

***Utilization of Silver Diamine Fluoride by Dentists in the United States: A Dental Claims Review***

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## Introduction

Dental caries is an almost universal disease in adults with 91% of adults aged 20-64 years having experienced dental caries, and 27% of adults in the same age group experiencing untreated caries.<sup>1</sup> Children are also affected by dental caries with 21% of children aged 6-11 years having dental caries and about one quarter of those children having untreated caries.<sup>2</sup> Diverse treatment options are important for a disease with such ubiquitous reach because some patients will have difficulties accessing or receiving traditional restorative care for their caries lesion. Patients for whom traditional restorative care is not feasible may benefit from non-surgical caries management, such as silver diamine fluoride (SDF). The American Dental Association (ADA) released a report in 2018 regarding nonrestorative treatments for carious lesions. This report recommends treatment with 38 percent SDF solution to arrest cavitated lesions on coronal surfaces of primary teeth supported by moderate certainty evidence and to arrest cavitated lesions on the coronal surfaces of permanent teeth supported by limited evidence.<sup>3</sup>

SDF has been used worldwide for decades to arrest cavitated caries lesions.<sup>5</sup> The effectiveness varies based on population, lesion location and application protocol but overall SDF has been shown to arrest 81% of active caries.<sup>6</sup> Dentists currently use SDF in an evidence-based manner to arrest cavitated caries lesions in both the United States and around the world.

The American Academy of Pediatric Dentistry (AAPD) published a clinical practice guideline on the use of SDF in a caries management protocol in 2017. This guideline “supports the use of 38 percent SDF for the arrest of cavitated caries lesions in primary teeth as part of a

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comprehensive caries management program” with a conditional recommendation due to the low quality of evidence available to support the findings.<sup>8</sup> Although the recommendation is conditional, the panel felt that the potential benefits of SDF application outweighed the potential negative sequelae. The advantages of SDF include that it is non-invasive, easy to use, more effective than other non-invasive options and may provide cost savings and lower risks through avoiding sedation and general anesthesia.<sup>8</sup>

Although SDF has been used worldwide for decades, it is still relatively new in the United States, gaining FDA approval in 2014, entering the marketplace in 2015 and having a CDT code (D1354) activated at the beginning of 2016.<sup>4,7</sup> SDF still faces several limitations in the United States due to its novelty. The major limitation of SDF is that it stains carious tissue black. This can limit patient and guardian acceptance due to esthetic concerns especially if the treated teeth are in the anterior.<sup>9,10</sup> Additionally, acceptance of dentists may be limited due to limited training and knowledge about the material and the esthetic concerns from staining carious tissue black.<sup>11</sup> Finally, SDF use can be limited by the lack of reimbursement from dental insurances.

The purpose of this study was assess utilization of silver diamine fluoride by pediatric dentists (PD) and general dentists (GD) in the United States using dental claims warehouse data from the introduction of the product to the marketplace in 2016 to 2019.

## Methods

This project was granted exempt status by the Institutional Review Board at Indiana University, Indianapolis, IN, USA (Study 1508889495). Data were obtained from a commercial dental insurance claims data warehouse, P&R Dental Strategies, LLC, that collects claims data from over 50 private dental insurance plans and multiple carriers in the United States. A large proportion, but not all, of the dental plans in the United States report data to the data warehouse. Deidentified nationwide data were obtained for all dental patients with a history of dental code D1354 to represent treatment with SDF. Data included: a unique patient identifying number, age in years of the patient, information about the teeth treated (tooth number, surface and dates of treatment), information about the reimbursement (date of submission, date of payment, submitting charges, and reimbursement amount) and information about the dental provider (a unique provider identifying number, billing zip code, and specialty or general practitioner).

