Effectiveness on Early Childhood Caries of an Oral Health Promotion Program for Medical Providers

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Objectives. To assess an oral health promotion (OHP) intervention for medical providers' impact on early childhood caries (ECC).

Methods. We implemented a quasiexperimental OHP intervention in 8 federally qualified health centers that trained medical providers on ECC risk assessment, oral examination and instruction, dental referral, and fluoride varnish applications (FVAs). We measured OHP delivery by FVA count at medical visits. We measured the intervention's impact on ECC in 3 unique cohorts of children aged 3 to 4 years in 2009 (preintervention; n = 202), 2011 (midintervention; n = 420), and 2015 (≥ 4 FVAs; n = 153). We compared numbers of decayed, missing, and filled tooth surfaces using adjusted zero-inflated negative binomial models.

Results. Across 3 unique cohorts, the FVA mean (range) count was 0.0 (0), 1.1 (0–7), and 4.5 (4–7) in 2009, 2011, and 2015, respectively. In adjusted zero-inflated negative binomial models analyses, children in the 2015 cohort had significantly fewer decayed, missing, and filled tooth surfaces than did children in previous cohorts.

Conclusions. An OHP intervention targeting medical providers reduced ECC when children received 4 or more FVAs at a medical visit by age 3 years. (*Am J Public Health.* 2017;107:S97–S103. doi:10.2105/AJPH.2017.303817)

Early childhood caries (ECC) is the most common chronic childhood health condition.[1–4] Although preventable,[3,5,6] ECC prevalence is increasing.[1,7] Children in low-income families have double the caries rate of advantaged children and are less likely to receive dental care.[1,8,9] Untreated ECC can lead to pain, low quality of life, missed school, emergency department visits, hospitalizations, and even death.[10–13] Furthermore, caries are costly to treat. The 2005 Medical Expenditures Survey estimated that $1.55 billion is spent annually to treat dental decay in children younger than 5 years (excluding hospital costs).[13]

Nationally, few dental providers participate in public insurance programs, leading publicly insured children to have less access to dental care than do privately insured children.[14] To reduce access barriers, all state Medicaid programs reimburse nondental health care providers for the provision of oral health promotion (OHP) services,[15] specifically fluoride varnish applications (FVAs). The provision of early OHP services has had variable medical provider uptake.[16] Pahel et al.[5] assessed the impact of medical provider FVAs on caries-related treatments as a proxy for ECC. They reported a reduction in caries-related treatments in children insured by Medicaid when 4 or more FVAs were received by age 3 years. Recognizing that low-income families have difficulty obtaining caries-related treatments, we assessed the impact of an OHP intervention (as measured by FVAs) for medical providers on the endpoint outcome, ECC, in children in low-income families.

METHODS

Denver Health is an integrated safety net health care system delivering inpatient, emergency, primary care, and public health services, with a 477-bed hospital, 8 federally qualified health centers (FQHCs), the Denver Public Health agency, and adult and pediatric emergency departments. Denver Health provides services to 40% of Denver's children. Among Denver Health primary care pediatric patients, 89% are below 200% of the federal poverty level, and 9% are uninsured. In 2015, Denver Health provided more than 155 000 outpatient pediatric visits. During the study period (2009–2015), 5 of the 8 FQHCs had dental clinics colocated within the medical clinic; Denver had optimally fluoridated water. In 2009, the Colorado Medicaid and State Children Health Insurance Plan began reimbursing medical providers for FVAs for children aged 0 to 5 years as an unbundled reimbursement. Denver Health Medical Plan, the private insurer for Denver Health employees, included FVA as a covered benefit in 2010.

We implemented a pragmatic OHP intervention using a quasiexperimental study

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design in Denver Health from 2009 to 2015. Four FQHCs received OHP training and ongoing practice coaching to develop OHP care delivery systems in 2009 (phase 1); the remaining 4 received the same in 2011 (phase 2).

