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# Outcomes associated with dentists' risk assessment

**D. Brad Rindal[1], William A. Rush[1], Nancy A. Perrin[2], Gerardo Maupomé[2,3] and James D. Bader[4]**

[1]HealthPartners Research Foundation, Minneapolis, MN, USA, [2]Center for Health Research, Kaiser Permanente, Portland, OR, USA, [3]Indiana University School of Dentistry, Oral Health Research Institute, Indianapolis, IN, USA, [4]School of Dentistry and Sheps Center for Health Services Research, University of North Carolina, Chapel Hill, NC, USA

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Abstract – *Objective:* To examine retrospectively the caries-related restorative experience of at-risk individuals who received fluoride-based preventive interventions to determine if the intervention resulted in fewer caries-related procedures. *Methods:* Administrative data from two dental health plans were used to determine the relationship between caries risk assessment (CRA) scores, preventive treatment and caries-related treatment procedures. We identified 45 693 adults who were consecutively enrolled for at least 1 year before and 2.5 years after the CRA. Variables representing the number of teeth with any caries-related treatment procedure and receipt of preventive treatment were created. *Results:* The outcome variable of interest was having at least one tooth with a caries-related procedure in the 2-year follow-up period. In plan A, the recommendation for home-use fluoride was not significantly related to caries-related treatment procedures in the follow-up period for individuals at low, moderate or high risk ($P > 0.300$). In plan B, application of in-office fluoride was associated with having at least one tooth with a caries-related treatment procedure in the follow-up period ($P < 0.001$). *Conclusions:* We found incomplete compliance with guidelines for recommendation or administration of preventive treatment for patients at elevated risk for caries. We were also unable to identify any significant reductions in caries-related procedures for individuals receiving a fluoride intervention, compared with those who did not, when stratified by risk level.

Key words: caries risk assessment; dental caries; dental caries incidence; dentist practice patterns

D. Brad Rindal, HealthPartners Research Foundation, 8100 34th Ave S, PO Box 1524, MS 21111R, Minneapolis, MN 55440-1524, USA
Tel: 952 967 5001
Fax: 952 967 5022
e-mail: d.brad.rindal@healthpartners.com

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There are increasingly frequent calls for incorporation of caries risk assessments into routine dental practice (1–5). Our own prior investigation has validated a simple approach to risk assessment as applied by dentists in general dental practice (6). However, to be effective, risk assessment must be accompanied by an appropriate intervention. For patients at elevated risk of caries, preventive interventions should be initiated that reduce the expected elevated incidence and severity of caries in the future. Patients at low risk do not need additional preventive interventions and should be offered extended recall intervals. This individualization of preventive and recall activity results in more appropriate use of dental resources and lower dental costs for some individuals.

Only minimal data are available regarding the application of preventive interventions by dentists, based on risk level. Despite numerous recommendations for use only in moderate- and high-caries children, Eklund et al. (7) reported that Michigan dentists did not apply topical fluoride based on risk. Our investigation of performance measurements in dental health maintenance organizations revealed that 13–18% of high-caries-risk adults received fluoride treatment at least once per year (8).

Current interventions available to reduce caries include additions of fluoride, chlorhexidine rinse, sealants, xylitol, behavior modification of diet and oral hygiene (9). There is good evidence for effectiveness of sealants (10) and topical fluorides (11–13) in children and adolescents, and limited evidence supports the effectiveness of chlorhexidine in some applications (14, 15). There is almost no evidence concerning the effectiveness of these preventive interventions in adults.

The evidence supporting the use of most preventive interventions as a part of risk assessment and management programs is very limited. A few very intensive interventions have been shown to be effective in high-risk subjects who have undergone head and neck radiation (16) and one study of an elderly population in a long-term care facility concluded that 0.2% neutral NaF mouth rinse every day does reduce the incidence of caries (17). However, several recent evaluations of the risk-based approach to prevention for high-risk children have suggested that the interventions used were ineffective in reducing caries rates (18–23).

The outcomes resulting from the application of a caries risk assessment that focuses preventive interventions on elevated risk groups have not been sufficiently tested. Furthermore, no studies have examined this question in ambulatory adult populations. Therefore, we selected two large group practices in Portland, Oregon and Minneapolis, Minnesota where risk assessment guidelines for caries have been adopted. The purpose of this study was to examine retrospectively the caries-related restorative experience of at-risk individuals who received fluoride-based preventive interventions to determine if the intervention resulted in fewer caries-related procedures over time.

