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ORIGINAL RESEARCH

Knowledge, Attitude and use of Fluorides among Dentists in Texas

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ABSTRACT

Aim: The centers for disease control and prevention (CDC) recommendations on fluoride use were published in 2001. This study examines how this information has diffused to practicing dentists and the level of fluoride knowledge and use among Texas dentists.

Materials and methods: A questionnaire was sent to dentists who self-identified as being in pediatric (343), dental public health (72), and general practices (980); a 12% sample of registered dentists in Texas.

Results: Response rate was 42.9%. About 90% of surveyed dentists reported using fluorides routinely. Only 18.8% reported fluoride varnish as the topical fluoride most often used. About 57% incorrectly identified primary effect of fluoride. 'Makes enamel stronger while tooth is developing prior to eruption' was the most commonly cited wrong answer (44%). Only 5% identified that posteruptive effect exceeds any preeruptive effect.

Conclusion: Despite the evidence for fluoride varnish preventing and controlling dental caries being Grade I, its use is still uncommon. Dentists are expected to be knowledgeable about products they use, but this study reflects lack of understanding about fluoride's predominant mode of action. More accurate understanding enables dentists to make informed and appropriate judgment on treatment options and effective use of fluoride based on risk assessment of dental caries.

Clinical significance: Lack of knowledge of, or failure of adherence to evidence based guidelines in caries prevention by use of appropriate fluoride regimens may adversely affect caries incidence in the population.

Keywords: Dental caries, Fluorides, Evidence-based dentistry, United States, Diffusion of innovation.

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INTRODUCTION

Although major improvements have been seen over the past 20 years in the prevalence of dental caries in the permanent teeth of children and young adults, it is still a major problem, especially among the poor.[1,2] While good oral hygiene and diet, the use of toothpaste, and the application of sealants have contributed to the decline, the most effective methods have been those that include fluoride. In a 1994 survey, the Texas Department of Health found that 67% of children 6 to 8 years of age and 73% of those 15 years of age had experienced one or more carious lesions in either primary or permanent teeth.[3] Moreover, 43% of children 6 to 8 years of age and 45% of those 15 years of age had one or more decayed and untreated lesion either in primary or permanent teeth.[4] Recent national trends suggest that the rate of decay is declining; however, for children aged 2 to 5 years, dental caries in primary teeth has increased.[3] For most Americans, oral health status has improved since 1988 to 1994.[3] Dental caries continues to decrease in the permanent dentition for youths, adolescents, and most adults. Among seniors, the prevalence of root caries has decreased but there has been no change in the prevalence of coronal caries.[3] The decline in dental caries incidence reflects the success in prevention. Fluoride is the most effective preventative method against carries and effectiveness of fluoride in preventing and reversing incipient dental caries is well documented.[2,5] As the head of the oral health team, the dentist is responsible for his knowledge and practice to be based on most current information available.

After the success of water fluoridation in the 1940's, the Council on Dental Therapeutics of the ADA published its first fluoride dosage schedule in 1958.[6-8] In 2001, the CDC published the results of a consensus conference on fluorides in dentistry.[5] Panelists and reactors evaluated the quality of the scientific evidence relating to commonly used

fluoride modalities and made a series of recommendations. The report summarized the state of knowledge of fluoride actions emphasizing that the predominant benefit is in post-eruptive remineralization rather than the earlier belief that fluoride is incorporated in developing tissues as a pre-eruptive and systemic effect.[1,5,9] Also, since it is known that fluoride has the potential to remineralize incipient lesions in all teeth, adults also benefit from fluoride treatments contrary to prior belief that only children benefited from it.[5] Thus, it was recommended that the dentists decide the treatment according to risk of caries, past caries experience and not simply on age.[10]

Eklund et al in a study on data from 1990 to 1997, reported that Michigan dentists did not apply topical fluoride based on assessed risk.[11] Findings from a recent study of Indiana dental professionals concluded that many of the respondents did not know the mode of action or the relative concentrations of products. The investigators concluded that the dental professionals may not be adequately prepared to counsel patients on the appropriate use of fluorides.[12]

Diffusion of Innovation

Diffusion of innovation describes the process by which an innovation is communicated through certain channels over time among the members of a social system.[13] Diffusion among health care workers is a slow process.[13] The individuals in a social system do not all adopt an innovation at the same time but in an over-time sequence. They are classified into adopter categories in terms of time of adoption and are characterized by five phases: Innovators, early adopters, early majority, late majority and laggards.

