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## Concordance between Clinical Practice and Published Evidence: Findings from The National Dental Practice-Based Research Network

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## Abstract

**Background.**—Documenting the gap between what is occurring in clinical practice and what published research suggests is an important step toward improving care. This study quantified

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## DISCLOSURES

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concordance between clinical practice and published evidence across preventive, diagnostic and treatment procedures among a sample of dentists in the National Dental Practice-Based Research Network.

**Methods.**—Network dentists completed one questionnaire about their demographic characteristics and another about how they treat patients across 12 scenarios/clinical practice behaviors. Responses to each clinical practice were coded as consistent (i.e., ‘1’) or inconsistent (i.e., ‘0’) with published evidence, summed, and divided by the number of all non-missing to create an overall ‘concordance’ score, calculated as the mean percent of responses that were consistent with published evidence.

**Results.**—Analyses were limited to participants in the United States (N = 591). Mean concordance at the practitioner level was 62% (*SD* = 18); procedure-specific concordance ranged from 8-100%. Affiliation with a large group practice, being a female practitioner, and receiving a dental degree before 1990 were independently associated with high concordance ( 75%).

**Conclusions.**—Dentists reported a medium-range concordance between practice and evidence.

**Clinical Implications.**—Efforts to bring research findings into routine practice are needed.

### Keywords

Clinical practice; evidence-based dentistry; dentistry; implementation science

## BACKGROUND

Rigorous research findings provide the foundation for many clinical practice guidelines developed to improve care processes and improve patient outcomes. Although additional empirical evidence is needed to guide many areas of dentistry, a substantial amount of evidence already exists to support the use (or non-use) of specific materials, techniques, and/or treatment across a range of preventive, diagnostic, and treatment procedures. These include some of the most common issues faced by general dentists (e.g., caries diagnosis and treatment; deep caries diagnosis and treatment; third molar extraction; restoration diagnosis and treatment).<sup>1-11</sup>

Unfortunately, not all evidence-based recommendations are adopted in clinical practice settings, reflecting a gap between what we know works (or doesn’t work) and what is actually being done. Indeed, research suggests that dentists often do not engage in clinical practice behaviors that are consistent with evidence-based guidelines, recommendations, and/or published research findings. For example, in one study, only 69% of dental practitioners reported performing caries risk assessment (CRA) on their patients<sup>12</sup> despite recommendations to include CRA for all patients.<sup>5,9,13</sup> In another study, only 44% of general dentists reported using a rubber dam for all root canal treatments.<sup>14</sup> Several studies found that dentists do not use sealants for caries prevention and treatment for adults or children<sup>12,15,16</sup> as often recommended by evidence-based guidelines.<sup>1,17</sup>

The majority of studies documenting the gap between clinical practice behavior and evidence-based recommendations in dentistry, however, have focused on a single behavior (e.g., CRA, rubber dam use, sealants); few—if any—have attempted to examine the gap between practitioners’ clinical practice behavior and published evidence across a range of preventive, treatment and diagnostic behaviors. Thus, the extent to which the gap between clinical practice behaviors and empirical evidence exists across various preventive, diagnostic, and treatment procedures remains unknown. Assessing practitioners’ use of evidence in practice across several preventive, diagnostic and treatment procedures may be a better indicator of their broader use of evidence in practice than their response to a single

procedure. Moreover, relatively few studies have focused on identifying practitioner- and organizational-level correlates of use (or non-use) of published evidence in routine practice. Quantifying the gap between clinical practice behavior and published evidence-based findings—and identifying practitioner- and organizational-level correlates of use (or non-use) of published evidence—is a critical first-step toward understanding and improving clinical practice behaviors and patient health outcomes.<sup>18</sup>

To address this gap in the literature, the current study quantified the concordance between clinical practice and published evidence in the National Dental Practice-Based Research Network, a consortium of dental practices and dental organizations focused on improving the scientific basis for clinical decision-making.<sup>19</sup> The network was funded in 2012 and builds upon the former regional dental networks<sup>20</sup> that existed from 2005-2012. The network has a wide representation of practice types, treatment philosophies, and patient populations, including diversity regarding race, ethnicity, geography and rural/urban area of residence of both its practitioners and their patients. Analyses of these characteristics confirm that network dentists have much in common with dentists at large<sup>21</sup>, while also offering substantial diversity in these characteristics.<sup>22</sup>

Objectives of this study were to: (1) quantify the concordance between clinical practice and published evidence available at the time of data collection across a range of preventive, diagnosis, and treatment procedures and (2) test the hypothesis that certain practitioner- and organizational-level factors are significantly associated with that concordance.

## Methods

### Study population

We conducted this study with dentists in the network. At the time of the survey discussed in this report, the network comprised four main regions: Alabama/Mississippi (AL/MS), Florida/Georgia (FL/GA), Minnesota (MN), which comprised practitioners in the Health Partners Dental Group (HP) and other community practitioners, and Permanente Dental Associates (PDA) in Oregon and Washington. An additional region in Scandinavia (i.e., Denmark, Norway, Sweden) is not included in this report given substantial differences in practice patterns, insurance coverage, and reimbursement structures compared to the U.S.

