ARTICLE 2

Measuring quality of dental care
Caries prevention services for children

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Background. The authors conducted a study to validate the following 3 evidence-based, process-of-care quality measures focused on dental caries prevention for children with an elevated risk of experiencing caries: sealants for 6- to 9-year-olds, sealants for 10- to 14-year-olds, and topical fluoride.

Methods. Using evidence-based guidelines, the Dental Quality Alliance developed measures for implementation with administrative data at the plan and program levels. To validate the measures, the authors used data from the Florida and Texas Medicaid programs and Children’s Health Insurance Programs and from national commercial dental benefit plans. Data were extracted from 414 randomly selected dental office records to validate the use of administrative data to accurately calculate the measures. The authors also assessed statistically significant variations in overall measure performance.

Results. Agreement between administrative data and dental records was 95% for sealants ($\kappa = 0.82$) and 90% for topical fluoride ($\kappa = 0.78$). Sensitivity and specificity were 90.7% and 88.5% for topical fluoride and 77.8% and 98.8% for sealants, respectively. Variation in overall measure performance was greatest for topical fluoride ($\chi^2 = 5,887.1; P < .01$); 18% to 37% of children with an elevated risk of experiencing caries received at least 2 topical fluoride applications during the reporting year. Although there was greater variation in performance for sealants for 6- to 9-year-olds (range, 21.0-31.3%; $\chi^2 = 548.6; P < .01$) compared with sealants for 10- to 14-year-olds (range, 8.4-11.1%; $\chi^2 = 22.7; P < .01$), overall sealant placement rates were lower for 10- to 14-year-olds.

Conclusions. These evidence-based, caries prevention process-of-care quality measures can be implemented feasibly and validly using administrative claims data.

Practical Implications. The measures can be used to assess, monitor, and improve the proportion of children with an elevated risk of experiencing dental caries who receive evidence-based caries prevention services.

Key Words. Quality of care; performance measure; caries prevention.

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resources. Its initial measurement set (referred to as the Starter Set) focused on population-based quality measures of caries prevention and disease management for children that can be calculated using administrative data. The DQA developed the Starter Set measures using a transparent, evidence-informed, consensus-based process. Initial measure concepts were identified using a comprehensive environmental scan and expert consensus rating process regarding each potential measure’s importance, feasibility, and validity. On the basis of the expert ratings and identified gaps in measurement, the DQA selected a subset of measure concepts for measurement development and testing. The DQA’s overall approach for measurement development and testing for the Starter Set has been described elsewhere. The purpose of this article is to provide the details of measure validation for 3 evidence-based, dental care quality measures of caries prevention that were included in the Starter Set: Sealants for 6–9 Year-Old Children at Elevated Caries Risk (Sealants 6–9), Sealants for 10–14 Year-Old Children at Elevated Caries Risk (Sealants 10–14), and Topical Fluoride for Children at Elevated Caries Risk (Topical Fluoride). These 3 measures fall within the category of process-of-care quality measures, in which a process of care is a “health care–related activity performed for, on behalf of, or by a patient.” Process measures should be “supported by evidence that the clinical process—that is the focus of the measure—has led to improved outcomes.” The DQA developed the measures on the basis of evidence regarding the effectiveness of pit-and-fissure sealant placement on permanent molars (process of care) and topical fluoride application (process of care) in reducing dental caries (outcome) in children who have an increased risk of experiencing caries (targeted population for quality measurement as supported by the evidence). An independent expert panel review of the testing results reported in this article determined that the measures met National Quality Forum (NQF) criteria for scientific acceptability of quality measures, and all 3 measures received NQF endorsement (NQF measures 2508, 2509, and 2528). NQF endorsement is an important criterion for quality measure selection among many public and private payers. For example, in 2014, CMS added 1 endorsed measure—Sealants 6–9—to the 2015 Core Set of Children’s Health Care Quality Measures for Medicaid and the Children’s Health Insurance Program (CHIP). 

