Implementation of an Integrated Community-Based Dental Care System for Low Income Children: Initial Findings

Oral health of low income populations................................................................. 3
Dental care system for low income groups: United States.................................. 3
  Traditional versus community-based dental care systems.............................. 3
  Integrated community-based dental care......................................................... 4
Evaluation Design .......................................................................................... 6
Outer settings: Oregon....................................................................................... 6
  Oral health....................................................................................................... 6
  Dental care system......................................................................................... 6
Inner setting: Advantage Dental Services, LLC and University of Washington...... 7
Innovation: Dissemination of evidence-based practice guidelines for caries control 7
Implementation Strategies: PREDICT model features...................................... 8
  Core components......................................................................................... 8
  Peripheral components............................................................................... 10
Implementation stages .................................................................................... 11
Evaluation........................................................................................................ 11
  Baseline assessments.................................................................................... 11
  Utilization..................................................................................................... 11
  Implementation process and contextual changes........................................ 12
Baseline assessments...................................................................................... 12
Utilization........................................................................................................ 12
Implementation process and contextual changes............................................ 14
Findings........................................................................................................... 15
Strengths......................................................................................................... 15
Challenges...................................................................................................... 16
Conclusions.................................................................................................. 19

Implementation of an Integrated Community-Based Dental Care System for Low Income Children: Initial Findings

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Abstract

**Background:** To improve access to care and reduce disparities in oral health of low-income children and pregnant women, this quality improvement program used expanded practice dental hygienists, provided an evidence-based risk assessment and dental caries management protocol-based care in community settings, and paid personnel based on performance. A health information technology system was implemented integrating community-based practice, case management, and clinic records.

**Objectives:** Our objective was to describe the first year of implementation of the program including the processes, services provided, and factors that helped and hindered these implementation efforts.

**Methods:** The mobile integrated community-based delivery system (PREDICT) was implemented as a quality improvement project within a large Dental Care Organization (DCO) that includes fixed dental clinics and contracted practices. The program is being tested in a randomized controlled trial. The target populations were Medicaid-eligible children and pregnant women in 7 rural counties in Oregon State USA. Data were collected from staff and community surveys, interviews, and administrative and dental health records.

**Results:** Baseline assessments indicated patient satisfaction with care and staff readiness to implement changes were high. In PREDICT counties 9 expanded practice dental hygienists provided 37,369 services - an average of 4,152 services per EPDH in 198 community sites. Utilization ranged from 33-63% of eligible children and 30-42% of women, respectively, by county. For patients with $\geq$1 visits, 42% received a needs assessment, 88% preventive services and 26% restorative or endodontic services. By dental care need levels, 34% were low, 30% moderate, 32% high and 4% were not assigned to a group. Among moderate-need group, 51% received 1 silver diamine fluoride application and 19% two applications. Within the high-need group referred to dental clinics, 11% had urgent needs, 56% non-urgent needs, and the remaining
33% had non-urgent needs that could be treated in community settings. About 51% of the high-need group referred to dental clinics received services.

**Conclusions**: Initial findings confirm the strong emphasis of the program on access and use of preventive services, and the varying degrees of program reach in different counties. Implementation challenges in communities at different stages of collaboration between the dental care, school, and other community organizations limited the achievement of the audacious goals of the program in its first year.

ClinicalTrials.gov Identifier: NCT02312921

Keywords: Dental Caries; Delivery of Health Care, Integrated/organization & administration; Reimbursement mechanism; Health Planning; Health Care Disparities; Evidence-based Dentistry; Program evaluation

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**Introduction**

**Oral health of low income populations**

Despite recent improvements in oral health, dental caries (tooth decay) and utilization continue to be marked by socioeconomic, racial and rural disparities [1, 2]. Although low income children, and pregnant and post-partum women with public insurance are entitled to dental care in the United States, they have higher rates of disease and lower utilization rates than high income or privately insured populations [2, 3]. For example, while only 13% of 6 to 11 year-old children from high income families have experienced dental caries, 24% of children from low income families have experienced dental caries [2]. While 56% of the population with private dental coverage had a dental visit during 2015, only 33% with public dental coverage, and 26% with no dental coverage had a visit [4].

**Dental care system for low income groups: United States**

*Traditional versus community-based dental care systems*

In 2015 Medicaid and Children’s Health Insurance Program covered dental care for 43 million children, 33% of all children [5]. Those who are cared for are served largely by large dental group practices (about 70%) in fixed clinics that are paid fee-for-service [6, 7]. Federally Qualified Health Centers and other safety net clinics provide 30% of care in fixed clinics, and are reimbursed in different ways depending on the state [7]. Almost half of the US states (45%) contract with dental care organizations to provide services to Medicaid eligible populations under a prospective or capitated budget [7, 8]. Nevertheless, in both the private and safety net delivery systems, only patients who seek care and are able to navigate the system receive services [9], and racial differences in care seeking behaviors may exacerbate disparities [10].

In contrast, in community-based care dental hygienists use portable equipment and temporary space in local facilities (e.g., schools and early childhood programs), and reach out to provide screening and preventive services to low-income populations. Care can be provided at a lower cost than providers using fixed, brick, and mortar facilities. And, the community-based programs
are able to serve sites too small to warrant fixed clinics. The advantage of this delivery approach is reflected in the goals of Healthy People 2020: to increase the number of school-based health centers that include an oral health component [11], and is consistent with the Association of State and Territorial Dental Directors (ASTDD) “Best Practice Approach” for improving children’s oral health through a whole school, whole community, whole child model [12].

Most school-based programs are provided by local or county-level departments (33%), non-profit organizations (17%), FQHCs (17%), and for-profit organizations (17%) [13]. These programs provide preventive services that include fluoride varnish for preschool children and dental sealants for children in grades 1, 2, 6 and 7. Approximately one-third of local programs also provide oral prophylaxis, a service of limited, if any, effectiveness [14]. A major limitation of school programs is that most do not provide comprehensive care and are not integrated with dental practices. As a result, many children who need restorative or surgical care by dentists go untreated. This often results in the use of expensive hospital emergency departments for symptom control of pain and infection but not comprehensive care.

