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Author manuscript

*J Public Health Dent.* Author manuscript; available in PMC 2017 September 05.

Published in final edited form as:

*J Public Health Dent.* 2016 March ; 76(2): 91–97. doi:10.1111/jphd.12114.

## Practice-Evidence Gap for In-office Fluoride Application in a Dental Practice-based Research Network

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### Abstract

**Objective**—The aims of this study were to examine dentists' recommendations for in-office fluoride to patients, and identify dentists' characteristics associated with these recommendations.

**Study Design and Setting**—The study was conducted using a cross-sectional questionnaire survey in Japan. The survey queried dentists (N=282) in outpatient dental practices affiliated with the Dental Practice-based Research Network Japan (JDPBRN). This network aims to assist dentists in investigating research questions and sharing their experience and expertise.

**Results**—The responses were obtained by 189 dentists (67%). Among valid response, fifty-four percent of dentists (n=98) recommend in-office fluoride to more than 50% of their patients aged 6–18 years and 15% (n=29) recommended this care to more than 50% of their patients aged over

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#### Author Contributions

Revised and reviewed the paper: YY, NK, FS, YM, GHG and VVG. Conceived and designed the experiments: YY, NK, FS, YM, GHG and VVG. Performed the experiments: NK, YM and FS. Analyzed the data: YY and NK. Contributed reagents/materials/analysis tools: YY, NK, FS, YM, GHG and VVG. Wrote the paper: YY and NK.

#### Competing Interests

Two authors are dentists employed by a dental clinic (Dr. Futoshi Sumida: Mikami Dental & Orthodontics Clinic and Dr. Yuki Matsumoto: Matsumoto Dental Clinic). This does not alter the authors' adherence to all the International Journal of Public Health policies on sharing data and materials.

18 years. Multiple logistic regression analysis suggested that factors associated with the percentage of patients who are recommended in-office fluoride included patient interest in caries prevention; dentist belief in the effectiveness of caries risk assessment.

**Conclusions**—Dentist practice patterns for recommending in-office fluoride vary widely. Recommendation was significantly related to having a higher percentage of patients interested in caries prevention, and to the dentist's belief about the effectiveness of caries risk assessment.

([Clinicaltrials.gov](http://Clinicaltrials.gov) registration number NCT01680848).

### Keywords

dental caries; dentist's practice patterns; preventive dentistry; evidence-based dentistry; clinical epidemiology

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## 1. Introduction

Although dental caries is a largely preventable condition,(1–3) it affects 59% of adolescents and is the most common chronic disease among children and adolescents world-wide.(4, 5) Based on a recent systematic review of the evidence, professionally-applied topical fluoride agents are now recommended for caries prevention in patients at elevated risk of developing caries. However, dentist practice patterns regarding in-office fluoride application and factors that affect them remain unclear.

The recently established Dental Practice-based Research Network Japan (JDPBRN) provides an opportunity for international comparisons of dental care patterns. The Dental Practice-based Research Network Japan (JDPBRN) is a consortium of dental practices with a broad representation of practice types, treatment philosophies, and patient populations, and it has a shared mission with the US DPBRN,(6) now called the National Dental PBRN (<http://NationalDentalPBRN.org>). The network regions of the JDPBRN cover all seven regions of Japan, namely Hokkaido, Tohoku, Kanto, Chubu, Kansai, Chugoku-Shikoku, and Kyushu. The US DPBRN and JDPBRN have conducted studies in the US and Japan that share the aim of clarifying practice patterns in caries diagnosis and treatment. The aim of the current study is to: (1) quantify dentist practice patterns in Japan regarding in-office fluoride application; and (2) test the hypothesis that these practice patterns are associated with specific dentist characteristics.