METHODS

Measure specification. On the basis of expert ratings of measure concepts identified through the environmental scan, identified gaps in measurement, and evidence regarding the effectiveness of different processes of care, the DQA identified professionally applied topical fluoride and pit-and-fissure sealants on permanent molars as primary candidates for caries prevention process-of-care measures associated with improved health outcomes (that is, to reduce dental caries and associated sequelae). The DQA developed the measure specifications to be consistent with the evidence regarding the effectiveness of these procedures and feasible to implement with administrative enrollment and claims data. Figure 1 summarizes the criteria for each measure’s denominator and numerator. The denominator identifies the population who should receive the indicated process of care (that is, topical fluoride or sealants). The numerator is the subset of the population in the denominator who actually received the preventive service. The “measure score” is the numerator divided by the denominator (that is, the percentage of the target population who received the indicated process of care). The detailed measure specifications are publicly available. 

**Topical fluoride.** High-level evidence suggests that receiving professionally applied topical fluoride, starting as early as 6 months of age and applied at least every 3 to 6 months in children who are at increased risk of experiencing caries, is beneficial in reducing dental caries. The Topical Fluoride quality measure, which measures the percentage of children with an elevated risk of experiencing caries who receive at least 2 topical fluoride applications during the reporting year, directly reflects evidence-based guidelines regarding an effective caries prevention procedure (professionally applied topical fluoride), the population for whom this care is most effective (children at elevated caries risk), and the frequency required for clinical effectiveness (at least every 3 to 6 months). Topical fluoride is identified in the claims data by using the Code on Dental Procedures and Nomenclature (CDT) codes 1206 (topical fluoride varnish application) and 1208 (topical application of fluoride; historical codes D1203 and D1204); thus, both fluoride varnish and fluoride gel applications are captured.

**Sealants.** Evidence-based clinical guidelines recommend that sealants be placed on pits and fissures of children’s primary and permanent teeth when it is determined that the tooth, or the patient, is at risk of experiencing caries, and there is stronger evidence of the effectiveness of sealants that have been placed in

permanent molars compared with primary molars.\textsuperscript{35}
Sealants benefit children across a wide age range; however, to achieve greater effectiveness in caries prevention, it is recommended that sealants be placed on teeth soon after they erupt.\textsuperscript{2,19} The 2 DQA sealant measures directly reflect evidence-based guidelines regarding an effective caries prevention procedure (sealant application) as well as the specific tooth type for which the evidence is the strongest (permanent molar), and the timing of sealant placement to maximize effectiveness (shortly after eruption: aged 6 to 9 years for first molars and aged 10 to 14 years for second molars).

Elevated risk. Evidence-based guidelines indicate that topical fluoride and sealant application are most effective for children who are at increased risk of experiencing caries. Thus, the denominator inclusion criteria for these measures are limited to children identified as having a moderate to a high risk of experiencing caries. Dental administrative claims data typically do not include diagnostic codes. However, the measure specifications include the 2 CDT codes (D0602 and D0603) that are used to record moderate and high caries risk assessment findings. Because these 2 codes were introduced in 2014 and had not yet been adopted widely, the measure specifications also included a recent history of restorations and other treatment indicative of caries experience as the best available proxy to identify caries risk in administrative data. The results of a systematic review indicated that previous dental caries experience was an important predictor of future risk of experiencing caries in the primary and permanent dentition.\textsuperscript{20} Other investigators have used a similar approach, using placement of restorations as a proxy for caries risk, to identify adults at high risk of experiencing caries for a fluoride performance measure used within the Veterans Affairs health care system.\textsuperscript{21} When caries treatment services are used to identify children at increased risk of experiencing caries, only those children who receive treatment for dental caries will be identified as being at elevated risk; therefore, children who are at risk but do not receive treatment services will not be identified. Gibson and colleagues\textsuperscript{17} commented that “[performance measures] usually are not meant to identify every case that requires an intervention, but rather to stimulate the implementation of a clinical process that will result in a positive medical outcome for the patient.” This is precisely the intent of the 3 DQA measures: to evaluate receipt of evidence-based prevention for those children who can be identified positively as having an elevated risk and not to develop prevalence estimates of all children who are at elevated risk. In developing these measures, the DQA’s philosophy was that “this proposed methodology is not intended as a ‘risk assessment tool’ to be used at the level of the individual patient either to assess risk or to define dental benefits or qualification for services for specific groups of children. It is only a model for the purpose of identifying children who can be confirmed to be at ‘elevated risk’ for caries using claims data for the purpose of measuring program performance.”\textsuperscript{22}