While this paradigm was originally used to describe diffusion of innovation in farming, it has been applied to health care; however, such literature related to the practice of dentistry is lacking.[14,15]

A study of pit and fissure sealant use concluded that the time to adoption followed the predicted curve.[14] Factors have been suggested which influence innovation in dental practice are being in large group practices, and having frequent contact with outside organizations, reading journals, membership in professional associations, and attending scientific meetings correlated with innovation.[15]

Recommendations for using fluoride were first published by the CDC in August of 2001 and were then adopted by the ADA in August of 2006 and were published in Journal of American Dental Association (JADA). The CDC recommendations serve as a guide for dentists and other health care providers in the use of fluoride to achieve maximum protection against dental caries while using resources efficiently and minimizing the risk for enamel fluorosis. The recommendations by the ADA integrated the evidence in the literature, including the CDC recommendations, in a summarized format. The recommendations were stratified by patient age and risk for caries. There are various factors which affect the time for the new recommendations to be adopted by the practicing dentists.

Given the changing state of knowledge and clinical recommendations relating to the use of fluoride products and prevention in general, the extent to which dentists' knowledge and clinical practice are consistent with contemporary science is uncertain.[16] This study examines how information from the recommendations has diffused to practicing dentists and the level of fluoride knowledge and use among Texas dentists.

MATERIALS AND METHODS

This study was approved by the Institutional Review Board of Baylor College of Dentistry/Texas A&M University Health Science Center. A survey instrument was developed based on questions from a survey conducted in Indiana in 2005 and was modified using the current CDC guidelines.[5,12] The survey was pilot-tested on Baylor College of Dentistry faculty members.

Public domain Texas State Board of Dental Examiners' database of licensed dentists was used.[17] In addition to name and practice location, the database contained year of graduation from dental school, gender and type of practice (e.g. general dentistry, public health or pediatric). A questionnaire was designed and mailed with the purpose of determining the fluoride knowledge and practice among licensed and practicing dentists in Texas.

The database comprised 21,324 dentists. The focus of this study is dentists in self-identified public health (n = 151), general (n = 9,575) and pediatric practices (n = 610). Since, the number of dentists in public health and pediatric practices was small, surveys were mailed to all dentists in those categories. For dentists in general practice, STATA 9.0 (STATA Corp., College Station, Texas) was used to draw a random sample of 12% (n = 1,150). After the exclusion criteria were met, the sample was reduced to (n = 980).

A cover letter and coded survey were sent out to 343 dentists in pediatric, 72 dental public health and 980 dentists in general practice. Identities of the respondents were kept confidential and no personally-identifiable information was to be maintained throughout the survey and thereafter. The project budget allowed for two mailings which were sent out according to the total design method (TDM) by Dillman.[18] The mailings were done 2 months apart in 2007.

RESULTS

The overall response rate was 599 (42.9%). All the returned questionnaires were examined for completeness and responses were entered into SPSS version 14.0 for analysis. To compare the people who were in the sample and the sampling frame, an independent sample t-test was done with years since graduation (YOP) as the test variable. There was no significant difference between the two groups (p = 0.305) for the first wave of respondents *vs* respondents in the second wave, nor between respondents and non-respondents (p = 0.153). As in all survey research, there is a possibility of response bias, which we cannot measure.

Ninety-four percent of the surveyed dentists reported using fluorides routinely in their clinics. Twenty percent of the respondents were in agreement with the recommendation that patients having a low caries risk do not benefit from topical fluoride applications. Getting the correct response was not significantly associated with YOP (t = –1.47; p = 0.141) or to continuing education (t = –1.79; p = 0.073). Table 1 shows results of logistic regression models where general dentists were more likely to respond in accordance with current recommendations than pediatric dentists (p < 0.001). Due to the small numbers of self-identified public health dentists, logistic regression results are presented for only the general dentists and pediatric dentists.

Eighty-four percent of the respondents were in agreement with that moderate caries risk for below 6 years of age should receive topical fluoride applications every 6 months and 93% of the respondents responded correctly that for the high risk category for below 6 years of age, topical fluoride treatments should be at 3 or 6 months. Responding correctly was not significantly associated with YOP (t = 1.1; p = 0.258, t = 0.512; p = 0.6) respectively, but was significant with respect to CE (t = 2.0; p = 0.007, t = 2.0; p = 0.03) respectively.