### Study design

This was a cross-sectional study, consisting of a single administration of a questionnaire entitled “Impact of dental practice-based research networks on patient care” to all network dental practitioners who had participated previously in one or more network studies of any type, and who were in current practice with an active practice address. Data were collected from 2009 to 2010. The study was approved by the Institutional Review Boards (IRBs) at the University of Alabama at Birmingham and all of the network’s regional IRBs.

### Measures

**Enrollment Questionnaire**—Upon initial enrollment in the network, dental practitioners complete a 101-item Enrollment Questionnaire about their practice characteristics and themselves. This questionnaire is publicly available and the distribution of these characteristics for network dentists has been reported previously.<sup>21,22</sup> Among other items, this questionnaire includes practice location, type of practice, whether the dentist is a generalist or specialist, year of graduation from dental school, and the dentist’s gender, race, and Hispanic/Latino ethnicity.

**Practice Impact Questionnaire**—A copy of the questionnaire can be found online at. The questionnaire included 25 items and took approximately 30 minutes to complete. The present study examined responses to 12 of the 25 questions for which there was sufficient published evidence available to classify responses as consistent *vs.* inconsistent with published evidence. A brief description of each item and categorization of the responses as consistent or inconsistent with the evidence is noted below, corresponding to clinical area, clinical question or scenario, and response options provided in Table 1.

**Caries Diagnosis and Treatment:** Five questions or scenarios were used to assess participants' practice regarding caries assessment and treatment. For question one, participants were asked how often they used air drying to diagnose a primary caries lesion; a response of 80% or higher was categorized as consistent with the evidence base, while a response indicating anything less than 80% was categorized as inconsistent.<sup>23</sup> For item two, participants were asked if they assess caries risk for individual patients in any way; a response of 'Yes' was categorized as consistent with the evidence base, while a response indicating 'No' was categorized as inconsistent.<sup>24,25</sup> For items three and four, respectively, participants were shown two different clinical photographs of an unrestored occlusal surface of a mandibular left first molar, together with a description of the patient and asked how they would treat each one. For each question, a response of 'Amalgam restoration,' 'Composite restoration,' or 'Indirect restoration' was coded as inconsistent with the evidence, while any other response was coded as consistent.<sup>26</sup> Finally, for item five, participants were asked how often they used magnification to help diagnose caries lesions; a response of '80% or higher' was categorized as consistent with published evidence while a response indicating anything less than 80% was categorized as inconsistent.<sup>27</sup>

**Deep Caries Diagnosis and Treatment:** Two items were used to assess deep caries diagnosis and treatment. The first question asked participants to indicate what percentage of the time they used three treatment options when treating a patient with deep occlusal caries in the mandibular right first molar with a possible mild pulpitis. Response options indicating that they would stop before removing all caries and perform an indirect pulp cap greater than or equal to 25% of the time were categorized as consistent with the evidence; response options less than 25% were categorized as inconsistent.<sup>28,29</sup> For the second item, participants were asked what they would do in a scenario involving excavation of the caries in a lesion deeper than anticipated (in the same mandibular right first molar in the previous scenario) and perhaps involving the mesio-buccal pulp horn. A response indicating that they would, 'Stop removing decay near the pulp horn and remove it elsewhere,' was classified as consistent with the evidence; other responses were classified as inconsistent.<sup>28,29</sup>

**Third Molar Extraction:** A single item was used to assess third molar extraction practice. Participants who responded 'No pediatric patients' or 'Cannot provide a meaningful estimate' were excluded (not applicable) for this question. Response options of, 'I recommend removal of third molars if they are asymptomatic but have a poor eruption path (e.g., full/partial impaction), or do not appear to have sufficient space for eruption,' and 'I recommend removal of third molars only if a patient presents with symptoms or pathology associated with third molars' were classified as consistent with the evidence; the other response option (i.e., 'I recommend removal of most third molars for preventive reasons') was classified as inconsistent.<sup>3,4,6,30-32</sup> Participants were asked to indicate their philosophy on third molar referrals.

**Restoration Diagnosis and Treatment:** Four items assessed restoration diagnosis and treatment practices. For three of the questions, participants were shown a clinical photograph of a tooth accompanied by a brief description of the patient and were asked to

indicate what treatment they would provide from a list of 10 options. For all three questions, the option to ‘*Replace entire restoration*’ was classified as inconsistent with published evidence; all others were classified as consistent with published evidence.<sup>33</sup> For the fourth item, participants were shown five separate radiographs of the same tooth and asked to indicate the lesion depth at which they would do a permanent restoration instead of only doing preventive or non-surgical therapy. Response options corresponding with radiographs 3, 4, and 5 were classified as consistent with published evidence; radiographs 1 and 2 were classified as inconsistent.<sup>11,25</sup>

### Data collection

Questionnaires with a uniquely identified barcode were mailed in July 2009 to 1,013 enrolled dentists who had provided descriptive practice-level data, and who were either general dentists, pediatric dentists, or indicated that they performed at least some restorative dentistry. This included practitioners who enrolled by completing the online network Enrollment Questionnaire but who were outside the network’s five main administrative regions; most of these were in the southeastern region of the U.S. Reminders were sent 2-3 times to non-responders. Overall, 657 (64.8%) dentists completed the questionnaire between July 2009 and February 2010; analyses for the present study were restricted to the 591 U.S. dentists. To measure test-retest reliability, the questionnaire was completed twice by 18 network practitioners who completed the second questionnaire a mean (*SD*) of 63 (30) days after the first questionnaire. The median value of the kappa statistic for these questions was 0.81, with an inter-quartile range of 0.55-0.94.