## 2. Materials and Methods

### Study Design

The study was conducted using a cross-sectional questionnaire survey, administered from May 2011 to February 2012.(7) This study was consistent with the World Association's Declaration of Helsinki, and the protocol was approved by the Ethics Committee of the Graduate School and Faculty of Medicine of Kyoto University (No. E1157). Written consent was obtained from all participants prior to participation. We used the same questionnaire as the one used in a DPBRN study assessing caries diagnosis and treatment (8) and the DPBRN Enrollment Questionnaire. (9) These questionnaires were translated into Japanese by four

dentists and clinical epidemiologists using a collaborative approach (available at [http://www.dentalpbrn.org/uploadeddocs/Study%201\(Japanese%20Version\).pdf](http://www.dentalpbrn.org/uploadeddocs/Study%201(Japanese%20Version).pdf); original English versions are at <http://nationaldentalpbrn.org/pdf/Study%201%20questionnaire%20FINAL%20after%20pre-testing%20021306.pdf>). The Japanese versions were validated by expert consultation and focus groups on potential subjects.(10) Dentists were queried about practice patterns in caries preventive treatment, as well as demographic information on their patients, practice, and themselves. Questionnaire distribution, method of response, and return were as previously described.(7, 8, 11)

## Participants

Participants were dentists working in outpatient dental practices who were affiliated with JDPBRN (n=282) and who indicated that they conduct restorative dentistry in their practices. Recruitment was via the JDPBRN website and postal mailing.

## Variables

**1) Dentist Practice Patterns Regarding Caries Preventive Agents**—Practice patterns for caries preventive agents were measured using the following question: For what percent of your patients do you recommend in-office fluoride application, such as fluoride gel, fluoride varnish, or fluoride rinse?

**2) Variable Selection**—Characteristics of the dentist, patient, and practice that were associated with recommending in-office fluoride application were identified from theoretical models, in accordance with previous studies.(7, 8, 12, 13)

## Statistical Analysis

**1) Description and comparison of practice patterns**—We examined the dental practice patterns regarding the use of caries preventive agents such as in-office fluoride application in patient groups aged 6–18 years and over 18 years.

**2) Factors affecting the decision to provide in-office fluoride application**—Dentist practice patterns for recommending in-office fluoride application were descriptively analyzed by univariate regression analysis for explanatory variables. Data were compared with the US data by calculating the mean percentages of patients who would receive recommendations for caries preventive agents in a previous study.(13) In-office fluoride application was categorized dichotomously as “recommend in-office fluoride to less than 50% of patients” (0–49%), and “recommend in-office fluoride to more than 50% of patients” (50–100%), as described previously.(14) We then conducted multiple logistic regression analysis to evaluate the association between explanatory variables and the percentage of patients who have in-office fluoride application recommended. Odds ratios and 95% confidence intervals (CIs) were calculated. Percentages were calculated based on the number of valid responses to each question. All statistical analyses were performed with STATA/SE® version 10 (STATA Corporation, College Station, TX, USA), with statistical significance set at  $p < 0.05$ .

### 3. Results

#### Demographic information of participants

Questionnaires were distributed to 282 dentists, from whom valid responses were obtained from 189 (67%). Demographic characteristics of participants are provided in Table 1. (7, 15–18) Mean number of years ( $\pm$  standard deviation) since graduation from dental school was  $18.5 \pm 9.9$ . Participants were predominantly male ( $n=154$ , 82%). Regarding practice setting, 40% ( $n=76$ ) of practices were located in government ordinance-designated cities with a population over 700,000. The percentage of dentists conducting caries risk assessment as a routine component of treatment planning was 26% ( $n=49$ ), while the percentage who agreed that caries risk assessment is effective was 67% ( $n=127$ ).

#### Dentist practice patterns of the recommendation of in-office fluoride application

Ninety-eight participants (54%) responded that 50% or more of their patients were recommended for in-office fluoride application (i.e., answered “recommend in-office fluoride to more than 50%”) of patients aged 6–18 years. In contrast, 29 participants (15%) who answered that 50% or more of patients older than 18 years are recommended for in-office fluoride application. In-office fluoride application was not recommended for any patients by about 3% of dentists who provided dental care for patients aged 6–18, and about 40% for patients aged 18 years (Table 2).

