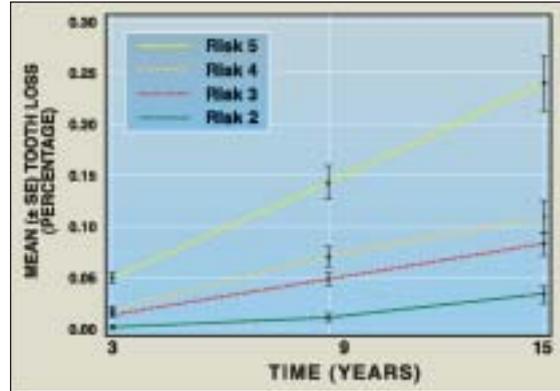


Figure 7—Mean (+standard error) tooth loss from baseline for risk groups 2 through 5, defined as the percentage of teeth present at baseline that were subsequently extracted. [Author: Per AMA. Written permission needed.] Reprinted with permission from J AM Dent Assoc.14 Copyright 2003. American Dental Association.

need for a clinically consistent, accurate, and objective method to assess risk of periodontitis.

Quantitative Assessment of Risk

The Previser Risk Calculator has been developed and its accuracy and validity documented. This tool is based on mathematically derived algorithms that assign relative weights to the various known risks that enhance a person's susceptibility to periodontitis. The tool is user friendly, is inexpensive to use, and requires very little dentist or staff time. Risk scores on a scale of 1 (lowest risk) to 5 (highest risk) are generated, along with separate reports for the dentist and the patient. After initial development and testing on individual cases, the tool was evaluated in 15 general dental practices in the Seattle, Washington area, and several modifications and improvements were made.

A longitudinal clinical study evaluated the validity and accuracy of risk scores calculated using the tool.^{13,14} Clinical records and radiographs of 523 subjects covering 15 years were used. Data from the baseline examinations were entered into the Previser Risk Calculator, and a risk score for periodontal deterioration was calculated for each subject. Actual periodontal status measured as alveolar bone loss (determined using digitized radiographs) and tooth loss (determined from the clinical records) was assessed at years 3, 9, and 15. The strength of the association between the risk prediction and actual outcome was determined statistically.

Throughout the 15 years, the risk scores calculated at baseline were strong predictors of future periodontal status measured as worsening severity and extent of alveolar bone loss (Figure 6) and tooth loss (Figure 7), especially loss of periodontally affected teeth. Risk scores consistently ranked patient groups from least to most alveolar bone loss and tooth loss. Risk groups differed greatly. By year 3, the incidence rate of bone loss of risk group 5 was 3.7-fold greater compared with risk group 2, and by year 15, loss of periodontally affected teeth was 22.7-fold greater ($P < .001$). Compared with a risk score of 2, the relative risk (RR) of any tooth loss was $RR=3.2$ for risk score of 3, $RR=4.5$ for risk score of 4, and $RR=10.6$ for risk score of 5. Thus, calculated risk scores accurately and validly predicted future periodontal status.

Quantitative Description of the Disease Status

In addition to the risk score, the Previser Risk Calculator provides a periodontal diagnosis based on standard terminology and a disease score on a scale from 1 (periodontal health) to 100 (severe generalized periodontitis) that quantitatively differentiates between levels of disease within the standard nomenclature. The method is based on a combination of sextant diagnoses determined by pocket depth, alveolar bone loss, and bleeding from probing using sound mathematical theories and periodontal principles. Each score on the disease scale represents a unique set of clinical conditions. Development, use, and advantages of the periodontal disease numeric scoring system have been reported (JA Martin, [Author: Martin's degrees?], and colleagues, unpublished data, 2004). Cases in which disease scores have been determined are shown in Figures 1A and 1B. By calibrating and quantifying the complete periodontal health in an objective and repeatable manner, the risk calculator creates an environment in which the results of therapeutic interventions can be quantified regarding their success in improving the risk and disease state scores. With this feedback, patient involvement is encouraged and supported. Only when results can be measured, can improvement in results be achieved.

Clinical Use of the Technology

The risk calculator creates reports that provide the requisite information for use of the

wellness model. One report is designed for the dentist's record and another for the patient. The patient report is optionally printed in layman's language or using purely clinical terms. The report provides the standard textual periodontal diagnosis, the color-coded risk score, and the periodontal disease score, along with color illustrations of the relative meaning of the periodontal disease score regarding loss of attachment and bone. Brief text explanations also are provided. Changes in these scores are graphically presented when more than 1 assessment has been conducted, providing a visual aid to patients and dentists. Treatment recommendations in the reports are based on the published literature and the current standards of care of the American Academy of Periodontology. Possible treatments and interventions are color coded and ranked as generally most effective, possibly effective, and probably not effective. These treatment options can be printed or omitted from the patient report if desired. A recommendation is made for the number of visits per year needed to maintain health. The report also provides access to an Internet site that presents free tutorials for additional patient education about their conditions and treatment.

Changes in the risk and disease scores reveal effectiveness of treatment and provide a powerful method to continually and dynamically select the best treatment. The report helps the patient understand the effects of their treatment choices. The risk score and disease score can help the general dentist and patient determine whether and when to seek care from a periodontist.

