Professionally Applied Topical Fluoride and Restorative Care in Insured Children

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Abstract

Objectives: This study evaluates the association between use of professionally applied topical fluoride and use of interproximal restorations in primary and permanent teeth of children. Methods: Insurance claims from 15,190 children, for treatment provided by 1,556 different dentists, were analyzed to look for associations between frequency of use of professionally applied topical fluoride and use of interproximal restorations. The average follow-up period for the children included in the analysis was 5.3 years, with the range from 3.0 to 7.9 years. Results: Both tabular and regression results failed to demonstrate an association between frequency of use of professionally applied topical fluoride and use of interproximal restorations in either the primary or permanent dentition. The most powerful predictor of restorative care for these children was the overall propensity of the dentist to place restorations in children. Conclusions: In this group of insured children, we were unable to find an association between the frequency of use of professionally applied topical fluoride and restorative care. Further, despite numerous recommendations that professionally applied topical fluorides should be used only in moderate- and high-caries children, approximately two-thirds of these children received topical fluoride at every recall visit, nearly two times per year. [J Public Health Dent 2000;60(1):33-38]

Key Words: topical fluoride, dental caries, dental insurance.

The importance of fluorides in the reduction of dental caries is well documented (1-4). Fluoridation of community water supplies has been standard practice in the United States for approximately 50 years. Experiments with topical applications of fluorides began even before the early community fluoridation trials (5,6). In addition, fluoride toothpastes were developed, which when used as recommended provide a daily topical effect (7-12). Fluoride also is widely available in the food chain due to preparation of canned goods and beverages using fluoridated water (13,14).

Professionally applied topical fluoride treatments were included as a standard benefit in the dental benefit programs that were negotiated in Michigan in the early 1970s. Topical fluoride usually was covered at 100 percent as a preventive measure. This emphasis on topical fluoride application was based on the information available at the time, which included high levels of caries in children, and because of concern about employees who were residing outside of fluoridated areas. After a relatively short time, coverage for adult fluoride treatments was dropped as a benefit because of lack of evidence to support its effectiveness. Currently, insurance payment for professionally applied topical fluoride usually is limited to children through 18 years of age.

The majority of the population in Michigan with dental benefits now resides in areas with fluoridated water supplies. In fact, 88.5 percent of the people in Michigan who use public water supplies are receiving fluoridated water (15). In addition, the nationwide decline in the incidence and prevalence of dental caries in children is well documented (16-18). The widespread exposure to fluorides from multiple sources, combined with low levels of caries in many children, have led to questions about the cost effectiveness of topical fluorides as a routine for all children (1,19-24).

Despite the fact that much of the evidence is old, published recommendations for the use of topical fluorides in children do exist (1,20). Routine use of professionally applied topical fluoride is not recommended in low-risk children. A recently published metaanalysis of fluoride gel treatment in children reached similar conclusions (23). The authors concluded that the cost effectiveness of "fluoride gel treatment in current low and even moderate caries incidence child populations must be questioned."

Methods

The purpose of the present study is to use dental insurance claims data to look for evidence of the effectiveness of professionally applied topical fluoride in reducing the need for restorations in children. Detailed dental claims data have been made available to us by Delta Dental Plan of Michigan. The data used in this analysis comes from the claims file that contains procedure-level individual claim lines, from 1990 through 1997, for well over 2 million total individuals, provided by more than 6,000 different dentists. The complete claims file contains approximately 100 million individual claim lines, and includes submitted as well as paid claims. The coverage typical in these groups is quite comprehensive, and dental insurance is so pervasive in Michigan that it is routine for dentists to submit claims for literally everything provided to an insured patient, and to let the insurer sort out what is covered and at what level. This behavior generally is true for all types of care, and certainly is true for diag-

Send correspondence and reprint requests to Dr. Eklund, University of Michigan, School of Public Health, Department of Epidemiology, Program in Dental Public Health, Ann Arbor, MI 48109-2029. E-mail: saeklund@umich.edu. Web site: http://www.sph.umich.edu/. Dr. Pittman is a consultant with the Delta Dental Plan of Michigan, St. Joseph. Dr. Heller is also at the University of Michigan, School of Public Health. This study was partially supported by Agency for Health Care Policy and Research grant #R03 HS09554. Manuscript received: 12/28/98; returned to authors for revisions: 2/23/99; accepted for publication: 6/22/99. nostic, preventive, and simple restorative care that is the focus of this paper. These data thus represent dental care provided to approximately 25 percent of the population of the state of Michigan through most of the 1990s.

