Patient-Level and Practice-Level Characteristics Associated with Receipt of Preventive Dental Services: 48-Month Incidence

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Abstract

Objectives: *This study aims to: a) quantify the incidence of preventive dental services [in-office fluoride application and dental cleaning (prophylaxis)]; b) determine if these services are effectively targeted to patients with the highest need; and c) quantify the role of practice characteristics and patient-level factors in service receipt.* ***Methods:*** *A population-based prospective cohort study was conducted with 873 adults who had at least one tooth at baseline, 743 of whom provided 48-month data. In-person interviews and clinical examinations were conducted biennially for 48 months, with 6-monthly telephone interviews in between. Dental records were abstracted afterward, and practices that served participants completed questionnaires. Analysis was limited to persons with at least one dental visit of any type during follow-up (87 percent of the sample).* ***Results:*** *Only 9 percent of the persons received at least one fluoride application; 75 percent received a dental cleaning. Persons with high need were actually less likely to have received preventive services. In multivariable regression analyses, characteristics of the practice in which the subject received care were very strongly related to fluoride receipt, independent of patient-specific characteristics.* ***Conclusions:*** *One preventive procedure was common; the other was uncommon. However, practices did not effectively target high-risk patients for either procedure. Instead, both services were typically received by persons with the least need for them. These findings are consistent with the conclusion that practitioners greatly influenced the delivery of fluoride services, with substantial contributions also made by patient-level predisposing and enabling factors for both preventive services.*

Key Words: preventive services, practice characteristics, practice pattern, adults, longitudinal, utilization

Introduction

Research has documented substantial variation and suboptimal quality in preventive health services (1,2). Early research proposed that this variation was caused by the providers' preferences for and beliefs about the effectiveness of particular procedures – or practice style – especially manifest where professional uncertainty exists (3). Others have concluded that this variation results from the providers operating in the patients' best interests, or in the providers' own economic self-interest, or in response to a range of constraints or incentives (4,5). Characteristics of the practice attended, such as its emphasis on prevention, have also been identified as significant and potentially useful focal points for interventions to improve preventive service delivery (1,2).

The dental care sector provides valuable opportunities for the study of preventive service delivery. Although major improvements in preventive dentistry have occurred in recent decades (6), the limited amount of research on practice variation in dental care has revealed substantial variation as well (7,8). Typically, practice variation studies – dental and medical – have either not been able to account for patient characteristics or have only been able to do so at the practice level. This distinction is important because patient-level data are usually necessary to avoid making incorrect conclusions about practice variation. One major advantage of the study herein, the Florida Dental Care Study (FDCS), is that it collected both patient-level and practice-level data. The FDCS was a prospective cohort study of oral health and dental care that used a diverse community-based sample without regard to past dental care use.

It is known that a particular dental preventive service – topical fluoride gel – is effective in at least one high-risk adult group, namely, persons receiving head and neck radiation therapy (9). Professional consensus prescribes that caries-active adults should receive topical fluoride application as part of a comprehensive-preventive program (10,11). For this

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reason, persons who had active dental caries at baseline are classified as "high-risk" in this analysis. Furthermore, we know that adults at increased risk for caries can be identified and that dentists can successfully classify patients according to caries risk (12). However, the literature provides no evidence that patients at increased risk actually receive needed preventive treatment once they enter the dental care system (13).

A second type of dental service of interest in this current study – dental prophylaxis (dental cleaning) – may have benefit for caries prevention (14). Nonetheless, current evidence is not sufficient to make conclusions about its beneficial or adverse effects, nor is it sufficient to make conclusions about the preferred frequency of prophylaxis (15), calling into question the utility of routinely providing large numbers of this service in the dental care system to prevent caries, although this service may also be provided for the prevention and treatment of periodontal diseases.