**Integrated community-based dental care**

A few FQHCs and other dental care organizations operate school-based care systems linked (integrated) to their central facilities to provide comprehensive care. These integrated systems have public health and business advantages. In addition to financial barriers [15], low-income families confront many social barriers to using the health system (e.g., limited transportation, time lost from work, language) [9, 16]. Integrated systems address these economic and social barriers, and provide children continuous, comprehensive care in the settings where they spend most of their time. These systems have the potential to markedly decrease oral health and dental care disparities. Because of low Medicaid reimbursement rates, most private and public clinics cannot cover their fixed operating expenses providing care to Medicaid children without public or private subsidies [17]. The major business advantage of an integrated school-based system is the low fixed capital investment required in facilities, equipment, and personnel. Dental hygienists or therapists, depending on the laws in each state, provide most of the care with mobile equipment in low-cost settings and refer children who need more complex services to dental clinics. This is expected to cut treatment costs in half [18, 19]. Most Medicaid-enrolled children are at low risk for caries and only need minimal services. For example, an assessment of the dental care needs of 303 5 to 6-year-old school children in East Cleveland in 2007-2008 reported that 58% of the children had no treatment needs [20]. Thus, integrated systems allow organizations to deliver care to large low-income populations and be financially viable.

The administrative challenges of integrated community-based dental care are the need for multiple stakeholder support, caregiver consent, and follow-on care at dental clinics or practices. The delivery of comprehensive services at community settings requires support of key local stakeholders. These “champions” include elected leaders (e.g., mayors, state legislators), school officials (e.g., superintendents, principals, teachers) and nurses, school parent organizations, municipal public health departments, local dental organizations [21]. Obtaining support is difficult, when community and school leaders who have private dental insurance and receive care in private dental practices do not recognize the magnitude of change needed to address access
and oral health disparities. Also, school staff and teachers may perceive that the dental programs interfere with routine school schedules; caregivers may believe that school-based dental programs provide second class care compared to traditional practices; and local dentists and competing organizations that provide preventive services may view new programs as an economic threat. To obtain support from so many different groups requires local staff with a detailed knowledge of community dynamics, and continuous personal contact with stakeholders.

A second challenge is obtaining informed consent from parents to provide services to their children. Some screening and prevention programs operate with passive consent. That is, written information is sent home, and all children receive services unless caregivers explicitly opt out [22]. In a screening program in New Hampshire, 92% of the students participated in schools that required passive consent versus 65% of students in schools that required active consent [23]. Initial rates of return of signed forms vary from 25% to 50% in most programs with active consent [22, 24]. Rates appear to be higher when programs are more established, or when multiple consents (e.g., medical and dental programs) are sent home in school registration packages at the beginning of the year [24]. Making consents available electronically on the web or through school district or school websites has increased consent rates for medical services [25].

A third challenge is follow-on care for the 15% of children who need treatment by dentists, because of complex dental, medical or behavioral conditions [26]. The most common practice is for community-based programs to send caregivers a letter informing them of the need for a dentist appointment. Programs communicate the findings to school staff who are responsible for follow up [22]. Often, these children will be given priority in obtaining an appointment to the referred dental facilities. However, only 25% to 35% of children receive the needed dental care within the next 60 days [20].

Recognizing the public health and business advantages of integrated community-based dental care systems, a large for profit dental care organization in Oregon partnered with the University of Washington researchers to implement this system (called PREDICT: Population-approach Risk- and Evidence-based Dental Inter-professional Care Team). This paper describes the implementation of this quality improvement project, reports the results of the first year of operations and discuss the factors that helped or hindered the implementation efforts. The overarching program goal is to reduce disparities in dental care and oral health for Medicaid eligible low-income children and pregnant women living in rural Oregon. The goal of this progress report is to share strengths and weaknesses of the implementation effort so that others who are contemplating similar quality improvement efforts can benefit.
Methods

This report presents a description of the project implementation (sections 2.1-2.5) and evaluation (section 2.6). The Consolidated Framework for Implementation Research (CFIR) [27] is used in describing the evaluation design, the external environment where the innovation takes place (outer setting), the organization implementing the innovation (inner setting), the innovation itself, and the implementation stages. The Standards for Reporting Implementation Studies (StaRI) statement [28] is followed for the description of the evaluation processes and outcomes, sample size and data collection and analysis. Since these methods were published in the PREDICT protocol [29], only the methods relative to the evaluation are considered.

Evaluation Design

Our research question is: Will a redesign of the dental care delivery and payment system with integrated community-based dental care and pay-for-performance targeted to decrease disparities when compared to a clinic-based dental care with limited pay-for-performance not targeted to decrease disparities improve the oral health and dental care of low income children? The evaluation uses a parallel-group cluster randomized controlled trial design in 14 rural counties in Oregon State USA with a Medicaid population of approximately 82,000 children and women. The target population for the implementation of PREDICT is approximately 41,000 Medicaid-enrolled children and women in the 7 randomly-assigned test counties. The evaluation uses a hybrid design to test both the effectiveness and the implementation process of PREDICT when compared to a fixed clinic model [30]. This evaluation was submitted to the Institutional Review Board of the University of Washington for consideration and it was determined to not meet the definition of human subjects research and therefore an IRB review was unnecessary.

Outer settings: Oregon

Oral health

The quality improvement project takes place in Oregon state where one-in-five children aged 6-9 years and 1-17 years have untreated decay or oral health problems such as toothaches, respectively [31]. Oregon has the second lowest dental Medicaid utilization rates in the USA. Only 44% of continuously enrolled Medicaid program children (<21 years old), 27% of adults, and 52% of pregnant women visited a dentist in 2011 [31]. In contrast, children enrolled in private dental insurance plans had utilization rates between 65% to 75%. Only 13% of Medicaid enrolled children aged 6-14 years old received a sealant on a permanent molar in 2013 [32] and 16% in 2015 [31]. As a predominantly rural state, only 23% of Oregon’s population lives in areas with community water fluoridation – the third lowest percentage in the USA [31].