This paper is based on data from a large insured group that was chosen because it contains a wide range of employee classifications and is spread across most of the state of Michigan, and thus is considered by us to be typical of insured groups in Michigan. In addition, this group has had continuous coverage through the 1980s and 1990s, and has had a highly stable beneficiary population, making it ideal for tracking individual patients through time. The data for this group total approximately 6.2 million claim lines, are derived from approximately 200,000 persons, and cover the period from January 1, 1990, through December 31, 1997. Benefits for children in this group include examinations, prophylaxes, and fluoride treatments all covered at 100 percent and restorations covered at 90 percent. Sealants also were a benefit for the entire period for unrestored permanent first and second molars in children through age 14 years. The analysis reported here is based on a subset of these data, the subset defined by the following conditions.

Patient Age at First Claim from 4 to 14 Years. This condition was chosen to ensure that each child was eligible for topical fluoride at the time of the initial claim, and that the child would continue to be eligible for several more years. Topical fluoride treatments are a benefit in this group through age 18.

At Least Three Years of Claims for Each Patient. This condition ensures that we have claims over a sufficient period of time to assess the consequences of preventive treatments. The method for determining that there were at least three years of claims for each patient is that the date of the first claim for each child was compared to the date of the last claim for each child, and only children for whom this interval was greater than 1,095 days were included in the analysis. Annual visit was not a requirement, although the data show that recall frequency was high, averaging 1.62 examinations per year. The average interval for the children included in the analysis is 5.3 years, with the range from 3.0 to 7.9 years. It is our view that this interval is sufficient to evaluate the effect of topical fluoride treatments on subsequent restorative need.

Treatment by Only One Dentist for Routine Care. This limitation was used to ensure that we could evaluate the treating dentists' tendencies as possible predictors of the treatment each child received. While we intend to look in the future at the issue of treatment patterns associated with changing dentists, the current analysis is limited to children with only a single dentist for routine care (additional treatment by orthodontists and oral surgeons did not exclude a child from the analysis, for example). Approximately two-thirds of all children were treated by only one general or pediatric dentist, and therefore qualified for this analysis. Just under 11 percent of the children were treated by pediatric dentists.

The Treating Dentist Provided Care to at Least 50 Unique Children Aged 4 to 14 Years During 1996 and **1997.** The reason for this requirement is linked to our desire to evaluate the characteristics of the treating dentist as possible predictors of the care a child receives. We used all of the 1996 and 1997 claims data (that is, from the more than 2,000 Delta-insured groups) to calculate for each provider, ratios, limited to their child patients, such as: number of topical fluoride treatments per examination, number of sealants per examination, number of singlesurface restorations per examination, number of multiple-surface restora-

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tions per examination, number of stainless steel crowns per examination, and total restorative services per examination.

To ensure that these ratios were valid indicators of a dentist's tendencies in treating child patients, we have limited the calculation of these ratios to dentists who treated at least 50 unique patients between 4 and 14 years of age in 1996 and 1997. The variables constructed for the characteristics of the providers are derived from data for nearly 400,000 unique patients aged 4 to 14 years. The data used to calculate these provider variables are thus essentially independent of the patient-level data used in the analysis. On average, approximately 250 such children per dentist were in the data to calculate these provider characteristics.

