The American Academy of Pediatric Dentistry defines early childhood caries (ECC) as the presence of 1 or more decayed teeth, missing teeth (due to caries), or filled tooth or tooth surfaces in any primary tooth in a child <6 years of age.1,2 ECC develops when teeth become colonized with cariogenic bacteria that metabolize carbohydrates on the tooth surface, forming acid that leads to demineralization of the tooth and resultant decay.3

Early risk assessment is the first step in prevention.4,5 Primary prevention involves preventing the transfer of cariogenic bacteria from mother to infant during eruption of the primary dentition, which occurs between 6 and 30 months of age.4,5 Secondary prevention involves oral hygiene instructions, dietary counseling, and early application of fluoride to manage acid-producing bacteria and possibly reverse the caries process.5 Few children <2 years of age establish a dental home

**BACKGROUND AND OBJECTIVES:** The American Academy of Pediatrics recommends periodic oral health risk assessments (OHRAs) for young children to prevent early childhood caries and promote oral health. The objective of this quality improvement project was to incorporate OHRAs, including documentation of the oral screening examination, into well-child visits for patients aged 12 to 47 months to drive (1) improved rates of preventive fluoride varnish (FV) application and (2) improved dental referrals for children at high risk for caries.

**METHODS:** We identified a quality gap in our OHRAs, oral examination completion, FV application rates, and dental referral rates via retrospective data collection. Plan-Do-Study-Act cycles targeted modification of electronic medical record templates, oral health education, and standardization of work processes. Process and outcome measures were analyzed with statistical process control charts.

**RESULTS:** At baseline, OHRAs and oral screening examinations were documented in <2% of patients. Of eligible children, 42% had FV applied. Routine dental referrals before age 3 years were uncommon. After multiple Plan-Do-Study-Act cycles, documentation of OHRAs and oral screening examinations (process measures) improved to 45% and 73%, respectively. The primary outcome measure, FV rates, improved to 86%. Referral of high-risk patients to a dentist improved to 54%.

**CONCLUSIONS:** A systematic, evidence-based approach to improving oral health, including electronic medical record–based interventions, resulted in improved documentation of oral health risks and oral screening, improved rates of FV application in young children, and increased identification and referral of high-risk patients.

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**POTENTIAL CONFLICT OF INTEREST:** The authors have indicated they have no potential conflicts of interest to disclose.
for this preventive care by age 12 months as recommended.6 With this in mind, the American Academy of Pediatrics (AAP) recommends that primary care clinicians play an active role in promoting dental health and preventing caries through periodic oral health risk assessments (OHRAs) of children, beginning at 6 months of age. The AAP developed an OHRA Tool in 2011 to facilitate this recommendation.7,8 In 2015, Douglass and Clark6 examined the effectiveness of the provision of oral preventive services in the primary care setting, the barriers to and potential cost savings of this care, and the effectiveness of current policy strategies regarding oral health care in young children. This review included studies from Medicaid programs in several states, including North Carolina, Washington, and Connecticut. They concluded that preventive services such as risk assessment, oral health counseling through motivational interviewing, and fluoride varnish (FV) application could be successfully implemented in the primary care setting, but common barriers such as time, integration of FV into routine office procedure, and resistance from support staff, etc, still exist. These barriers impact care. In a 2012 survey to physicians about childhood oral health, although 76% reported receiving oral health training, just 41% supported FV application in the office, and only 7% reported actually applying FV.9

Specifically in our community, authors of the Greater Kansas City Oral System Assessment of 2014, published by the Health Care Foundation of Kansas City, examined the state of oral health services in 5 counties in Missouri and Kansas through data analysis and surveys of oral health providers and stakeholders. An important finding was that just 30% and 40% of children with Medicaid insurance in Missouri and Kansas, respectively, received dental or oral health services in 2012. Noted was the lack of coordination between the oral health and primary care systems and the need for a focus on preventive oral services. They recommended training for primary care providers, integration of health care systems to meet the needs of underserved populations, and incorporating dental health educators into the medical team.10

The impact of the lack of preventive oral health care is profound. Significant morbidity and even mortality can result from untreated caries. In 2000, the Surgeon General’s Report identified dental caries as a “silent epidemic” and dental health as the primary unmet need for children.1 Data from the 2011 to 2012 NHANES revealed that ECC affects 24% of children 2 to 5 years of age and 53% of children 6 to 8 years of age. Approximately 58% of 12- to 19-year-olds and 90% of adults over age 20 years have experienced caries in their permanent dentition, providing evidence of the progressive nature of this disease.11,12

To address this unmet need, oral health preventive services were incorporated into our primary care services in 2008 with the initiation of FV application in 1- to 3-year-old children at well-child visits. FV rates rose but plateaued at 40%. The objective of this quality improvement (QI) project was to incorporate OHRAs, including documentation of the oral screening examination, into well-child visits for patients aged 12 to 47 months to drive (1) improved rates of preventive FV application and (2) improved dental referrals for children at high risk for caries.