Dental care system

There were 68.9 dentists per 100,000 population in Oregon state (2014), which is substantially above the US national average (60.2) [32], but most are located in affluent urban and suburban communities. About 39% of Oregon’s dentists participated in the Medicaid program (2014), but less than 10% provided most of the care [32]. Dental hygienists can obtain an extended practice certification to provide screening, topical fluorides, dental sealants and temporary fillings in community settings under the general supervision of dentists (dentist not physically present). In Oregon, these hygienists are called Expanded Practice Dental Hygienists (EPDHs). In 2015,
there were 13 EPDHs per 100,000 population and the majority served low-income populations (29).

Dental care organizations (DCOs) contract with Accountable Care Organizations (locally called Coordinated Care Organizations, CCO). CCOs coordinate the delivery of primary and specialty physical, behavioral and oral health care. This structure was created in response to the US Affordable Care Act and its expansion of public benefit programs, often called Obamacare. Nine DCOs contract with 16 CCOs. DCOs, paid age-adjusted per capita rates based on historical utilization data, assume the full financial risk for delivering dental care to Medicaid beneficiaries and for achieving State set performance levels. DCO performance data is published in local newspapers annually. Over the past 10 years, reimbursement rates for Medicaid capitated child dental programs decreased 27.8%, and Medicaid fee-for-service reimburses 33% of the private dental benefit plan charges [32]. The Oregon Health Authority (OHA) partners with non-profit local organizations to provide school-based dental sealant programs for grades 1, 2, 6 and 7 in schools with at least 40% of students eligible for free or reduced school lunch programs. In the school year 2015-16, these sealant programs operated in 715 elementary and middle schools and 88% of the elementary and 47% of middle school grades received the program [26].

**Inner setting: Advantage Dental Services, LLC and University of Washington**

The PREDICT program is under the control of one dental care organization (DCO), Advantage Dental Services, LLC. The DCO has 42 staff-model group practices and contracts with approximately 200 affiliated smaller, largely rural primary care practices. The objective of the Advantage performance improvement initiative is to reduce barriers to access to care and disparities in oral health.

The Northwest Center to Reduce Oral Health Disparities at the University of Washington is conducting the evaluation of the PREDICT changes. The project is part of the Robert Wood Johnson Foundation Finding Answers: Solving Disparities through Payment and Delivery System Reform program [33].

**Innovation: Dissemination of evidence-based practice guidelines for caries control**

The intervention or innovation include evidence-based clinical practices already proven to be effective in controlling dental caries and recommended by leading national authoritative bodies [34-36]. Recommendations to assess dental care needs are based on visual changes in tooth structure using criteria from the ASTDD Basic Survey [35] and the International Caries Diagnosis Assessment System [37] (Table 1). Needs are assessed based on visual tooth structure changes, rather than surrogate estimators (e.g., school status, family income or clinician preference). As a result, assessments are individualized to each patient and standardized across providers. This approach reduces the waste associated with providing primary prevention treatments (i.e., topical fluoride treatments and sealants) to patients, even if they are at low risk for tooth decay. Risk-based primary prevention treatments are fluoride toothpaste [38, 39], topical applications of fluoride, with silver diamine fluoride (SDF) as first choice [40] and fluoride varnish with topical 10% povidone iodine, if the child is available for four yearly treatments [41]. Secondary prevention treatments include SDF for caries arrest [42, 43] and interim restorations with glass ionomer cement [44, 45], restorations [46] and extractions.
Table 1. PREDICT dental care needs assessment and correspondence with other assessment tools, Oregon USA.

<table>
<thead>
<tr>
<th>PREDICT</th>
<th>Description of visual changes</th>
<th>ASTDD</th>
<th>ICDAS</th>
<th>CDT</th>
<th>ADIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>High with urgent needs</td>
<td>Signs of an infection such as pulp involvement, fistula or abscess</td>
<td>Urgent need</td>
<td>6</td>
<td>0603</td>
<td>2</td>
</tr>
<tr>
<td>High with early need at practice setting</td>
<td>Distinct cavity in tooth with interproximal involvement or with esthetical concern</td>
<td>Early need</td>
<td>5 and 6</td>
<td>0603</td>
<td>1B</td>
</tr>
<tr>
<td>High with early need at community setting</td>
<td>Distinct cavity in tooth in the occlusal surface</td>
<td>Early need</td>
<td>5 and 6</td>
<td>0603</td>
<td>1A</td>
</tr>
<tr>
<td>Moderate</td>
<td>Visual changes in tooth structure (enamel breakdown) and no obvious problems</td>
<td>No obvious problems</td>
<td>3 and 4</td>
<td>0602</td>
<td>0B</td>
</tr>
<tr>
<td>Moderate</td>
<td>Restorations or missing teeth due to caries (previous caries experience) and no obvious problems</td>
<td>No obvious problems</td>
<td></td>
<td>0602</td>
<td>0B</td>
</tr>
<tr>
<td>Low</td>
<td>None of the above</td>
<td>No obvious problems</td>
<td>0, 1 and 2</td>
<td>0601</td>
<td>0A</td>
</tr>
</tbody>
</table>


**Implementation Strategies: PREDICT model features**

The PREDICT model has three core components: 1) an evidence-based dental caries management protocol; 2) a multi-purpose health information technology system; and 3) staff compensation based on pay-for-performance. These core components are closely monitored to achieve consistent implementation across multiple contexts, while other components are considered peripheral to them. Peripheral components are the 1) staffing, 2) setting and equipment, 3) optional dental clinical procedures, 4) organizational processes and outer setting. These peripheral components allow flexibility for teams to adapt the innovation to the local environment.

**Core components**

Caries management protocol. The protocol describes the evidence-based practice guidelines for the control of dental caries. The protocol contains policies, algorithms and flow charts to help incorporate the guidelines into routine care. The delivery of care follows risk-based algorithms for primary and secondary prevention based on the individual needs assessment. When non-cavitated lesions are identified, preventive measures are provided, and children and pregnant women are reassessed annually. For cavitated lesions, treatment is provided in community
settings whenever possible. Patients are referred to dental clinics for restorative care that cannot be provided in community settings. Urgent care is provided in dental clinics within 24-48 hours and restorative or surgical care within 6-8 weeks. The algorithms also specify the recall interval for preventive services. The algorithm also determines the need for case management to obtain parental consent for treatment or to schedule dentist appointments. The protocol is described in Table 2.