## Methods

To determine the relationship between caries risk assessment (CRA) scores, preventive treatment and future caries-related treatment, we used administrative data from two dental health plans. This study's design and conduct followed the regulations stipulated for protection of human subjects at the two organizations where data collection took place. Plan A was a group practice in a fluoridated community and plan B was a group practice in a largely nonfluoridated area. Members in the dental plans lived in Minnesota, Oregon, and Washington, and had a broad socioeconomic background that spanned from public assistance members to blue collar and professional backgrounds. Participant inclusion criteria were: (i) 25 years of age or older, (ii) receipt of a CRA during a specified reference period, and (iii) continuous enrollment in the dental plan for at least 1 year prior to and 2.5 years following the CRA. Each patient's reference date was the date of the most recent CRA during the reference period. The reference period was different for the two plans to insure that the CRA had been in use for at least 2 years and fully implemented at each site. The reference period for plan A was January 1, 1998 to June 30, 1999. The reference period for plan B was January 1, 2000 to December 31, 2000.

### *Study variables*

The date of the CRA defined a reference date for each patient. Data were collected from the administrative data systems for the year prior to the reference date (prior period), the 6 months following the reference date (washout period – to allow for treatment of caries seen at the time of the risk assessment), and the 2 years following the 6-month washout period (follow-up period). Variables representing the number of teeth with any caries-related procedure and receipt of preventive treatment were created for each of those three periods. In plan A, existing diagnostic codes were used to identify restorative, endodontic, and surgical procedures to treat caries. In plan B, existing reason-for-treatment codes were used for the same purpose. Missing data resulted when the diagnostic or reason-for-treatment codes were missing. The codes were missing for <1.2% of the procedures in plan A and <1% of the procedures at plan B. Only those procedures with a valid diagnostic or reason-to-treat code were included in the counts. The restorative procedures were limited to intra- and extracoronal restoration. Endodontic procedures were limited to first endodontic therapy, and surgical procedures to simple extractions. The distributions of these three types of caries-related treatment procedures were 95.9% restorative, 1.2% endodontic, and 2.9% surgical in plan A and 96.7% restorative, 0.4% endodontic, and 2.9% surgical in plan B. Crowns were not included in these counts of procedures for either plan, because of high percentage of missing data (10.9% compared with <1% for all other procedures) in plan B. Additionally, only 3.5% of those crowns with associated diagnoses had a caries diagnosis. Caries-related treatment procedures are an indirect measure of caries activity as it is possible that some procedures could have been performed for reasons other than active caries such as dentists' assessment of the potential for caries. A preliminary study of the reliability of the dentists' assessment of reasons for treatment codes in plan B was reported previously, and found to be reasonable, with kappa = 0.69 (24).

In plan A (serving a mostly fluoridated community), a preventive procedure was defined as a formal recommendation for an at-home fluoride product, reflecting the predominant practice pattern in that plan. The most frequent recommendation was for a 5000-ppm toothpaste, for which a prescription was written. Recommendations were also made for prescription fluoride rinses or over-the-counter fluoride rinses. In plan B (serving a mostly nonfluoridated community), a preventive procedure was defined as the application of in-office fluoride, typically a fluoride varnish or a fluoride gel application, again reflecting plan B's predominant practice pattern. In addition to these variables, data regarding CRA at the reference date, patients' age at the time of the CRA and gender were collected.

### *Analysis strategy*

We used chi-squared tests to determine if the receipt or recommendation of fluoride varied across the three caries-risk levels. Logistic regression was used to test the effect of preventive treatment on caries-related treatment in the follow-up period. As the distribution of the number of teeth with any caries-related procedure was highly skewed, we dichotomized this variable into none vs. one or more caries-related procedures. The logistic regressions were conducted separately for the low-, moderate-, and high-caries-risk groups to control for differences in risk levels. Age, gender, and preventive treatment in the prior period, were included in the model. Age by preventive treatment and gender by preventive treatment interaction terms were tested to determine if the effect of preventive treatment was consistent across age, and for males and females. Nonsignificant interactions were dropped from the final model.

