Published in final edited form as:

J Dent. 2018 February ; 69: 83–87. doi:10.1016/j.jdent.2017.11.004.

Dentists' Decision Strategies for Suspicious Occlusal Caries Lesions in a National Dental PBRN Study

Sonia K. Makhija, DDS, MPH¹, Michael E. Robinson, PhD², James D. Bader, DDS, MPH³, Daniel A. Shugars, DDS, MPH, PhD³, Mark S. Litaker, PhD¹, Hong R. Im, DDS⁴, D. Brad Rindal, DDS⁵, Daniel J. Pihlstrom, DDS⁶, Cyril Meyerowitz, DDS, MS⁷, Valeria V. Gordan, DDS, MS, MS-CI², Meredith K. Buchberg, MPH⁸, Gregg H. Gilbert, DDS, MBA¹, and National Dental PBRN Collaborative Group⁹

¹University of Alabama at Birmingham, Birmingham, AL

²University of Florida, Gainesville, FL

³University of North Carolina at Chapel Hill, Chapel Hill, NC

⁴Private Practice, Austin, TX

⁵HealthPartners Institute, Minneapolis, MN

⁶Permanente Dental Associates, Portland, OR

⁷University of Rochester, Eastman Institute for Oral Health, Rochester, NY

⁸University of Texas Health Science Center at San Antonio, San Antonio, TX

Abstract

Objective—Case presentations (vignettes) were completed by dentists in the National Dental Practice-Based Research Network study “Decision Aids for the Management of Suspicious Occlusal Caries Lesions (SOCLs)”. The objective was to determine dentists’ decision strategies for SOCLs).

Methods—107 dentists viewed a series of 16 vignettes that represented all combinations of 4 clinical cues: color, luster, lesion roughness, and patient-level caries risk. Each vignette included a patient description and a photograph of a tooth presenting the 4 cues. Dentists were asked to decide the likelihood that a suspected lesion extended into dentin. A lens model analysis was used to examine how dentists use these cues in making their decisions.

Results—86% of dentists had a consistent pattern of cue use that defined their decision strategy. On average, 70% of the variance in their decisions was accounted for by their use of the 4 cues.

*To whom correspondence and reprint requests should be addressed: Dr. Sonia K. Makhija, Associate Professor, Department of Clinical & Community Sciences, UAB School of Dentistry, SDB Room 111, 1919 7th Avenue South, Birmingham, AL 35294-0007, Office: 1-205-996-5298, Facsimile: 1-205-975-0603, smakhija@uab.edu.

⁹The National Dental PBRN Collaborative Group includes practitioner, faculty, and staff investigators who contributed to this activity. A list is available at <http://nationaldentalpbrn.org/collaborative-group.php>

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

However, there was considerable variability in the individual cues used by each dentist. The percentages of dentists who used the different cues consistently were: luster (58%), color (48%), roughness (36%), and risk (35%). 14% of dentists reliably used only color, 7% used only luster, 4% used only roughness, and 1% used only risk when making SOCL decisions.

Conclusions—The online vignette system suggests that clinical SOCL decision strategies are highly individualized and dentists do not use all cues available to them to make these decisions.

Clinical Significance—Prior to this study, there has been little evidence about how dentists use these cues (either individually or in combination) when judging the extent of caries progression. Such knowledge would be valuable when designing interventions to help dentists maximize the likelihood of appropriate treatment decisions.

Keywords

caries; diagnosis; vignettes; dentin; cues

INTRODUCTION

Suspicious occlusal caries lesions (SOCLs) are initial caries lesions on occlusal surfaces of posterior permanent teeth. They often present a diagnostic challenge because it is difficult to determine if the lesion has penetrated into dentin [1,2,3]. Determining the depth of penetration is critical to providing the appropriate treatment. Non-surgical therapy (fluoride, sealant) is recommended when lesions are confined to enamel and when dentinal lesions are inactive. Surgical treatment is reserved for active lesions that have penetrated into dentin [4,5]. In the event of uncertainty, watchful waiting and/or non-surgical treatment are recommended because the proportion of these lesions that progress is small and progression is seldom rapid [4,6,7]. The treatment selection is important because surgical treatment predisposes for ever-larger restorations in the future [8].