Table 1: Results of logistic regression model with variables with correct answers by type of provider controlled for years of practice

Variables	*Pediatric vs general dentists*	
	Odds ratio (95% CI)	*p-value*
Moderate caries risk	4.16 (2.1, 8.08)	(<0.001)
Determine patients getting enough systemic fluorides	8.031 (4.0, 15.7)	(<0.001)
Inhibits bacterial metabolism	1.8 (1.08, 3.18)	(0.024)
Remineralizes incipient caries	4.1 (1.21, 13.8)	(0.023)
Age of brushing	4.6 (3.1, 7.05)	(<0.001)
Counsel patients on correct portion of toothpaste	0.175 (0.041, 0.268)	(<0.001)
ppmF in APF foam	3.3 (2.2, 5.0)	(<0.001)
ppmF in fluoride varnish	2.7 (1.86, 4.1)	(<0.001)
ppmF in toothpaste	2.3 (1.5, 3.3)	(<0.001)
Topical fluoride can be used on fluorosis	2.5 (1.6, 4.0)	(<0.001)

About 92% of the respondents agreed that the majority of their patients had access to fluoridated tap water. Of concern are the 14 (2.4%) of respondents who did not know whether the majority of their patients drank fluoridated tap water. Texas had a fluoridation rate of 78.1% of persons on public water supply systems at the time of the survey.

Almost 99% of the respondents correctly agreed that fluoride increases enamel resistance and 16% of the respondents reported incorrectly that they did not agree that fluoride inhibits bacterial metabolism. More than 95% of the respondents correctly reported that fluoride remineralizes incipient caries.

More than 88% of the respondents were correct when they disagreed that application of fluoride can cause fluorosis. Almost 57% of the respondents incorrectly identified the primary effect of fluoride on developing tooth enamel. 'Makes enamel stronger while the tooth is developing prior to eruption' was the most commonly cited wrong answer by 257 (44%) of the respondents. The most current evidence is that the posteruptive topical effect of fluoride is the predominant mode of action in caries prevention.[5]

Only 5% of the respondents identified that the posteruptive effect exceeds any preeruptive effect. Responding correctly was not significantly associated with the type of practice (t = 0.458, p = 0.647)*. Responding correctly was not significantly associated with CE (t = 1.07, p = 0.285). Over 54% of the respondents correctly recommended that children's teeth should not be brushed before 2 years of age with fluoridated toothpaste, and when analyzed by YOP, it was significant (t = 5.04, p = < 0.001). Over 74% of respondents did not correctly identify the approximate concentration of APF foam as 12,000 ppmF even though 30% of them reported using them most commonly in their offices. An additional 293 (48.9%) respondents reported, 'I do not know'. Respondents who graduated recently were more likely to answer correctly than those who had been graduated for a longer time (t = 2.3, p = 0.018). Few respondents could accurately identify the approximate concentration of fluoride in fluoride varnish. Only 26% of them answered correctly. Few dental professionals (n = 179, 31%) could correctly identify the approximate concentration of fluoride in dentifrice. A majority (n = 390, 63%) of respondents did not answer correctly.

Survey participants were asked if topical fluoride could be used on patients with fluorosis, sensitivity, root caries, and incipient caries. About 70% responded correctly that topical fluoride could be used on teeth with fluorosis, and 98% responded correctly that it could be used on sensitive

*The t-tests listed in this analysis are all two-tailed t-tests.

teeth, teeth with incipient caries, and root caries. Respondents who had attended recent continuing education classes were more likely to answer correctly ($t = 3.5$, $p \leq 0.001$). Over 98% of respondents answered correctly that topical fluorides could be used on teeth with sensitivity. Of the respondents, 392 (66%) reported that they preferred new information about fluorides from published journals, e.g. Journal of the American Dental Association (JADA) or other professional journals, rather than from continuing education classes (n = 110, 19%), information mailed to their office (n = 77, 13%) or from the CDC website (n = 20, 3%). Only 118 (20%) of the respondents reported attending a preventive dentistry continuing education session within the past year. Bivariate logistic regression models show that it was more common for pediatric dentists to answer correctly than either dental public health or general dentists.

