Original Contributions

Association between first oral examination characteristics and dental treatment needs in privately insured children

A claims data analysis

Supplemental material is available online.

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ABSTRACT

Background. Early childhood caries (ECC) remains the most common, preventable infectious disease among children in the United States. Screening is recommended after the eruption of the first tooth, but it is unclear how the age at first dental examination is associated with eventual restorative treatment needs. The authors of this study sought to determine how provider type and age at first dental examination are associated longitudinally with caries experience among children in the United States.

Methods. Deidentified claims data were included for 706,636 privately insured children aged 0 through 6 years as part of the nationwide IBM Watson Health Market Scan (2012-2017). The authors used Kaplan-Meier survival analysis to describe the association between the age of first visit and restorative treatment needs.

Results. A total of 21% of this population required restorative treatment, and the average age at first dental examination was 3.6 years. A multivariable Cox proportional hazards model showed increased hazard for restorative treatment with age at first dental visit at 3 years (hazard ratio, 2.05; 95% CI, 1.97 to 2.13) and 4 years (hazard ratio, 3.99; 95% CI, 3.84 to 4.16).

Conclusion. The high proportion of children requiring restorative treatment and late age at first dental screening show needed investments in educating general dentists, medical students, and pediatricians about oral health guidelines for pediatric patients.

Practical Implications. Communicating the importance of children establishing a dental home by age 1 year to parents and health care professionals may help reduce disease burden in children younger than 6 years.

Key Words. Dental home; physicians; pediatrics; age 1 visit; early childhood caries.

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Early childhood caries (ECC) is diagnosed via the presence of 1 or more decayed, missing, or filled primary teeth in children younger than 6 years.[1] ECC disproportionately affects children in low-income families and racial and ethnic minority populations and in those lacking dental insurance coverage.[2] Despite preventive clinical guidelines and recommendations from both the American Dental Association and the American Academy of Pediatric Dentistry, ECC remains the most common, preventable infectious disease among children in the United States, with 21.4% of children aged 2 through 5 years having caries and 8.8% having untreated caries.[3,4] When left untreated, ECC has immediate and long-term consequences; odontogenic pain and loss of efficient chewing surfaces from large carious lesions can interfere with normal eating, drinking, and sleeping behaviors that are essential for healthy growth and development.[5]

The cornerstones of the preventive clinical guidelines and recommendations in pediatric dentistry are early preventive dental visits and the use of anticipatory guidance.[6] Anticipatory guidance is the process of providing parents with information about health behavior best practices

for the prevention of disease. Given children's reliance on their parents and caregivers to effectively perform oral hygiene, anticipatory guidance is critical for increasing oral health literacy in caregivers. A systematic review of the literature in 2018 describing the relationship between parental oral health literacy and children's oral health outcomes reported that low oral health literacy in parents was associated with increased susceptibility to caries experience in their children.[7] Furthermore, anticipatory guidance has proven efficacious in a clinical setting in which only 1.7% of children whose parents received anticipatory guidance developed caries before age 3 years at follow-up compared with 9.6% of children in a control group whose parents did not receive anticipatory guidance.[8]

The American Academy of Pediatric Dentistry recommends all children undergo an oral health screening with anticipatory guidance for parents as early as the eruption of the first tooth and no later than 12 months of age.[6] Early childhood dental examinations can help mitigate future caries experience through early detection of incipient disease processes and increased parental oral health literacy. A 2018 study reported that for each additional year that the first dental visit is delayed, the odds of having caries increases 110%.[9]

Given that there are only 9 pediatric dentists per 100,000 children in the United States,[10] general dentists and other medical professionals, like primary care physicians (PCPs), have played an increasingly important role in performing oral health examinations for children in their first years of life. Owing to the wide acceptance and expanded practice of well-child visits, PCPs have multiple encounters with children who are approximately the average age when the primary dentition begins to erupt (6 months),[11] which often offers PCPs the first opportunity to provide dental examinations and oral health anticipatory guidance to new parents. Although PCP participation in oral health examinations is necessary for maximizing the number of children screened, it is not sufficient for accurate diagnosis of dental disease and appropriate referral to dental providers for treatment interventions.[12] Pierce and colleagues[12] reported that PCPs undercounted the number of teeth with carious lesions—only accurately diagnosing caries 49% of the time—and underreferred patients for the treatment of active caries. However, it is unclear what proportion of children younger than 6 years undergo their first dental screening from a PCP versus a dental practitioner.