#### Factors associated with the recommendation of in-office fluoride application

Results of multiple logistic regression analysis are provided in Table 3. Four factors were significantly associated with whether the dentist recommended in-office fluoride application to 50% or more of patients aged 6–18 years old. Odds ratios (95% CI) were as follows: agreement with the effectiveness of caries risk assessment, 2.72 (1.12–6.60); percentage of patients interested in caries prevention, 2.38 (1.47–3.86); percentage of child and teenage patients (6–18 old), 1.04 (1.00–1.08); and percentage of practice revenue or charges from self-pay, 1.04 (1.01–1.07).

In contrast, percentage of patients interested in caries prevention was significantly associated with whether the practitioner recommended in-office fluoride application to 50% or more of patients aged over 18 years. The odds ratio (95% CI) for the percentage of patients interested in caries prevention was 5.07 (2.13–12.07).

### 4. Discussion

We found that the mean percentage of patients who have in-office fluoride application recommended was higher for patients aged 6–18 years (52%) than for those older than 18 years (21%). Ninety-eight participants (54%) responded that the percentage of patients who received individualized caries prevention was 50% or more (“recommended in-office fluoride to more than 50%”). Multiple logistic regression analysis suggested that several variables were associated with whether dentists recommended in-office fluoride application to 50% or more of patients. Specifically, dentist outcome expectancy for caries prevention

was significantly associated with a higher percentage who have in-office fluoride application recommended.

The results of the same questionnaire survey by the US DPBRN found that 82% of patients aged 6–18 years had in-office fluoride application recommended [14], compared to 52% in the JDPBRN. Also, 35–40% of US DPBRN patients older than 18 years had in-office fluoride application recommended, compared to 21% in the JDPBRN.(19) Based on those findings, we conclude that dentists in the US DPBRN recommend in-office fluoride more frequently than those in the JDPBRN and that the difference is larger for 6–18-year-olds patients. The lower percentage of patients who have in-office fluoride recommended may be due to the differences between the US and Japanese healthcare systems. In the US, the average percentage of dentists who recommend topical fluoride application to adults increased from about 9% in 1975 to 20% in 1995.(20) During the same period, the average real (base = 1995) fee for topical application of fluoride to an adult decreased by about 20%, or from \$24.59 to \$19.79.(20) In Japan, the dental insurance systems mainly cover general dental treatment;(21) however, coverage excludes higher-cost treatments such as gold crowns, dental implants for a small number of missing teeth, and orthodontic and preventive care services (in-office fluoride can be only partially applied to high-caries risk children who have many decayed or filled teeth).(22) The current Japanese health insurance system mainly focuses on disease treatment and doesn't cover most preventive dental care services. Because of this, the percentage of Japanese dentists providing preventive treatment may be reduced by economically-driven patient decision making and preference for preventive care.

Our study clarified that the use of in-office fluoride application was associated with: (1) a positive dentist perception of the effectiveness of caries assessment; and (2) patients who are interested in caries prevention (as measured by a higher percentage of patients aged 6–18 years and a higher percentage of self-funding patients).