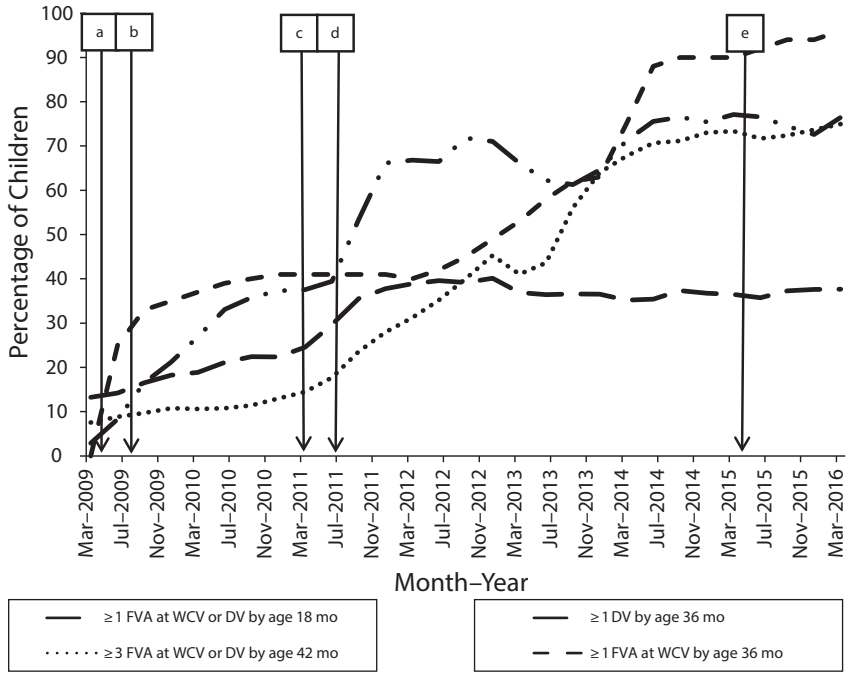
Oral Health Intervention

Oral health promotion training. In 2008, an interprofessional team of experts developed a standardized interprofessional OHP program, Cavity Free at Three, in Colorado. The program teaches medical and dental health care providers about caries risk assessment, oral examination, oral health instruction, FVA, and dental referral. A dentist and physician team delivered this OHP program in this pragmatic intervention to the Denver Health FQHC's physicians, physician assistants, and nurse practitioners (henceforth, providers) and their nurses and medical assistants (henceforth, staff) over a half day of training that included a hands-on demonstration of FVA. New providers and staff received the training as part of their onboarding process.

Clinical care guideline. We developed a standard work guideline detailing the care delivery process from patient check-in through billing. Medical providers assessed children's risk of ECC at well child visits (WCVs) from age 6 months through 3 years. Care included an oral health examination and instruction and a dental referral for all children as well as FVA for those determined to be at high risk for ECC (up to 7 FVAs by age 3 years). Support staff were tasked with giving the medical provider an oral health kit (child and parent toothbrushes, fluoridated toothpaste, single-dose fluoride varnish, gauze, and aftercare instructions) for all age-appropriate WCVs. High-risk children received FVAs from the provider or delegated staff. Providers were tasked to document their findings, refer to a dentist, apply fluoride varnish, and complete billing for FVAs for insured children. Uninsured children were not charged.

Oral health metrics. As a proxy measure for the delivery of the OHP intervention, the Denver Health Quality Improvement Committee designated the provision of FVAs for children up to age 3 years as a quality improvement metric. The 2009 metric goal was for 75% or more of Denver Health children to receive 1 or more FVAs at a WCV by age 36 months. In 2011, the goals were increased to (1) 75% or more to receive 1 or more FVAs by age 18 months and (2) 50% or more to receive 3 or more FVAs or have 1 or more dental visits by age 36 months. Each FQHC's team leader regularly reviewed the team's progress toward the metric goals, using summary tables, and compared their FQHC's progress with that of the other FQHCs.