Table 2. PREDICT caries management protocol based on dental care needs assessment

<table>
<thead>
<tr>
<th>Dental Care Needs Assessment</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual exam with the provider, unless otherwise indicated by the provider.</td>
<td>Annual exam with the provider, unless otherwise indicated by the provider.</td>
<td>Annual exam with the provider, unless otherwise indicated by the provider.</td>
<td></td>
</tr>
<tr>
<td>Provision of fluoride toothpaste and toothbrush.</td>
<td>Provision of fluoride toothpaste and toothbrush.</td>
<td>Provision of fluoride toothpaste and toothbrush.</td>
<td>Twice-annual application of Silver Diamine Fluoride to the occlusal surfaces of posterior teeth for prevention (D1208), in lieu of other forms of topical fluoride or sealants.</td>
</tr>
<tr>
<td>Twice-annual application of Silver Diamine Fluoride to the occlusal surfaces of posterior teeth for prevention (D1208), in lieu of other forms of topical fluoride or sealants.</td>
<td>Twice-annual application of Silver Diamine Fluoride to the occlusal surfaces of posterior teeth for prevention (D1208), in lieu of other forms of topical fluoride or sealants.</td>
<td>Twice-annual application of povidone-iodine and fluoride varnish (D1209), if seen more than twice a year</td>
<td></td>
</tr>
<tr>
<td>Caries stabilization services: silver diamine fluoride (D1354) and/or Interim Therapeutic Restoration – primary dentition (ITR) (D2941) or protective restoration – permanent dentition (D2940).</td>
<td>Caries stabilization services: silver diamine fluoride (D1354) and/or Interim Therapeutic Restoration – primary dentition (ITR) (D2941) or protective restoration – permanent dentition (D2940).</td>
<td>Additional restorative and surgical services at dental practices</td>
<td></td>
</tr>
</tbody>
</table>

*Health information technology:* A cloud-based centralized electronic records management system - Advanced Dental Information Network (ADIN) was enhanced for recording, billing and managing community setting patients. Integrated with the dental clinic electronic records system.
(Dentrix, Henry Schein, American Fork, UT), reports track progress in reaching program goals. The EPDHs enter clinical data into this system via portable computers. Case managers use these records to schedule dentist appointments. Team members generate reports to track which patients need services. The system also automates the dental report card which is sent to parents after services are provided in community settings.

**Pay-for-performance compensation:** PREDICT includes quarterly pay-for-performance incentives for project staff. The performance metrics were selected based on increasing utilization (metric 1), providing continuous preventive care (metric 2) and promoting continuity between community and clinic/practice settings by treating early and urgent care needs on a timely manner (metric 3). These metrics are being phased in over 2 years with increasing target levels per quarter until reaching 80% in quarter 8. Contracted primary care dentists in private practice, salaried providers and staff from company-owned clinics, and centralized case managers receive incentive compensation, if county specific targets are met. Case managers and other central administration staff members (administrators, managers, accountants, IT staff, customer service) receive incentive compensation if all test counties meet incentive targets in each quarter. If targets are reached at the end of the year, team members receive the incentives from previous quarters. Results for the first year of the pay for performance incentives has been published elsewhere [47].

**Peripheral components**

**Staffing:** Project staff includes salaried county-based EPDHs and dental assistants, Regional Manager Community Liaisons (RMCLs), centralized case managers, dentists and auxiliaries in company-owned practices and contracted primary care dentists in private practices. EPDHs provide care under practice agreements with supervising dentists. RMCLs are responsible for obtaining local community participation. Case managers assist parents schedule appointments at dental offices/clinics for referred patients and remind parents to sign consent forms. Dentists provide restorative and surgical care to referred patients.

**Settings and equipment:** Dental care is provided in community settings such as schools, Head Start classrooms, WIC programs and, secondarily, at dental clinics within each county. All patients receive a visual assessment and assignment to a caries risk category and a toothbrush, toothpaste, and brief oral health education. On average, visits require 2 minutes per child or pregnant woman. Less than 60% of patients require twice yearly topical application of fluoride (either SDF or fluoride varnish with povidone iodine), which requires an additional 2-5 minutes. Less than 25% require caries arrest or stabilization treatment in cavitated teeth and additional twice a year preventive services. The latter adds 2-10 minutes to the appointment and requires additional mobile equipment. Less than 15% of patients have cavitated teeth that require referral to dentists.

**Optional clinical procedures:** Some dental procedures are not essential and prescription varies by dental team and community. These include referrals for malocclusion, oral hygiene instruction, xylitol mints or gum for pregnant and special need patients, and dental sealants.

Other traditional dental services and activities that do not reduce tooth decay are discouraged, including dental prophylaxis [14], dietary counseling for sugar consumption [48], changes in oral hygiene behavior [49, 50] and biannual fluoride varnish applications [51-54].
Organizational processes and outer setting: Qualities of leadership and supervision (style, frequency and content), community support (staff members on community advisory boards) and external support (funding from Robert Wood Johnson Foundation and the university partnership) are also considered peripheral components and are not anticipated to change during the study.

Implementation stages

The implementation process, described in the results section, is divided into 5 stages: exploration and planning, installation, implementation, dissemination, and evaluation and reflection.

Evaluation

This section presents data collection and analysis methods and is divided into 3 subsections: baseline assessments, utilization, and process evaluation of implementation and contextual changes.

Baseline assessments

Baseline assessments were conducted during the planning stage and included an environmental scan, patient and staff surveys. These assessments will be repeated annually.

Environmental scan: Scans were conducted in the 14 counties (August 2015). Information was collected on community and school-based dental programs, collaborating entities and other dentally related activities.

Patient survey: A survey was conducted from August to September 2015. A random sample of patients was surveyed by telephone by trained Advantage bilingual staff. Inclusion criteria included 1) caregivers of children (<19 years) or adolescents (19-<21 years), or pregnant women, 2) resident of a test county; and 3) Medicaid enrollee assigned to Advantage. Using the Consumer Assessment of Healthcare Providers and Systems (CAHPS) survey instrument, questions focused on satisfaction with dental care and communication with providers [55]. Mean and standard deviations were calculated for the scales of satisfaction with dentist/staff care, with access to care and overall satisfaction with dental care received.