METHODS

Context

The Pediatric Care Clinic (PCC) is a primary care clinic within an urban, academic children’s hospital. Thirty-one pediatricians, 13 nurse practitioners, and 60 pediatric residents working in 4 clinic pods see ~46,000 patient visits annually, with 50% of those visits being well-child examinations. The patient population demographics are as follows: 40% African American, 28% Hispanic, 17% white, and 8% multiracial. Twenty-one percent of patients do not speak English, and 85% of patients are insured by Medicaid. Complete ambulatory documentation in the Cerner Electronic Medical Record (EMR) began in 2012. As part of the clinic’s patient-centered medical home (PCMH) transformation, previsit planning and huddles began in 2014.

Interventions

We examined our performance by process mapping (Fig 1), which identified multiple opportunities to effect change. A prioritization matrix was used to select interventions. Standardization of the practice to consistently place the FV kits within reach of the provider responsible for applying it was initiated across all clinic pods. We modified the Cerner EMR template as follows: (1) we revised the “Physical Examination” section to include prompts for documenting the state of teeth and gums, (2) the “Dental History” section to include the majority of the AAP OHRA Tool questions, and (3) the “Plan” section to include prompts to document FV application as well as reasons for not applying it and prompts to document dental referrals (by providing a list of community dentists or making a general recommendation to see a dentist). The provider was responsible for documentation in all these sections of the note.

Non-EMR–based interventions were chosen to address other key areas identified during process flow mapping; these included communication, workflow, and education. Communication during
daily staff huddles reminded providers to perform OHRA and to review patients’ FV needs at their preclinic provider and nurse dyad huddles. Communication to providers of group and individual data were implemented on a monthly basis. Workflow changes involved having care assistants (clinic personnel working under supervision of clinic nurses who obtain vitals, some medical history, and transports patients within clinic) inquire about and document the approximate date of the last dental visit or upcoming appointment during check-in. An updated list of local dentists was made available to providers in the examination rooms to hand out to patients. Provider education on oral health was given by our dental chairperson at a lunchtime meeting, and visual reminders to apply FV were posted in work areas and examination rooms. A time line of these interventions is listed in Table 1.

**Measures**

Data were extracted from the EMR for all patients aged 12 to 47 months seen for well-child visits. Periodic audits of data occurred, particularly after each EMR modification, to ensure data were captured completely and accurately.

Process measures included (1) the percentage of patients aged 12 to 47 months seen for well-child visits who had documentation of an oral screening examination. An OHRA required evaluation for at least 1 risk and 1 protective factor for ECC per the AAP OHRA Tool, whereas the oral screening examination required documentation of the state of teeth or gums (in a predentate child). The screening examination referred to above is distinct from the comprehensive oral examination, which only qualified dental health professionals perform. We chose these measures to monitor our progress in using the AAP OHRA Tool, which incorporates multiple questions assessing for both risk and protective factors as well as clinical findings to determine a child’s risk for caries. This tool was piloted in several practices by the QI Network.
and was found to increase the identification of high-risk patients for dental referrals from 11% to 87%.13

Our primary outcome measure was the percentage of eligible children who had FV application (a National Quality Forum–endorsed oral health measure).14 All children <6 years of age were eligible for FV application if they did not have an existing dental provider, had not had FV applied in the previous 6 months, and had 4 or more teeth. If children did not meet these criteria, the provider could still choose to apply FV if applying FV was in the patient’s best interest; for example, a provider could choose to apply fluoride in a child at high risk if 3 months had elapsed since the previous FV application, and the patient had yet to see a dentist. All FV applications in children 12 to 47 months of age (which was the age group of focus for the project) were included in the calculations.