Delayed diagnosis, referral, and treatment of ECC may allow for the rampant progression of caries to the extent that the use of general anesthesia is the only viable option for treatment. In addition to the severity of disease present in children, another oft-cited indication for treatment under general anesthesia is for children who are uncooperative or precooperative.[13] For clinicians without additional training in behavior management techniques, pharmacologic interventions may be relied on more heavily out of necessity or convenience. However, it is unclear if the use of general anesthesia for restorative treatment differs between general dentists and pediatric dentists in the pediatric population.

ECC persists for privately and publicly insured children alike despite the implementation of new recommendations and recruitment of other health care professionals for early oral health screenings.[14] A retrospective analysis of National Health and Nutrition Examination Survey data from 2011 through 2014 revealed that the odds of having caries, or untreated caries, did not differ significantly between publicly and privately insured children when adjusting for the level of education attained by parents and family income.[14] However, much is still unknown about the caries experience, barriers to care, and treatment trends among privately insured children.

Our investigation sought to characterize the types of providers performing the first dental screening and analyze the relationships between the child's age at first dental examination and caries experience in the first 6 years of life among privately insured children in the United States.

METHODS

Study population

Deidentified administrative claims data from private dental insurers were collected from 2012 through 2017 as part of the nationwide IBM Watson Health MarketScan Database. We used this database to identify our initial cohort of 706,636 privately insured children aged 0 through 6 years. Inclusion criteria required patients to have had an initial oral health screening visit performed by a medical or dental professional at 6 months of age or greater, at least 1 subsequent visit after the

ABBREVIATION KEY

CDT: Current Dental Terminology.
ECC: Early childhood caries.
PCP: Primary care physician.

initial examination up to the age of 6 years, and at least 2 continuous years of enrollment with no coverage lapses exceeding 365 days.

Given that the average age of the eruption of the first primary tooth is at 6 months,[11] observations within the data set in which patients were younger than 6 months were more likely to be related to dental and craniofacial anomalies and not caries and therefore were excluded. The "provider type" variable included many subtypes of medical providers but only 2 classifications of dental providers (dentist and dental specialist). In our study, we assumed dental specialists were pediatric dentists on the basis of the Current Dental Terminology (CDT)[15] codes analyzed, the patient's age when these codes were billed, and their clinical relevance.

Data procedures

We analyzed CDT and Current Procedural Terminology billing codes using SAS Version 9.4, with the patient's age at first dental examination as our main predictor.[15,16] The exact date of birth was not available in the data set, but the age of the patient at the time of the billed procedure was available in the data set. We also sought to specify the patients' ages further by estimating their ages in months. To estimate the months of age, we used the enrollment date as a proxy for their birth date to estimate their years and months of age. We used enrollment dates because patients typically are enrolled on birth or within 30 days of birth. We identified a patient's first visit as the first observation of any 1 of the following CDT codes for clinical oral evaluations and examinations, prediagnostic services, professional consultations, or professional visits: D0145, D0140, D0150, D0160, D0170, D0171, D0180, D0190, D9310, D9311, or D9420.

There were 2 outcomes for this analysis: restorative treatment needs and use of general anesthesia. We defined restorative treatment as the presence of CDT codes for restorative (D2000-D2999), endodontics (D3000-D3999), or oral and maxillofacial surgery (D7000-D7251) services. We identified use of general anesthetic for restorative treatment when a patient had "deep sedation/general anesthesia- each subsequent 15 minute increment" (D9223) and any of the aforementioned restorative treatment codes billed on the same date of service. In addition, we cross-referenced inpatient and outpatient medical claims data to capture any general anesthesia encounters related to the completion of dental procedures in hospitals and ambulatory surgical centers.

Our study received an exemption from review by the University of California, Los Angeles, Institutional Review Board (IRB 20-000469).

Statistical methods

We conducted univariate analyses to generate descriptive statistics for age at first visit, the type of provider performing initial oral examinations, restorative treatment needs, and use of general anesthesia. We conducted bivariate analyses using Pearson correlation tests to describe the relationship between age at first dental examination and restorative treatment needs (for example, operative, pulp therapy, or extraction services).

We conducted multivariable analyses using Kaplan-Meier survival curves with adjusted hazard ratios to describe the temporality of restorative treatment stratified by a patient's age at initial dental examination. We used a Cox proportional hazards model to determine the association between age at first oral examination as the main predictor and survival time to first restorative treatment as the main outcome. We also controlled for provider type and preventive dental services, which include number of prophylaxes, oral examinations, and fluoride applications before restorative treatment.