As a result of this set of limiting conditions, the analysis reported here was conducted on treatment provided to 15,190 children by 1,556 different dentists. A summary of some of the treatment provided, on an annual basis, to the 15,190 children included in this analysis is displayed in Table 1. The data in Table 1 show a group of children who are receiving recall visits approximately every seven months (examinations 1.62 times per year), prophylaxis at virtually every recall visit, and topical fluoride at approximately 75 percent of these recall visits. These children also received 0.67 restorative procedures per year, on average, with one-surface and multiple-

TABLE 1

lean l	Number of	Annual	Treatments	per Chilo	l and	Range	for the	15,190
		Child	dren Include	ed in Ana	lysis	-		

Procedures	Mean	Range
Examinations	1.62	0.2–3.33
Prophylaxes	1.69	0.0-3.84
Topical fluoride treatments	1.18	0.0-3.22
Sealants	0.31	0.0-3.92
Restorations		
Proximal—permanent teeth	0.12	0.0-10.06
Proximal—primary teeth	0.14	0.0-6.08
Occlusal—1-surface permanent molars	0.18	0.0-2.97
Complex	0.02	0.0-3.28
Stainless steel crowns	0.01	0.0-1.63
All other	0.20	0.0-5.67
Total restorations	0.67	0.0–11.66

surface restorations accounting for 54 and 46 percent, respectively. These figures characterize a group of children with regular recall patterns and low levels of restorative need. Their level of receipt of restorative care is remarkably close to that reported by von der Fehr and Gropen (25) for a group of children in Norway, which like the United States has experienced a substantial caries decline over the past several decades.

Analytic Approach. The analysis conducted uses the child patient as the unit of analysis. Our attempt is to evaluate the characteristics of the patient—such as the frequency of receipt of professionally applied topical fluoride and the characteristics of the treating dentist—as predictors of the intensity of restorative services that the child actually receives.

The primary outcome variable in this analysis is restorations on mesial and distal surfaces. The rationale for this outcome variable is that fluoride is thought to have the greatest proportional effect on smooth surfaces, and its successful use should be reflected in the need for fewer restorations on proximal surfaces. We looked at restorations for primary and permanent teeth separately.

The results are arranged to first show tables of bivariate relationships, that is, how use of professionally applied fluoride is associated with various levels of use of restorations. These tables are stratified by age of the child, because age is an important factor in the use of restorations, and by presenting the results for each age stratum we control for imbalance by age that might occur between treatment groups. Ordinary least-squares regression analysis is then used to assess the simultaneous roles of various patient and provider characteristics on the use of restorations. The outcome variable used in the regression analysis is interproximal restorations per child per year. Primary and permanent teeth are considered separately.

Results

Tables 2 and 3 show the annual mean number of interproximal restorations, stratified by the age of the child and by average annual frequency of fluoride use. Table 2 shows the results for primary teeth and Table 3 shows the results for permanent teeth. The first data column in Table 2

	· •	*	
Age (Years)	<.4/Year (<i>n</i> =2,583)	.4 to 1/Year (<i>n</i> =3,329)	>1/Year (<i>n</i> =9,278)
4	.28 (331)	.35 (549)	.32 (2,071)
5	.31 (160)	.29 (237)	.28 (812)
6	.20 (124)	.28 (263)	.22 (803)
7	.21 (138)	.22 (238)	.18 (762)
8	.11 (154)	.18 (231)	.12 (802)
9	.04* (176)	.09* (267)	.07 (842)
10	.04 (210)	.03 (271)	.04 (832)
11	.01 (241)	.02 (310)	.01 (736)
12	.00 (302)	.00 (294)	.01 (690)
13	.00 (353)	.00 (323)	.00 (544)
14	.00 (394)	.00 (346)	.00 (384)

*Statistically different at P=.05, Scheffé's test and Tukey's test (numbers of children in parentheses).