The data extraction encompassed all records between January 2016 and July 2019. The zip code of the billing practice was used to determine average income levels of that county and categorize practice locations into regions based on the American Association of Pediatric Dentistry districts: Northcentral, Northeastern, Southeastern, Southwestern and Western areas of the United States. The income levels were used to compare the proportion of the population receiving SDF treatment to the total US population to establish if children in different socioeconomic status groups were receiving an uneven distribution of SDF treatment.

Summary statistics for all ages were calculated and summarized using the number, percentage and averages per month. Chi-square tests were performed to exam the relationship between child's age group ( $0 \leq \text{Age} < 8$  and  $8 \leq \text{Age} \leq 18$ ) and provider's specialty (Pediatric Dentist (PD) and General Dentist (GD)). Chi-square tests were also performed to exam the relationship between tooth location (Anterior and Posterior), and provider's specialty (PD and GD) by child's age group ( $0 \leq \text{Age} < 8$  and  $8 \leq \text{Age} \leq 18$ ). Chi-square test for specified proportions was performed to compare the proportions of patients with SDF treatment in each income level (under \$24,999, \$25,000-\$74,999 and \$75,000 or more) to the population proportion of income levels from 2017 US Census Bureau representing the entire population of the US during the middle of the study timeframe.

## **Results**

The data included 321,726 claims for the dental code D1354 in the 3 years and 7 months included in the query. Claims by service year were 11,495 (958/month, 3.6% of the total) in 2016; 46,401 (3,867/month, 14.4%) in 2017; 138,893 (11,574/month, 43.2%) in 2018; and 124,937 (17,848/month, 38.8%) through July, 2019. The percent of paid claims by the insurance companies per year were 5% in 2016; 3.7% in 2017; 9.4% in 2018; and 44.6% in 2019.

Claims separated by AAPD district chapters were 21,487 (17.8%) from Northeastern; 19,405 (16.1%) from Southeastern; 21,912 (18.2%) from Northcentral; 21,884 (18.1%) from Southwestern; and 36,030 (29.8%) from Western (Figure 1). The most frequently treated teeth were primary posterior (171,769; 53.4%) and permanent posterior teeth (106,160; 33%) followed by primary anterior teeth (31,269; 9.7%) and permanent anterior teeth (12,528; 3.9%).

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Figure 2 shows the average claims per month divided by tooth location. 152,644 (47.4%) D1354 codes were submitted by pediatric dentists (PD) and 169,082 (52.6%) were submitted by general dentists (GD). The number of unique PD who billed the D1354 code was 743 (9.8% of practicing PD) in 2016; 1788 (23%) in 2017; 2541 (31.6%) in 2018; and 2488 (30.1%) in 2019. The number of unique GD who billed the D1354 code was 1407 (0.9% of practicing GD) in 2016; 4050 (2.6%) in 2017; 8194 (5.2%) in 2018; and 8246 (5.2%) in 2019 (Figure 3). The cumulative patient age distribution includes 25.6% 0-4 years, 38.2% 5-9 years, and 14.2% 10-19 years. The average number of claims made per month in each year separated by age from 0 years to >70 years can be seen in Figure 4.