Periodic coaching. Two dental champions provided periodic coaching visits to the FQHCs, reviewing progress toward metric goals and working with the staff to identify obstacles and strategies to overcome them.



[a]2009 (preintervention) data collection (2009 cohort, n = 202).
[b]Phase 1 oral health promotion training.
[c]2011 (midintervention) data collection (2011 cohort, n = 420).
[d]Phase 2 oral health promotion training.
[e]2015 (≥ 4 FVAs) data collection (2015 cohort, n = 153).

FIGURE 1—Percentage of All Children Who Received Any Fluoride Varnish Application (FVA) at a Denver Health Well Child Visit (WCV) or Attended a Denver Health Dental Visit (DV): Denver, CO, 2009–2015

Study Population

We measured the effectiveness of this OHP intervention on reducing ECC by comparing tooth surface-level dental decay in 3 mutually exclusive and representative cohorts of children aged 3 to 4 years receiving care in the Denver Health system in 3 separate years: 2009 (preintervention), 2011 (midintervention), and 2015 (≥ 4 FVAs). We used administrative data to identify children in the 3 cohorts in each of these years. Inclusion criteria included being aged 3 to 4 years, having had 2 or more previous Denver Health visits, and having had 1 or more visit in the previous 18 months. In 2015, we included only children who had received 4 or more FVAs at a WCV because of limited resources and new evidence suggesting that 4 or more FVAs reduces Medicaid caries-related treatments.[5,17]

We excluded foster and kinship children and non–English- and non–Spanish-speaking families. A bilingual (English and Spanish) research assistant blinded to the child's Denver Health utilization and dental experience randomly called the families and

invited them to a study visit. Caregivers provided verbal consent at the study visit and were compensated.

Outcomes

The primary outcome was decayed, missing, filled tooth surface (dmfs) count measured by 3 dental hygienists masked to the child's experience. The dental hygienists were trained and calibrated (interrater reliability $\kappa > 0.75$) before data collection.[18,19] The examiners visually assessed dmfs with clinical examinations without x-rays or probing. White spot (d1) lesions were not counted as decayed, and d2–3 lesions were equally categorized as decayed.[20] For teeth crowned or missing because of caries, we gave a score of 4 surfaces to anterior teeth and 5 to posterior teeth. The secondary outcome measure was decayed tooth surface count (ds).

Caregiver characteristics and 8 oral health behaviors (OHBs)[21] on behalf of the child were measured at the child's dental examination visit with a handwritten survey (English and Spanish). We identified the mean number of FVAs received at a WCV using Denver Health billing data.

Data Analyses

We calculated descriptive statistics to describe all outcomes. We used χ^2, the Fisher exact test, or the Kruskal–Wallis test for assessing the significance of individual measures with outcomes across the unique cohorts. Because many children were caries free, we estimated ECC prevalence differences and dmfs and ds mean differences using a zero-inflated negative binomial regression model.[22,23]

We estimated ECC prevalence differences and dmfs and ds mean count differences among those with ECC using a zero-truncated negative binomial model. The dependent variables for both models were the dmfs and ds indices. Independent variables were child age, gender, ethnicity, and insurance; caregiver's education; number of children in the household; presence of a caregiver or family member with recent cavity; and all 8 OHBs. We carried out data analyses using SAS version 9.4 (SAS Institute Inc., Cary, NC); P levels were significant at less than .05.

RESULTS

From 2009 to 2015, the proportion of all Denver Health children younger than 3 years who received FVA at a medical WCV increased; the proportion who attended a Denver Health dental visit increased from 2009 to 2014 but then remained steady (Figure 1).

Unique Cohorts' Characteristics

Of the 4855 children across all 3 evaluation cohorts, the proportion who received 4 or more FVAs at a WCV by age 3 years increased (0% in 2009, 4% in 2011, 23% in 2015). We collected the data and outcomes of 782 children: 202 (preintervention), 420 (midintervention), and 153 (≥ 4 FVAs; Table 1).