Objective and Hypotheses Tested. To our knowledge, this is the first longitudinal study of the receipt of specific types of preventive dental services not based on self-reported data. Our objective was to: a) quantify the incidence of preventive procedures; b) determine if these services are effectively targeted to patients with the highest need; and c) quantify the role of practice characteristics and patient-level factors in service receipt. Therefore, we tested the following hypotheses:

Hypothesis 1: Dental practice characteristics are significantly associated with receipt of preventive dental services, with patient-level characteristics already taken into account.

Hypothesis 2: Patient-level characteristics are significantly associated with service receipt, with practice characteristics already taken into account.

Methods

Sampling Methods. Details of the sampling methodology are provided in an earlier publication (16). Briefly, however, the 873 baseline subjects were representative of the population, defined as persons 45 years old or older, who had a telephone, did not reside in an institutional setting, resided in one of the four counties in north Florida (the three nonmetropolitan counties of Hamilton, Jefferson, and Madison, referred to herein as "rural" counties; the metropolitan, "urban" county of Duval, which contains the city of Jacksonville), could engage in a coherent telephone conversation, and had at least one tooth (one study objective was to investigate tooth loss). This sample had an "interval since last dental visit" at baseline that was very similar to National Health Interview Survey (NHIS) data, and conclusions regarding the sociodemographic determinants of dental care interval were the same (16). Additionally, the percentage of those who had at least one dental visit in the first 2 years of the FDCS, 77 percent, was very similar to the figure, 75 percent, among the comparable NHIS group (16,17).

Although the study began with 873 subjects, by 48 months, 82 percent ($n = 714$) remained. The issue of bias resulting from attrition has been previously examined, and the impact was modest (18,19). As an example of its typical magnitude, 47 percent of the baseline subjects had been to a dentist in the previous 6 months. If the baseline had only included persons who ultimately participated for the 48-month clinical examination, that figure would have been 49 percent.

Data Collection Stages. An in-person interview was conducted at baseline, immediately followed by a clinical dental examination. These were followed by telephone interviews at 6, 12, 18, 30, 36, and 42 months. At 24 and 48 months, the interview was done in-person instead of by telephone, and was again followed by a clinical examination.

A Model of Health Services Utilization. To conceptualize the patient-level factors, we used the behavioral model of Andersen (20). In this model, health care utilization is the result of the characteristics of the population and the health care delivery system (such as dental practice characteristics). Patient-level characteristics can be summarized as predisposing, enabling, and need characteristics. *Predisposing* characteristics are those that exist prior to disease (Table 1). *Enabling* characteristics are resources that affect one's ability to access the health care system, such as household income or health insurance (Table 1). *Need* variables reflect illness that requires service use; examples are the oral health measures listed in Table 1.

Participant and Dental Practice Questionnaires. Participants were asked about past dental care utilization behavior and other items listed in Table 1. Full questionnaire content and test–retest reliability have been described previously (see the FDCS Web site for details). Actual wording of all questionnaires can also be found at the FDCS Web site. Certain questions warrant more description for this report.

Participants were asked to describe their "approach to care" as: a) "I never go to a dentist"; b) "I go to a dentist when I have a problem or when I know that I need to get something fixed"; c) "I go to a dentist occasionally, whether or not I have a problem"; or d) "I go to a dentist regularly." Persons who responded letters a or b were classified as "problem-oriented attenders." Those who responded letters c or d were classified as "regular or occasional attenders." Although incident dental care was quantified, previous FDCS findings have shown that "approach to care" is a key predisposing factor because it crosses race and socioeconomic status lines (18,19,21). Aggregating the four categories into these two categories is justified based on substantial previous FDCS work that demonstrates that these groupings are strongly predictive of incident dental care utilization and disease incidence.