Use of the risk calculator provides a simple and rapid means to standardize documentation of a patient's periodontal condition. This information can engage the patient, simplify the dentist's explanation of the diagnosis and treatment plan, and facilitate the informed consent process. The numeric scores and the list of possible interventions aid the clinician in matching the treatment plan to the individual patient's disease and risk status and enhance the likelihood that interventions prescribed will be appropriate and successful.

The numeric scores can be used to establish guidelines for setting recall intervals and referral to the periodontist. The dentist can quantify the improvement in the patient's oral

health regarding the cost of interventions used per gain in health status. The dentist also could use such information to build a more loyal and trusting patient base.

Practices of different types and in different locations (eg, urban and rural or regions of the country) can be compared. The effectiveness of one intervention vs another can be compared for patients with the same periodontal status. The dentist can use this information to modify diagnosis and treatment planning, providing better service to patients.

The measurements are sufficiently sensitive to detect minor changes, either improvement or deterioration, in the health status of an individual patient, groups of patients, or entire populations. When combined with the known cost of the care provided, they comprise a very powerful new method for accurately quantifying health benefits and the cost of those benefits. This information can be highly valuable and useful to patients, practitioners, health maintenance organizations, public health agencies, the armed services, and third-party payers. Assessment of level of risk and disease status of a population to be insured provides precision in determination of the likely cost of care and permits development of customized insurance plans. Health benefits enjoyed by the insured population and their cost can be quantified, permitting various plans to be compared. Matching proposed treatment plans to the risk and disease status of the individual may reduce costs by reducing the number of claims that require adjudication and making submission of periodontal charting and radiographs unnecessary.

An economic model has been developed indicating that the use of the technology described will result in increased dentist productivity, decreased complexity of periodontal care, and considerable savings in the cost of periodontal care. The economic impact of this technology is not yet known but currently is being assessed in a longitudinal clinical trial.

Conclusion

The cost of oral health care is escalating at a rate far exceeding inflation. Use of the wellness model of oral health care can reduce costs and improve oral health. Transition to the wellness model requires accurate and valid assessment of risk. Qualitative assessment of

risk by clinicians is too variable to be of use in clinical decision making. The risk calculator accurately predicts risk and quantifies changes in risk and periodontal disease extent and severity. These values provide precision to diagnosis and treatment planning. Using this technology, the cost and benefit of oral health outcomes can be quantified. This information can benefit clinicians, patients, payers, and health care authorities.

References

1. Sherman M. Centers for Medicare and Medicaid. *The Seattle Times*. February 12, 2004:A7.
2. del Aguila MA, Anderson M, Porterfield D, Robertson PB. Patterns of oral care in a Washington State dental service population. *J Am Dent Assoc*. 2002;133:343-351.
3. Manski RJ, Moeller JF. Use of dental services: an analysis of visits, procedures and providers, 1996. *J Am Dent Assoc*. 2002;133:167-175.
4. Brown LJ, Johns BA, Wall TP. The economics of periodontal diseases. *Periodontol* 2000. 2002;29:223-234.
5. Persson GR, Mancl LA, Martin J, Page RC. Assessing periodontal disease risk: a comparison of clinicians' assessment versus a computerized tool. *J Am Dent Assoc*. 2003;134:575-582.
6. Cobb CM, Carrara A, El-Annan E, et al. Periodontal referral patterns, 1980 versus 2000: a preliminary study. *J Periodontol*. 2003;74:1470-1474.
7. Axelsson P, Lindhe J, Nystrom B. On the prevention of caries and periodontal disease. Results of a 15-year longitudinal study in adults. *J Clin Periodontol*. 1991;18:182-189.
8. Axelsson P, Paulander J, Svardstrom G, Kaiser H. Effects of population based preventive programs on oral health conditions. *J Parodontol Implantol Orale*. 2000;19:255-269.
9. Axelsson P, Lindhe J. Effect of controlled oral hygiene procedures on caries and periodontal disease in adults. Results after 6 years. *J Clin Periodontol*. 1981;8:239-248.
10. Albandar JM, Brunelle JA, Kingman A. Destructive periodontal disease in adults 30 years of age and older in the United States, 1988-1994 [published correction appears in *J Periodontol*. 1999;70:351]. *J Periodontol*. 1999;70:13-29.
11. Page RC, Beck JD. Risk assessment for periodontal diseases. *Int Dent J*. 1997;47:61-87.
12. Bader JD, Shugars DA, Kennedy JE, et al. A pilot study of risk-based prevention in private practice. *J Am Dent Assoc*. 2003;134:1195-1202.
13. Page RC, Krall EA, Martin J, et al. Validity and accuracy of a risk calculator in predicting periodontal disease. *J Am Dent Assoc*. 2002;133:569-576.
14. Page RC, Martin J, Krall EA, et al. Longitudinal validation of a risk calculator for periodontal disease. *J Clin Periodontol*. 2003;30:819-827.

[Author: Per AMA, cannot include material not accepted for publication in references.]