SOCLs are commonly encountered in general dental practice, with approximately one-third of patients exhibiting such a lesion at any given time [9]. Despite the generally acknowledged threshold of limiting surgical treatment to lesions that penetrate dentin [10], many teeth with such lesions are opened unnecessarily: in a large National Dental Practice-Based Research Network (“network”) study almost one-half of the lesions that practitioners opened surgically did not penetrate clinically into dentin [11]. While a majority of dentists in the network subscribe to the “restorative threshold” of caries penetrating into dentin, their ability to preoperatively detect when this penetration has occurred is not optimal [12].

By definition, initial caries lesions have not penetrated far enough into the occlusal dentin for its demineralization to be evident radiographically. Therefore, practitioners often rely solely on clinical examination to assess the likelihood of lesion progression into dentin. Diagnosing caries can be thought of as a process that involves three steps: detection, assessment of the severity, and assessment of the activity [13], which will lead to an appropriate treatment plan. Assessment of severity and activity can be established by cues such as color, feel, and luster of the lesion [14], as well as caries risk of the patient. Makhija et al. studied 2,603 SOCL in 82 practices [9]. Their findings showed that a majority of the

lesions were on molars (69%), about ½ were chalky (49%), approximately ½ were rough (45%), and most were dark in color (85%). The available clinical cues are the lesion's color, surface smoothness, and luster. However, studies that have investigated these characteristics do not agree on whether these cues are significantly associated with depth of penetration [6,11,14,15]. Furthermore, there is no evidence in the literature about how dentists use these cues (either individually or in combination) when judging the extent of caries progression. Such knowledge would be valuable when designing interventions to help dentists maximize the likelihood of appropriate treatment decisions. As a first step in determining how cues are used, this study employed a series of patient vignettes to explore, within dentists, strategies to decide whether caries have penetrated into dentin.

MATERIALS AND METHODS

This study is based on vignettes completed by dentists in the network. The network is a consortium of dental practices and dental organizations focused on improving the scientific basis for clinical decision-making [17]. Detailed information about the network is available at its web site [18]. The network's applicable Institutional Review Boards approved the study; all participants provided informed consent after receiving a full explanation of the procedures.

Selection and recruitment process

Network practitioners were recruited by Regional Coordinators (RC) through letters and announcements sent to licensed practitioners from all six network regions (Western, Midwest, Southwest, South Central, South Atlantic, and Northeast). To be eligible for this study, practitioners had to complete an Enrollment Questionnaire (EQ), attend an orientation session or watch a video of it, and complete their training in human subjects' protection. The EQ, which is publicly available at <http://nationaldentalpbrn.org/enrollment.php>, collects information about practitioner, practice, and patient characteristics. Once practitioners completed the requirements, the RC provided a training session with the practitioner and staff that included an overview of the study, steps to complete the study, and answered any questions they had related to the study. The network's applicable Institutional Review Boards approved the study.

Once the practitioner agreed to participate in the study, an email with an individualized link was sent to the practitioner to complete the vignettes. It was recommended the practitioner complete the vignettes in one sitting; however, an option of saving and continuing was given. If the vignettes were not completed within a 7-day period, a reminder email was sent to the practitioner. All practitioners completed the vignettes in the timeframe allowed. The study began practitioner recruitment in April 2015 and the study ended in August 2015. 119 practitioners were assessed for eligibility and 12 declined to participate, leaving a total of 107 practitioners who completed the vignettes.

Enrollment Questionnaire—As part of the enrollment process, practitioners complete an Enrollment Questionnaire that describes themselves, their practice(s), and their patient population. This questionnaire, which is publicly available at <http://nationaldentalpbrn.org/enrollment.php>, collects information about practitioner, practice and patient characteristics.

Questionnaire items, which had documented test/re-test reliability, were taken from our previous work in a practice-based study of dental care and that PBRN ultimately led to the development of the National Dental PBRN [19,20].