Table 1
Patient-Level Predisposing, Enabling, and Need Variables Tested for Their Association with Receipt of Incident Preventive Services

Patient's predisposing variables	Patient's enabling variables	Patient's need variables
Sociodemographic	Annual household income*	Baseline clinical status‡
Approach to dental care*	Poverty status†	Worst attachment loss in mouth
Race*	Ability to pay an unexpected $500 dental bill*	Had active dental caries
Sex*	Dental insurance coverage*	Number of teeth present
Age group*		
Area of residence*		Self-reported oral health*
Level of formal education*		Toothache
Self-reported health†		Tooth that is sensitive to hot/cold/sweets
		Abscessed tooth
Attitudinal*		Infected or sore gums
Frustration with past care		Bleeding gums
Quality of recent dental visit		Loose tooth
Importance of dental visits to prevent dental problems		Teeth stained or look bad
Eventuality of decline		Problem with bad breath
Influence of dental care costs on past dental treatment		Avoided laughing/smiling because of unattractive teeth or gums
Cynicism toward dentists and dental care		Avoided talking because of unattractive teeth/gums/bad breath
Effectiveness of dental care		Been embarrassed by the appearance/bad health of your teeth/gums
		Perceived need for dental care
Behavioral*		No, in good shape now
Smokes cigarettes		Yes, for a routine checkup
Uses smokeless tobacco		Yes, for a dental problem
Brushing frequency		No, has a problem, but can wait
Flossing frequency		
Uses toothpick to clean teeth		

* Measured at baseline by interview.
† Measured during the telephone screening interview before baseline.
‡ Measured at baseline by direct clinical examination.

Five enabling variables were queried: household income, poverty status, ability to pay an unexpected $500 dental bill, and dental insurance coverage (Table 1). Household income was ultimately the variable used in regression modeling because its standardized parameter estimate was the largest among the enabling variables.

Dentists who coincidentally served at least one participant were asked to complete a questionnaire about their practices. Practice characteristics were conceptualized as having to do with practice setting, patient population, dental procedures, and dentist characteristics (Table 2).

Clinical Examination. An examination recorded the location of remaining teeth, root fragments, tooth surfaces with dental restorations and active dental decay, fractures of teeth and restorations, severe root defects, and severely loose teeth. Full diagnostic criteria and interexaminer reliability have been detailed elsewhere (22,23).

Dental Chart Data Collection. Participants provided written permission to review their dental records from dental practice(s) attended since baseline and let that permission remain until study completion (24). Of the 297 dentists in 286 practices named by FDCS subjects, all but 10 practices participated; these 10 had provided treatment to 17 subjects (24). Dental hygienist research assistants abstracted from each chart the dates of visit, teeth/areas treated, and American Dental Association (ADA) procedure codes. The ADA "current dental terminology CDT-2" codes that went into effect in 1995 were used (25).

Dental practices were classified consistent with the Florida Statute 381.0406 (2) (a) as "rural," wherein population density was less than 1,000 persons per square mile. A total of 9 percent of practices were classified as rural, and 91 percent as urban. However, because the FDCS sample was stratified by area of residence such that 50 percent of the sample at baseline comprised urban residents, 57 percent of the FDCS subjects in the current analysis attended only an urban practice(s), and 41 percent attended only a rural practice(s). A total of 99 percent of urban subjects attended only an

Table 2
Practice Characteristics Tested for Their Association with the Patient's Receipt of Incident Preventive Services

Practice setting	Patient population	Dental procedure characteristics	Dentist's individual characteristics
Number of different general practices attended during follow-up*	Dental insurance coverage	Percent of extracted teeth that are replaced by specified treatment options (five total)¶	Year of graduation from dental school
Number of different specialty practices attended during follow-up*	Practice charges by payment source	Number patients each month receiving or referred for dental extractions	Agreement with beliefs about treatment options (five total)•
Practice busyness†	Percent of patients on extended payment schedules	Percent time each day doing specified procedure categories (seven total)§	
Waiting time for new patient exam	Percent of patients who have certain characteristics (12 total)‡		
Waiting time for restorative dentistry appointment	Age distribution		
Waiting time after arriving at the waiting room	Racial/ethnic distribution		
Percent of visits because of unscheduled care			
Number of patient visits each week			
Hours in patient care each week			
Number of dental chairs regularly used			
Number of full-time staff			
Number of part-time staff			

* Although this variable can also be conceptualized as a patient-specific characteristic, we have operationalized it herein as a measure of practice setting because it also reflects exposure to different sets of practice characteristics.