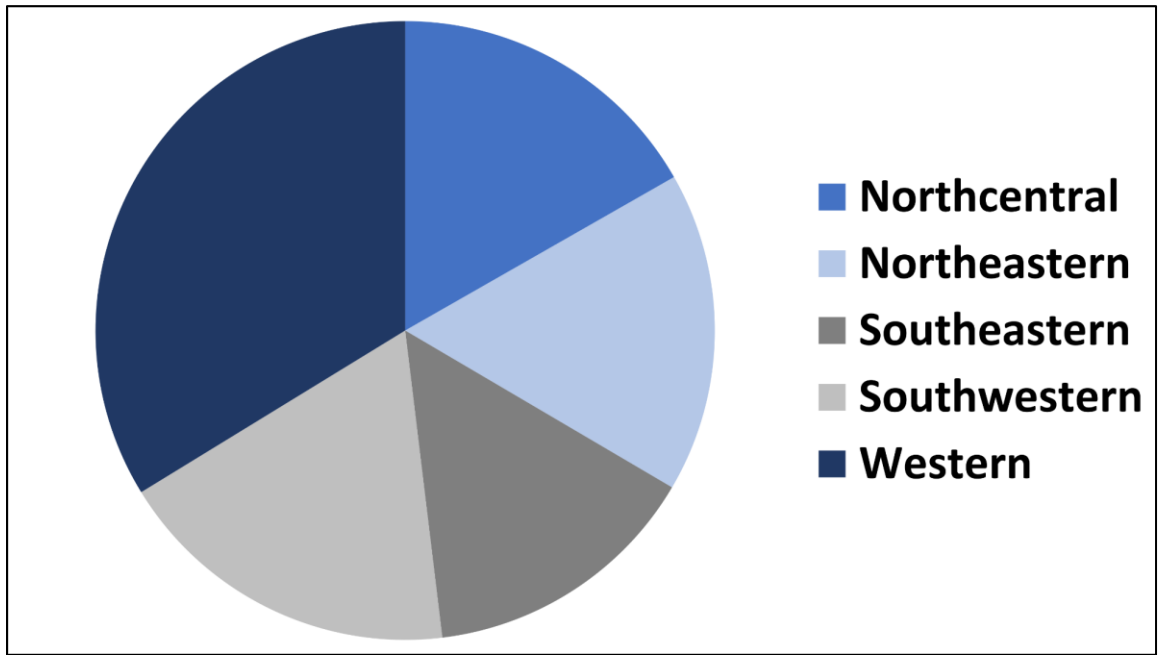


Figure 1: Total D1354 claims made from January, 2016-July, 2019 per AAPD District

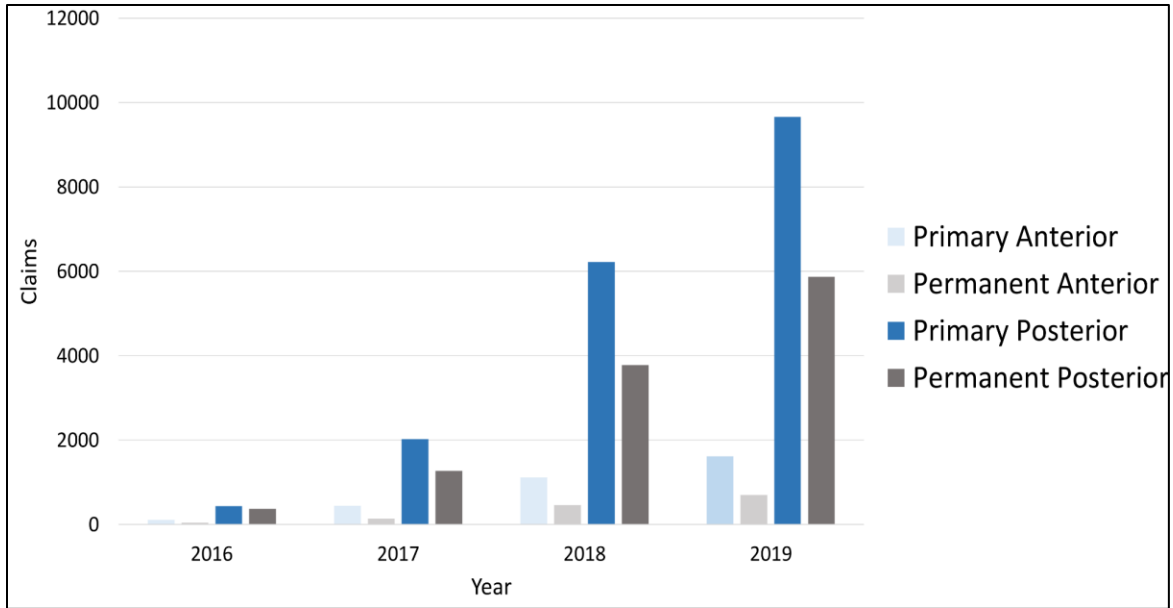


Figure 2: Average number of treated teeth per month by arch location and tooth type