Data sources. The DQA specified the measures for reporting at the dental plan and program (for example, Medicaid and CHIP) levels by using administrative enrollment and claims data for children with private or public dental benefits. The measures were tested using private and public dental benefits administrative data. Specifically, test data included person-level enrollment and dental claims data for children who received publicly funded insurance in the Texas and Florida Medicaid and CHIP programs as well as national commercial data from DentaQuest. The 5 data sources collectively represented a variety of delivery system models: dental fee-for

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**Figure 1.** Caries prevention process of care quality measures.
service in Texas Medicaid, a single dental benefits administrator (DBA) in Texas CHIP, dental fee-for-service and prepaid dental programs in Florida Medicaid, and 2 DBAs in Florida CHIP. The commercial data included members in indemnity and preferred provider organization product lines. We report on testing results for the calendar year (CY) 2011 for 4 of the programs and CY 2010 for Florida Medicaid because 2011 data were not available.

**Study design.** For measure testing, we followed NQF guidance regarding the scientific acceptability of measure properties, which recommended validity testing of both the critical data elements used to calculate the measure and the overall measure score, although testing at only 1 level was required for endorsement.25

**Critical data element validation.** Newly developed measures frequently do not have numerous testing sites; therefore, investigators often conduct reliability and validity assessments at the critical data element level by comparing the data used in the measure to an authoritative source.24 Validation of the correctness of the data elements used to calculate the measure score provides evidence of the correctness of the computed quality measure score. Validation of administrative data elements typically involves comparison with data abstracted manually from the patient’s full health record as the authoritative source. The critical data elements for the caries prevention measures include member identification (to link claims and enrollment data), date of birth, monthly enrollment indicator, date of service, and CDT codes. Because the first 4 items are used in virtually all quality measures relying on administrative data and are essential for reporting or billing purposes, we determined that these fields did not require additional validation. Thus, we focused critical data element validation on assessing the accuracy of the dental procedure codes reported in the claims data.

To assess whether fluoride application and sealant placement are captured accurately by claims data, dental procedure codes in the claims data were compared with manual reviews of the dental records from the offices of dentists who provided services to the children (“record reviews”). Two coders certified as registered health information technicians (RHITs) conducted the record reviews, using a pilot-tested record abstraction form and protocol. The RHITs recorded in a Microsoft Access (Microsoft) database whether there was any evidence of topical fluoride or sealants, respectively, applied to the teeth during the visit. The programming team queried the administrative claims data for the same members and dates of service to record the presence or absence of CDT codes for topical fluoride (D1203, D1204, and D1206) and sealants (D1351).

Validation of administrative claims data against the patient’s health record commonly includes calculating sensitivity (that is, accuracy of administrative data indicating a service was received when it is present in the record), specificity (that is, accuracy of administrative data indicating a service was not received when it is absent from the record), positive predictive value (PPV) (that is, probability that a procedure that is present in the administrative data also is present in the record), and negative predictive value (NPV) (that is, probability that a procedure that is absent from the administrative data is also absent from the record).25-28 Investigators also commonly calculate the $\kappa$ statistic to evaluate the agreement between administrative claims data and the patient’s health record.25,27,28 A $\kappa$ statistic value of 0 reflects the amount of agreement that would be expected to be observed by chance; a value of 1 indicates perfect agreement. When interpreting values between 0 and 1, 0.01-0.20 indicates “slight” agreement, 0.21-0.40 indicates “fair” agreement, 0.41-0.60 indicates “moderate” agreement, 0.61-0.80 indicates “substantial” agreement, and 0.81-0.99 indicates “almost perfect” agreement.29 Quan and colleagues30 described their inclusion of the $\kappa$ statistic as “a more ‘neutral’ description of agreement” between the 2 data sources if an investigator considers record reviews as a comparator but not necessarily the reference standard. However, the investigators of another study noted the limitations of the $\kappa$ statistic, including the influence of procedure prevalence and marginal distributions on the resulting values and elected to report observed agreement instead.26 To allow comparisons with previous research results, particularly validation of dental procedures,28 we report overall agreement, the $\kappa$ statistic, sensitivity, specificity, PPV, and NPV. Because the $\kappa$ statistic, PPV, and NPV are influenced by procedure prevalence, we report the prevalence values to provide context for the interpretation of the findings. We also provide 95% (2-sided) confidence intervals (CI) to indicate the precision of the estimates. We conducted validation analyses using Stata/MP 12.1 (StataCorp).