### Data analysis

An overall “concordance” score was calculated as percent of ‘responses’ that were consistent with published evidence. To examine concordance, we coded responses to each of the 12 clinical procedures as consistent (i.e., ‘1’) or inconsistent (i.e., ‘0’) with published evidence. Responses were then summed and divided by the number of all non-missing to create an overall ‘concordance’ score, calculated as the percent of responses that were consistent with the evidence, with a higher percentage indicating greater concordance between clinical practice and published evidence. Practitioners were classified as ‘highly concordant’ if their score was greater than or equal to 75%.

Two sets of analyses were conducted: one using a continuous measure of concordance as the outcome (i.e., 0-100%) and the other using a dichotomous measure of concordance as the outcome (i.e., <75% vs. 75%). Bivariate analysis was conducted to quantify associations between concordance and practitioner gender, race/ethnicity, whether general or specialty practice, year graduated, network administrative region, and whether or not the practitioner belonged to either of two large group practices in the network (PDA and HP). The continuous measure of percent concordance did not strictly satisfy the normality assumption of one-way analysis of variance (ANOVA); however, the deviation was minor (slightly skewed). Statistical significance was also assessed using rank statistics. Findings were virtually identical with parametric and non-parametric tests. Because parametric tests are more familiar and have a measure of variability (standard deviation [*SD*]), these are presented in the results section. Chi-square tests were used for dichotomous measures of high performers. Models were built using backwards elimination regression (linear and logistic), all variables in Table 2 were entered, and retained if  $p < 0.10$ . Analyses were then repeated separately according to whether or not the dentist practiced in PDA or HP.

Sensitivity analyses were performed with stricter requirements for 3 of the 12 practices used: requiring use of air drying and magnification 100% instead of 80% when diagnosing caries,

and stop removing >50% (instead of 25%) of caries and perform indirect pulp cap. All analyses were performed using SAS version 9.3.

## Results

### Participant characteristics

Participant characteristics are displayed in Table 2. Most participants were male (82%), non-Hispanic White (89%), in general practice (95%), received their dental degree before 1990 (68%) and were from the southeastern U.S. (77.5%; AL, MS, FL, GA); 14% practiced in a large group practice located in Oregon (PDA) or Minnesota (HP). These two large group practices have higher proportions of females, non-Hispanic White practitioners and more recent graduates (since 1990).

### Concordance score

Descriptives of concordance scores (overall and by participant characteristics) are displayed in Table 2. Mean procedure-specific concordance score was 62% (SD=18) [range: 8-100%]; median procedure-specific concordance score was 64% [interquartile range: 50-75%]. Distribution for concordance by specific clinical question or clinical scenario is displayed in Table 3. Missing data on components of concordance were rare. Of the 591 practitioners, 507 (86%) had none missing, 72 (12%) were missing only one. There was a weak inverse association with number missing and score: spearman  $r = -0.12$ ,  $p=0.004$ . Only two participants omitted a majority of responses, however these two were not responsible for the weak inverse relationship, omitting these two: spearman  $r = -0.14$ ,  $p=0.0008$ . Procedures for which more than 80% of practitioners were concordant with published evidence were assessing caries risk, non-invasive treatment of an unrestored occlusal surface of a mandibular left first molar, and not extracting third molars solely for preventive reasons. Procedures for which few practitioners were concordant with the evidence were indirect pulp cap.

### Dentist/practice characteristics and association with concordance

Table 2 displays bivariate results for the association between dentist/practice characteristics and association with concordance. Using the continuous measure of concordance as the outcome, females and practitioners from Oregon or Minnesota, or in terms of practice setting, practitioners from PDA/HP, had higher scores than their counterparts in bivariate analysis. In adjusted analysis, presented in Table 4, mean concordance was higher for practicing in PDA/HP or not ( $p<0.001$ ), for women ( $p=0.06$ ), and for older graduates (before 1990;  $p=0.02$ ).

Associations with high concordance were similar as with the continuous measure; namely, in adjusted analysis, female gender and practicing in PDA/HP or not graduation before 1990 were significantly associated with high concordance.

In analysis stratified by whether practicing in PDA/HP or not (Table 4), the associations of higher concordance for women and for graduates before 1990 were still present among non-PDA/HP practitioners. In contrast, virtually no differences in concordance were present by gender or graduation year within PDA/HP practitioners.

Analyses using the stricter requirement for concordance resulted in a slightly lower mean concordance of 56%, but had virtually no difference in associations with gender, year graduated or practice setting.