Participant Characteristics of Final Sample

The purpose was to test hypotheses about what cues/signs dentists used to conclude that the lesion required treatment. Examining the validity of the dentists' treatment decisions was not a part of this study, its focus is exclusively on how dentists use cues in making those decisions. The individual dentist is the unit of analysis and that is our area of interest. Participants were 107 dentists (68 males, 39 females) from the network's 6 regions [17]. The majority of participants were Caucasian (76%), with the remaining 24% comprising minorities from 5 different categories. Mean age (SD) of the participants was 52.5 (11.0), ranging from 29 to 72 years. The participants tended to be experienced practitioners with an average of 24.7 (11.6) years since receiving their dental degree. The range of experience was 2 to 44 years.

Cue Validation Procedures

The four cues used in this study were identified from a previous network study on suspicious lesions [7]. Results from that study showed that a majority of lesions were dark brown/black or yellow/light brown, comprising 85% of all lesions. Lesion luster was evenly divided (shiny or chalky), as was roughness (rough or smooth) of the enamel surface as judged with light application of an explorer. The fourth cue, overall caries risk of the patient, was based on various factors, such as fluoride level (93% of patients were categorized as optimal fluoride level), self-care (60% of patients were categorized as good self-care), history of restorations (83% had a history of restorations), and cariogenic diet (25% of patients were categorized as having a cariogenic diet).

Vignettes consisted of a brief description of a patient along with a photograph of a tooth. The patient's caries risk level was dichotomous and was described as low or elevated, as was whether the lesion depicted was rough or smooth. All vignettes used in this study are publicly available on the network website [21]. A three-stage procedure assured that the teeth depicted in the photograph accurately represented clear examples of all four possible combinations of color and luster when the photographs were viewed online. Stage 1: Study investigators reviewed available images to identify 25 high-quality pictures of teeth they thought clearly depicted the key features. Stage 2: 5 practitioners from each of the network's 6 regions viewed the photographs in an online format and rated whether the lesion depicted in the tooth was 1) yellow/light brown vs. dark brown/black and 2) shiny vs. chalky. Stage 3: From these ratings, the investigators selected the 4 photographs that had the highest level of agreement for depicting the 4 cue combinations. The final four photos had almost unanimous agreement for color (97%) and a high agreement for luster (83%).

SOCL Decision Capturing Study

Participants viewed the vignettes and responded online. The order of vignette presentation was randomized for each dentist. Dentists were asked to decide the likelihood that the lesion extended into the dentin on a visual analog scale ranging from 0 = not at all likely, to 100 =

very likely. In addition, dentists indicated which of 6 potential treatment options they would choose for each vignette. These options were: 1) no treatment, 2) preventive treatment, 3) sealant or unfilled resin (tooth structure not altered), 3) sealant (minimal drilling or air abrasion), 4) Preventive resin (minimal drilling or air abrasion), 5) direct restoration (amalgam or composite) and (6) other. Thus, each dentist provided ratings of the likelihood that the lesion extended into the dentin. This provided a rating for each cue combination, and allowed us to examine the influence of each cue on their likelihood rating. Each dentist therefore represents a complete version of the study (idiographic analysis), with the 4 cues regressed on their rating of likelihood that the lesions extended into the dentin.