Our second outcome measure was the percentage of children at high risk referred to a dental provider. Children at high risk were identified as those who had any caries activity on oral screening examination or had a primary caregiver with active caries in the previous 12 months.8 Although we promoted dental referrals starting at age 1 year for all children, we chose this measure to identify children at absolute high risk (AHR) for caries, according to the AAP OHRA Tool, to track our dental referral patterns for those with the greatest need for dental services in a resource-limited environment. Wait time (days between order and appointment) in the hospital-based dental clinic was chosen as a balancing measure to monitor the effect of increased referrals.

### Analysis

Process and outcome measure data were extracted electronically in a monthly report. Baseline data, available for the FV application and oral screening examination measures, and postintervention data for all measures were plotted on p-charts and analyzed by using Excel QI macros. Dental referrals for patients at high risk for caries were tracked quarterly. The balancing measure data were extracted from a separate report and tracked over 10 months. Special cause variation was defined as a shift of 8 or more points above the previous average, a trend of 6 or more points up or down, or a single point outside the 3 σ control limits. Control charts were updated when data revealed special cause variation.

### RESULTS

In 2016, the last complete year of this project, there were 6100 well-child care visits for children aged 12 to 47 months. Out of those visits, 2554 patients (42%) had an OHRA, 4201 (69%) had documented oral screenings, and 3729 of 4652 eligible patients (80%) had FV applied. There were 266 patients identified as AHR for caries. Of the 177 AHR patients without a dental provider, 88 (~50%) were referred to a dentist. Our findings from the onset of this project (2013) to date are summarized below.

Documentation of OHRA improved from a baseline of 2% (not shown) to a mean of 17% shortly after the incorporation of the OHRA Tool into the EMR in 2013. After several Plan-Do-Study-Act (PDSA) cycles, the rate improved to a mean of 48% (Fig 2).

Documentation of oral screening examinations improved from a baseline of 0% to 10% immediately after incorporating a dental section of the physical examination into the EMR. Through several PDSA cycles, documentation of the screening examination improved to 73% (Fig 3).

FV application rates improved from a baseline of 42% to a mean of 79%. Application rates have remained consistently above the mean in the last 10 months of the project, peaking at 86% in February 2017 (Fig 4).

Rates of referral of children at high risk to a community dentist or the hospital-based dental clinic rose from a baseline of 8.6% (third quarter of 2013) to 54% (first quarter of 2017) (Fig 5). This measure was tracked quarterly because of the low monthly numbers.

Except for a solitary unsustainable special cause point in February 2016, there was no change in the days between referral order placement and appointment for dental referrals in our hospital-based dental clinic (Fig 6).

### DISCUSSION

In this QI project, we have successfully improved the provision of oral health services in primary care by improving our rates of FV application and initiating dental referrals for young children at high risk for caries. Through process measures requiring documentation of OHRA and oral screening examinations at well-child visits, we

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**TABLE 1 List of Interventions Performed During the Project, Listed in Chronological Order**

<table>
<thead>
<tr>
<th>Date</th>
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<td>July 2013</td>
<td>OHRA template embedded in EMR. Standardization of practices</td>
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<td>February 2014</td>
<td>Oral health template embedded into EMR</td>
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<td>February 2015</td>
<td>“Oral Health Plan” section modified in EMR</td>
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<td>March 2015</td>
<td>Individual data about performance on process and outcome measures sent to providers</td>
</tr>
<tr>
<td>May 2015</td>
<td>Staff training about dental caries and FV given by dentist</td>
</tr>
<tr>
<td>October 2015</td>
<td>CA documents last dental visit</td>
</tr>
<tr>
<td>March 2016</td>
<td>OHRA template modified in EMR</td>
</tr>
<tr>
<td>April 2016</td>
<td>Reminders in daily huddles</td>
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CA, care assistant; HEENT, head, eyes, ears, nose, and throat.
provided an opportunity to identify high-risk children and provided appropriate oral health counseling. The clinic flow processes and EMR template changes improved our process and outcome measures. Addressing barriers such as inconsistent provision of FV kits to the provider facilitated provider application of FV. Providing updated lists of local dentists who accepted Medicaid improved dental referrals.

Meropol et al.15 studied a novel approach to simultaneously improving the delivery of 3 pediatric preventive services, including FV application, in 30 practices in Cleveland, Ohio. This approach, called Practice-Tailored Facilitation Intervention, involved weekly visits from a practice facilitator who implemented rapid cycle change tailored to individual practices, developed long-term relationships with providers, and provided necessary audits, staff training, feedback, and redesign of practice systems. In the first 4 months of the 6-month study period, FV application rates rose from a baseline of <1% to 89% in the practices randomly assigned to receive facilitation intervention versus 4.4% in the control group.15 In our project, by incorporating a less-costly model by using a practice change champion with access to local improvement expertise, barriers to effective care were identified through process flow mapping, data were fed back to the clinical teams, and changes were implemented to drive improved outcomes. Although our FV application rates peaked at 86%, higher rates are feasible with sustained intervention.