## Discussion

The objectives of the present study were to examine the concordance between clinical practice and published evidence across a range of preventive, diagnostic, and treatment procedures, and identify practitioner- and organizational-level correlates associated with high concordance. Among a sample of 591 dentists, mean concordance score across 12 clinical practices was 62% ( $SD = 18$ ). Concordance was considerably higher among practitioners in PDA/HP than those not ( $p < .001$ ), moderately so for older graduates ( $p = 0.02$ ), and slightly so for women ( $p = .06$ ). Among non-PDA/HP practitioners, the associations with gender and graduation year remained, while no associations were indicated within PDA/HP practitioners. Findings were similar using a high performer categorization as with using a continuous measure of concordance.

Although not optimal, concordance rates reported herein are similar to those found in medicine. In a landmark study conducted by McGlynn and colleagues (2003), patients received 54.9% of recommended care across 439 indicators of quality of care that included 30 acute and chronic conditions as well as preventive care.<sup>34</sup> Similar rates of concordance between recommended care and actual care received have been found across other health conditions and care processes. It is worth noting, however, that differences in data collection methods (i.e., medical chart abstraction/review *vs.* self-report survey) may limit head-to-head comparisons between these studies conducted in medicine and the findings reported herein for dentistry.<sup>35-37</sup> Importantly, since the gap has been documented between recommended and actual care, widespread effort has been made to better understand and ultimately improve the quality of health care, perhaps providing an example for dentistry to follow.

The data set from this study cannot provide definitive explanations for why PDA/HP group practice setting and gender are associated with higher levels of concordance. Therefore, we can only speculate and state that additional research is warranted to explain these findings. Regarding the association with PDA/HP group practice, we do know that both of these groups have formalized efforts and practitioner meetings that are designed to discuss the latest clinical evidence and how it applies to routine clinical practice. It is possible that these organizational efforts are effective at closing the research-to-practice gap for these groups of practitioners. In addition, both PDA and HP create evidence-based guidelines on various topics, and these guidelines are disseminated to staff. Regarding the association with gender, female dentists were more likely to have high concordance with the evidence on the dichotomous measure (i.e., 75%), even once other key factors were taken into account in the same regressions (namely, year of graduation and PDA/HP group practice membership). Earlier work from the network, which used a different questionnaire that was limited to caries diagnosis and caries treatment, observed a similar finding; female dentists were more likely to recommend at-home fluoride (compared to in-office fluoride, which was recommended more often by male dentists) and chose preventive therapy more often at the earlier stages of dental caries.<sup>38</sup>

Limitations of the present study should be noted. First, responses may be subject to social desirability bias; it is possible that participants provided less-than-accurate responses because they wanted to portray themselves in a way that would be perceived positively by others (i.e., engaging in clinical behavior that is consistent with published evidence). This, however, is not supported by the data, as many participants reported poor concordance between clinical practice and published evidence, which one would not expect to see if participants' responses were influenced by social desirability bias. Second, data were collected via self-report and were not validated by other methods (e.g., observational data or chart abstraction). As with all self-report data, it is possible that participants' responses may

not accurately reflect their actual behavior; future work is needed to validate participants' responses to clinical practice behavior for all of the procedures of interest in this report, perhaps through the use of observational/ethnographic methods. Nonetheless, previous work from the network has shown that depth at which a practitioner would intervene in proximal caries, based on response to a questionnaire clinical scenario, is a valid predictor of actual clinical behavior,<sup>39</sup> as is whether a defective restoration should be repaired or replaced.<sup>40</sup> Additionally, network practitioners who stated that they would intervene surgically early in the caries process (for both occlusal caries and proximal caries) were also more likely to report that they would replace entirely a restoration rather than repair it, which suggests a consistency across a range of clinical restorative situations regarding the extent to which a practitioner is surgically invasive.<sup>40</sup> It is possible that some of the questions and/or case scenarios were misinterpreted and/or perceived as too ambiguous by some participants, resulting in lower concordance scores that would not actually be reflective of a gap between practice and evidence. It is worth noting, however, that survey questions and case scenarios were written by content experts, pilot tested with practitioners, and assessed for test-retest reliability before being included in the final version of the survey in an effort to enhance face validity and content validity. Our classification of each of the 12 preventive, diagnostic and treatment scenarios and/or clinical procedures as consistent or inconsistent with published evidence may spark debate since such assessment was based on the strongest available published evidence and expert review at the time data from this study were collected and not based on systematically-developed ratings of the strength of the evidence.. Nonetheless, results from both the continuous and dichotomous outcome measure of concordance, as well as sensitivity analyses, suggest a substantive gap between clinical practice and published findings. Finally, it is important to note that this study was unable to assess how clinical expertise and patients' needs and preferences played a role in practitioners' responses to the 12 preventive, diagnostic and treatment practices. Future research is needed to better understand how the components of evidence-based dentistry (namely, evidence, clinical expertise, and patients' needs and preferences<sup>41</sup>) interact to influence practitioners' decision-making process and provision of care.