Lens Model Analysis

The lens model is an analogue method to study how individuals use information (cues) to make decisions [22,23]. Individual dentist (e.g., idiographic or intra-rater) decision equations are developed, and then summarized at the group level. For these analyses, the cues (e.g., lesion color, luster, roughness, risk) were analyzed to determine their effects on dentists' decisions about the likelihood that the SOCL extended into dentin. This design allows us to analyze subjects' decisions at the level of the individual and overall sample. This is an advantage over usual methods that permit only group analyses of the overall sample. Because group analyses average data across subjects, they do not permit the examination of individual differences in subjects' cue use. Group analyses would provide information only about the extent to which subjects, *on average*, made different decisions about SOCLs with different levels of color, roughness, luster or risk. This information is meaningful but incomplete; e.g., some subjects may only use color in making decisions, whereas others may make their decisions on other cues, or combinations of cues. Only individual-level analyses provide this specific information. To assess the overall decisions strategy for each dentist's rating of the likelihood that a lesion extended into the dentin, a regression equation for each dentist was calculated to compute an overall strength of his or her decision strategy, expressed as R^2 , with significance determined by $p < .05$. The significance and magnitude of each cue used to make the overall rating was determined by the significance ($p < .05$) and magnitude of the beta weight in each dentist's regression equation. The R^2 and beta weights from these individual regressions were then summarized with descriptive statistics (number of dentists with statistically significant decisions, and significant cues). Each dentist's R^2 value was also used as a dependent variable to assess potential explanatory variables of the strength of decision strategies across dentists.

RESULTS

Decision Strategy

As shown in Table 1, 86% ($n=92$) of participants had a statistically significant unique decision strategy, with an overall average $R^2 = .70 (.16)$. This suggests that the vignette presentations provided a vast majority of the participants with adequate information to make decisions about SOCLs. Table 1 also shows the frequency of significant ($p < .05$) cue use. The relative frequencies of cue use illustrate that there is substantial heterogeneity in how participants arrived at what were ultimately highly predictable decision strategies.

To explore cue use patterns, we examined how many participants used each cue as a single predictor in their decision, and how many used more than one cue. Table 2 shows these frequencies. Most participants used multiple cues, with a minority using only a single cue of any type. The strength of a dentist's decision strategy as measured by R^2 did not differ between individuals who used a single cue, as compared to those who used multiple cues. This suggests that those who relied on a single cue, relied on it heavily.

Several *a priori* selected variables were employed to explore variability in cue use. The sample was largely white or Caucasian, and the minority groups were distributed across 5 categories with insufficient individual sample sizes to warrant analysis by racial group. Therefore, a dichotomous variable of Non-Hispanic White/Caucasian vs. minority was created to explore potential race differences. Results indicated that minority dentists' decision strategies had slightly higher R^2 , ($t(105) = -2.34$, $p = .023$) representing approximately 7% variance difference between groups. No race comparisons for individual cue use were significant.

There were no significant associations between dentist age and decision strategies or individual cue use, as measured by regression parameter estimates. There was a small association ($r = -.191$, $p = .048$) between R^2 and the number of years since attaining the dental degree. Those in practice longer had smaller R^2 values. There were no significant differences between gender for decision strategies or any of the cues.

Fifteen participants did not have a significant decision strategy. We explored potential differences between those with and without significant strategies by examining the same demographic variables employed in the previous analyses. Participants who had non-significant decision strategies were older (59.2 (10.9) vs. 51.7 (10.7)) and had been in practice longer (31.8 (11.3) vs. 23.7 (11.4)), $t = 2.5$, $p = .014$, and $t = 2.6$, $p = .011$ respectively. These variables are highly related and may represent the same construct. Having a non-significant strategy was not related to dentist sex or race.

Relationship of dentin likelihood to decision to surgically intervene

To examine the relationship of ratings of "likelihood the SOCL extended into dentin" (how likely it is that the suspicious area extends into dentin using a sliding scale) with dentists' decisions to intervene surgically (alter tooth structure), a composite variable derived from a six-point response about treatment was computed. This resulted in a binary "surgical intervention" or "non-surgical intervention" response for each vignette. The association between the frequency of the decision to surgically intervene and the likelihood was evaluated, and was represented by the correlation coefficient. The correlation between these two variables was $r = .48$, $p < .001$, suggesting that whether the dentist judged that the SOCL extended into dentin was moderately correlated with whether or not that dentist recommended surgical intervention.