**Additional validity testing: relevance of tooth type.** Evidence for caries prevention is stronger for sealant placement on permanent first molars compared with primary molars.31 In addition, it is recommended that sealants should be placed on teeth shortly after they erupt.2,29 Thus, we also sought to evaluate how well the specifications addressed both the tooth type on which sealants were placed and the timeliness of care. We examined frequency distributions of sealant placement by tooth type in the administrative data for 3 of the programs. Specifically, we assessed the percentage of children with any sealants (regardless of tooth type), sealants on permanent first molars, and sealants on permanent second molars by age for children enrolled at least 1 month.

**Ability of measure scores to detect variations in performance.** At the measure score level, we evaluated the ability of the measure scores to detect statistically significant variations in performance within and between
reporting entities by examining 95% CIs around the measure scores and calculating the \( \chi^2 \) statistic. We used SAS 9.3 (SAS Institute) to create and manage the administrative data sets for each program and calculate the measure scores.

**Sample.** For the measures collectively, we included all members aged 0 to 20 years as of December 31, 2011 (2010 for Florida Medicaid), in the administrative data analytic files. Within the Medicaid programs, we excluded those who were not eligible for Early and Periodic Screening, Diagnostic, and Treatment benefits. The number of children within this broad sample who qualified for denominator inclusion varied according to the measure specifications.

Because of the high resource cost of conducting manual reviews of patient records from dental offices, we conducted validation of the critical data elements in the administrative data against patient dental records for a sample of children enrolled in the Texas Medicaid and CHIP programs. We selected a random sample of members who had at least 1 outpatient dental visit for record reviews. We requested these members’ outpatient dental records covering an 8-month period from the offices of dentists who provided services to these children. The targeted number of records was 400, and the expected return rate was 65% based on several years of dental and medical record reviews previously conducted for these programs. Therefore, we requested 600 records. We used these records for data element validation for several Starter Set measures, including the fluoride and sealant measures. The targeted number of 400 records met the sample size requirements for assessing validity using the \( \kappa \) statistic. Larger sample sizes are needed when the probability of positive ratings for the measure are either very low (closer to 0%) or very high (closer to 100%) compared with when the probability of positive ratings is close to 50%. For example, we observed sealant placement among 10- to 14-year-olds to be approximately 10%, which would require a relatively large sample size. A sample size of 335 is required to detect a statistically significant difference between a null \( \kappa \) value of 0.61 (that is, the lower bound of the “substantial agreement” range) and a value of 0.81 (that is, the lower bound of the “almost perfect agreement” range) at 80% power using a 2-tailed test with an \( \alpha \) of 0.05 when the proportion of positive ratings is expected to be 10%.  

We used only Texas Medicaid data to validate the critical data elements for the topical fluoride measure because it was not a reimbursed service in Texas CHIP during the study period.

We received approval for this retrospective study as expedited by the University of Florida Institutional Review Board. The approval included a full waiver of informed consent.

**RESULTS**

**Sample characteristics.** Table 1 provides the member characteristics for each of the programs. Across the 5 programs, there were 6,956,669 members aged 0 to 20 years enrolled for at least 1 month. Table 2 summarizes the number of children eligible for each measure’s denominator and numerator.

**Critical data element validation.** Of the 600 records requested, we received 414 (69%), exceeding the targeted number of 400. The 414 records represented 631 dates of service. Table 3 summarizes the agreement between the dental records and administrative data for fluoride and sealant application, respectively. Overall agreement

### Table 1

Descriptive characteristics of members aged 0 to 20 years enrolled for at least 1 month.