The often-lamented 17-year gap between published clinical evidence and actual application in routine clinical practice is a problem described for many health professions.<sup>34,42-44</sup> Documenting the gap between clinical practice and published research is an important, albeit sometimes uncomfortable, first step toward being able to improve quality of care and patient outcomes. Future research is needed to identify and better understand factors that contribute to the discrepancy between clinical practice and published research. Possible drivers of this gap may include limited access to peer-reviewed publications, lack of social normative support, rigid organizational cultures, reimbursement schemes, and other factors identified in other clinical health areas as barriers toward the timely and effective adoption of clinical research findings.<sup>45-51</sup> Importantly, this work can serve as the foundation for developing and testing strategies to facilitate the systematic implementation of published evidence into clinical dental practice in order to improve the profession and public oral health.<sup>52-55</sup>

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## References

1. Beauchamp J, Caufield PW, Crall JJ, et al. Evidence-based clinical recommendations for the use of pit-and-fissure sealants: a report of the American Dental Association Council on Scientific Affairs. *J. Am. Dent. Assoc.* Mar; 2008 139(3):257–268. [PubMed: 18310730]
2. American Dental Association. Policy on Evidence-Based Dentistry. 2008. <http://www.ada.org/1754.aspx>. Accessed September 17, 2012
3. American Public Health Association. Opposition to Prophylactic Removal of Third Molars (Wisdom Teeth). 2008. <http://www.apha.org/advocacy/policy/policysearch/default.htm?id=1371>
4. Daley TD. Third molar prophylactic extraction: a review and analysis of the literature. *Gen. Dent.* Jul-Aug;1996 44(4):310–320. quiz 321-312. [PubMed: 8957825]
5. Evans RW, Pakdaman A, Dennison PJ, Howe EL. The Caries Management System: an evidence-based preventive strategy for dental practitioners. Application for adults. *Aust. Dent. J.* Mar; 2008 53(1):83–92.
6. National Institute for Health and Care Excellence. Guidance on the extraction of wisdom teeth. London, UK2000:
7. Felton D, Cooper L, Duqum I, et al. Evidence-based guidelines for the care and maintenance of complete dentures: a publication of the American College of Prosthodontists. *J. Am. Dent. Assoc.* Feb; 2011 142(Suppl 1):1S–20S. [PubMed: 21282672]
8. Felton DA. The ACP's Evidence-Based Guidelines for the Care and Maintenance of Complete Dentures. *J. Prosthodont.* Dec.2010 19(8):591. [PubMed: 21129079]
9. Fontana M, Young DA, Wolff MS. Evidence-based caries, risk assessment, and treatment. *Dent. Clin. North Am.* Jan; 2009 53(1):149–161. [PubMed: 19215749]
10. Frantsve-Hawley J, Jeske A. The American Dental Association's Center for Evidence-Based Dentistry: a critical resource for 21st century dental practice. *Tex. Dent. J.* Feb; 2011 128(2):201–205. [PubMed: 21473248]
11. NIH Consensus Report. Diagnosis and Management of Dental Caries Throughout Life. 2001; 18(1):1–24. <http://consensus.nih.gov/2001/2001Dentalcaries115html.htm>.
12. Riley JL 3rd, Gordan VV, Ajmo CT, et al. Dentists' use of caries risk assessment and individualized caries prevention for their adult patients: findings from The Dental Practice-Based Research Network. *Community Dent. Oral Epidemiol.* Dec; 2011 39(6):564–573. [PubMed: 21726268]
13. Young DA, Featherstone JD, Roth JR, et al. Caries management by risk assessment: implementation guidelines. *J. Calif. Dent. Assoc.* Nov; 2007 35(11):799–805. [PubMed: 18080486]
14. Anabtawi MF, Gilbert GH, Bauer MR, et al. Rubber dam use during root canal treatment: findings from The Dental Practice-Based Research Network. *J. Am. Dent. Assoc.* Feb; 2013 144(2):179–186. [PubMed: 23372134]
15. Tellez M, Gray SL, Gray S, Lim S, Ismail AI. Sealants and dental caries: dentists' perspectives on evidence-based recommendations. *J. Am. Dent. Assoc.* Sep; 2011 142(9):1033–1040. [PubMed: 21881070]
16. Riley JL 3rd, Gordan VV, Rindal DB, et al. General practitioners' use of caries-preventive agents in adult patients versus pediatric patients: findings from the dental practice-based research network. *J. Am. Dent. Assoc.* Jun; 2010 141(6):679–687. [PubMed: 20516100]
17. Feigal RJ, Donly KJ. The use of pit and fissure sealants. *Pediatr. Dent.* Mar-Apr;2006 28(2):143–150. [PubMed: 16708789]
18. Stetler CB, Mittman BS, Francis J. Overview of the VA Quality Enhancement Research Initiative (QUERI) and QUERI theme articles: QUERI Series. *Implement Sci.* 2008; 3:8. [PubMed: 18279503]
19. Gilbert GH, Williams OD, Korelitz JJ, et al. Purpose, structure, and function of the United States National Dental Practice-Based Research Network. *J. Dent.* Apr 15.2013
20. Gilbert GH, Williams OD, Rindal DB, et al. The creation and development of the dental practice-based research network. *J. Am. Dent. Assoc.* Jan; 2008 139(1):74–81. [PubMed: 18167389]