DISCUSSION

To our knowledge, this is the first attempt to evaluate how dentists use the cues of color, luster, lesion roughness, and patient-level caries risk in determining the likelihood that a

SOCL has penetrated into dentin. Given the high prevalence of these lesions, and the uncertainty that surrounds their management, it is surprising that such an evaluation has not previously appeared. According to a survey of the teaching of cariology in North American dental schools [24], about 2/3 of schools advocated surgical intervention when lesions have reached dentin, mainly at the level of the outer 1/3 of dentin (level D1), with the aid of radiographs. The remaining one-third of schools taught the operative treatment of enamel lesions, mainly lesions in the inner 1/2 of enamel (level E2), which is also similar to responses from a survey of dental schools in Latin America [25]. In a systematic review of 10 studies involving occlusal caries, for occlusal lesions with no dentin involvement, 12% of dentists would choose to intervene surgically and were almost 3 times more likely to intervene in high vs low caries risk groups. For lesions with dentin involvement, 74% stated they would intervene, and were 1.5 times more likely to intervene in high vs low caries risk groups. These trends were consistent globally [26]. Given that the majority of dentists have indicated that they do try to open only those lesions in dentin [12], this finding supports the external validity of the vignette system as a realistic presentation of the clinical situation. This is an important finding because these vignettes could be used as a pre/post-test of an intervention designed to improve clinical decision making.

For example, continuing education courses could be given as an attempt to reduce the proportion of inappropriate surgical decisions, which would allow these vignettes to be used as an estimate of the effectiveness of the course to modify their behavior. Additionally, the results from these analyses show that vignettes such as these could be a valuable teaching tool in that they would allow faculty to determine what cues students use and how consistently they apply them. This information would be part of the feedback to students in order to guide or shape their clinical decision making. For example, if a student were making a large number of unacceptable decisions, these analyses could reveal an over-reliance on a certain cue or set of cues. Knowing this information could assist the faculty in guiding students to change their cue use.

Most dentists do have seemingly fixed routines for determining whether a lesion has penetrated into dentin. This finding is in concert with our earlier suggestion that dentists may use pattern recognition, or “scripts” in deciding when and what treatment to provide [27]. Such a process effectively skips any diagnosis step in making the treatment decision, by simply matching the clinical presentation with the “script” which in turn dictates the treatment. Variation in which cues are used is also in line with the authors’ suggestion that dentists’ scripts tend to be individualized, and not easily described to other dentists.

The association between the frequency of the decision to surgically intervene and the likelihood was evaluated, and was represented by the correlation coefficient. The correlation between these variables was significant, suggesting that the more likely a SOCL was deemed to be in dentin, the more likely the dentists were to decide to intervene by opening the lesion. This was in line with a questionnaire completed by Scandinavian dentists, from which it was evident that almost 3/4 of respondents would only intervene when the caries reached dentin [28]. A previous network questionnaire also found that 90% of respondents would surgically restore a tooth in the outer 1/3 of dentin in a low-risk patient [12].

One limitation of these vignettes is that photographs may not be able to fully replicate a clinical setting. Overall, the vignettes found that the majority of dentists appear to use one or more of these 4 cues consistently when making decisions about depth of suspected lesions. It remains to be determined if these idiosyncratic strategies are used in actual clinical situations as well. Additionally, we were limited by the size of the study to a single variable describing risk level. To introduce multiple factors that cumulatively present a risk profile would have been desirable, but impossible with the available sample. Furthermore, there are other clinical factors (such as magnification, air-drying, or caries detecting devices) that could influence the pattern of cue use. Visual examination may be considered the gold standard for caries detection, which can be a limitation. It is important to note that the purpose of the study was not to assess the accuracy of whether the lesion actually penetrated the dentin, but to examine systematically what cues dentists could reliably use to make those decisions.