† 1 = too busy to treat all people requesting appointments; 2 = provided care to all who requested appointments, but the practice was overburdened; 3 = provided care to all who requested appointments, and the practice was *not* overburdened; 4 = not busy enough – the practice could have treated more patients.

‡ Percent of patients you see who: seek care soon enough; fear dentists; complain about waiting; pay their bills; follow advice about oral hygiene; show for appointments as scheduled; take responsibility for their oral health; treat me with the respect that I deserve; want to know details about the condition of their mouth; want to know details about their treatment options; use credit cards to pay for their dental treatment in my practice.

¶ For extractions that you do or recommend, other than wisdom teeth, deciduous teeth, or for orthodontic reasons, what percent are replaced eventually by a: fixed bridge; removable partial or full denture; dental implant; not replaced; other.

§ Percent of patient contact time that you spend in a typical month performing the following procedures: nonimplant restorative dentistry (fillings, etc.); implants (either implant surgery or time spent with implant placement); removable prosthetics (dentures); dental extractions; periodontal therapy (either time spent doing surgery or nonsurgical procedures); endodontic therapy (root canals, etc.); other (preventive and diagnostic).

• Patients should seek second opinions; patients are better off not knowing all the facts about their oral problems; dentists should present all treatment options to patients; if a patient opposes the dentist's recommended treatment, the dentist should try to convince the patient to accept it; if a patient does not accept the dentist's recommended treatment, the patient should be dismissed from the practice (1 = very strongly disagree; 2 = strongly disagree; 3 = somewhat disagree; 4 = somewhat agree; 5 = strongly agree; 6 = very strongly agree).

urban practice(s) during follow-up; 76 percent of rural residents attended only a rural practice(s).

Definition of Coding Terms. Services coded as ADA codes 1000-1999 were "preventive services." These included a 1110 code ("prophylaxis"), a 1204 code ("topical application of fluoride; prophylaxis not included – adult"), a 1205 code ("topical application of fluoride including prophylaxis – adult"), a 1330 code ("oral hygiene instruction"), and a 1351 code ("sealant – per tooth"). A procedure was termed a "prophylaxis" if it was either a 1110 or 1205 code.

A total of 677 subjects ultimately reported having at least one dental visit during the first 48 months of follow-up. Of those 677, we located dental records on 619 persons, of whom 618 had a documented dental visit during their 48 months of follow-up. We also found dental records on 10 of the 111 persons who had said that they had no dental visits or for whom there were missing dental visit data, of whom four actually had a documented dental visit during their 48 months of follow-up. Therefore, we had dental chart data on 622 persons who had

Table 3
Results from a Single Bivariate Multivariable Logistic Regression of Receipt of a Fluoride Procedure or Prophylaxis during Follow-Up

Explanatory variable	Fluoride	Prophylaxis
Practice-level characteristics to which FDCS participant was exposed		
Typical percentage of patients in the practice who receive in-office fluoride application		
Practice is in second quartile	1.8 (0.3, 9.3)	–
Practice is in third quartile	9.0 (2.2, 37.9)	–
Practice is in fourth quartile	22.3 (5.8, 86.1)	–
Practice is in an urban location	6.1 (2.6, 14.3)	–
Patient-level predisposing characteristics		
Approach to dental care	4.0 (1.6, 9.7)	4.5 (2.5, 8.2)
Race	–	4.0 (2.1, 7.6)
Influence of dental care costs on past dental treatment	–	1.4 (1.1, 1.8)
Flossing behavior	–	2.3 (1.3, 4.1)
Patient-level enabling characteristics		
Household income	–	2.2 (1.2, 4.0)
Patient-level need characteristics		
Sensitive teeth	2.7 (1.3, 5.4)	–
Number of remaining teeth (17-24)	–	6.9 (3.2, 15.1)
Number of remaining teeth (25 or more)	–	3.8 (1.9, 7.9)