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>COMMERCIAL</th>
<th>FLORIDA MEDICAID</th>
<th>FLORIDA CHIP</th>
<th>TEXAS MEDICAID</th>
<th>TEXAS CHIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Members</td>
<td>184,152</td>
<td>2,068,670</td>
<td>317,146</td>
<td>3,544,247</td>
<td>842,454</td>
</tr>
<tr>
<td>Age Group Distribution, y (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1</td>
<td>1.54</td>
<td>6.05</td>
<td>NA†</td>
<td>7.05</td>
<td>0.11</td>
</tr>
<tr>
<td>1-2</td>
<td>5.75</td>
<td>14.23</td>
<td>NA†</td>
<td>14.32</td>
<td>5.34</td>
</tr>
<tr>
<td>3-5</td>
<td>12.68</td>
<td>19.26</td>
<td>3.81</td>
<td>19.46</td>
<td>11.70</td>
</tr>
<tr>
<td>6-7</td>
<td>9.57</td>
<td>10.47</td>
<td>13.05</td>
<td>11.21</td>
<td>12.30</td>
</tr>
<tr>
<td>8-9</td>
<td>16.02</td>
<td>9.19</td>
<td>15.00</td>
<td>9.85</td>
<td>14.40</td>
</tr>
<tr>
<td>10-11</td>
<td>10.55</td>
<td>8.74</td>
<td>15.71</td>
<td>9.03</td>
<td>14.03</td>
</tr>
<tr>
<td>12-14</td>
<td>16.09</td>
<td>11.87</td>
<td>23.73</td>
<td>11.63</td>
<td>19.57</td>
</tr>
<tr>
<td>15-18</td>
<td>22.13</td>
<td>14.73</td>
<td>28.70</td>
<td>13.19</td>
<td>22.54</td>
</tr>
<tr>
<td>19-20</td>
<td>11.50</td>
<td>5.47</td>
<td>NA†</td>
<td>4.27</td>
<td>NA†</td>
</tr>
<tr>
<td>Geographic Location (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>95.95</td>
<td>91.47</td>
<td>92.94</td>
<td>83.63</td>
<td>84.33</td>
</tr>
<tr>
<td>Rural</td>
<td>3.86</td>
<td>7.30</td>
<td>5.02</td>
<td>15.15</td>
<td>14.61</td>
</tr>
<tr>
<td>Missing data</td>
<td>0.19</td>
<td>1.23</td>
<td>2.04</td>
<td>1.22</td>
<td>1.06</td>
</tr>
<tr>
<td>Race and Ethnicity (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic white</td>
<td>NA†</td>
<td>29.89</td>
<td>NA†</td>
<td>17.36</td>
<td>NA†</td>
</tr>
<tr>
<td>Non-Hispanic black</td>
<td>NA†</td>
<td>29.39</td>
<td>NA†</td>
<td>15.08</td>
<td>NA†</td>
</tr>
<tr>
<td>Hispanic</td>
<td>NA†</td>
<td>29.65</td>
<td>NA†</td>
<td>58.07</td>
<td>NA†</td>
</tr>
<tr>
<td>Other and unknown</td>
<td>NA†</td>
<td>11.06</td>
<td>NA†</td>
<td>9.49</td>
<td>NA†</td>
</tr>
</tbody>
</table>

* CHIP: Children’s Health Insurance Program.
† NA: Not applicable; that is, the age category was not part of the program-eligible age range.
‡ NA: Not applicable; that is, race and ethnicity data were not available or had very high rates of missing data.
for topical fluoride application was 89.9%. The \( \kappa \) statistic value was 0.78, which is at the high end of the “substantial agreement” category. The values for both sensitivity and specificity were high at 90.7% and 88.5%, respectively. Positive predictive value was 93.5%, and negative predictive value was 83.9%. Overall agreement (concordance) for sealant placement was 95.2%. The \( \kappa \) statistic for sealants also was high at 0.82, indicating “almost perfect” agreement. Sensitivity was moderately high (77.8%), specificity was very high (98.8%), and the positive and negative predictive values were both high (> 93%). Collectively, the critical data element validation findings indicated good data element reliability and validity for the prevention measures. The strong evidence of the correctness of the critical data elements used to calculate the measure score supports the correctness of the overall measure score, which is a key component of establishing measure validity.