CONCLUSION

The use of these vignettes will lend evidence to how dentists use lesion characteristics to make treatment decisions. The vignette system, coupled with an idiographic analysis demonstrated that decision strategies for SOCLs are highly individualized and expectations that dentists use all cues available to them to make decisions are not tenable. This study also collected actual clinical findings and future plans include investigating how the results from the vignettes correspond to the actual clinical findings and treatment.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This work was supported by NIH grant U19-DE-22516. An Internet site devoted to details about the nation's network is located at <http://NationalDentalPBRN.org>. We are very grateful to the network's practitioners who participated in the study as well as the Regional Coordinators who followed-up with network dentists (Midwest Region: Tracy Shea, RDH, BSDH; Western Region: Stephanie Hodge, MA; Northeast Region: Christine O'Brien, RDH; South Atlantic Region: Hanna Knopf, BA, Deborah McEdward, RDH, BS, CCRP; South Central Region: Claudia Carcelén, MPH, Shermetria Massengale, MPH, CHES, Ellen Sowell, BA; Southwest Region: Stephanie Reyes, BA, Meredith Buchberg, MPH, Colleen Dolan, MPH). Opinions and assertions contained herein are those of the authors and are not to be construed as necessarily representing the views of the respective organizations or the National Institutes of Health. The informed consent of all human subjects who participated in this investigation was obtained after the nature of the procedures had been explained fully. The authors declare that there is no conflict of interest.

References

1. Lussi A. Comparison of different methods for the diagnosis of fissure caries without cavitation. *Caries Research*. 1993; 27:409–16. [PubMed: 8242679]
2. Kidd EAM, Ricketts DNJ, Pitts NB. Occlusal caries diagnosis: A changing challenge for clinician and epidemiologists. *Journal of Dentistry*. 1993; 21:323–31. [PubMed: 8258581]
3. Pine CM, Bosch JJ. Dynamics of and diagnostic methods for detecting small carious lesions. *Caries Research*. 1996; 30:381–8. [PubMed: 8946093]
4. Bader JD, Shugars DA. The evidence supporting alternative management strategies for early occlusal caries and suspected occlusal dentinal caries. *Journal of Evidence-Based Dental Practice*. 2006; 6:91–100. [PubMed: 17138407]