In 2011, the dental experiences of the children receiving care in the phase 1 FQHCs (started intervention in 2009) and phase 2 FQHCs (had not yet started intervention) were similar ($P > .05$); therefore, they were grouped together as 1 cohort for all analyses. Overall, these children were similar in age (mean: 42.2 months), largely Hispanic (89%), and insured by Medicaid or SCHIP (92%; Table 2). The mean and range number of FVAs at a WCV by age 3 years was 0.0 (0) in 2009, 1.1 (0–7) in 2011, and 4.5 (4–7) in 2015.

In unadjusted analyses, the dmfs prevalence of the 2015 (≥ 4 FVAs) cohort was 9.2 percentage points (20.0%) lower than was that of the preintervention cohort (46.5%, 57.6%, and 37.3% in 2009, 2011, and 2015, respectively; $P < .001$). Their dmfs mean was 1.7 (31.0%) lower; 5.4, 6.0, and 3.7 in 2009, 2011, and 2015, respectively; $P < .001$); their ds prevalence was 26.6 percentage points (76.0%) lower (35.1%, 44.3%, and 8.5% in 2009, 2011, and 2015, respectively; $P < .001$); and their ds mean was 2.7 (90.0%) lower (3.0, 2.2, and 0.3 in 2009, 2011, and 2015, respectively; $P < .001$; Table 2).

Caregiver Oral Health Behaviors

Caregiver-reported OHB measures differed across cohorts (Table 2). Caregivers more commonly reported that they took their child to a dental visit over cohort years (59.9, 75.0, and 92.8 in 2009, 2011, and 2015, respectively; $P < .001$) and that their child no longer used a bottle (92.1, 91.9, and 98.0 in 2009, 2011, and 2015, respectively; $P = .03$).

The proportion of caregivers who reported that their child drank tap water differed across cohort years (64.4, 71.7, and 62.1 in 2009, 2011, and 2015, respectively; $P = .04$), as did those who reported their child's teeth were brushed with fluoridated toothpaste (65.3, 52.9, and 64.7 in 2009, 2011, and 2015, respectively; $P = .003$).

After adjusting for child age, gender, ethnicity, and insurance; caregiver education; number of children in the home; presence of a caregiver or family member with recent cavity; and all OHB measures in zero-inflated negative binomial models analyses, there was not a statistically significant difference in

TABLE 1—Proportion of all Denver Health Children Aged 36–42 Months Recruited for Evaluation of Oral Health Promotion Intervention: Denver, CO, 2009–2015

Variable	2009 Preintervention, No. (%)	2011 Midintervention, No. (%)	2015,[a] No. (%)
Children aged 36–42 mo[b]	1501	1646	1708
Had ≥ 4 FVAs at a WCV	0 (0)	66 (4)	391 (23)
Called by study staff	1250 (83)	1215 (74)	359 (92)
Contacted by study staff	437 (29)	755 (46)	236 (60)
Scheduled by study staff	260 (17)	517 (31)	224 (57)
Examined by calibrated dental examiner	202 (13)	420 (26)	153 (39)

Note. FVA = fluoride varnish application; WCV = well child visit.

[a]In 2015, we included only children who had received ≥ 4 FVAs because of limited resources and new evidence suggesting that ≥ 4 FVAs reduces Medicaid caries-related treatments.

[b]Inclusion criteria included being aged 3–4 years, having ≥ 2 previous Denver Health visits, and having ≥ 1 visits in the previous 18 months.