Relevance of tooth type for sealant placement.
Analysis of sealant placement by tooth type and age validated the importance of identifying the specific tooth type (permanent first molars and permanent second molars, respectively) and the corresponding age ranges (6 to 9 years and 10 to 14 years, respectively) in the specifications for the 2 sealant measures to have reliable indicators of whether children are receiving recommended and timely preventive services. Table 4 indicates, by age, the percentage of children who had a sealant placed on any tooth, a sealant placed on a permanent first molar, and a sealant placed on a permanent second molar; the same child could be included in more than 1 category. In the Florida CHIP and commercial programs, the percentage of children aged 6 to 9 years with sealants on permanent first molars was very close to the percentage of children with sealants on any tooth, suggesting that most children ages 6 to 9 years who received sealants received them on permanent first molars. However, in Texas Medicaid, there was a substantial difference between the percentage of children with a sealant on any tooth compared with the percentage of children with a sealant on a permanent first molar. For children aged 10 to 14 years, in all programs, the percentage of children with “any sealants” was greater than the percentage of children with sealants specifically on permanent second molars. Children aged 10 to 14 years may receive sealants or replacement sealants on premolars or permanent first molars, which confounds findings about whether permanent second molars are being sealed when the tooth type is not identified in the measure specifications. Failure to specify tooth type would result in counting in the numerator sealants placed on teeth other than those intended for the measure, thereby inflating the measure score and resulting in misleading comparisons between programs. Thus, we determined that incorporating tooth type in the measure specifications was significant and important.

Measure scores. Figure 2 provides the overall quality measure scores (and the 95% CIs) for each program. The measure scores are calculated from the denominator and numerator data in Table 2. For example, in Texas Medicaid, there were 1,172,846 children aged 0 to 20

**TABLE 2**

| Denominator and numerator eligibility for each quality measure. |
|-------------------|------------------|------------------|------------------|------------------|------------------|
| QUALITY MEASURE   | COMMERCIAL       | FLORIDA MEDICAID | FLORIDA CHIP*    | TEXAS MEDICAID   | TEXAS CHIP       |
| Topical Fluoride (No. Eligible) |                   |                  |                  |                  |                  |
| Denominator       | 42,919           | 196,995          | 50,697           | 1,172,846        | NA²              |
| Numerator         | 9,459            | 35,765           | 13,762           | 435,448          | NA²              |
| Sealants, 6 to 9 Years (No. Eligible) |                   |                  |                  |                  |                  |
| Denominator       | 9,860            | 72,333           | 16,528           | 460,222          | 59,907           |
| Numerator         | 2,227            | 15,222           | 5,179            | 109,016          | 13,785           |
| Sealants, 10 to 14 Years (No. Eligible) |                   |                  |                  |                  |                  |
| Denominator       | 14,764           | 68,017           | 28,371           | 443,058          | 87,407           |
| Numerator         | 1,601            | 5,744            | 3,002            | 49,089           | 9,260            |

* CHIP: Children’s Health Insurance Program.  
† NA: Not applicable; topical fluoride was not a reimbursed service.

**TABLE 3**

<table>
<thead>
<tr>
<th>PROCEDURE</th>
<th>CONCORDANCE, %</th>
<th>PREVALENCE, %</th>
<th>SENSITIVITY, % (95% CI)</th>
<th>SPECIFICITY, % (95% CI)</th>
<th>POSITIVE PREDICTIVE VALUE, % (95% CI)</th>
<th>NEGATIVE PREDICTIVE VALUE, % (95% CI)</th>
<th>( \kappa ) STATISTIC (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topical Fluoride Applied†</td>
<td>89.91</td>
<td>64.67</td>
<td>90.73 (85.70-94.18)</td>
<td>88.49 (80.63-93.43)</td>
<td>93.46 (88.84-96.33)</td>
<td>83.90 (75.74-89.79)</td>
<td>0.782 (0.710-0.853)</td>
</tr>
<tr>
<td>Sealants Applied‡</td>
<td>95.22</td>
<td>17.22</td>
<td>77.78 (68.56-84.98)</td>
<td>98.84 (97.37-99.53)</td>
<td>93.33 (85.50-97.26)</td>
<td>95.53 (93.33-97.05)</td>
<td>0.820 (0.758-0.882)</td>
</tr>
</tbody>
</table>