21. Makhija SK, Gilbert GH, Rindal DB, et al. Dentists in practice-based research networks have much in common with dentists at large: evidence from the Dental Practice-Based Research Network. *Gen. Dent.* May-Jun;2009 57(3):270–275. [PubMed: 19819818]
22. Makhija SK, Gilbert GH, Rindal DB, et al. Practices participating in a dental PBRN have substantial and advantageous diversity even though as a group they have much in common with dentists at large. *BMC Oral Health.* 2009; 9:26. [PubMed: 19832991]
23. Bader JD, Shugars DA, Bonito AJ. A systematic review of the performance of methods for identifying carious lesions. *Journal of Public Health Dentistry.* Fall;2002 62(4):201–213. [PubMed: 12474624]
24. Fontana M, Zero DT. Assessing patients' caries risk. *J. Am. Dent. Assoc.* Sep; 2006 137(9):1231–1239. [PubMed: 16946427]
25. American Dental Association Council on Scientific Affairs. Professionally applied topical fluoride: evidence-based clinical recommendations. *J. Am. Dent. Assoc.* Aug; 2006 137(8):1151–1159. [PubMed: 16873333]
26. Bader JD, Shugars DA. The evidence supporting alternative management strategies for early occlusal caries and suspected occlusal dentinal caries. *J Evid Based Dent Pract.* Mar; 2006 6(1): 91–100. [PubMed: 17138407]
27. Ismail AI. Visual and visuo-tactile detection of dental caries. *J. Dent. Res.* 2004; 83:C56–66. Spec No C. [PubMed: 15286124]
28. Ricketts DN, Kidd EA, Innes N, Clarkson J. Complete or ultraconservative removal of decayed tissue in unfilled teeth. *Cochrane Database Syst Rev.* 2006; (3):CD003808. [PubMed: 16856019]
29. Hilton TJ. Keys to clinical success with pulp capping: a review of the literature. *Oper Dent.* Sep-Oct;2009 34(5):615–625. [PubMed: 19830978]
30. Friedman JW. The prophylactic extraction of third molars: a public health hazard. *Am J Public Health.* Sep; 2007 97(9):1554–1559. [PubMed: 17666691]
31. Song F, Landes DP, Glenny AM, Sheldon TA. Prophylactic removal of impacted third molars: an assessment of published reviews. *Br. Dent. J.* May 10; 1997 182(9):339–346. [PubMed: 9175290]
32. Mettes TG, Nienhuijs ME, van der Sanden WJ, Verdonshot EH, Plasschaert AJ. Interventions for treating asymptomatic impacted wisdom teeth in adolescents and adults. *Cochrane Database Syst Rev.* 2005; (2):CD003879. [PubMed: 15846686]
33. Gordan VV, Garvan CW, Blaser PK, Mondragon E, Mjor IA. A long-term evaluation of alternative treatments to replacement of resin-based composite restorations: results of a seven-year study. *J. Am. Dent. Assoc.* Dec; 2009 140(12):1476–1484. [PubMed: 19955065]
34. McGlynn EA, Asch SM, Adams J, et al. The quality of health care delivered to adults in the United States. *N Engl J Med.* Jun 26; 2003 348(26):2635–2645. [PubMed: 12826639]
35. Mularski RA, Asch SM, Shrank WH, et al. The quality of obstructive lung disease care for adults in the United States as measured by adherence to recommended processes. *Chest.* Dec; 2006 130(6):1844–1850. [PubMed: 17167007]
36. Shrank WH, Asch SM, Adams J, et al. The quality of pharmacologic care for adults in the United States. *Med Care.* Oct; 2006 44(10):936–945. [PubMed: 17001265]
37. Asch SM, McGlynn EA, Hiatt L, et al. Quality of care for hypertension in the United States. *BMC Cardiovasc Disord.* 2005; 5(1):1. [PubMed: 15638933]
38. Riley JL 3rd, Gordan VV, Rouisse KM, McClelland J, Gilbert GH, Dental Practice-Based Research Network Collaborative G. Differences in male and female dentists' practice patterns regarding diagnosis and treatment of dental caries: findings from The Dental Practice-Based Research Network. *J. Am. Dent. Assoc.* Apr; 2011 142(4):429–440. [PubMed: 21454850]
39. Rindal DB, Gordan VV, Fellows JL, et al. Differences between reported and actual restored caries lesion depths: results from The Dental PBRN. *J. Dent.* Mar; 2012 40(3):248–254. [PubMed: 22245444]
40. Heaven TJ, Gordan VV, Litaker MS, et al. Agreement among dentists' restorative treatment planning thresholds for primary occlusal caries, primary proximal caries, and existing restorations: Findings from The National Dental Practice-Based Research Network. *J. Dent.* Jun 3.2013
41. American Dental Association Center for Evidence-Based Dentistry. 2013. Accessed on October 29, 2013