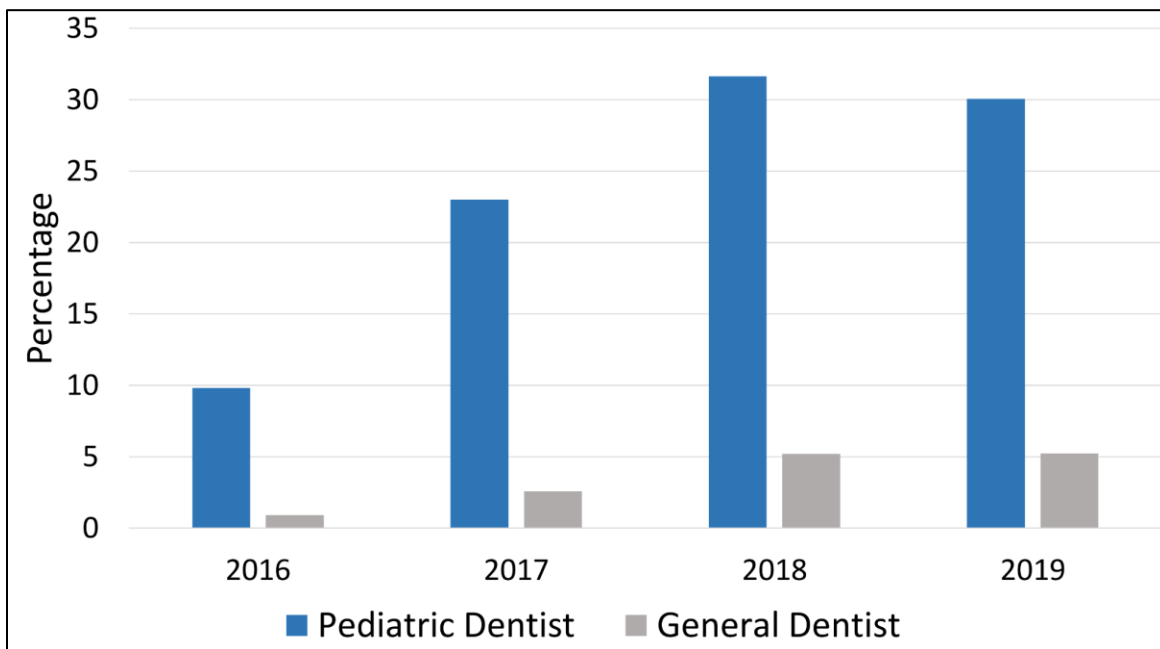


Figure 3: Percentage of total practicing providers submitting a D1354 claim per year by type of provider

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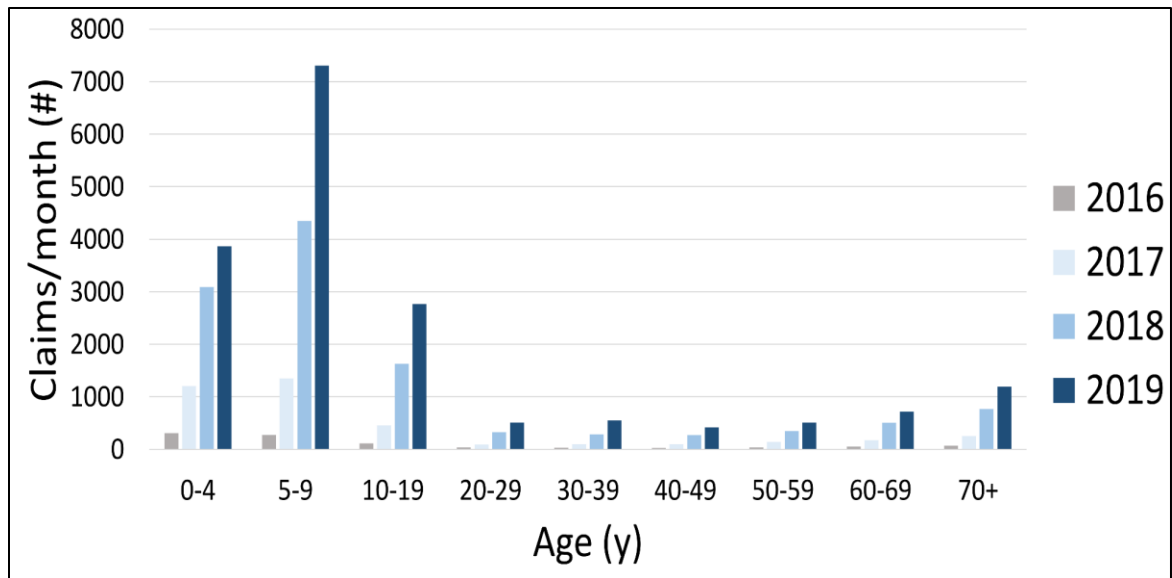