Parameter estimates were converted to odds ratios along with their 95% confidence intervals. $n = 500$.
Coding of outcomes of interest:
Fluoride:1 = had one or more fluoride procedures during follow-up; 0 = did not.
Prophylaxis:1 = had one or more prophylaxis procedures during follow-up; 0 = did not.
Coding of explanatory covariates:
Practice-level characteristics:
Typical percentage of patients in the practice who receive in-office fluoride application: dentist's report from 0 to 100%. Responses were recoded into quartile rankings based on the combined responses from all practices, and the quartile(s) to which the individual FDCS participant was exposed was the explanatory variable of interest. The reference group is the first quartile.
Practice is in an urban location: 0 = not in an area with a population density of more than 100 individuals per square mile (rural); 1 = in an area with a population density of more than 100 individuals per square mile (urban).
Patient-level characteristics:
Approach: 0 = problem-oriented dental attender as reported at baseline; 1 = regular or occasional attender.
Race: 0 = non-Hispanic African-American; 1 = non-Hispanic White.
Influence of dental care costs on past dental treatment: 1 = strongly agree; 2 = somewhat agree; 3 = somewhat disagree; 4 = strongly disagree.
Flossing behavior: 0 = does not floss as reported at baseline; 1 = flosses at least some.
Household income: household income as reported at baseline: 0 = below $20,000; 1 = at or above $20,000.
Sensitive teeth: 0 = did not report at baseline having teeth that are sensitive; 1 = did report sensitive teeth.
Number of remaining teeth (17-24): 1 = had 17-24 teeth upon clinical examination at baseline; 1 = did not. The reference group is 1-16 teeth.
Number of remaining teeth (25 or more): 1 = had 25 or more teeth upon clinical examination at baseline; 1 = did not. The reference group is 1-16 teeth.
FDCS, Florida Dental Care Study.

at least one documented dental visit during 48 months of follow-up. Of these 622, 597 also participated for the 48-month interview, and 500 had data on all variables used in the multivariable regression analysis done in Table 3. A table of the baseline characteristics of these persons is available at http://nersp.nerdc.ufl.edu/~gilbert/supplemental.html.

Statistical Methods. Results were weighted using sampling proportions to reflect the population in the counties studied using a method that minimized the variance inflation resulting from sample design effects (16). All analyses were done using SAS (26). Comments about statistical significance refer to probabilities of less than 0.05.

Multivariable logistic regression models used a SAS macro (27), wherein the two dichotomized dental service variables (received topical fluoride, received a prophylaxis) were the outcomes of interest. This single bivariate (two outcomes) multivariable (multiple covariates) regression correlated error terms across the two outcomes. This approach avoids the misestimation of parameter estimates and standard deviations and allows comparisons across outcomes for the effects of individual predictors. This is in contrast to doing a separate univariate multivariable logistic regression for each outcome, the error terms of which would not be correlated across equations, and which would preclude a direct comparison of parameter estimate magnitudes.

Variable selection was driven by the theory in the Andersen behavioral model of health services utilization discussed earlier, but we adopted a stepwise modeling technique for the sake of parsimony and to avoid problems with multicollinearity. This is because we had a large number of hypothesized predictive variables for each dimension in Tables 1 and 2. For this stepwise technique, we adopted a less-stringent criterion for statistical significance, $P < 0.10$, and retained any variable at every step except the last that met this criterion for at least one of the service outcomes. The final regression in Table 3 used a $P < 0.05$ criterion.