* CI: Confidence interval.  
† Dates of service: 317; number indeterminate records: 0.  
‡ Dates of service: 613; number indeterminate records: 4.
years enrolled in the program for at least 12 months continuously identified as being at elevated caries risk (denominator). Among these, 435,448 children received at least 2 topical fluoride applications during the year (numerator). Therefore, 37% of children identified as having an elevated risk of experiencing caries did not receive at least 2 topical fluoride applications during the year compared with sealants for 6- to 9-year-olds. Although there were statistically significant differences detected for both measures (aged 6 to 9 years: $\chi^2 = 548.6; P < .01$; aged 10 to 14 years: $\chi^2 = 22.7; P < .01$). Overall, sealant placement rates were much lower for 10- to 14-year-olds compared with 6- to 9-year-olds.

We also evaluated whether there were disparities in performance by subpopulations for the measures. To illustrate, Figure 3 shows the measure scores for topical fluoride application by age. There was a significant decrease in the measure scores for children as they moved through middle childhood years into the teen years, and the decline continued throughout the teen years. The use of the Starter Set measures to detect and reduce disparities, including race, ethnic, and geographic disparities, has been described in more detail elsewhere.28

**DISCUSSION**

The purpose of this study was to validate 3 caries prevention, process-of-care quality measures. Our results indicate that these measures can be implemented feasibly and validly by using administrative claims data at the program and plan levels. Our testing included validation of the critical data elements used to calculate the measure scores and the overall quality measure scores. Our critical data element validation findings are similar to the results of a study whose investigators used data from 3,751 patient visits in 120 dental practices participating in the Ohio Practice-Based Research Network to examine the concordance of chart and billing data with direct observation of dental procedures.28 For sealants, the authors of that study28 found lower sensitivity (73% compared with 78% in our study), similar specificity (100% versus 99%, respectively), and a similar $\kappa$ value (0.84 versus 0.82, respectively) of billing data compared with direct observation. For fluoride, they found lower sensitivity (80% versus 91%, respectively), higher specificity (98% versus 88%, respectively), and a similar $\kappa$ value (0.81 versus 0.78, respectively) of billing data compared with direct observation.28

Our findings for the overall quality measure scores indicate that there are variations in performance and significant opportunities for improvement. When measured at the program and plan levels, improvement requires engagement of all participants in the health care system, including the purchaser (for example, the state Medicaid agency), the plan (for example, the dental benefits administrator), the provider delivering the care, and the patient. For topical fluoride, the percentage of children identified as having an elevated risk of experiencing caries who received at least 2 topical fluoride applications during the year ranged from 18% to 37%. Even in the highest performing program, almost two-thirds of children did not receive the recommended prevention. The percentage of children receiving sealants on permanent molars was significantly lower among children aged 10 to 14 years at elevated caries risk (8-11%)
compared with those aged 6 to 9 years (21-31%). These findings represent missed opportunities to reduce the burden of dental caries, and they are consistent with other data indicating that children have suboptimal use of preventive dental services and that there are disparities in the receipt of preventive services. National data from CMS indicate large variations in preventive dental service use between states: 14% to 58% of children enrolled in Medicaid or CHIP for at least 90 continuous days in Federal Fiscal Year 2011 received some type of preventive dental service, broadly defined as any CDT code within the range of D1000 to D1999. An analysis of data from the National Survey of Children’s Health published in 2009 noted disparities in access to preventive dental services by race and income. An analysis of the Medicaid Analytic eXtract files for 9 states published in 2009 noted disparities in access to preventive dental services by race and income. An analysis of the Medicaid Analytic eXtract files for 9 states published in 2009 noted disparities in access to preventive dental services by race and income. 