5. Fejerskov, O., Kidd, E. Dental caries: the disease and its clinical management. New Jersey: Wiley-Blackwell; 2008.
6. Hamilton JC, Dennison JB, Stoffers KW, Gregory WA, Welch KB. Early treatment of incipient carious lesions: a two-year clinical evaluation. *Journal of the American Dental Association*. 2002; 133:1643–51. [PubMed: 12512664]
7. Makhija SK, Gilbert GH, Funkhouser E, Bader JD, Gordan VV, Rindal DB, Qvist V, Nørrisgaard P. National Dental PBRN Collaborative Group. Twenty-month follow-up of occlusal caries lesions deemed questionable at baseline: findings from the National Dental Practice-Based Research Network. *Journal of the American Dental Association*. 2014; 145:1112–8. [PubMed: 25359642]
8. Brantley CF, Bader JD, Shugars DA, Nesbit SP. Does the cycle of reresoration lead to larger restorations? *Journal of the American Dental Association*. 1995; 126:1407–13. [PubMed: 7594013]
9. Makhija SK, Gilbert GH, Funkhouser E, Bader JD, Gordan VV, Rindal DB, Bauer M, Pihlstrom DJ, Qvist V. National Dental Practice-Based Research Network Collaborative Group. The prevalence of questionable occlusal caries: findings from The Dental Practice-Based Research Network. *Journal of the American Dental Association*. 2012; 143:1343–50. [PubMed: 23204090]
10. Baelum V. Caries management: technical solutions to biological problems or evidence-based care? *Journal of Oral Rehabilitation*. 2008; 35:135–51. [PubMed: 18197847]
11. Makhija SK, Gilbert GH, Funkhouser E, Bader JD, Gordan VV, Rindal DB, Pihlstrom DJ, Qvist V. National Dental PBRN Collaborative Group. Characteristics, detection methods, and treatment of questionable occlusal carious lesions: findings from the National Dental Practice-Based Research Network. *Caries Research*. 2014; 48:200–7. [PubMed: 24480989]
12. Gordan VV, Bader JD, Garvan CW, Richman JS, Qvist V, Fellows JL, Rindal DB, Gilbert GH. Dental Practice-Based Research Network Collaborative Group. Restorative treatment thresholds for occlusal primary caries among dentists in the dental practice-based research network. *Journal of the American Dental Association*. 2010; 141:171–84. [PubMed: 20123876]
13. Ekstrand KR, Ricketts DN, Kidd EA. Occlusal caries: pathology, diagnosis and logical management. *Dent Update*. 2001; 28(8):380–7. [PubMed: 11764611]
14. Pitts NB, Stamm J. International Consensus Workshop on Caries Clinical Trials (ICW-CCT) Final Consensus Statements: Agreeing Where the Evidence Leads. *J Dent Res*. 2004; 83(SpecC):C125–128. [PubMed: 15286139]
15. Francescut P, Lussi A. Correlation between fissure discoloration, Diagnodent measurements, and caries depth: an in vitro study. *Pediatric Dentistry*. 2003; 25:559–64. [PubMed: 14733470]
16. Steiner M, Helfenstein U, Menghini G. Association of salivary mutans streptococci with discoloured pits and fissures. *Community Dentistry Oral Epidemiology*. 1998; 26:412–7. [PubMed: 9870541]
17. Gilbert GH, Williams OD, Korelitz JJ, Fellows JL, Gordan VV, Makhija SK, et al. Purpose, structure, and function of the United States National Dental Practice-Based Research Network. *Journal of Dentistry*. 2013; 41:1051–1059. [PubMed: 23597500]
18. The National Dental Practice-Based Research Network. [Accessed October 23, 2017] <http://www.NationalDentalPBRN.org>
19. Study, F. D. C. Florida Dental Care Study. Retrieved October 23, 2017, from <http://nersp.nerdc.ufl.edu/~gilbert/>
20. Gilbert GH, Richman JS, Gordan VV, Rindal DB, Fellows JL, Benjamin PL, et al. Lessons learned during the conduct of clinical studies in the dental PBRN. *Journal of Dental Education*. 2011; 75:453–465. [PubMed: 21460266]
21. National Dental PBRN.org. [accessed October 23 2017] Study Results. http://nationaldentalpbrn.org/tyfoon/site/fckeditor/a-SOCL-PreStudyVignette-2015-03-03-V2_0.pdf
22. Beal D, Gillis JS, Stewart T. The lens model: Computational procedures and applications. *Perceptual & Motor Skills*. 1978; 47:3–28.
23. Cooksey, RW. Judgment analysis: Theory, methods, and applications. California: Academic Press; 1996.
24. Clark TD, Mjör IA. Current teaching of cariology in North American dental schools. *Operative Dentistry*. 2001; 26:412–18. [PubMed: 11504443]

25. Martignon S, Gomez J, Tellez M, Ruiz JA, Marin LM, Rangel MC. Current cariology education in dental schools in Spanish-speaking Latin American countries. *Journal of Dental Education*. 2013; 77:1330–1337. [PubMed: 24098037]
26. Innes NPT, Schwendicke F. Restorative thresholds for carious lesions: systematic review and meta-analysis. *Journal of Dental Research*. 2017; 96:501–508. [PubMed: 28195749]
27. Bader JD, Shugars DA. What do we know about how dentists make caries-related treatment decisions? *Community Dentistry Oral Epidemiology*. 1997; 25:97–103. [PubMed: 9088698]
28. Espelid I, Tveir AB, Mejare I, Sundburg H, Hollonsten AL. Restorative treatment decisions on occlusal caries in Scandinavia. *Acta Odontologica Scandinavica*. 2001; 59:21–7.

Table 1

Number and percentage of dentists whose overall decision equation was statistically significant, and number and percentage who used a particular cue in that decision (n=107 dentists)

	Number of dentists	Percentage of dentists
R ² for decision equation was statistically significant	92	86%
Color used in decision	62	58%
Luster used in decision	52	49%
Risk used in decision	37	35%
Surface used in decision	38	36%

Table 2

Number and percentage of dentists who used a single cue or multiple cues when making the decision (n=107 dentists)

	Number of dentists	Percentage of dentists
Color only	15	14%
Luster only	8	7%
Risk only	1	1%
Surface only	4	4%
More than one cue	79	74%