For patients aged 6–18 years, the dentist's belief about the effectiveness of caries risk assessment was more strongly related to in-office fluoride recommendation than other factors. In terms of behavioral science, belief about the effectiveness of caries risk assessment is related to 'outcome expectation', which is the belief that performing a specific behavior (caries risk assessment) will lead to a desired outcome (dental caries prevention). Previous research has suggested that those outcome expectations are important predictors of dental preventive behavior.(23) In our study, 33% of dentists had a low outcome expectancy toward the effectiveness of caries risk assessment compared to 23% in the US DPBRN. Caries risk assessment is an essential component of providing minimally-invasive dentistry and is recommended as the first step in caries prevention.(24, 25) Increasing dentist outcome expectancy presumably requires continuing education in evidence-based preventive dental care, including the appropriate use of topical fluoride. Our data show that these same factors are related to in-office fluoride application for 6–18-year-old patients, and that dentist outcome expectancy and patient preference for preventive dentistry were more strongly related to in-office fluoride recommendations. Cabana et al. reviewed barriers to physician adherence to clinical practice guidelines and pointed out that outcome expectancy is a potential barrier.(26) However, to our knowledge, no study has clarified the degree to which dentist outcome expectancy is related to preventive dentistry compared to other dentist or

patient characteristics, practice settings or dental procedure characteristics. As noted by Cabana et al., potential barriers to adherence to physician guidelines varied with type of practice,(26) and our study revealed that dentist outcome expectancy and dentist rating of patient preference are strongly related to whether or not they provide preventive dentistry. Outcome expectancy is a modifiable factor, and might be a strong predictor of recommendation of in-office fluoride.

Dentist rating of patient preference for preventive care was strongly related to in-office fluoride application in both age groups. In particular, for patients older than 18 years, this factor was the strongest predictor of recommending in-office fluoride application. These results are consistent with a previous study, which also found that dentist rating of patient preference for preventive care was more strongly related to preventive services.(17)

The same questionnaire survey done by the US DPBRN also showed that higher rates of in-office fluoride to adult patients were associated with a higher percentage of 6–18-year-old patients in the practice, and a higher percentage of patients who self-pay.(19) These results are consistent with the results in the present study. Previous studies clarified that dentists made more-preventive treatment decisions for pediatric patients than adult patients in cases of occlusal caries within the inner half of the enamel.(15) Moreover, the percentage of patients who self-funded their care was significantly associated with dentist decisions to intervene surgically with carious lesions in the inner half of the enamel.(15)

The main strength of this study was its relatively wide diversity of participants, with respondents from all seven regions of Japan. Nevertheless, the study does have limitations. First, participants were not selected randomly, but by their response to a request for participation in the JDPBRN. However, the age and gender distribution of the study sample was similar to the actual distribution of dentists in Japan (80% male, average age in the 40s), (27) which supports the generalizability of the findings. Second, although we used previously planned cut-offs based on means from the previous US studies, there is no professional consensus regarding what objective cut-off value should be used as an adequate percentage of patients who receive in-office fluoride application. Third, validity of the questionnaire might be influenced by national reimbursement or insurance systems, which differs substantially between the US and Japan. Fourth, patient characteristics such as percentages of patients interested in caries prevention were reported by dentists. There could be a difference between the dentist's perception of patients' interests in caries prevention and patient's or patient's parents' (in case of younger patients) own interests. Finally, our study was conducted using a cross-sectional design, limiting assessment of causative relationships between the factors identified and recommendation of individualized caries prevention.

## 5. Conclusion

We found that dentist practice patterns regarding caries preventive dentistry vary substantially in this study population. Regardless of evidence-based recommendations for aged 6–18 years, in-office fluoride application was not recommended for any patients by about 3% of dentists who provided dental care for patients aged 6–18, and about 40% for

patients aged 18 years. Recommendation of in-office fluoride application was significantly related to the dentist's belief about the effectiveness of caries risk assessment and to a higher percentage of patients interested in prevention within the practice.