TABLE 2—Parent or Caregiver and Child Characteristics of 3 Unique Cohorts Receiving Care in a Large Safety Net Health Care System: Denver, CO, 2009–2015

Independent Variable[a]	2009 Preintervention (n = 202)	2011 Midintervention (n = 420)	2015[b] (n = 153)	*P*
Child characteristics				
Age, mo, mean (range)	43.8 (36.0–68.4)	40.8 (33.3–65.9)	44.1 (38.0–51.4)	< .001
Female gender, %	52.5	48.8	41.2	.1
Hispanic ethnicity, %	81.3	90.0	96.2	< .001
Insurance, %				.4
Public[c]	95.5	94.5	94.8	
Private	2.5	1.4	0.7	
Other	2.0	4.0	4.6	
FVA count at WCV, mean (range)	0 (0–0)	1.1 (0–7)	4.5 (4–7)	< .001
dmfs prevalence, %	46.5	57.6	37.3	< .001
dmfs count, mean (range)	5.4 (0–66)	6.0 (0–93)	3.7 (0–60)	< .001
ds prevalence, %	35.1	44.3	8.5	< .001
ds count, mean (range)	3.0 (0–50)	2.2 (0–25)	0.3 (0–11)	< .001
Caregiver characteristics				
Education, %				< .001
< high school	27.7	20.5	26.8	
Some high school	49.5	49.3	51.0	
> high school	15.3	14.5	20.9	
Cavity in past 2 y, %				.59
Yes	32.8	31.9	38.2	
No	36.8	38.2	37.5	
Don't know or not sure	30.3	30.0	24.3	
Cavity in someone else in home in past 2 y, %				.05
Yes	43.3	52.4	57.5	
No	36.8	29.4	30.1	
Don't know or not sure	19.9	18.2	12.4	
Caregiver oral health behaviors on behalf of child (adherent response[d])				
Has your child ever visited a dental provider? (yes), no. (%)	121 (59.9)	315 (75.0)	142 (92.8)	< .001
Does your child currently use a bottle? (no), no. (%)	186 (92.1)	386 (91.9)	150 (98.0)	.03
At what age did your child stop sleeping with a bottle in bed? Do not include bottles with plain water (after 12 mo but before 18 mo), no. (%)	101 (50.0)	191 (45.5)	73 (47.7)	.56
Does your child drink any fluoridated tap water (for example, water your child drinks or water you may use to prepare your child's drinks like juice or Kool-Aid)? (yes), no. (%)	130 (64.4)	301 (71.7)	95 (62.1)	.04
How often do you or someone else brush your child's teeth? (at least twice daily), no. (%)	116 (57.4)	224 (53.3)	95 (62.1)	.16

Continued

dental experience (95% confidence interval [CI]) of children in the midintervention cohort of 2011 compared with the preintervention cohort of 2009: dmfs prevalence difference (+7.2; 95% CI = –0.93, 15.0), ds prevalence difference (+5.3; 95% CI = –3.6, 13.2), dmfs mean difference (+0.14; 95% CI = –2.1, 2.2), and ds mean difference (–0.61; 95% CI = –1.9, 0.44; Table 3).

However, we compared the cohort of 2015 that had 4 or more FVAs to the preintervention cohort of 2009 with a similar adjustment; there was a statistically significant decrease in both dmfs and ds prevalence as well as the dmfs and ds mean of children in the 2015 cohort with 4 or more FVAs: dmfs prevalence difference (–15.9; 95% CI = –24.3, –5.2), ds prevalence difference (–28.3; 95% CI = –34.9, –18.5), dmfs mean difference (–2.8; 95% CI = –5.2, –0.79), and ds mean difference (–2.5; 95% CI = –3.7, –1.7).

Similarly, we compared the cohort of 2015 that had 4 or more FVAs with the midintervention cohort of 2011; there was a statistically significant improvement in the dental experience of children in the cohort of 2015 that had 4 or more FVAs: dmfs prevalence difference (–23.1; 95% CI = –30.6, –13.0), ds prevalence difference (–33.6; 95% CI = –38.5, –24.0), dmfs mean difference (–3.0; 95% CI = –4.7, –1.2), and ds mean difference (–1.9; 95% CI = –2.6, –1.3).

In an adjusted zero-truncated negative binomial analysis (which included only children with any dmfs or ds), the dmfs means were similar across the cohort years; however, the ds mean of children in the cohort of 2015 was lower than were those of the cohorts of 2009 and 2011.