TABLE 3 Average Number of Interproximal Surfaces Restored in Permanent Teeth per Patient per Year, by Initial Patient Age and Child's Receipt of Topical Fluoride (Expressed as Fluoride Treatments per Year)

Age (Years)	<.4/Year (<i>n</i> =2,583)	.4 to 1/Year (<i>n</i> =3,329)	>1/Year (<i>n</i> =9,278)
4	.02 (331)	.03 (549)	.02 (2,071)
5	.03 (160)	.04 (237)	.04 (812)
6	.04 (124)	.06 (263)	.04 (803)
7	.07 (138)	.08 (238)	.07 (762)
8	.10 (154)	.09 (231)	.08 (802)
9	.05* (176)	.16* (267)	.11 (842)
10	.12 (210)	.15 (271)	.12 (832)
11	.17 (241)	.24 (310)	.19 (736)
12	.21 (302)	.30† (294)	.20† (690)
13	.26 (353)	.34 (323)	.25 (544)
14	.22 (394)	.24 (346)	.32 (384)

*Statistically different at P=.05, Scheffé's test and Tukey's test (numbers of children in parentheses).

†Statistically different at P=.05, Tukey's test.

shows the average annual use of interproximal restorations in children who received fewer than 0.4 fluoride treatments per year over the time period analyzed. At the other extreme, the far right column shows the average annual use of interproximal restorations for children who received more than one topical fluoride treatment per year. The data in the middle column are for children who received intermediate numbers of fluoride treatments. Tables 2 and 3 show that in both primary and permanent teeth, children who receive topical fluoride most frequently are at least as likely to receive interproximal restorations as those children who receive little or no topical fluoride.

Tables 4 and 5 are similar to Tables 2 and 3, except that the stratifying variable in the columns is the treating dentists' overall tendency to use topical fluoride for their child patients. The results for the left column are from patients who are treated by dentists who never or almost never use topical fluoride for their child patients. Patients are included in this column only if the dentist treating them provided

TABLE 4Average Number of Interproximal Surfaces Restored in Primary Teeth perPatient per Year, by Initial Patient Age and Dentist's Tendency to Use TopicalFluoride (Expressed as Fluoride Treatments per 100 Examinations)

Age (Years)	<.01 (<i>n</i> =3,113)	.0198(n=2,032)	>.98 (n=10,045)
4	.39* (516)	.20 (351)	.30* (2,084)
5	.31 (233)	.24 (163)	.29 (813)
6	.26 (250)	.22 (132)	.23 (808)
7	.23 (232)	.15 (151)	.19 (755)
8	.16 (249)	.10 (175)	.13 (763)
9	.08 (285)	.07 (175)	.07 (825)
10	.03 (271)	.03 (180)	.04 (862)
11	.02 (284)	.02 (198)	.01 (805)
12	.01 (275)	.00 (176)	.00 (835)
13	.00 (258)	.00 (184)	.00 (778)
14	.00 (260)	.00 (147)	.00 (717)

*Statistically different at P=.05, Scheffé's test and Tukey's test (numbers of children in parentheses).

TABLE 5 Average Number of Interproximal Surfaces Restored in Permanent Teeth per Patient per Year, by Initial Patient Age and Dentist's Tendency to Use Topical Fluoride (Expressed as Fluoride Treatments per 100 Examinations)

Age (Years)	<.01 (<i>n</i> =3,113)	.0198(<i>n</i> =2,032)	>.98 (n=10,045)
4	.03 (516)	.02 (351)	.02 (2,084)
5	.04 (233)	.04 (163)	.04 (813)
6	.06 (250)	.04 (132)	.04 (808)
7	.09 (232)	.06 (151)	.07 (755)
8	.11 (249)	.06 (175)	.08 (763)
9	.11 (285)	.09 (175)	.12 (825)
10	.12 (271)	.15* (180)	.12* (862)
11	.23 (284)	.30 (198)	.16 (805)
12	.24 (275)	.28 (176)	.21 (835)
13	.27 (258)	.27 (184)	.28 (778)
14	.22 (260)	.28 (147)	.27 (717)

*Statistically different at P=.05, Scheffé's test and Tukey's test (numbers of children in parentheses).