Partial clustering occurred in these data because the same dental practice or combination of practices was attended by multiple patients. This occurred for only 22 percent of practice combinations, so practices and patients, to a large extent, defined the same stratification. Diagnostic analyses showed a very low intraclass correlation coefficient (<0.05), so this effect was excluded from the final modeling.

Results

Distribution of Service Types. Among all 11,417 dental procedures of all types recorded for the 48-month period, preventive services

Table 4
Percent of Persons Who Received Preventive Services during 48 Months of Follow-Up

Type of preventive service and ADA code	Percent of persons who received this service at least once during 48 months of follow-up	
	One service type only	Combination of more than one service type
Prophylaxis with topical fluoride (ADA 1205)	3	
Topical fluoride only (ADA 1204)	6	
Oral hygiene instruction (ADA 1330)	18	
Prophylaxis (ADA 1110)	75	
Any topical fluoride (ADA 1204 or 1205)		9
Any prophylaxis (ADA 1110 or 1205)		76
Any preventive service (ADA 1000-1999)		77

Analysis in this table is limited to persons who had at least one dental visit during 48 months of follow-up, whose dental chart(s) could be located, and who participated in the 48-month interview.
Less than 1% of persons received these preventive services: 1310, 1320, 1351, 1510, 1515, 1520, 1525, and 1550.
ADA, American Dental Association.

comprised 18 percent of all procedures. When limited to preventive services, prophylaxis (ADA 1110) comprised 84 percent of procedures, oral hygiene instruction (ADA 1330) 9 percent of procedures, 6 percent of procedures were fluoride only (ADA 1204), and prophylaxis with fluoride (ADA 1205) comprised 3 percent. Other preventive procedures comprised less than 1 percent each. Table 4 shows the results from an analysis of what percent of persons received services of specific types. Preventive services were common (77 percent of the sample). More than three-fourths of the sample had at least one dental prophylaxis. Only 9 percent of the sample received at least one topical fluoride service.

Characteristics of Practices That Provided Preventive Services. A total of 209 of the 279 dentists with complete data provided these preventive services. Of these 209 dentists, 90 percent were generalists, 4 percent were periodontists, and 1 percent were prosthodontists. More than 96 percent of the preventive procedures were done in generalists' offices.

All topical fluoride procedures were provided in generalists' offices. These fluoride services were clustered in a minority of "fluoride practices," defined for this paper as the 23 percent of generalist practices that provided one or more topical fluoride services to at least one participant. These "fluoride practices" significantly differed from practices that did not provide at least one fluoride service to at least one participant (tabular results at http://nersp.nerdc.ufl.edu/~gilbert/supplemental.html). For example, fluoride practices reported that a higher percentage of their patients received in-office fluoride application, that they recommend fluoride gel or rinse for home use, and do blood pressure screening on a higher percentage of patients, as compared with nonfluoride practices.

Unlike fluoride services, provision of prophylaxis services was very common and not clustered: 89 percent of practices provided one or more prophylaxis services to at least one participant. Practices that did not provide at least one prophylaxis service to at least one participant had a higher percentage of patients on public dental programs, reported fewer patients who seek care soon enough, more patients who fear dentists, more patients who complain about waiting, and fewer patients who show for appointments as scheduled and "treat me with the respect that I deserve" (tabular results are available at http://nersp.nerdc.ufl.edu/~gilbert/supplemental.html).

Receipt of Services, by Participant Characteristics. Receipt of at least one topical fluoride procedure or one prophylaxis varied by certain participant characteristics (tabular results at http://nersp.nerdc.ufl.edu/~gilbert/supplemental.html).

Following the order in which the predisposing, enabling, and need characteristics are shown in Table 1, persons with certain sociodemographic characteristics were significantly more likely to have received at least one topical fluoride service, namely, regular or occasional dental attenders (compared with problem-oriented attenders), non-Hispanic Whites (compared with non-Hispanic African-Americans), urban residents (compared with rural), high school graduates (compared with nongraduates), and persons who rated their general health as high. With the exception of rural/urban area of residence, these same characteristics were significantly associated with receipt of a prophylaxis.