DISCUSSION

In this pragmatic, quasiexperimental study of an OHP intervention for medical providers working in a large safety net health care system, we integrated basic OHP services into medical WCVs over a 6-year period (2009–2015).

The proportion of Denver Health children who received these OHP services (specifically FVAs) increased over this timeframe. ECC experiences 2 years into the activity (midintervention) were not statistically different than at preintervention when the mean FVAs

TABLE 2—*Continued*

Independent Variable[a]	2009 Preintervention (n = 202)	2011 Midintervention (n = 420)	2015[b] (n = 153)	*P*
Are your child's teeth brushed with toothpaste with fluoride? (yes), no. (%)	132 (65.3)	222 (52.9)	99 (64.7)	.003
During the past week, on how many days did your child go to sleep with a bottle with a drink other than water—like milk, juice, Kool-Aid, Gatorade, Sunny D, soda pop, or formula? (none), no. (%)	177 (87.6)	351 (83.6)	135 (88.2)	.23
During the past week, on how many days did your child go to sleep with a sippy cup with a drink other than water—like milk, juice, Kool-Aid, Gatorade, Sunny D, soda pop, or formula? (none), no. (%)	176 (87.1)	319 (76.0)	120 (78.4)	.005
How often does your child have snacks between meals, including drinks like juice, Kool-Aid, Gatorade, Sunny D, or soda pop? (never), no. (%)	121 (59.9)	272 (64.8)	115 (75.2)	.01

Note. dmfs = missing or filled tooth surfaces; ds = decayed tooth surface; FVA = fluoride varnish application; WCV = well child visit.

[a]We used the χ^2 test to compare gender, insurance, education, and cavities in past 2 years of the caregiver or someone else; primary dentition decayed; dmfs; and ds prevalence. We used the Krustal–Wallis test to compare the number of FVAs at a WCV, dmfs, and ds means. Missing values are included in the denominators but values are not presented; therefore, percentages may not sum to 100.

[b]We included only children who had received ≥ 4 FVAs at a medical WCV in the 2015 cohort.

[c]Public insurance is Medicaid, the State Children's Health Insurance Plan, or the Indigent Care Program.

[d]We calculated the behavior scores as percentages of adherent responses. We counted responses marked "unknown" in the denominators.

at a WCV was only 1; however, they were significantly lower 6 years into the intervention in children who received 4 or more FVAs at a WCV by age 3 years. Multiple reported parent or caregiver OHBs improved over study years.

After adjusting for child and parent or caregiver characteristics and OHBs, children who received 4 or more FVAs at a WCV by age 3 years had lower ECC prevalence (dmfs and ds) than did children in previous cohorts who received fewer FVAs. Specifically, from 2009 to 2015, adjusted ECC prevalence (dmfs) decreased 16 percentage points (3.5-fold), and adjusted untreated ECC (ds) decreased by 28 percentage points (7.7-fold).

Limitations and Strengths

This study has limitations, including its quasiexperimental design and its absence of a true control group. We measured outcomes only in children in the 2015 cohort who had 4 or more FVAs at a WCV because of new evidence of a decrease in caries-related treatments with 4 or more FVAs by age 3 years[5] and budget constraints. This decision had the potential to introduce selection bias, making our results less generalizable. We compared the dental experiences of children across 3 cohorts and cannot account for the impact of secular trends. Also, although we did not quantify the number of dental visits each child had, we did measure (and adjusted for) caregiver report of having had any previous dental visit. Additionally, there was the potential for measurement error in the dental examinations and survey.

In 2014, the US Preventive Service Task Force concluded that there was sufficient evidence of the benefits of FVA on preventing ECC and recommended its provision at medical visits of all children up to age 5 years (B recommendation). The evidence included clinical trials examining the efficacy of FVA primarily in indigenous populations.[6,24–26] They did not reference any effectiveness or pragmatic trials that assessed the impact of FVA on ECC when provided by nondental providers. Our findings add important and meaningful evidence to the US Preventive Service Task Force B recommendation regarding the effectiveness of FVA by medical providers at preventing ECC in children of low-income families.