Staff survey: A staff survey of organizational readiness to implement change was conducted from October to November 2015. All staff members from the dental care organization were invited to participate. The online survey instrument focused on readiness to implement changes [56] and innovation fit. Mean and interquartile ranges for the scales of change commitment and change efficacy were calculated.

Utilization

Utilization data come from ADIN, claims and Medicaid enrollment files for children and pregnant women with at least 90 continuous days of Medicaid eligibility (2016). Results are reported for six test counties, since one county was dropped. The key variables included at least one dental service (any Current Dental Terminology (CDT) code in the claims database), risk assessments (CDT 0601, 0602, 0603), preventive services (CDT 1000 to 1999), topical application of fluoride (CDT 1206 or 1208), dental sealants (CDT 1351) and SDF for caries arrest (CDT 1354). Year 1 metrics were calculated; metric 1 – utilization – any dental service received; metric 2 – SDF twice annually for moderate risk patients (CDT codes 1354 or 1208.
together with 9910); and metric 3 – follow-on care in dental offices/clinics for high-risk patients (any CDT code, except 0191 or 1000-1999).

Implementation process and contextual changes

Data on the implementation processes and contextual changes were collected from internal records and key-informant interviews.

Review of internal records: The review provided data on activities taking place during each implementation stage, and this includes use of human resources, supplies and equipment.

Staff interviews: Interviews were conducted by two University of Washington researchers between December 2016 and January 2017. Participants were 9 EPHDs, 4 RMCLs, 2 case managers and their supervisors. Following the CFIR, questions centered on implementation challenges in the domains of innovation, outer and inner settings.

Results

Baseline assessments

Environmental scan: The local teams identified that there was substantial variation among counties in community sites distances and the number of schools and other settings participating in dental prevention programs. In some counties, up to 65% of the schools had dental programs, while in other counties none had such programs.

Patient survey: Of 1,079 patients invited to participate, 865 met inclusion criteria and 80% participated. On a 4-point scale (never to always), the mean (and standard deviation) overall satisfaction with dentist/staff care for patients with at least 1 visit was 3.7 (0.5) and with access to care 2.3 (0.6). For children needing emergency care, 75% of caregivers reported that they obtained treatment as soon as they wanted. On a scale from 0 to 10 (worst to best dental care possible), mean ratings of care received was 8.8 (1.8).

Staff survey: Of 769 people contacted, 28% completed the survey. On a 5-point scale, the median (and interquartile range) organizational commitment to change was 3.8 (3.3-4.3); change efficacy was 3.8 (3.0-4.2), and support for the caries management protocol was 4.4 (4-5).

Utilization

Community setting services: In the test counties 9 EPDHs provided 37,369 services - an average (and county range) of 4,152 services (1,154 to 7,457) per EPDH. They cared for 10,792 children and pregnant women from 198 community sites. The average number of services provided to children and pregnant women treated per site was 191. Medicaid reimbursed Advantage for 57% of services. The dental hygienists provided free preventive/disease management services. Referrals of the remaining children to their own provider, if insured. If uninsured, collaborative efforts with local community entities took place. Oregon also has a program for uninsured children as a partnership of the Oregon Educators Benefit Board and MODA Health plans that provided free treatment. Advantage also saw children uninsured who needed immediate needs addressed at no charge.

Study population: Some 61,573 Medicaid beneficiaries assigned to Advantage had at least 90 days of continuous eligibility and resided in the test counties. By age group, 29% were under 6
years, 41% were 6 to 14 years, and 23% were 15 to 20 years, and 7% were pregnant and postpartum women.

Utilization: Utilization of dental services in community or practice settings was 44% for children less than 21 years old (33%-63% variation between counties) and 36% for pregnant women (30%-42%). By age group, 36% of children less than 6 years accessed services, 56% of patients 6 to 14 years old and 34% of those 15 to 20 years old (Table 3). For those with visits, 25% of children and 4% of pregnant and postpartum women were seen in community settings.

Table 3. Dental care utilization of Medicaid population assigned to the dental care organization during 2016 by counties implementing the integrated community dental care system, Oregon USA

<table>
<thead>
<tr>
<th>Age groups</th>
<th>County 1</th>
<th>County 2</th>
<th>County 3</th>
<th>County 4</th>
<th>County 5</th>
<th>County 6</th>
<th>All counties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total eligible</td>
<td>% with any claims</td>
<td>Total eligible</td>
<td>% with any claims</td>
<td>Total eligible</td>
<td>% with any claims</td>
<td>Total eligible</td>
</tr>
<tr>
<td>0 - 5 years old</td>
<td>4553</td>
<td>44%</td>
<td>7292</td>
<td>54%</td>
<td>3819</td>
<td>35%</td>
<td>15664</td>
</tr>
<tr>
<td>6-14 years old</td>
<td>4159</td>
<td>41%</td>
<td>5861</td>
<td>63%</td>
<td>3387</td>
<td>34%</td>
<td>13407</td>
</tr>
<tr>
<td>15-20 years old</td>
<td>5624</td>
<td>22%</td>
<td>7157</td>
<td>45%</td>
<td>4354</td>
<td>28%</td>
<td>17135</td>
</tr>
<tr>
<td>All children &lt; 21 years old</td>
<td>2035</td>
<td>38%</td>
<td>2749</td>
<td>55%</td>
<td>1512</td>
<td>39%</td>
<td>6296</td>
</tr>
<tr>
<td>Pregnant and postpartum women</td>
<td>5624</td>
<td>22%</td>
<td>7157</td>
<td>45%</td>
<td>4354</td>
<td>28%</td>
<td>17135</td>
</tr>
</tbody>
</table>

Services: For patients with one or more visits, 42% received a needs assessment, 88% preventive services and 26% restorative or endodontic services (Table 4). By risk level, 34% were low risk, 30% moderate risk, 32% high risk and 4% were not assigned to a risk group. For preventive services, 72% received at least one caries preventive service (fluoride varnish, gel or SDF). Dental sealants were placed in 19% of treated children, and 31% of children 6 to 14 years old. In relation to caries arrest treatments, 13% received SDF (6%-18%) and 5% received glass ionomer restorations (<1%-7%).