## Acknowledgments

Certain components of this work were supported by the National Institutes of Health grants U01-DE-16746, U01-DE-16747, and U19-DE-22516. 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 of the National Institutes of Health. The funders had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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**Table 1**

## Participant Characteristics (7, 15–18)

|  | <b>Number (%) or<br/>Mean <math>\pm</math> SD</b> |
|--|---|
| <b>Dentist Individual Characteristics</b>  |   |
| Years since graduation from dental school (year) * (n=185)                           | 18.5 $\pm$ 9.9                                    |
| Gender (male), n (%) (n=187)   | 154 (82)  |
| Belief about the effectiveness of caries risk assessment, n (%) (n=189)              |   |
| Agree  | 127 (67.2)  |
| Neutral  | 5 (2.7)   |
| Disagree   | 57 (30.2)   |
| <b>Practice Setting</b>  |   |
| Type of practice, n (%) (n=182)  |   |
| Employed by another dentist  | 77 (41)   |
| Self-employed without partners and without sharing of income, costs, or office space | 105 (56)  |
| Practice busyness, n (%) (n=181)   |   |
| Too busy to treat all people requesting appointments                                 | 19 (11)   |
| Provided care to all, but the practice is overburdened                               | 72 (40)   |
| Provided care to all, but the practice is not overburdened                           | 59 (33)   |
| Not busy enough  | 31 (17)   |
| City population (government ordinance-designated city), n (%) (n=189)                | 76 (40)   |
| <b>Patients' Characteristics</b>   |   |
| Percentage of patients interested in caries prevention, n (%) (n=189)                |   |
| 0% (none)  | 16 (8)  |
| 1–24%  | 80 (42)   |
| 25–49%   | 38 (20)   |
| 50–74%   | 46 (24)   |
| 75–99%   | 8 (4)   |
| 100%   | 1 (1)   |
| Patient age distribution *   |   |
| 1–18 years old (%) (n=183)   | 16.1 $\pm$ 13.2                                   |
| 19–44 years old (%) (n=188)  | 24.8 $\pm$ 11.0                                   |
| 45–64 years old (%) (n=183)  | 30.4 $\pm$ 11.2                                   |
| 65+ years (%) (n=183)  | 28.5 $\pm$ 17.4                                   |
| Percent of patients who self-fund (%) * (n=183)                                      | 8.6 $\pm$ 16.6                                    |
| <b>Dental Procedure Characteristics</b>  |   |
| Percentages of patients who receive individualized caries prevention, n (%) (n=189)  |   |
| 0% (none)  | 9 (5)   |
| 1–24%  | 68 (36)   |
| 25–49%   | 40 (21)   |
| 50–74%   | 37 (20)   |

|  | <b>Number (%) or<br/>Mean <math>\pm</math> SD</b> |
|--|---|
| 75–99%   | 24 (13)   |
| 100%   | 11 (6)  |
| Caries risk is assessed as a routine part of treatment planning, n (%) (n=189) | 49 (26)   |
| Percentage of patients who received hygiene instruction (%) * (n=183)          | 67.3 $\pm$ 34.8                                   |

\* mean $\pm$ SD

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**Table 2**

Dentist reports of the percentage of patients who were recommended in-office fluoride

| % (N)                  | Mean         | Not<br>recommender<br>for any<br>patient<br>(0%) | Recommended<br>for<br>1–49% of<br>patients | Recommended<br>for<br>50–100% of<br>patients |
|------------------------|--------------|--|--|--|
| <b>6–18 years old*</b> |              |  |  |  |
| In-office Fluoride     | 52.0 (n=182) | 3.3 (n=6)  | 42.9 (n=78)                                | 53.9 (n=98)                                  |
| <b>Over 18 years*</b>  |              |  |  |  |
| In-office Fluoride     | 21.0 (n=189) | 39.2 (n=74)                                      | 45.5 (n=86)                                | 15.3 (n=29)                                  |

\* Number of dentists who answered this question is different due to missing data.