Efforts to promote oral health care in primary care settings have been championed by the AAP,16 the American Academy of Pediatric Dentistry,17 and the Campaign for Dental Health and its affiliates.18 The federal government has encouraged these services by providing physician reimbursement for FV applications through Medicaid programs in 49 states, currently.19 Following the US Preventive Services Task Force recommendations, FV application is now recommended for all children from time of tooth eruption, irrespective of risk.20

Despite all these efforts, barriers still exist in implementing oral health services in the primary care setting. In our setting, nonstandardized clinic workflow processes, lack of templated EMR documentation, and inconsistent access to FV kits were some of the barriers identified.

By addressing these barriers, we improved our FV application rates,
our primary aim, and initiated dental referrals of high-risk patients as a secondary aim. Documentation of OHRA questions improved, although it lagged behind our other measures. The OHRA process measure did not appear to influence FV application as much as we expected. We assume that the recommendation for FV application irrespective of risk influenced this. OHRA documentation could be improved by having support staff ask the questions. The oral screening examination is an important aspect of risk assessment that we intentionally tracked as a separate measure. Our improved performance here likely influenced both outcome measures. Our rates of dental referral for high-risk children peaked at 59% in the first quarter of 2016 (Fig 5). Per Douglass and Clark,6 “Dental referral and case management for children at high risk for caries is important but often not very successful.” Our experience is similar, but we will continue to explore barriers to achieving our referral goals. Overall, the success of this program was influenced by the involvement of stakeholders and local QI experts. The adoption of the project as a division goal and the provision of maintenance of certification credits to physician providers were important factors.

Looking holistically at oral health in the primary care setting, there are several key components to successfully integrating care. Although the evidence for the validity of current caries risk assessment tools in predicting caries risk is weak, these tools do provide opportunities for patient-specific counseling and oral health education for the family.21 Caries incidence may be decreased with motivational interviewing and counseling about good oral hygiene and diet, thus providing some evidence that introducing a risk assessment tool may help oral health overall.22,23 The most important known predictor of future caries is current or previous caries experience, making the importance of documenting a good examination paramount.16 FV application has been shown in several studies to reduce the incidence of caries; thus, it is an excellent primary outcome measure for this QI intervention.20,24

In this project, we looked at oral health through each of these lenses.
and clinical workflow resulted in improvement in FV application and high-risk dental referrals.

There are several limitations to this QI project. We established exclusion criteria for FV application early in the project on the basis of recommendations of when FV should be applied (ie, when the child has a sufficient number of teeth) to prevent unintended fluorosis. The denominator for our primary outcome measure was based on these exclusion criteria. However, because of the fluid nature of this QI project, because changes in recommendations to apply FV at tooth eruption occurred during the intervention period, provider judgment could supersede exclusion criteria, should the right clinical scenario arise. Thus, a few patients who could have benefited from FV application may have been excluded. In addition, we relied on providers’ documentation to know that FV was applied. This documentation was not compared with our actual supplies of FV, and thus actual FV application rates may be underreported. Lastly, there may be limits to how generalizable our outcomes are to general outpatient pediatric practice. This project started shortly before and continued through the PCC’s preparation for certification as a PCMH. The ongoing process changes required for certification may have benefited the oral health project through staff desire for successful certification. Conversely, the additional PCMH-related process changes could have induced “change fatigue” and negatively impacted the project. Despite these limitations, the response to our interventions over time is robust, and we attained our primary outcome measure goal.

CONCLUSIONS

Incorporating EMR-based oral health tools helped improve the provision of and documentation of OHRA and oral health examinations. The addition of clinical workflow changes helped improve the rates of FV application and dental referrals for high-risk patients. This project has spread successfully to 2 satellite clinics in our hospital system. An important next step would be to develop closer collaboration with community dentists to ensure that young children at high risk for caries receive services in a timely manner.

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# Promoting Oral Health in Childhood: A Quality Improvement Project

Abiye Okah, Kristi Williams, Nasreen Talib and Keith Mann

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