Although there is evidence from clinical trials supporting the efficacy of FVA on reducing caries,[27] there are few reports of its effectiveness when applied by medical providers in real-world settings. Pahel et al. evaluated North Carolina's Into the Mouth of Babes (IMB) program using Medicaid claims data and reported that children who had claims for at least 4 FVAs by a medical provider at a WCV had a 17% reduction in Medicaid claims for future caries-related treatments compared with similar children who had no IMB visits.[5]

Further evaluation of the IMB program compared the dental experience of kindergarteners using 2005 to 2006 public health dental surveillance data linked to 1999 to 2006 Medicaid claims for IMB visits and reported that children who had 4 or more IMB visits had a lower ECC prevalence than did children with no IMB visits but similar rates of untreated decay.[17] Our findings expand this evidence. We have reported a larger reduction in ECC prevalence and a large reduction of untreated decay. We hypothesize that this difference may be because we measured ECC in children who had not yet exfoliated any of their primary dentition and had access to restorative dental care, whereas Kranz et al.[17] included kindergarteners who may have already exfoliated teeth. They also reported ECC at the tooth level, whereas we reported ECC at the tooth surface level. Further studies are needed to clarify the discrepancy between the Kranz et al. study and our findings.

Other studies support the number of FVAs needed to improve outcomes. Holve reported 35% lower overall caries increments for Navajo children who received 4 or more FVAs at medical visits before entering Head Start (at age 3 years) compared with children who had no FVA.[3] Navajo children have the worst level of dental disease in the world[28,29]; our findings expand the generalizability of Holve's work. Our study and the others[3,5,17]

TABLE 3—Comparison of Dental Experience Across 3 Unique Cohorts of Children Receiving Care at a Safety Net Health Care System: Denver, CO, 2009–2015

Cohort	Zero-Inflated Negative Binomial Model[a,b]		Zero-Truncated Negative Binomial Model[a,c]
	ECC Prevalence Difference (95% CI)	Overall Mean Difference (95% CI)	Mean Difference Among Those With ECC (95% CI)
dmfs[d,e]			
Cohort year			
2011 vs 2009	7.2 (−0.9, 15.0)	0.14 (−2.1, 2.2)	−1.1 (−5.1, 2.1)
2015 vs 2009	−15.9 (−24.3, −5.2)	−2.8 (−5.2, −0.8)	−3.1 (−7.5, 0.8)
2015 vs 2011	−23.1 (−30.6, −13.0)	−3.0 (−4.7, −1.2)	−2.0 (−5.0, 1.5)
2015 vs 2009, 2011	−20.7 (−27.8, −11.3)	−2.9 (−4.5, −1.3)	−2.3 (−5.2, 1.0)
ds[d,f]			
Cohort year			
2011 vs 2009	5.3 (−3.6, 13.2)	−0.6 (−1.9, 0.4)	−2.5 (−5.5, −0.5)
2015 vs 2009	−28.3 (−34.9, −18.5)	−2.5 (−3.7, −1.7)	−3.9 (−7.1, −0.8)
2015 vs 2011	−33.6 (−38.5, −24.0)	−1.9 (−2.6, −1.3)	−1.4 (−3.3, 1.6)
2015 vs 2009, 2011	−31.9 (−36.1, −23.2)	−2.1 (−2.7, −1.6)	−2.1 (−4.0, 0.8)

Note. CI = confidence interval; dmfs = decayed, missing, filled tooth surfaces; ds = decayed tooth surface; ECC = early childhood caries.

[a]Adjusted for child age, gender, ethnicity, insurance; caregiver education; > 1 child in the house; caregiver or other family with cavity; and all 8 oral health behaviors on behalf of the child.