Table 4. Type of services provided to the Medicaid population who accessed services during 2016, Oregon USA

<table>
<thead>
<tr>
<th>County 1</th>
<th>County 2</th>
<th>County 3</th>
<th>County 4</th>
<th>County 5</th>
<th>County 6</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n=7634)</td>
<td>(n=6892)</td>
<td>(n=6155)</td>
<td>(n=3067)</td>
<td>(n=1283)</td>
<td>(n=1828)</td>
<td>(n=26859)</td>
</tr>
<tr>
<td>Assessment</td>
<td>33%</td>
<td>53%</td>
<td>36%</td>
<td>40%</td>
<td>55%</td>
<td>57%</td>
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### Low risk

<table>
<thead>
<tr>
<th>Service</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventive services</td>
<td>89%</td>
<td>89%</td>
<td>88%</td>
<td>88%</td>
<td>90%</td>
<td>80%</td>
</tr>
<tr>
<td>Topical application of fluoride</td>
<td>67%</td>
<td>76%</td>
<td>75%</td>
<td>75%</td>
<td>78%</td>
<td>64%</td>
</tr>
<tr>
<td>Dental Sealants</td>
<td>13%</td>
<td>21%</td>
<td>21%</td>
<td>16%</td>
<td>23%</td>
<td>17%</td>
</tr>
<tr>
<td>Silver Diamine Fluoride for caries arrest</td>
<td>7%</td>
<td>16%</td>
<td>14%</td>
<td>15%</td>
<td>19%</td>
<td>10%</td>
</tr>
<tr>
<td>Protective or Interim Therapeutic Restoration</td>
<td>6%</td>
<td>7%</td>
<td>4%</td>
<td>2%</td>
<td>2%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Restorative or endodontic services</td>
<td>30%</td>
<td>23%</td>
<td>26%</td>
<td>30%</td>
<td>28%</td>
<td>17%</td>
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</tbody>
</table>

### Moderate risk

<table>
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<tr>
<th>Service</th>
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<th>%</th>
<th>%</th>
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<tbody>
<tr>
<td>Preventive services</td>
<td>89%</td>
<td>89%</td>
<td>88%</td>
<td>88%</td>
<td>90%</td>
<td>80%</td>
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<td>14%</td>
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<td>10%</td>
</tr>
<tr>
<td>Protective or Interim Therapeutic Restoration</td>
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<td>7%</td>
<td>4%</td>
<td>2%</td>
<td>2%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Restorative or endodontic services</td>
<td>30%</td>
<td>23%</td>
<td>26%</td>
<td>30%</td>
<td>28%</td>
<td>17%</td>
</tr>
</tbody>
</table>

### High risk

<table>
<thead>
<tr>
<th>Service</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
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</tr>
</thead>
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<tr>
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<td>88%</td>
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<td>30%</td>
<td>28%</td>
<td>17%</td>
</tr>
</tbody>
</table>

*The percentage numbers for low, moderate and high risk represent the percentage of those who received a dental care needs assessment.

**Risk-based services**: All low risk children and pregnant women received fluoride toothpastes. For moderate risk patients, 51% received 1 SDF application (27%-70%) and 19% two applications (9%-40%). Within the high-risk group identified in community settings referred to dental practices/clinics, 11% had urgent needs, 56% non-urgent needs, and the remaining 33% had non-urgent needs that could be treated in community settings. Some 51% (29%-68%) of high risk patients referred from community settings to dental practices/clinics received services.

### Implementation process and contextual changes

**Exploration and planning stage**: The Advantage management staff and UW researchers worked together to develop the caries management protocol, and plans for monitoring performance, financial incentives, and evaluation. The 14 counties were selected and baseline assessments completed.

**Installation**: The 14 counties were randomly assigned to 7 test and 7 control counties. The budget for staffing, equipment and IT needs was developed, and community site supplies and equipment ordered. Project staff were hired or retrained, and their salaries were adjusted to reflect new roles. Communication materials (e.g., consent forms to gain stakeholder support) were produced and approved by the company’s legal department. EPDHs and RMCLs met with community stakeholders to introduce the care model and establish cooperative agreements. ADIN was further tested from September to December 2015. Companywide training on oral health disparities was conducted, as well as specific training on the core PREDICT components.

In terms of contextual changes, the Oregon Health Authority started to require pay for reporting...
metrics for all DCOs starting on 2015. There are two dental quality incentive measures accountable to the OHA: dental sealants for children aged 6-9 and 10-14 years old and dental assessments within 60 days for children in Department of Human Services custody. For sealants, a 3% increase was needed from baseline with a target of 20% and for assessments, increases from baseline varied by CCO with a target of 90%.

**Implementation stage:** In January 2016, PREDICT was launched in the test counties. The mobile project staff included 7 EPHDs, and 5 regional manager/community liaisons. Centrally there were 2 case managers, and 3 supervisors. Efforts were made to obtain stakeholder support in new sites. One test county was dropped because of poor provider/community organization support. In part, this was because within a single health district, multiple CCOs served both test and adjoining control counties. Other contextual changes during this period included new state requirements for active parental consent for the oral health needs assessment in community settings.

**Implementation and dissemination stage:** Plans for sustainment and dissemination will be developed after the evaluation of the implementation is completed, and Advantage has assessed the scalability and sustainability of the model. This assessment will be completed a year after the implementation stage.

**Discussion**

**Findings**

Designing and implementing an evidence-based population approach to providing dental care in rural community settings was a challenge both conceptually and practically. The baseline assessments indicated that Medicaid beneficiaries were satisfied with the care provided by Advantage, but access to care could be improved. Project staff seemed ready to implement the changes proposed in the PREDICT model. Moderate to high scores were seen in readiness to implement change and support for the caries management protocol.

During the first year of implementation, services were provided at both community and practice settings. Within 12 months, almost 50% of Medicaid-enrolled children received services. Consistent with the ASTDD “whole school, whole community, whole child” model [12], services were offered to all children in community settings, regardless of their dental insurance status. As a consequence, almost 50% of children treated were not Medicaid-beneficiaries assigned to Advantage. About 50% of children referred for dentist services visited a dental practice.