TABLE 6
Factors Associated with Use of Interproximal Restorations on Primary Teeth
$(R^2=0.13)$

Factor	Coefficient	SE	P-value
Topical fluoride treatments per year (patient)	-0.002	0.005	.6658
Patient age at first claim	-0.034	0.001	.0001
Dentists' tendency to use one-surface restorations on primary teeth	0.898	0.047	.0001
Dentists' tendency to use multiple-surface restorations on primary teeth	0.191	0.036	.0001
Sealants per year (patient)	0.014	0.007	.0403

fewer than one topical fluoride treatment per 100 examinations (in child patients). These are dentists who rarely use fluoride.

At the other extreme, the patients included in the right-most column in Tables 4 and 5 are those receiving care from dentists who almost always use topical fluoride. To be in this column, a child must have been treated by a dentist who provides at least 98 topical fluoride treatments for every 100 examinations (in children). These are intensive users of fluoride.

It is important to note that these two extreme groups of dentists cannot be characterized as selectively using fluoride only on higher-risk patients. They clearly either use fluoride for every recall visit for every child, or they do not use it at all. The middle column of data is from patients who are treated by dentists whose use of topical fluoride is between the two extremes.

Table 6 shows the regression statistics for predictors of interproximal restorations on primary teeth. Patient age at first claim was an important predictor variable for multisurface restorations in primary teeth. The coefficient here indicates that the older the child, the less likely the child is to receive restorations on the interproximal surfaces of primary teeth. This association makes sense, because children in this age range will be exfoliating primary teeth with increasing age. Also statistically significant are the variables for the treating dentists' ratio of singlesurface restorations to examinations, and the treating dentists' ratio of multiple-surface restorations to examinations. Children who are treated by dentists who are more intensive users of restorations are more likely to receive restorations. The variable for sealants per child per year also shows a slight positive association between receipt of dental sealants and interproximal restorations in primary teeth. Finally, the variable for topical fluoride treatments per child per year was not statistically significant. After accounting for the effects of the other included variables, there is no apparent association between frequency of professionally applied topical fluoride and interproximal restorations on primary teeth.

Table 7 shows the regression results for predictors of interproximal restorations on permanent teeth. The predictor variables for interproximal restorations in permanent teeth that were found to be important are patient age at first claim, the treating dentists' ratio of single-surface restorations to examinations, and the treating dentists' ratio of multiple-surface restorations to examinations. With increasing age, children are more likely to receive interproximal restorations on permanent teeth. Also, as with the primary dentition, the most powerful predictors of whether any particular child will receive restorations on the interproximal surfaces of permanent teeth is the tendency of the treating dentist to place restorations on the permanent teeth of children. Predictor variables that were not statistically significant are topical fluoride treatments per child per year, and sealants per child per year

Discussion

A reasonable first reaction to the apparent lack of an association between topical fluoride frequency and interproximal restorations, as seen in Tables 2 and 3, is to suggest that it may be due to selective use of fluoride by dentists. Dentists could be targeting fluoride to children who are most at risk for developing caries. Under such circumstances, children who were most prone to caries also would be those receiving the most intense exposure to topical fluoride, and thus higher use of fluoride would, quite appropriately, be associated with higher use of restorations.

The results in Tables 4 and 5, however, provide little convincing evidence of selective use of professionally applied fluoride. The fact that the patients of dentists who always use fluoride are nearly as likely to receive restorations as those who do not use fluorides at all, argues against a protective action of fluoride when used in a wholesale manner. Dentists who never use fluoride and those who always use fluoride clearly are not making selective choices for individual patients. Further, the fact that the patients of dentists in the "middle use" group do not show consistently lower use of restorations argues against the ability of these dentists to successfully select patients for treatment who can profit most from it.

A second potential explanation of the apparent absence of a protective effect of professionally applied topical fluoride is the possibility that the dentists who are high users of fluorides are in nonfluoridated communities, and that their patients do, as a result, have more disease, and that the dentists are appropriately using fluoride more intensively in this potentially higher-disease population. This possibility is not the case. The overwhelming majority of dentists in both the high- and low-use groups are practicing in communities that have been fluoridated for decades.