Regarding the attitudinal predisposing characteristics, persons who reported more positive attitudes were significantly more likely to have received fluoride or prophylaxis services. Persons who rated more positively on "influence of dental care costs" were significantly more likely to have received a prophylaxis service, but not a fluoride service.

Persons who did not smoke cigarettes, did not use smokeless tobacco, brushed *more often*, and flossed *more often* were more likely to have received a prophylaxis service. Flossing frequency was the only behavioral predisposing characteristic that was significantly associated with receipt of a fluoride service, with frequent flossers being *more* likely to receive a fluoride service.

Each of the five measures of enabling characteristics was significantly associated with prophylaxis procedures – more financially secure

persons were more likely to have received a prophylaxis. Three measures were also significantly associated with fluoride procedures – those with the greatest financial need were less likely to have received a fluoride procedure.

Each measure of need determined by a direct clinical examination was significantly associated with prophylaxis procedures – those with the most need were *least* likely to have received a prophylaxis procedure. Additionally, persons with active dental decay at baseline were *less* likely to have received a fluoride procedure.

All 15 need variables determined by self-report were significantly associated with receipt and/or number of prophylaxis procedures. However, the direction of effect was such that those with the greatest need were *less* likely to have received a prophylaxis procedure, except in instances where perceived need indicated good health instead of need because of a problem. Regarding fluoride procedures, for the two variables that were statistically significant (reporting a specific problem, but that it could wait; and avoided laughing or smiling because of dental appearance), persons with the greatest need were also less likely to have received a fluoride procedure.

Bivariate Multiple Logistic Regression Results. Hypotheses 1 and 2 were tested using a single bivariate logistic regression, in which the outcomes of interest were whether or not the participant received at least one fluoride procedure or prophylaxis procedure (Table 3). Parameter estimates were converted to odds ratios (OR) as a measure of the variable's independent association with the outcomes.

Persons who attended a dental practice(s) that reported providing topical fluoride to a large percentage of patients were much more likely to have received such a service (OR = 22.3 if the practice was in the fourth quartile, OR = 9.0 if in the third quartile). Persons who attended an urban practice(s) also were much more likely to have received a topical fluoride service (OR = 6.1). These practice-level characteristics were not significantly associated with prophylaxis receipt, and, consequently, were not included in the final regression.

Persons who reported at baseline being regular or occasional dental attenders were much more likely to have received a fluoride procedure during follow-up (OR = 4.0), as well as a prophylaxis procedure (OR = 4.5). Non-Hispanic Whites, persons who stated at baseline that dental care costs have not affected their past dental treatment, and persons who reported that they floss their teeth were more likely to have received a prophylaxis procedure during follow-up, compared with their counterparts.

Higher-income persons were substantially more likely to have received a prophylaxis (OR = 2.2). No enabling characteristic was independently associated with fluoride receipt.

One need variable – reporting sensitive teeth at baseline – was a significant independent predictor of fluoride procedures. Persons with more remaining teeth at baseline were more likely to have received a prophylaxis.

Discussion

The percentage of total services that comprised preventive services in this study (18 percent) was similar to the few studies that have reported these figures. Analyses from the Medical Expenditure Panel Survey (MEPS) suggested that about 30 percent of all dental procedures are preventive procedures (28). Although the MEPS was a nationally representative sample, a limitation is that it relied on respondents' self-reports. Additionally, multiple procedures of the same type during a single reported dental visit were recorded as a single procedure type in the MEPS. A study of Canadians observed that for participants with at least one tooth, preventive services comprised 23 percent of services (29).