Figure 4: Average monthly claims by patient age per year

### *Statistical analysis*

#### **Claims by patient and tooth factors**

Table 1 shows counts, percentages and p-values that were calculated using type of dentist as the outcome variable (PD vs. GD). When comparing SDF utilization, PD treated significantly more children of all ages ( $<0.001$ ), significantly more anterior and posterior teeth in younger children ( $p<0.001$ ), and significantly more posterior teeth in older children ( $p<0.001$ ) than GD.



Table 1. SDF CLAIMS SUMMARY BY PROVIDER SPECIALTY				
Category	Pediatric Dentists N (%)	General Dentists N (%)	Total N (%)	p-value* PD vs. GD
District for All Ages				<0.001
Northcentral	21,663 (40.5%)	31,841 (59.5%)	53,504 (16.7%)	
Northeastern	26,056 (48.7%)	27,401 (51.3%)	53,457 (16.7%)	
Southeastern	20,674 (44.2%)	26,051 (55.8%)	46,725 (14.6%)	
Southwestern	25,663 (44.2%)	32,397 (55.8%)	58,060 (18.1%)	
Western	57,992 (53.8%)	49,890 (46.2%)	107,882 (33.8%)	
Patient Age				<0.001
0y≤Age<8y	108,414 (62.4%)	65,447 (37.6%)	173,861 (54.0%)	
8y≤Age≤18y	42,355 (56.3%)	32,922 (43.7%)	75,277 (23.4%)	
>18y	1,875 (2.6%)	70713 (97.4%)	72,588 (22.6%)	
Tooth Location for 0≤Age≤18				<0.001
Anterior	34,366 (60.2%)	22,680 (39.8%)	57,046 (13.9%)	
Posterior	206,720 (58.7%)	145,562 (41.3%)	352,282 (86.1%)	
Tooth Location for 0≤Age<8				<0.001
Anterior	30,527 (63.0%)	17,920 (37.0%)	48,447 (25.7%)	
Posterior	140,169 (61.8%)	86,821 (38.3%)	140,169 (74.3%)	
Tooth Location for 8≤Age≤18				<0.001
Anterior	3,839 (44.6%)	4,760 (55.4%)	8,599 (6.4%)	
Posterior	66,551 (53.1%)	58,741 (46.9%)	125,292 (93.6%)	

\*Chi-square test used to calculate p-values

**SDF claims by income level**

Table 2 shows number of SDF claims stratified by income level.<sup>12</sup> The study population had a higher percentage of claims in the \$25,000-\$74,999 and >\$75,000 (p<0.001) than would be expected based on the census numbers from 2017, the middle of the investigated timeframe.