RESULTS

Approximately 470,000 privately insured patients ages 6 months through 5 years 11 months were included in our analysis. The mean (standard deviation) age for patients' first oral examination was 3.62 (1.26) years (median, 3.64 years). First oral examinations were performed by pediatric dentists (13.8%), general dentists (85%), and physicians (1.2%) (Table 1). The proportion of patients in this cohort who required restorative treatment before 6 years of age was 21.3% (Table 2). General anesthesia was used for 1,200 patients to complete restorative treatment (Table 1). Of these patients, those who were age 3 years at their first dental examination had the highest incidence (n = 324, 27%) of undergoing restorative treatment under general anesthesia, followed by patients first examined at age 4 years (n = 275, 22.9%). Patients who were first examined by general dentists

Table 1. Dental examinations and use of general anesthesia for completion of restorative treatment stratified by age at first dental visit and type of provider performing the first dental examination.

CHARACTERISTIC	DENTAL EXAMINATION		GENERAL ANESTHESIA	
	Frequency, No.	%	Frequency, No.	%
Age at First Visit, y				
0	6,475	1.4	88	7.3
1	45,877	9.7	121	10.1
2	90,640	19.2	248	20.7
3	133,217	28.2	324	27.0
4	114,941	24.3	275	22.9
5	81,836	17.3	144	12.0
Total	472,986	100.0*	1,200	100.0
Provider Type				
General dentist	401,896	85.0	856	71.3
Pediatric dentist	65,272	13.8	306	25.5
Physician	5,534	1.2	10	0.8
Other	Not applicable	Not applicable	28	2.3
Total	472,986	100.0	1,200	100.0†

* Rounding yielded a total of 100.1% † Rounding yielded a total of 99.9%

Table 2. Restorative treatment needs stratified by age at first dental visit.

AGE AT FIRST VISIT, Y	TREATMENT REQUIRED, NO.	NO TREATMENT REQUIRED, NO.	TOTAL, NO.	%
0	474	6,001	6,475	7.32
1	4,440	41,437	45,877	9.68
2	13,620	77,020	90,640	15.03
3	28,368	104,849	133,217	21.29
4	30,757	84,184	114,941	26.76
5	22,918	58,918	81,836	28.00
Cumulative Total	100,577	372,409	472,986	21.26

(71.3%) had more restorative treatment completed under general anesthesia than those first examined by pediatric dentists (25.5%) and physicians (0.8%).

Patients who had their first oral examinations performed at age 3 years had an increased risk of needing restorative treatment, with a more than 2-fold greater hazard (hazard ratio [HR], 2.05; 95% CI, 1.97 to 2.13) than patients who had the first oral examination performed before age 1 year (baseline). Patients who underwent their first oral examination at age 4 years had the highest increased risk of needing restorative treatment, with a nearly 4-fold greater hazard (HR, 3.99; 95% CI, 3.84 to 4.16) (Table 3) than the baseline. A Pearson correlation coefficient of 0.96 ($P < .001$) showed a strong relationship between an older age of first oral examination and increased restorative treatment needs. The Kaplan-Meier survival curves (Figure) illustrate this relationship, with patients undergoing their first oral examination at the ages of 3 or 4 years having an immediate precipitous drop in survival time to first restorative treatment, indicating that the probability of these patients' requiring restorative treatment is much higher than in patients who have their first oral examination at a younger age.

Patients whose first oral examination was performed by pediatric dentists had a 15.8% increased hazard (HR, 1.158; 95% CI, 1.144 to 1.172) of needing restorative treatment than patients whose first oral examination was performed by general dentists. Patients whose first oral examination was performed by physicians had a 16.7% decreased hazard (HR, 0.83; 95% CI, 0.79 to 0.87) of needing

Table 3. Cox proportional hazards model of age at first oral examination, provider type performing the first oral examination, and preventive dental services on survival time between first oral examination and first restorative treatment.