DISCUSSION

Even though research, which shows that posteruptive effect is greater (more beneficial) than preeruptive effect, had been published for 6 years at the time of the survey, only 5% of the respondents knew the predominant effect of fluoride.[5] This reflects that this information has not diffused well and also that adults at moderate or high-risk caries are not getting fluoride treatments. Risk assessment for treatment planning has been recommended by the ADA, and patients classified as low caries risk do not benefit from topical fluoride applications, thus fluoride applications are not recommended.[19] Only 20% of the respondents were in agreement with this recommendation. These results show a lack of diffusion of information, and suggest that practitioners are still not using risk assessment for treatment planning for fluoride treatments.

Also, only recently has fluoride varnish been shown in evidence-based dentistry research to be very effective in remineralization, which might explain why more practitioners do not use it. The CDC guidelines which were published in 2001 have only recently (2006) been summarized in the JADA, which may also explain why so many are using APF foam instead of more concentrated (and very safe) 5% NaF varnish, and why so many are still giving fluoride treatments to low risk patients. On the other hand, despite the evidence of the effectiveness of fluoride varnish, it has been approved as a cavity varnish by the Food and Drug Administration and not as a caries-preventive agent. Consequently, manufacturers may not claim effectiveness in caries reduction—notwithstanding the scientific evidence. When fluoride varnish is used as a caries-preventive agent, it is used off-label.[20]

Interestingly, only 15.7% of general dentists, 30.8% of pediatric dentists and 20.5% of public health dentists most often used fluoride varnish, which is surprising due to the fact that current research and recent studies show that the evidence for the efficacy of varnish preventing and controlling dental caries is grade 1 (Table 2).[5,21] In addition, it is interesting to note that almost 30% of the respondents still use APF foam even though efficacy of foam used for less than 4 minutes has not been tested. The use of APF foam for 1 minute is not endorsed.[22]

Table 2: Grading system used for determining the quality of evidence for a fluoride modality

Grade	*Criteria*
I	Evidence obtained from one or more properly conducted randomized clinical trials
II-1	Evidence obtained from one or more controlled clinical trials without randomization
II-2	Evidence obtained from one or more well-designed cohort or case-control analytic studies, preferably from more than one center or research group
II-3	Evidence obtained from cross-sectional comparisons between times and places; studies with historical controls; or dramatic results in uncontrolled experiments
III	Opinions of respected authorities on the basis of clinical experience, descriptive studies or case reports, or reports of expert committees

Surprisingly, 92% of the respondents reported that the majority of their patients had access to fluoridated water when only 78.1% of the state's public water supply is fluoridated.[23] This finding may be due to the fact that dentists usually practice in urban populated areas and such areas are more likely to be fluoridated.

An important finding is the fact that a majority of the respondents failed to identify the fluoride concentration in commonly used products. To correctly counsel parents on tooth brushing behaviors of children and to correctly determine, if supplements have to be prescribed, the dentist needs to know the correct fluoride concentrations of available products.

It should be noted that practitioners who classified themselves as dental public health dentists often had less knowledge than pediatric dentists or general practitioners. Given the assumption that dentists who have completed dental public health residencies would have a greater exposure to information regarding the preventive modalities of fluoride, it is most likely that the dentists who are classifying themselves as public health dentists are doing so due to job location or practice—funding source rather than formal training. Therefore, any conclusions drawn from analyses of this group's answers to the questionnaire should be interpreted with caution. The odds of responding correctly increased with recent graduation and very rarely with recent attendance to a continuing education class. Most of the respondents preferred to obtain new information from

published journals such as JADA than from continuing education classes. Only 20% of the respondents attended a continuing education class in the past year.

CONCLUSION AND CLINICAL SIGNIFICANCE

One year after the recommendations by the ADA were published, there is still a major lack of current knowledge among practitioners in this sampling frame for the state of Texas. It is expected by the public that dentists be knowledgeable about the products they use, but this study shows that steps have to be taken to address the lack of understanding about the predominant mode of action of fluoride. Since, most of the providers prefer information from leading journals, the journals should take the lead in diffusing the knowledge. Better understanding of fluoride products will enable the dentists to make informed and appropriate judgment on treatment options for adults and children and lead to effective use of fluoride based on the risk assessment of dental caries and the adherence to evidence-based guidelines. Ignorance of or failure to heed evidence-based guidelines may result in an adverse effect on the incidence of dental caries in the population.

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