As is often the case with new measure development, our validation testing was restricted in the number of measured entities included due to resource constraints, which may limit the generalizability of our findings. However, the programs represented included both private and public payers, including the Florida and Texas Medicaid and CHIP programs, which are among the largest and most diverse of these programs in the United States. Data available from CMS indicate that these 2 states also represented the lower and upper ranges of dental utilization. As described previously, our findings were consistent with results reported elsewhere in the peer-reviewed literature, which increases our confidence in the generalizability of our results. Coding inaccuracies can limit the validity of administrative data; however, our validation against the dental records found a very high accuracy of CDT procedure codes, with PPVs of 93% for both sealants and topical fluoride. Despite the high feasibility of implementation and relatively low cost of implementing measures by using administrative claims data, the lack of widespread use of diagnosis codes in dental claims has historically made it difficult to characterize caries risk. The measure specifications use a history

![Figure 2. Measure scores by program. CHIP: Children’s Health Insurance Program.](http://jada.ada.org)
of restorations and other caries-related treatment as the best available proxy to identify children at increased risk of experiencing caries until there is more widespread adoption of the new CDT codes to record clinical caries risk assessment findings. This methodology is limited because it is dependent on the documented presence of disease. In addition, claims history is required to most effectively implement this approach. However, implementation of the new caries risk assessment CDT codes should overcome both of these limitations. More generally, authors of other studies have identified the lack of standardized and widely used diagnosis codes as a key limitation in oral health quality measurement. Diagnostic information is critical for assessing disease burden, evaluating a patient’s current disease status, assessing the appropriateness of treatment, and evaluating oral health outcomes. This limitation was part of the rationale for initially focusing on process measures. To continue to move quality measurement forward in dentistry, however, diagnosis code capture is essential. Once diagnostic codes are consistently available in dental administrative claims data, existing process measures can be updated during their review cycles to incorporate this information, and new measures that focus more directly on oral health outcomes can be developed.

Some of the limitations associated with using administrative claims data can be overcome by using data from patient health records. There is increasing emphasis on developing quality measures that take advantage of the rich data contained within EHRs, including the Meaningful Use Medicare and Medicaid EHR Incentive Programs. EHR data contain significantly more clinical patient-level detail than is found in claims data (for example, it is possible to identify teeth that have untreated decay) and include all patients in a practice; thus, EHR data are potentially more reliable for measuring quality at the individual provider and practice levels.

The DQA concurrently developed 2 pediatric oral health measures for inclusion in Meaningful Use Stage 3, which will begin in 2017. Each data source offers advantages and limitations, and the measurement approaches are inherently different. Thus, it is important to recognize that

Figure 3. Topical fluoride measure scores by age category. CHIP: Children’s Health Insurance Program.
comparing performance on “similar” measures addressing the same care goal (for example, improving the use of dental sealants) that were developed using different data sources may not be appropriate or reliable. Furthermore, information systems to aggregate EHR data across large populations covered by a plan or program have not been established; therefore, using EHR data to calculate program or plan level measure scores remains a vision for the future.

CONCLUSIONS

Professionally applied topical fluoride and timely application of pit-and-fissure sealants to permanent molars are effective caries prevention services. In this study, we validated 3 evidence-based, process of care, caries prevention quality measures: Topical Fluoride for Children at Elevated Caries Risk, Sealants for 6–9 Year-Old Children at Elevated Caries Risk, and Sealants for 10–14 Year-Old Children at Elevated Caries Risk. Based on the study findings, NQF endorsed these 3 measures,37 and 1 of the measures (Sealants for 6–9 Year-Old Children) was included in the 2015 Core Set of Children’s Health Care Quality Measures for Medicaid and CHIP.38 Implementation of these measures will allow private and public payers at the program and plan levels to identify, address, and monitor performance gaps and disparities at any given time and over time. Performance improvement on these measures is expected to improve oral health outcomes and the overall health and well-being of children in the United States. ■

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