42. Institute of Medicine. *Crossing the Quality Chasm: A New Health System for the 21st Century*. The National Academies Press; 2001.
43. Balas, EA.; Boren, SA. *Managing clinical knowledge for health care improvement*. Schattauer Verlagsgesellschaft; Stuttgart, Germany: 2000.
44. Grol R, Grimshaw J. From best evidence to best practice: effective implementation of change in patients' care. *Lancet*. Oct 11; 2003 362(9391):1225–1230. [PubMed: 14568747]
45. Fontana M, Wolff M. Translating the caries management paradigm into practice: challenges and opportunities. *J. Calif. Dent. Assoc.* Oct; 2011 39(10):702–708. [PubMed: 22132581]
46. Merijohn GK. The practicing clinician's perspective: using the EBD approach and CDS tools in private practice. *J Evid Based Dent Pract*. Sep; 2008 8(3):203–205. [PubMed: 18783768]
47. Kao RT. The challenges of transferring evidence-based dentistry into practice. *Tex. Dent. J.* Feb; 2011 128(2):193–199. [PubMed: 21473247]
48. Spallek H, Song M, Polk DE, Bekhuis T, Frantsve-Hawley J, Aravamudhan K. Barriers to implementing evidence-based clinical guidelines: a survey of early adopters. *J Evid Based Dent Pract*. Dec; 2010 10(4):195–206. [PubMed: 21093800]
49. Anderson GC. Dissemination tools and resources: assisting colleagues in the implementation and promotion of EBD principles. *J Evid Based Dent Pract*. Sep; 2008 8(3):155–158. [PubMed: 18783759]
50. Hannes K, Norre D, Goedhuys J, Naert I, Aertgeerts B. Obstacles to implementing evidence-based dentistry: a focus group-based study. *J Dent Educ*. Jun; 2008 72(6):736–744. [PubMed: 18519604]
51. Shaneyfelt TM. Building bridges to quality. *JAMA*. Nov 28; 2001 286(20):2600–2601. [PubMed: 11722277]
52. Simpson DD. A framework for implementing sustainable oral health promotion interventions. *Journal of Public Health Dentistry*. 2011; 71(Suppl 1):S84–94. Winter.
53. Petersen PE, Kwan S. Evaluation of community-based oral health promotion and oral disease prevention--WHO recommendations for improved evidence in public health practice. *Community Dent. Health*. Dec; 2004 21(4 Suppl):319–329. [PubMed: 15617418]
54. Merijohn GK, Bader JD, Frantsve-Hawley J, Aravamudhan K. Clinical decision support chairside tools for evidence-based dental practice. *J Evid Based Dent Pract*. Sep; 2008 8(3):119–132. [PubMed: 18783753]
55. Frantsve-Hawley J, Meyer DM. The evidence-based dentistry champions: a grassroots approach to the implementation of EBD. *J Evid Based Dent Pract*. Jun; 2008 8(2):64–69. [PubMed: 18492572]

Table 1

## Categorization of Concordance between Clinical Practice and Published Evidence

Clinical Area	Question or Scenario #	Clinical Question or Scenario *	Response option(s) classified as inconsistent with evidence	Response option(s) classified as consistent with evidence
<b>Caries Diagnosis and Treatment</b>	1.	Use of air drying to diagnose primary caries lesion	<80%	80% or every time
	2.	Assess caries risk for individual patients in any way	No	Yes
	3.	Treatment of unrestored occlusal surface of a mandibular left first molar that has brown discoloration in some of the fissures in the occlusal surface and no cavitation	Amalgam restoration; Composite restoration; Indirect restoration	Any non-invasive restoration procedure
	4.	Treatment of unrestored occlusal surface of a mandibular left first molar that has brown discoloration in most of the fissures in the occlusal surface and no cavitation	Amalgam restoration; Composite restoration; Indirect restoration	Any non-invasive restoration procedure
	5.	Use of magnification to diagnose caries lesions	<80%	80% or every time
<b>Deep Caries Treatment and Diagnosis</b>	6.	Treatment options for patient with deep occlusal caries in the mandibular right first molar and possible mild pulpitis	Stop removing all caries and perform an indirect pulp cap <25% of the time	Stop removing all caries and perform an indirect pulp cap 25% of the time
	7.	Treatment options for excavation of caries deeper than anticipated for patient with deep occlusal caries in the mandibular right first molar and perhaps involving mesio-buccal pulp horn	Continue and remove all the decay; Temporize and treat or refer the tooth for endodontics	Stop removing decay near the pulp horn and remove it elsewhere
<b>Third Molar Extraction</b>	8.	Third molar referrals	I recommend removal of most third molars for preventive reasons	I recommend removal of third molars if they are asymptomatic but have a poor eruption path (e.g., full/partial impaction) or do not appear to have sufficient space for eruption; I recommend removal of third molars only if a patient persists with symptoms or pathology associated with third molars
<b>Restoration Diagnosis and Treatment</b>	9.	Defective composite restoration with enamel margins	Response included (but not limited to) replace entire restoration	Response included (but not limited to) polish, re-surface, or repair restoration but not replace
	10.	Defective amalgam restoration	Response included (but not limited to) replace entire restoration	Response included (but not limited to) polish, re-surface, or repair restoration but not replace
	11.	Lesion depth for permanent restoration instead of only preventive or non-surgical therapy (proximal caries)	Radiograph #1 or 2 (lesion in enamel only)	Radiographs #3, 4, or 5 (lesion into dentin)
	12.	Defective composite restoration with cementum-dentinal margins	Response included (but not limited to) replace entire restoration	Response included (but not limited to) polish, re-surface, or repair restoration but not replace

\* Brief statement or summary of the clinical scenario or question. For exact wording of each item and associated clinical photographs and radiographs (as appropriate), visit <http://nationaldentalpbrn.org/peer-reviewed-publications.php> (the specific file is at <http://nationaldentalpbrn.org/tyfoon/site/fckeditor/file/Concordance%20Questionnaire.pdf>).