Table 2. SDF CLAIMS AND INCOME LEVEL			
Income Level	SDF Claims	2017 Income Data	p-value*
under \$24,999	141 (0.12%)	19.1%	
\$25,000-\$74,999	59,784 (49.52%)	38.0%	<.0001
\$75,000 or more	60,793(50.36%)	42.9%	

\*Chi-square test for specified proportions used to calculate p-value

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## Discussion

This study reports on data and trends regarding the use of the CDT code D1354 by practicing dentists in the United States. The study serves as a natural experiment of the use of D1354 code on a large scale including over 190,000 dentists and over 70 million patients in the US. The database is geographically broad, covering every state and data shows that the database has received a claim from 93% of licensed US dentists within the last 60 days. Therefore, this data is in a unique position to analyze dental claims trends in the United States.

D1354 claims were examined as the monthly average claims in a given year to account for the partial year of data collection in 2019. This data shows a trend of increasing use of SDF over time which is in agreement with a state level trend reported by Hansen et. al that SDF use increased from 2016 to quarter 2 of 2017 in Oregon.<sup>13</sup> There are likely several reasons for this trend. First, dentists, especially pediatric dentists, are becoming more aware of the uses and benefits of SDF in the United States. The AAPD Annual Session has had an increasing number of scientific talks on SDF from 1 session in both 2015 and 2016 to 5 and 6 sessions in 2017 and 2018 respectively.<sup>14-17</sup> Additionally, the AAPD published both a policy statement on the use of silver diamine fluoride as well as clinical practice guidelines on the use of silver diamine fluoride in 2017 which corresponds with a large increase in the number of D1354 claims in 2018 and 2019 as well as an increase in the percentage of unique pediatric dentists submitting a D1354 claim.<sup>18-20</sup> On January 1, 2018, the D1354 code was revised to clarify that it is a 'per tooth' code.<sup>21</sup> Therefore, some of the increase in total number of claims may be attributed to this clarification. However, this coding clarification would not have an effect on the proportion of

unique dentists submitting a claim. As dentists become more aware of the proper uses and indications for a material, they are more likely to use it in their practice.

The data also shows that the percentage and average number per month of paid claims increased each year from 2016 to 2019. The early lack of reimbursement for the D1354 code is consistent with Niederman et. al's findings using data from 2016 that the D1354 code was not reimbursed by either state run Medicaid insurances or private insurances.<sup>22</sup> A survey from the AAPD found that in the middle of 2017 the number of state Medicaid programs reimbursing the D1354 code had gone from 0 to 19 states.<sup>23</sup> For example, Oregon's Medicaid program starting reimbursing for the D1354 code at the beginning of 2016 and claims for the code increased dramatically for both patients with Medicaid insurance and private insurance.<sup>13</sup> Although our data only includes private payer information, the trend of increasing reimbursement agrees with our data and the increasing number of paid claims. The financial implications of covered vs. non-covered services are influential in patient's and parents' treatment plan acceptance.

When D1354 claims were examined stratified by age groups, 63.8% of the claims were submitted for children 0-9 years old. Claims then decrease to a nadir in the 40-49 years old group and slowly start to rise again to the oldest group of  $\geq 70$  years old. Although the use of SDF in different age groups has not been reported in the literature, the finding of the large peak in the younger age group with a smaller peak in the older age group is in agreement with published recommendations and indications for the use of SDF. These indications include issues that are more likely to affect young children including behavior management challenges and severe early childhood caries. The recommendations also include problems that are more likely

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to affect the older population such as high caries risk due to xerostomia, medically complex patients and difficult to treat caries lesions such as at the margin of crowns. Finally, the recommendations include indications that are most likely to affect both very young and very old patients such as patients without access to regular dental care and multiple lesions that are not able to be treated in a timely fashion.<sup>19,24,25</sup> Additionally, some insurance carriers put age restrictions on what ages are eligible for reimbursement of the D1354 code which, as discussed above, can affect a patient's acceptance of treatment.