**Strengths**

Three major PREDICT innovations are expected to significantly improve access to care and oral health and spread to other areas of the country. First, children are screened and assigned to caries risk categories. The technology to assign risk is not new and is within the scope of practice of EPHDs. The American Dental Association recently introduced dental procedure codes for caries risk assessment (CDT 0601, 0602, 0603) which facilitated the implementation [57]. Although disparities exist between low- and high- income children, almost half of children were classified as low risk [20, 26]. Thus, most children do not need any preventive treatment beyond periodic
screening and regular use of fluoride toothpaste. As school programs mature, the percentage of low risk children should increase.

The second innovation is the use of an evidenced-based caries management protocol to prevent or stabilize tooth decay. The implementation coincided with the 2015 Food and Drug Administration clearance of a new topical treatment for dental caries [58]. Endorsed by the American Academy of Pediatric Dentistry [43], SDF (Advantage Arrest, Elevate Oral Care LLC, West Palm Beach, FL USA) is a topical agent that arrests the growth of dental caries lesions [42, 59-61] and prevents development of new lesions [61-64]. The application is painless, but the treatment does leave a dark stain in cavitated lesions, so patients have to be informed before SDF is used. The dark stain is not an issue for most caregivers when SDF is applied to deciduous teeth that will eventually be shed or posterior permanent teeth (the majority of lesions) that are not visible [65]. Anecdotal experience from the local teams implementing PREDICT confirms that study findings. There is no staining when there are no cavitated lesions.

The evidence suggests that SDF is the most cost-effective primary prevention treatment for dental caries. It is superior to fluoride varnish and as effective as dental sealants. Recent trials concluded that fluoride varnish, as a supplement to fluoride toothpaste, failed to reduce caries development in toddlers and preschool children from high- or low-risk communities [51-54]. Resin-based and glass ionomer dental sealants prevent tooth decay [66, 67] and are as effective as biannual application of 38% SDF [63, 64]. However, sealants’ failure rates are approximately 50% [63, 64] and resin-based sealants are associated with caries recurrence [68]. SDF is simple for dentists and dental hygienists to apply and is effective for both primary and secondary prevention [58] and should reduce the cost of operating school-based programs [69]. Other studies of SDF in the United States are underway.

The third innovation is the use of human and technological resources with evidence-based management strategies to meet efficiency standards. Advantage’s community-based health information technology system included the caries management protocol and automated routines for streamlining treatment decisions based on dental care needs and case management activities, such as tracking parental consent return and referrals to dental practices. The electronic system generates reports to continuously monitor quality improvement efforts and to assess quarterly pay-for-performance metrics. Human resource innovations included the employment of EPDHs, RMCLs and case managers. The community liaisons, drawn from the communities they serve, are in a unique position to obtain community support and establish agreements for new sites. Bilingual and culturally-competent case managers proactively contacted families to help them navigate the system (e.g., returning consents and schedule practice visits). The metrics and incentives to reach program goals have increased staff team work.

Challenges

The implementation of the integrated community- and practice-based innovation was difficult. There were challenges identified in the innovation itself and in the inner and outer settings. The main challenges identified in the innovation was calibration of providers for assessing dental care needs, implementation of the information technology changes, and the impact of the incentive metrics on staff morale in low performance settings.
**Calibration of Risk Assessment:** Without extra training, there were variations in clinical interpretation among dental hygienists and we learned that some of the expanded practice dental hygienists classified more patients than expected as high risk because they did not fully “buy-in” to the risk assessment protocol. They were tied to previous practices where poverty and other social factors were included in the assessment. Also, the providers in the peripheral dental practices were informed about the PREDICT caries management protocol but were not trained on dental care needs assessment criteria. Efforts to standardize the needs assessment are ongoing. Online training materials on the PREDICT needs assessment criteria have been made available and a campaign to incorporate risk/needs assessment in all comprehensive exams is underway coupled with specific new financial incentives.

**Information Technology:** The challenges with the implementation of the health information technology were multiple. While the management team was committed to improve the systems, the changes were disruptive and labor intensive. There was insufficient beta testing, not all the computer routines worked initially as required, and documentation of routines was not always clear. There were, for example, technical difficulties such that the case management tracking system was not updated with data from the electronic health records to provide confirmation (or lack of) that the patient visited a dental practice when assessed in the community setting with urgent or early needs. Another example were problems blending the culture of business and conducting research. The university researchers were accustomed to a more iterative process while organization staff wanted to develop the work order for the changes and carry them out one time. This cultural accommodation delayed the evaluation. Finally, to evaluate PREDICT and to generate the metric reports for the pay-for-performance incentives in a timely manner, a large amount of data from different sources needed to be collated - Medicaid enrollment data, dental claims data, electronic health records from the community settings (ADIN) and case management tracking system. Data from external sources are also being requested from the Oregon Health Authority on medical treatments, pharmacy prescriptions and emergency department visits for the cost and utilization data analysis. The organization will also collect data from two surveys to be conducted at the end of the first two years of implementation of PREDICT – one on consumer satisfaction and another on staff satisfaction.

**Unintended Impact of Financial Incentives:** The last main challenge to the innovation core components was the unintended effects of the pay-for-performance incentives on local staff. The selected implementation counties were not alike in terms of company market share of the Medicaid population and access to community sites. In some counties, the company had an exclusive market while in others they shared the market with others. Similarly, in some counties there were extant outreach activities that gave staff an initial boost in achieving the dental utilization metric, while others were working in counties without this history. Because the targets were an absolute number, and not relative to baselines levels in each county, some staff members have been discouraged as they encountered barriers. This has pointed to the need for greater team building, training, and support. It also triggered changes in the pay-for-performance scheme with proportional payments for partial success and lower targets for the second year. In addition to the realization that counties were at different stages of maturity of community-based programs, PREDICT metrics were in conflict with the performance metrics required from the coordinated care organizations by Oregon Health Authority. The organization as a whole, but particularly the community-focused staff serving implementation counties, felt burdened with the expectation to improve performance in two conflicting set of metrics.
**Inner Setting:** The evaluation has revealed weaknesses within the project’s inner setting and organizational processes as well. It is not possible to successfully implement a community- and practice-based integrated model without a marked expansion of community sites and participation of caregivers and patients within each site. Regional managers initially were inadequately trained and accountability for increasing the number of sites was split between two supervisors. There was also confusion in relation to the roles within the teams and available resources for reaching out to caregivers and patients to increase participation in the program for both the parental consent process and follow-on care at dental practices. In addition, outreach efforts in each county were at different stages of development when PREDICT was deployed and this was reflected on the variation between counties on the reach of these services and consequently the dental care utilization within each county. These issues are being addressed internally by changes in supervision, increasing and replacing staff at the local levels, training on communication for case managers and streamlining workflow processes.