## Results

In plan A, 14 859 patients with a mean age of 49.76 years were included (SD = 13.12), of whom 42% were males. In plan B, 30 834 patients (44% males) of a mean age of 50.52 years (SD = 13.38) were included. Data on ethnicity were not available. In plan A, 8992 (61%) were classified as being at low risk for caries, 4233 (28%) at moderate risk, and 1634 (11%) at high risk. A recommendation for use of an at-home fluoride product varied across these three caries-risk levels ($\chi^2 = 4918.89$, d.f. $= 2$, $P < 0.001$) with 11.3% of the low-risk, 68.2% of the moderate-risk, and 62.7% of the high-risk groups receiving a recommendation. To determine the extent to which this distribution was a reflection of some dentists simply providing little or no preventive therapy to any patients regardless of risk, we also examined the mean and associated percentiles for the percentage of each dentist's patients receiving a recommendation of use of an at-home fluoride product. Table 1 summarizes the findings for dentists with at least 25 patients at a given risk level.

Of the 30 834 patients in plan B, 16 913 (55%) were classified as being at low risk for caries, 12 688 (41%) at moderate risk, and 1233 (4%) at high risk. Whether or not in-office fluoride was administered varied across the three caries-risk levels ($\chi^2 = 29.29$, d.f. $= 2$, $P < 0.001$) with 37.0% of the low-risk, 39.6% of the moderate-risk, and 42.4% of the high-risk groups receiving fluoride. Table 1 shows the variability across dentists with at least 25 patients at a given risk level in recommending home fluoride product use or providing in-office fluoride.

To examine the effect of the preventive use of fluoride, logistic regression was used within each caries-risk group. Age, prior preventive treatment, and gender were included in the models as covariates as well as age by preventive treatment and gender by preventive treatment interactions. The outcome variable of interest was having at least one tooth with a caries-related procedure in the 2-year follow-up period. The interaction terms were not significant in any of the models at either

Table 1. Mean percent of dentists' patients at each risk level receiving a preventive fluoride treatment

| | Plan A: Recommendation for home-use Fl+ | | | Plan B: Administration of in-office Fl+ | | |
|---|---|---|---|---|---|---|
| | Low ($n = 49$) | Moderate ($n = 43$) | High ($n = 31$) | Low ($n = 103$) | Moderate ($n = 92$) | High ($n = 8$) |
| Mean (%) | 10.4 | 64.0 | 63.5 | 36.5 | 42.4 | 41.1 |
| Range | 0–64.5 | 6.9–96.2 | 8.8–93.3 | 2.0–73.0 | 7.4–77.4 | 14.7–76.9 |
| 25th percentile | 2.4 | 49.6 | 40.6 | 20.3 | 33.6 | 19.1 |
| 50th percentile | 4.4 | 71.0 | 75.9 | 32.4 | 40.9 | 47.6 |
| 75th percentile | 12.0 | 82.1 | 85.6 | 55.6 | 51.6 | 51.9 |

Table 2. Mean (standard deviations) number of teeth with any caries-related procedures in the 2-year follow-up period

| | Plan A: Recommendation for at-home Fl+ | | Plan B: Application of in-office Fl+ | |
|---|---|---|---|---|
| | No | Yes | No | Yes |
| Low CRA | 0.24 (0.64)<br>$P = 0.009$ | 0.30 (0.73) | 0.49 (1.04)<br>$P < 0.001$ | 0.60 (1.21) |
| Moderate CRA | 0.58 (1.12)<br>$P = 0.070$ | 0.63 (1.16) | 0.90 (1.52)<br>$P < 0.001$ | 1.20 (1.85) |
| High CRA | 1.50 (2.27)<br>$P = 0.632$ | 1.34 (1.96) | 2.24 (3.10)<br>$P < 0.001$ | 3.14 (3.51) |

plan and hence were dropped from the final models. In plan A, the recommendation for home-use fluoride was not significantly related to caries-related treatment in the follow-up period for individuals at low ($P > 0.422$), moderate ($P > 0.338$) or high risk ($P > 0.824$). In plan B, the application of an in-office fluoride was associated with having at least one tooth with a caries-related procedure in the follow-up period. Having an in-office fluoride made it nearly 1.2 times more likely in the low-caries-risk group ($P < 0.001$), 1.2 in the moderate-caries-risk ($P < 0.001$) and 1.7 in the high-risk group ($P < 0.001$) to have at least one tooth with a caries-related procedure in the 2-year follow-up period (odds ratios and 95% CIs: low 1.19, 1.11–1.28; moderate 1.24, 1.15–1.33; high 1.70, 1.33–2.18). Table 2 summarizes the number of teeth with a caries-related procedure in the 2-year follow-up period for those with and without preventive treatment in each risk level and the *P*-values associated with Mann–Whitney *U*-tests of the difference in the number of teeth with a caries-related procedure between those with and without preventive treatment.