The literature provides no evidence that patients at increased risk for dental decay actually receive needed preventive treatment once they do enter the dental care system (13). Unfortunately, our findings suggest that few patients receive topical fluoride treatment regardless of risk for decay, and that if they are at high risk, they are actually *less* likely to receive topical fluoride treatment. Additionally, although a dental decay prevention benefit from prophylaxis has been suggested (14), but not scientifically demonstrated (15), persons at increased risk for dental decay were again *less* likely to have received this procedure – even though this procedure was very common.

Results from Table 3 suggest that whether persons get fluoride services is very strongly influenced by which dental practice they happen to attend. If the practice is preventively oriented, as measured by its tendency to provide and/or recommend preventive services, then a given patient is much more likely to receive such a service, even with patient-specific characteristics taken into account. It is possible that characteristics of the patient population served by a given dental practice (a practice-level characteristic) could also influence this service provision. However, these factors were accounted for in the regression modeling, and were not found to be significant. These findings are consistent with the notion that fluoride services are strongly driven by dentists' preventive tendencies. If this provider behavior could be changed successfully, such an intervention could substantially improve preventive service delivery.

It is possible that dentists are not applying risk assessment principles to their caries treatment (7). However, we do know that practitioners are indeed able to assign patients to risk categories (13). The authors of a survey of Texan dentists speculated that the reason that a higher percentage of dentists did not report using topical fluoride is because they may use topical fluoride on all child patients, but not use it on adults (30). However, the Texas

questionnaire did not query age-specific usage. Therefore, the role that the dentist plays in this pattern of utilization is worthy of further investigation, as well as how differences in insurance reimbursement might differ based on the patient's age. In our study, practices with higher percentages of middle-aged and older adults were indeed significantly more likely to have provided a topical fluoride service to persons in this sample (all of whom were middle-aged or older).

The OR for patient-level factors in Table 3 are consistent with the conclusion that even with practice-level factors taken into account, and even when the analysis was limited to persons who had actually entered the dental care system, receipt of these services is also heavily patient-driven. For the sake of elucidating the mechanisms by which a population receives appropriate in-office topical fluoride, we can conceptualize a three-stage process. The first stage requires a decision by the potential patient to enter the dental care system for any reason. The fact that 13 percent of the sample did not receive dental care of any type during follow-up suggests that their lack of receipt of fluoride services was entirely or mainly patient-driven. A second stage involves patients who have entered the dental care system, but who only demand nonpreventive treatment. Patients who arrive at the dental practice requesting only treatment of symptoms and/or active disease, instead of preventive services, are presumably much less likely to end up receiving preventive services. This is consistent with the magnitude of the OR for the "approach to care" variable in Table 3. A third stage involves influence from the practitioner (dentist or dental hygienist), who may or may not emphasize preventive services. The fact that clustering of fluoride services among specific practices was evident is consistent with a strong practice-level effect at this last stage.

We remind the reader that generalizations are with regard to the defined population of interest, and studies from other adult populations are advisable. Because a substantial amount of practice variation can be a result of the differences in the patient population served – sometimes leading to incorrect conclusions about the source of that variation – it is important that these analyses accounted for patient-specific clinical and sociodemographic characteristics. Although we judge that our measurement of patient- and practice-level characteristics was comprehensive, it is possible that unmeasured variables affected preventive service receipt as well, and thereby affected our conclusions.

This study suggests that: a) in-office fluoride receipt was uncommon and prophylaxis was very common; b) neither fluoride nor prophylaxis was received more commonly among those at high risk for dental caries; in fact, the opposite was true; and c) both patient-level and practice-level factors were key predictors of preventive service receipt for fluoride services, but not prophylaxis services. These results demonstrate that dental preventive care is well short of the ideal. Like physicians, dentists can influence the uptake of services. Providers can act in response to a combination of patients' interests, economic self-interests, and their own treatment preferences. The larger contribution of these results lies in their demonstration of a large variation in preventive services and the contribution that specific provider and patient factors make to preventive service receipt. These factors offer several points upon which to intervene to improve preventive dental services and population health.

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