**Outer Setting:** Finally, the biggest challenge was obtaining stakeholder support. The outer setting, we have learned, is a critical aspect of what was initially thought of as an internal improvement effort. The challenges with patient stakeholders were not on the application of the new technology as mentioned above, but on increasing their participation in the program. The rates of return of consents continues to be a challenge, particularly for high schools and sites where the program is new. Also, the rates of follow on care at a dental practice after the identification of urgent or early needs need to be improved. Besides continuous efforts of all the organization team members from local EPDHs and regional managers to case managers and dental practice staff to proactively contact caregivers, understanding and removing the barriers that prevent these low-income families eligible to receive the dental care to actually do so is a major task.

The community, particularly powerful stakeholders, are accustomed to the predominant practice-based delivery system that only provides services to those who seek them out and the prospects of a universal proactive integrated system with a public health orientation and new care technology was puzzling. At the local level, there was resistance to the caries management protocol from some community and professional stakeholders. Other competing dental care organizations and non-profit organizations offered only limited community-based services, primarily screening and sealants, without integration with dental practices through case management or health information technology. While patient stakeholders were supportive, some community or professional stakeholders felt threatened. There was push back on the use of silver diamine fluoride, particularly as substitute for fluoride varnish or dental sealant.

At the state level, restrictive policies for school-based programs conflicted with the PREDICT model. The PREDICT caries management protocol differed from state policies and recommendations in relation to dental care needs assessment and primary prevention. The state uses percentage of children on free and reduced lunch program as a proxy for high risk of dental caries whereas the PREDICT protocol uses only visual signs of changes in tooth structure (i.e. current or past signs of caries) at the individual level. Such policy inappropriately increases the number of children receiving preventive care while wasting resources that could have been directed to those in real need. The PREDICT protocol also conflicted with the primary prevention methods suggested by the state, which called for resin-based sealants in selected school grades, to the exclusion of glass ionomer sealants or silver diamine fluoride. Even more importantly, there were no policies in place for care coordination or reimbursement for services.
provided at community settings for children and women who were not members of the dental care organization. Since there were multiple dental care organizations sharing the same market in a geographical area, the organization notified the other dental organizations that their members needed care. Likely many were not seen because of inadequate care coordination. Failure to fully appreciate how the change was being perceived by community stakeholders at the state and local levels reduced access to community sites and impacted the success in achieving the goals for dental care utilization, primary and secondary prevention.

In summary, the redesign of the dental care delivery system for Medicaid-enrolled children is innovative because it seeks to integrate practice- and community-based services and streamlines evidence-based risk assessment and care. It de-implements practices where there is no benefit. Services are delivered by extended practice permit dental hygienists working at the top of their scope of practice in temporary facilities with only inexpensive portable equipment. All the children receive services and have an electronic health record. Centralized case management and effective referrals to dental practices address the problems of the small proportion of children who need the services of a dentist, without duplicating the bricks and mortar in a school setting. Several challenges in implementing this integrated system in its first year were identified and efforts to improve the program are ongoing. Future implementation efforts will need to devote large efforts to understand geographical settings, spaces and places in which service change occurs and be able to target the contextual influences on innovations. For integrated delivery systems to be sustainable and scalable a massive commitment from CCOs, dental care organizations and other stakeholders at the local and state level is necessary and policies to deal with the costs of uncompensated care need to be in place. Results of the cluster randomized controlled trial with quality of care, consumer satisfaction and cost analysis will be available once the implementation of the model is concluded.

Conclusions

This is a report about the implementation of an on-going quality improvement program of a major USA dental care organization. The PREDICT model integrates practice- and community-based services and promotes evidence-based risk assessment and care. Services are delivered by EPDHs in temporary facilities with portable equipment. All children receive services and have an electronic health record. Centralized case management and effective referrals to dental practices address the problems of the 15% of children who need the services of dentists. Many first-year implementation problems were identified and efforts are now underway to address these problems. To be sustainable and scalable, community-based integrated delivery systems require a substantial commitment from the CCOs, dental care organizations and other stakeholders at the local and state levels. This includes policies to deal with the costs of uncompensated care.

Acknowledgements

The quality improvement project was conceived and designed by JCC, CEH, JS, DC, JD, MM, GA, RMS, CS, HLB and PM and all of the authors contributed to the data collection, analysis, and interpretation; contributed to the synthesis of the findings reported here; critically revised the manuscript for important intellectual content; approved the final version; and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.
Conflict of Interest

The authors declare they have no conflicts of interest.

Abbreviations

ADIN: Advanced Dental Information Network
ASTDD: Association of State and Territorial Dental Directors
CAPHS: Consumer Assessment of Healthcare Providers and Systems
CCO: Coordinated Care Organizations
CDT: Current Dental Terminology
CFIR: Consolidated Framework for Implementation Research
DCO: Dental Care Organization
EPDH: Expanded Practice Dental Hygienists
FQHC: Federally Qualified Health Centers
ICDAS: International Caries Detection and Assessment System
OHA: Oregon Health Authority
PREDICT: Population-approach Risk- and Evidence-based Dental Inter-professional Care Team
RMCL: Regional Manager Community Liaisons
SDF: silver diamine fluoride
StaRI: Standards for Reporting Implementation Studies

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5. CMS. 2015 Dental and Oral Health Services in Medicaid and CHIP. Center for Medicare and Medicaid, 2016.


22