To examine the hypothesis that dentists further stratified patients within risk levels based on prior and current caries related treatment, we tested whether patients receiving a recommendation for home use of fluoride in plan A or an in-office fluoride treatment in plan B were more likely to have had previous and current caries-related treatment than those who did not receive preventive treatment. In plan A, those receiving preventive treatment were more likely to have had at least one tooth with prior caries-related treatment (24.0% vs. 10.2%, $P < 0.001$) and current caries-related treatment (26.3% vs. 10.7%, $P < 0.001$) than those who did not receive preventive treatment. Plan B followed the same pattern for both prior (23.3% vs. 17.3%, $P < 0.001$) and current (31.3% vs. 24.0%, $P < 0.001$) caries-related treatment.

## Discussion

The results of this retrospective study offer limited insight into the outcomes associated with a risk assessment program. Overall, we found incomplete compliance with expectations for recommendation or administration of preventive treatment for patients at elevated risk for caries as defined by guidelines developed by the dental groups. The guidelines of both practices utilize current and past caries experience (plan A) or current caries experience (plan B) in the assignment of risk with other factors receiving less consideration. The guidelines advise more intense preventive interventions for individuals at moderate or high risk. We were unable to identify any significant reductions in caries-related procedures for individuals receiving a fluoride intervention, compared to those who did not, when stratified by risk level. These results suggest that the preventive interventions used in these two large group practices are not effective in reducing the caries experience of at-risk individuals, a finding consistent with other reports (18–23). Several caveats must be advanced with respect to our results. A significant limitation of this investigation is the lack of a prospective and randomized design. We do not know why dentists provided fluoride application or recommendation for some at-risk individuals but not others. We hypothesize that dentists were stratifying patients within risk levels. Further analysis testing this idea revealed that prior caries experience was somewhat lower in the individuals not receiving a fluoride intervention. Regardless of the reason for this decision, these individuals still experience more caries than low-risk individuals and would be candidates for the intervention. Another limitation of this study was the short observation window of 2 years. Maybe this was too small a time to see impact of a preventive intervention on caries experience in populations at elevated risk of caries.

We acknowledge the limitation of our outcome measure, caries-related treatment procedures. This is an indirect measure of caries experience, but it does measure a 'downstream' effect of prevention, thus a more suitable measure of the long-term effectiveness of these interventions in adult populations. However, by using this indirect measure, further opportunities for bias are introduced into the analysis resulting from dentists' differing thresholds for restorative intervention, and to a lesser extent, their assessments of caries, particularly secondary caries (25). Regarding possible financial bias, dentists in the two plans have some broad incentives for productivity but no incentive to place restorations. Patients may have some financial barriers in terms of deductibles and copays but the financial hurdles are modest. Additionally, we did not have any information on other behaviors that may influence the caries experience, such as compliance with recommendations for home use of a prescription, use of over-the-counter preventive products in the absence of any recommendations or the dietary patterns of the patient.

The results of this study do contribute to the literature that puts into question the impact of a preventive intervention when applied within the context of a caries risk assessment. The results also demonstrate again that dentists do not always initiate caries preventive interventions as expected in a risk-based system. The purpose of a caries risk assessment is to help the clinician focus preventive efforts and assist in making other clinical decisions regarding treatment. Clearly, we lack sufficient understanding of both the effectiveness of preventive interventions designed to reduce caries among high-risk individuals and strategies designed to assist clinicians in reducing caries experience for at-risk groups. Additional clinical trials of caries preventive interventions in high-risk individuals are needed, and just as important, examinations of clinicians' decision-making behaviors surrounding initiating these interventions are necessary if effective interventions are to benefit patients.

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