CHARACTERISTIC	STANDARD ERROR	*P* VALUE	HAZARD RATIO (95% CI)
Age at First Visit, y			
< 1 [Reference]			
1	0.05779	< .0001	1.032 (0.991 to 1.073)
2	0.05677	< .0001	1.329 (1.278 to 1.382)
3	0.05666	< .0001	2.053 (1.974 to 2.136)
4	0.05679	< .0001	3.995 (3.838 to 4.157)
First Visit Provider Type			
General dentist [Reference]			
Pediatric dentist	0.01009	< .0001	1.158 (1.144 to 1.172)
Physician	0.0368	.2375	0.830 (0.793 to 0.868)
Preventive Services			
Prophylaxes	0.00341	< .0001	0.813 (0.810 to 0.816)
Oral examinations	0.00189	< .0001	0.822 (0.820 to 0.824)
Fluoride applications	0.00593	< .0001	1.189 (1.183 to 1.196)

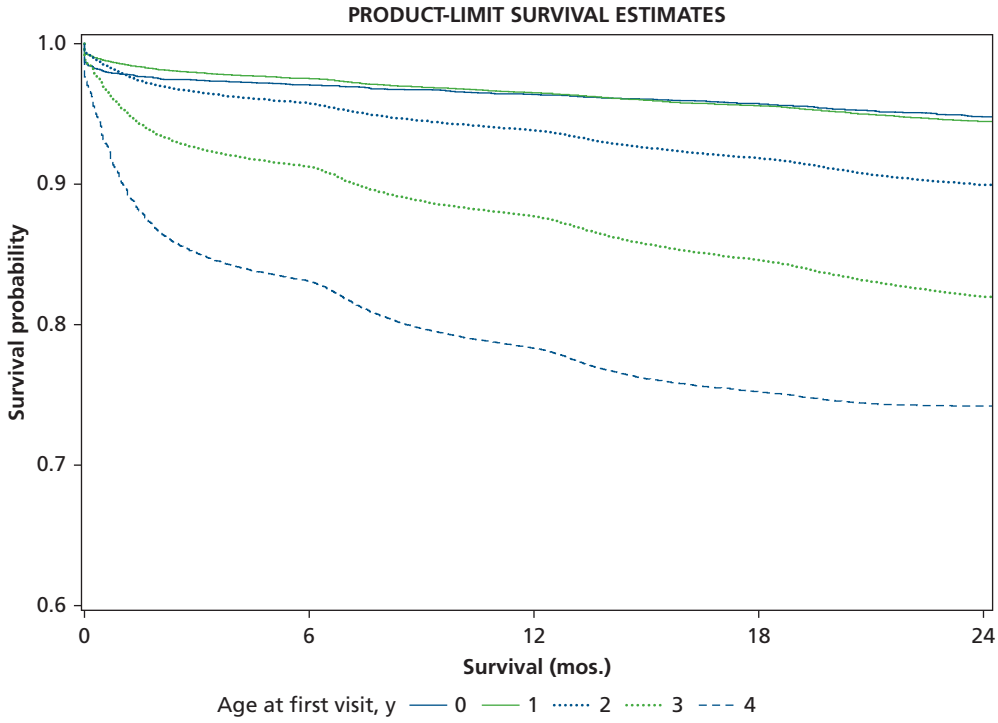

Figure. Survival curve for time between first dental visit (oral examination) and restorative treatment stratified by age at first dental visit.

restorative treatment than patients seen by general dentists (Table 3). The number of prophylaxes undergone during each patient's period of observation was associated with a decreased hazard of needing restorative treatment before age 6 years of 18.7% (HR, 0.813; 95% CI, 0.810 to 0.816). Oral examinations were associated with a decreased hazard of needing restorative treatment by 17.8% (HR, 0.822; 95% CI, 0.820 to 0.824). Fluoride applications were associated with an increased hazard of 18.9% (HR, 1.189; 95% CI, 1.183 to 1.196) for needing restorative treatment (Table 3).

DISCUSSION

Children covered under private insurance are often assumed to be of higher socioeconomic status than those covered under Medicaid. The average age at first visit was considerably higher in this sample of privately insured children than the recommended age for children to establish a dental home. Providers performing first oral examinations were predominantly general dentists and pediatric dentists, with physicians performing few initial oral examinations in this population. Multivariate analysis showed that children who were older at the age of first visit, were first seen by pediatric dentists, and had fluoride varnish applications were more likely to undergo restorative treatment.

The study sample had an average age at first visit of 3.6 years despite recommendations to establish a dental home by age 1 year. It is possible that the "age 1 dental visit" recommendation is not reaching most new parents or PCPs. Increasing knowledge among physicians and pediatricians about best practices for oral health in pediatric populations may be an effective means of ensuring new parents receive this information.