[b]Zero-inflated negative binomial model was on the basis of 100 000 simulations of all children with and without ECC.

[c]Zero-truncated negative binomial model was on the basis of 100 000 simulations of children with ECC.

[d]Decayed included d2 (caries in enamel only) and d3 (caries in enamel and dentin) lesions but not d1 (precarious).

[e]Zero-inflated negative binomial model n = 775, zero-truncated negative binomial model n = 393.

[f]Zero-inflated negative binomial model n = 387, zero-truncated negative binomial model n = 270.

found an improvement in dental experience when 4 or more FVAs were received. Collectively, these findings support the provision of early and frequent OHP services by medical providers. A better understanding of these services on precarious (d1) decay is needed.

Our OHP intervention included the provision of oral health instruction. Recognizing that the intention of providing these instructions was to influence caregiver behaviors on behalf of the child, we measured caregiver-reported OHBs rather than the provision or receipt of instruction. We then adjusted our regression analyses for the OHBs to better understand the impact of FVA on ECC. Caregivers of the children in the 2015 cohort (≥ 4 FVAs) reported more favorable OHBs than did caregivers in previous cohorts, with the exception of the use of fluoridated toothpaste or the consumption of tap water. These differences may suggest that families who received more FVAs also received more oral health instruction, which influenced their OHBs. We encourage further research to better understand the multifactorial influences on a child's risk to develop ECC, including those of caregiver OHBs.

When we analyzed the mean ds and dmfs only in the children with ECC across cohorts, we found a reduction in ds mean (untreated decay) but not in mean dmfs (treated and untreated decay). This may suggest that the children who developed ECC had more access to restorative dental services. The collective efforts of medical and dental providers, as well as efforts to change the norms of families accustomed to living with dental disease, will require additional approaches that address the upstream influences on their oral health—including dental services for all—and the downstream influences—including tooth-level care.[30]

The primary prevention of ECC by providing OHP activities at early medical WCVs takes advantage of the frequent visits young children have with medical providers but does not replace a dental home for children. Once children reach 3 years old, WCVs are recommended annually and preventive dental visits are recommended biannually. Medical and dental providers must work together to ensure that children receive enough early preventive oral health services. We have presented evidence that suggests that these services, specifically FVA, need to be provided early and frequently.

Previous findings described factors that both promote and create barriers to medical provider delivery of OHP services. Promoters included community need and program support; barriers included lack of time, training on how to build an OHP program, and lack of referral dentists.[16,31–34] Reimbursement has been reported to promote program adoption, and the lack of adequate reimbursement has been reported as a barrier. Our findings suggest that medical providers working in large health care systems can learn new skills and incorporate them into their standard of care with sufficient support—such as being trained, having systems to standardize care delivery, and tracking quality improvement metrics—and that this work can improve their patients' oral health–related outcomes.

Public Health Implications

Medical providers have a unique opportunity to use health care visits to promote the primary prevention of ECC. Transforming their practice to include OHP services takes time but can improve children's oral health outcomes. OHP education and ongoing technical assistance programs, such as Cavity Free at Three, are necessary for practice transformation. Our findings suggest that children at risk for ECC could benefit if state policies regarding the interprofessional provision of and reimbursement for OHP services allow at least 4 FVAs by age 3 years.

Additional work is needed to better understand how to engage medical providers in the provision of OHP services. These strategies include integrating dental hygienists into medical teams to comanage children at highest risk for ECC.[35] Our findings contribute new evidence regarding a best practices model for the interprofessional delivery

of preventive oral health services to young children. AJPH

CONTRIBUTORS

P. A. Braun conceptualized and designed the study. P. A. Braun, K. Widmer-Racich, and C. Sevick led the acquisition and analyses of the data. All authors interpreted the data, wrote the article, approved the final version of this article, and agreed to be accountable for all aspects of the work.

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HUMAN PARTICIPANT PROTECTION

This study was approved by the Colorado Multiple institutional review board.

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