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**Table 3**

Multiple logistic regression of recommendation of in-office fluoride to 50% or more of patients (n = 163)

|   | 6–18 years old |             |             | over 18 years     |             |             |              |                   |
|---|----------------|-------------|-------------|-------------------|-------------|-------------|--------------|-------------------|
|   | Odds Ratio     | 95% CI      | p-value     | Odds Ratio        | 95% CI      | p-value     |              |                   |
| <b>Dentist Individual Characteristics</b>   |                |             |             |                   |             |             |              |                   |
| Years since graduation from dental school (every 1 year)                                    | 0.96           | 0.92        | 1.01        | 0.109             | 1.04        | 0.96        | 1.11         | 0.341             |
| Gender (reference: male)  | 0.61           | 0.20        | 1.81        | 0.372             | 1.52        | 0.19        | 11.92        | 0.691             |
| Belief about effectiveness of caries risk assessment  |                |             |             |                   |             |             |              |                   |
| Disagree or neutral   | 1.00           |             |             |                   | 1.00        |             |              |                   |
| Agree   | <b>2.72</b>    | <b>1.12</b> | <b>6.60</b> | <b>0.027</b>      | 0.89        | 0.19        | 4.11         | 0.886             |
| <b>Practice Setting</b>   |                |             |             |                   |             |             |              |                   |
| Type of practice  |                |             |             |                   |             |             |              |                   |
| Employed by another dentist   | 1.00           |             |             |                   | 1.00        |             |              |                   |
| Self-employed without partners and without sharing of income, costs, or office space        | 0.50           | 0.20        | 1.29        | 0.154             | 4.61        | 0.72        | 29.42        | 0.106             |
| City population (reference: non-government ordinance designated city)                       | 0.97           | 0.43        | 2.16        | 0.953             | 1.74        | 0.41        | 7.41         | 0.451             |
| <b>Practice busyness</b>  |                |             |             |                   |             |             |              |                   |
| Too busy to treat all people requesting appointments  | 1.00           |             |             |                   | 1.00        |             |              |                   |
| Provide care to all who request appointments, but the practice is overburdened              | 1.86           | 0.48        | 7.31        | 0.372             | 0.97        | 0.12        | 8.03         | 0.975             |
| Provide care to all who request appointments, but the practice is not overburdened          | 1.33           | 0.33        | 5.31        | 0.687             | 0.41        | 0.04        | 4.01         | 0.443             |
| Not busy enough-the practice could treat more patients                                      | 1.11           | 0.23        | 5.38        | 0.898             | 0.79        | 0.08        | 7.94         | 0.84              |
| <b>Patient Characteristics</b>  |                |             |             |                   |             |             |              |                   |
| Percentage of patients interested in caries prevention (every 25%)                          | <b>2.38</b>    | <b>1.47</b> | <b>3.86</b> | <b>p&lt;0.001</b> | <b>5.07</b> | <b>2.13</b> | <b>12.07</b> | <b>p&lt;0.001</b> |
| Percentage of child & teenage patients (1–18 years old) (every 1%)                          | <b>1.04</b>    | <b>1.00</b> | <b>1.08</b> | <b>0.04</b>       | 1.02        | 0.98        | 1.06         | 0.322             |
| Percentage of practice revenue or charges from self-pay (every 1%)                          | <b>1.04</b>    | <b>1.01</b> | <b>1.07</b> | <b>0.02</b>       | 1.01        | 0.98        | 1.05         | 0.447             |
| <b>Dental Procedure Characteristics</b>   |                |             |             |                   |             |             |              |                   |
| Caries risk assessment is conducted as a routine part of treatment planning (reference: no) | 0.85           | 0.30        | 2.42        | 0.757             | 0.53        | 0.11        | 2.45         | 0.414             |
| Percentage of patients who received hygiene instruction (every 1%)                          | 1.01           | 1.00        | 1.02        | 0.116             | 1.00        | 0.98        | 1.03         | 0.829             |
| Percentage of patients who received dietary advice (every 1%)                               | 1.24           | 0.53        | 2.88        | 0.622             | 0.40        | 0.10        | 1.71         | 0.218             |
| Percentage of patients who receive blood pressure screening (every 25% increase)            | 0.96           | 0.79        | 1.16        | 0.657             | 1.17        | 0.90        | 1.51         | 0.236             |