The most claims came from the Western region as categorized by the AAPD with almost 30% of the total claims. The remaining regions all filed between 16% and 18.1% of claims. When comparing the higher proportion of claims filed in the Western region to the other regions each of the regions total population, number of states reimbursing for the D1354 code in 2017, the total population of the states reimbursing for the D1354 code, the number of full time equivalent (FTE) pediatric dentists in each region and the number of FTE pediatric dentists practicing in states reimbursing the D1354 code was investigated (calculations not shown).<sup>26,27</sup>

Although the Western region was by far the region with the most claims, it was not the top ranked in any of the categories investigated. This suggests that there are other factors affecting the use of SDF in the regions that was not explored in this data nor in previously published literature. More data are needed to determine the effect of region on the use of silver diamine fluoride.

Analysis showed that there was a significantly lower percentage of claims in the income under \$25,000/year group than would be expected using the 2017 income data.<sup>12</sup> This dataset

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includes private insurance claims only, no Medicaid or state insurance claims. The federal poverty guideline for a family of four in 2018 was \$25,100.<sup>28</sup> Each state sets its own guidelines for Medicaid eligibility that also vary based on other factors such as age and disability. Some states require that a family's income is below the federal poverty line (FPL), while others allow families to have an income above the FPL. Therefore, the FPL was used as the cutoff for lowest income group. According to a study by the U.S. Department of Commerce, most people with Medicaid insurance do not have another type of insurance throughout the year.<sup>29</sup> Therefore, the lower proportion of claims made for patients in counties with incomes below the FPL is expected because the dataset consisting only of private insurance claims. More information will need to be gathered about claims made for people with state sponsored insurance plans to comment more on the use of SDF based on income level.

Overall, GD provided a slightly higher percentage of D1534 claims than PD. However, when SDF claims submitted for children are investigated and further divided by age 0-8 and 8-18 years, PD provide more SDF treatment than GD in both age groups. This is despite the fact that GD see the majority of children in the United States and PD comprise only about 3.3% of dentists in the United States; GD account for about 79% of dentists.<sup>30,31</sup> Additionally, only 0.9%-5.2% per year of all practicing GD submitted a D1354 claim during the study while 9.8%-31.6% of all practicing PD submitted a claim in the same years.<sup>20</sup> This finding suggests that PD are more aware of the indications and benefits of silver diamine fluoride and feel more comfortable using it on children. This is potentially due to the 11 courses discussing SDF at the AAPD annual session

between 2017 and 2018 compared to the only 3 courses discussing SDF at the American Dental Association (ADA) annual session in those same years.<sup>16,17,32,33</sup>

Both PD and GD placed significantly more SDF on posterior teeth than anterior teeth. Informed consent is an important factor in any treatment, but especially in treatment such as SDF which stains carious lesions black, an esthetic outcome that some may find displeasing. This is consistent with previous studies that found dentists were weary to use SDF due to patient objection as well as parents being more accepting of the black stain in less visible, posterior areas than in anterior areas.<sup>9-11</sup>

Although this study looked at a large number of dental claims it does have some potential limitations. First, only claims from private insurance companies were captured. This means that neither claims made from state sponsored insurances such as Medicaid nor claims that were paid out of pocket and not submitted to insurance were captured. Additionally, if providers knew that the claim would not be reimbursed they may not submit the claim to avoid using staff time and resources. Another potential limitation is that the D1354 code is not exclusive to silver diamine fluoride as a medicament and some of the claims may have been for another medicament such as the combination of silver nitrate and fluoride varnish.

## **Conclusions**

1. The use of SDF is increasing by both pediatric dentists and general dentists in a population with private insurance plans.

2. The majority of SDF is used in the 0-9 year age range with another small increase seen starting at 50 years and older.
3. Dentists in the AAPD Western region are using SDF more than expected compared to the other AAPD regions.
4. SDF was used significantly more on posterior teeth than anterior teeth.
5. Pediatric dentists were more likely than general dentists to use SDF on children of all ages including anterior and posterior teeth in younger children and posterior teeth in older children..

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