The regression results in Table 6 show that the coefficient for the association between annual frequency of topical fluoride use and interproximal restorations in primary teeth is exceedingly small (-0.002), suggesting that even if this association could be shown to be real with a larger sample of children, it would be of virtually no clinical importance. As with the primary teeth (Table 6), the coefficient of the association between topical fluoride frequency and interproximal restorations in permanent teeth (Table 7) is so small (-0.003) that, even if it were

TABLE 7
Factors Associated with Use of Interproximal Restorations on Permanent Teeth
$(R^2=0.06)$

Factor	Coefficient	SE	P-value
Topical fluoride treatments per year (patient)	-0.003	0.005	.5098
Patient age at first claim	0.025	0.001	.0001
Dentist's tendency to use one-surface restorations on primary teeth	0.106	0.022	.0001
Dentist's tendency to use multiple-surface restorations on primary teeth	0.597	0.052	.0001
Sealants per year (patient)	-0.007	0.007	.3227

shown to be statistically significant, it too would be of little clinical importance. Therefore, the major finding of these analyses is that, when controlling for the effect of other patient- and provider-related variables, no protective effect of professionally applied fluoride can be detected. The results of the regression analyses substantiate the results that were seen in the less complex analyses presented in Tables 2 through 5.

An additional important result is that the most important predictor of restorations that a child received is the overall tendency of the treating dentist to do restorations in children. That the provider tendencies are important predictors is consistent with much accumulated evidence. Provider variation has long been shown to be common in both medicine and dentistry (26-28). An additional important finding that is evident in Tables 4 and 5 is that approximately two-thirds of these children are being treated by dentists who provide topical fluoride treatment to virtually every child at every recall visit. These results appear to apply equally to general practitioners and pediatric dentists. Neither including a variable for specialty nor running the regressions separately for general practitioners and pediatric dentists altered the results in any material way, and in no instance did the coefficient for professionally applied topical fluoride move closer to statistical significance (results not tabulated).

Do these results imply that professionally applied topical fluorides are not effective in preventing caries? Not necessarily-several limitations must be remembered. First, the children covered by these dental benefit policies are middle or upper socioeconomic status, and they have very low levels of disease. On average, these children are receiving only about 0.18 one-surface occlusal restorations and 0.12 interproximal surface restorations per year in their permanent teeth. The potential for additional savings through prevention is therefore limited. Also, nearly all of them are living in fluoridated communities, all are dependents of employed parents who are in a job that carries substantial fringe benefits, and-related to their socioeconomic status level-they are likely to be regular users of fluoridecontaining toothpaste. Further, because they live in a state where about 85 percent of community water supplies are fluoridated, even the processed foods they eat are likely to contain biologically relevant quantities of fluoride. Against this background-low disease levels, substantial fluoride exposure, and middle to upper socioeconomic status-it may be reasonable that professionally applied fluoride once or twice a year cannot be expected to show a measurable effect. This is not to say, however, that professionally applied fluoride is not effective under different circumstances. Nevertheless, on average, the benefit of professionally applied fluoride is not evident in these insured children.

We also emphasize that this study is not a clinical trial, where patients are randomly assigned to the various treatments. In fact, it is an observational study in which decisions to provide topical fluoride were not made randomly. In this situation there is always the possibility of misleading patterns because it is possible that topical fluoride could be reserved for the caries-active patients. Were this the case, there could be an apparent association between higher disease measures (restorations) and the use of professionally applied fluoride. However, the fact that the majority of dentists among those studied do not make decisions to use topical fluoride on an individual patient basis (that is, some never use it, some use it at every other recall, and most use it at every recall) gives us considerable confidence that we are not being mislead by this sort of association. Even though published recommendations for caries diagnosis and risk assessment do not recommend routine use of professionally applied fluoride in low-risk children (1, 20-22), the majority of these children are receiving topical fluoride at every recall visit.

Although there is evidence of the efficacy of professionally applied topical fluorides from clinical trials done many decades ago, it is important to evaluate the effectiveness of these products in modern clinical use. This analysis of insurance claims data failed to demonstrate an association between frequency of professionally applied topical fluorides and use of interproximal primary or permanent restorations in a group of privately insured children.

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