The finding that children first seen by general dentists have less restorative treatment completed is similar to the findings of the 2014 study by Kranz and colleagues[17] that described less spending on dental services for children younger than 3 years if seen primarily by a nonspecialist. Pediatric dentists typically use caries management interventions in younger patients who cannot tolerate traditional restorative treatment, such as interim therapeutic restorations, application of caries-arresting medicaments, and increased recall frequency for high caries risk children for additional prophylaxes and fluoride applications. Pediatric dentists also receive advanced training in behavior management techniques that allow young children to tolerate restorative treatment in a traditional dental setting. Kranz and colleagues[17] also observed that cost savings were significantly attenuated by age 4 years. Table 2 provides a possible explanation for this observation. Of the 1,200 patients who required general anesthesia for the completion of restorative treatment, 856 (73%) were first seen by a general dentist. Without advanced training in behavior management and other caries-arresting techniques, the costly use of general anesthesia may be the only or preferred means by which general dentists can treat or manage caries in young children. An increased familiarity with incipient lesions and their clinical presentation in combination with use of advanced behavior management techniques by dental specialists can allow for earlier detection and intervention of an active, noncavitated carious lesion. This detection bias may account for the increased hazard dental specialists carry when performing the first oral examination.

Increased frequency of fluoride applications for high caries risk patients is a common preventive strategy used by dentists familiar with pediatric populations. The increased frequency of fluoride applications among high caries risk patients who will later undergo restorative treatment is our current hypothesis for fluoride conferring an increased hazard for needing restorative treatment in our model (eTable, available online at the end of this article). However, caries risk data were not available in the data set to test this hypothesis.

Our study was subject to notable limitations. First, ambiguity in variable definitions in combination with the assumptions and estimations used in our analysis may lead to misclassification bias. It is possible that dental specialists other than pediatric dentists may have been included in our analysis related to the provider type "dental specialists." However, children with craniofacial abnormalities that would necessitate an oral examination by a dental specialist other than a pediatric dentist likely would be treated within the first few weeks of life. To minimize this misclassification bias, our inclusion criterion for the youngest age at which a child realistically would undergo an oral examination was set at 6 months, which also coincides with the average age at which a child's first primary tooth would begin to erupt. In addition, the exact date of birth was not available in the data set, only the age of the patient at the time of the billed procedure in "years of age." We sought to further specify patient age by means of incorporating their age in months. To estimate the months of age, we used the enrollment date as a proxy for their birth date to estimate their years and months of age. We used enrollment dates assuming patients typically are enrolled in their parents' insurance policy on birth. However, we have no data to support that a plurality of children is enrolled on birth. Further study is needed to validate this methodology. In addition, some parents may opt to pay out of pocket for routine dental examinations and preventive services and later purchase a dental insurance policy if more costly restorative treatment is required, and therefore the first claims

visit may not be the first dental visit. Selection bias is an inherent limitation of any analysis solely using administrative claims data to describe risk and protective factors related to a specific disease. The data set used in our study did not include information about several social determinants of health known to be associated with ECC (for example, race, ethnicity, and socioeconomic status).[18,19]

CONCLUSIONS

This cohort of privately insured patients aged 0 through 6 years are poorly served according to the current evidence-based recommendations and standards. Health care providers should actively seek existing and nascent means of facilitating the establishment of a dental home for their patients by age 1 year. Investments in educating medical students, pediatricians, and other PCPs about oral health best practices and guidelines for pediatric patients should be pursued. At the 6-month well-child visit, all PCPs should be looking for the eruption of the first tooth and making recommendations for seeing a dentist, provide basic oral hygiene instruction and anticipatory guidance, and be able to facilitate scheduling the appointment for the patient. In addition, given the increased use of and familiarity with teleconferencing during the COVID-19 pandemic, teledentistry may be a viable means to increase access to initial dental examinations and anticipatory guidance for parents of children younger than 1 year. To reduce the use of general anesthesia for the completion of restorative treatment in pediatric patients, dental school curricula and continuing education sessions should include advanced behavior management techniques and noninvasive caries management methods for treating pediatric patients. ■

SUPPLEMENTAL DATA

Supplemental data related to this article can be found at: https://doi.org/10.1016/j.adaj.2021.05.020.

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eTable. Summary statistics for fluoride applications stratified by age of application and treatment needs.

AGE OR TREATMENT NEED	AVERAGE (STANDARD DEVIATION) FLUORIDE APPLICATIONS, NO.
Age, y	
0	0.31 (0.48)
1	0.74 (0.72)
2	1.08 (1.00)
3	1.35 (1.24)
4	1.76 (1.52)
5	2.17 (1.78)
Treatment Need	
Treatment required	1.66 (1.55)
No treatment required	1.74 (1.55)