Table 2

Characteristics of 591 participating dentists

Characteristic*	Overall				High Performers ( 75%)	
	Distribution of participants		Concordance <sup>1</sup>		N	% who were high performers
	N	%	Mean %	(±SD)		
<b>ALL</b>	591	100.0%	62	(± 18)	187	32%
<b>Gender</b>						
Male	487	83%	61	(± 18)	140	29%
Female	103	18%	66	(± 20)	47	46%
missing	1		$p^2=0.007$			$p^3<0.001$
<b>Race/ethnicity</b>						
Non-Hispanic	457	89%	62	(± 19)	149	33%
White						
Other	56	11%	60	(± 20)	19	34%
missing	78		$p=0.4$			$p=0.8$
<b>General practice</b>						
Yes	561	95%	62	(± 18)	179	32%
No	30	5 %	61	(± 19)	8	27%
			$p=0.8$			$p=0.5$
<b>Year dental degree</b>						
before 1990	401	68%	62	(± 18)	130	32%
1990 or later	189	32%	61	(± 20)	57	30%
missing	1		$p=0.99$			$p=0.90$
<b>Network administrative region **</b>						
AL/MS	334	57%	57	(± 18)	79	24%
FL/GA	125	21%	62	(± 18)	36	29%
MN	47	8%	74	(± 16)	32	68%
PDA	52	9%	77	(± 12)	34	65%
US-Other***	33	6%	62	(± 16)	6	18%
			$p<0.001$			$p<0.001$
<b>PDA/HP</b>						
Yes	82	14%	77	(± 12)	55	67%
No	509	86%	59	(± 18)	132	26%
			$p<0.001$			$p<0.001$

\*\* AL/MS (Alabama/Mississippi); FL/GA: Florida/Georgia; MN: HealthPartners and private practitioners in Minnesota; PDA: Permanente Dental Associates (WA and OR); US-Other: Participants outside the main regions.

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US-Other states: 17 in NC, 4 in SC, 4 in TN, 2 in NY, and one each in CA, CO, DE, ME NM, OH, PA, TX

<sup>1</sup> Overall, and according to each practice/practitioner characteristic presented, the mean percent of the 12 indices that the practitioners' responses were consistent or 'concordant' with.

<sup>2</sup> Significance of differences in mean percent concordant using t-test or ANOVA.

<sup>3</sup> Significance of differences in proportions of practitioners classified as high-performers according to indicated

**Table 3**

Percent in the sample who reported concordance by specific clinical question or clinical scenario

Clinical Area	#	Clinical Question or Scenario	N*	%
<b>Caries Diagnosis and Treatment</b>	1	Air dry 80% of the time	373/588	63%
	2	Assess caries risk on all patients	463/545	85%
	3	Non-invasive treatment (occlusal 1)	515/586	88%
	4	Non-invasive treatment (occlusal 2)	392/588	67%
	5	Use magnification 80% to diagnose caries lesions	335/583	57%
<b>Deep Caries Treatment and Diagnosis</b>	6	Stop removing all deep occlusal caries and perform indirect pulp cap 25% of the time	131/584	22%
	7	Stop removing decay near pulp horn and remove it elsewhere	190/578	33%
<b>Third Molar Extraction</b>	8	Do not recommend removal of third molar for preventive reasons	497/582	85%
<b>Restoration Diagnosis and Treatment</b>	9	Polish, resurface or restore but do not replace	246/589	42%
	10	Polish, resurface or restore but do not replace	381/588	65%
	11	Polish, resurface or restore but do not replace	388/582	67%
	12	Depth for permanent restoration (proximal caries)	297/588	51%

\* Difference in denominator and 591 is number missing, ranges from 2 (#9, *Polish, resurface or restore but do not replace*) to 46 (#2, *Assess caries risk on all patients*).



**Table 4**

Adjusted<sup>1</sup> mean percent concordance and association with high performers according to practice/practitioner characteristics, overall and according to whether practiced in PDA/HP

Characteristic	Mean Percent Concordant	<i>p</i> -value	High Performers		
			Odds Ratio	95% Confidence Interval	<i>p</i> -value
<b>ALL</b>					
Gender: Female vs. Male	70 vs. 67	0.06	2.0	1.2–3.2	0.007
PDA/HP: Yes vs. No	77 vs. 60	<0.001	6.0	3.6–10.1	<0.001
Graduated before 1990 vs. 1990 or later	65 vs. 62	0.02	1.7	1.1–2.6	0.01
<b>STRATIFIED BY PDA/HP</b>					
<b>Among Non-PDA/HP practitioners</b>	62 vs. 58	0.08	2.2	1.3–3.8	0.004
Gender: Female vs. Male	62 vs. 57	0.01	1.7	1.1–2.8	0.02
Graduated before 1990 vs. 1990 or later					
<b>Among PDA/HP practitioners</b>	78 vs. 76	0.5	1.2	0.4–3.3	0.7
Gender: Female vs. Male	77 vs. 78	0.8	1.7	0.6–4.4	0.3
Graduated before 1990 vs. 1990 or later					

<sup>1</sup> Adjusted for characteristics listed.