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Improvements in appropriate placement of dental sealants after implementation of a clinical decision support system

Joanna Mullins, RDH, MHI,

VP of Strategic Business Operations, Willamette Dental Group, Hillsboro, OR, USA

Ryan Brandon, MS,

Consultant, Willamette Dental Group and Skourtes Institute, Hillsboro, OR, USA

Nicholas Skourtes, DMD,

Vice President, Willamette Dental Group, Hillsboro, OR, USA

Elsbeth Kalenderian, DDS, MPH, PhD,

Dean and Professor, Marquette University School of Dentistry, Milwaukee, WI, USA

Muhammad Walji, PhD

Director and Professor, Texas Center for Oral Healthcare Quality and Safety, Chair, Department of Clinical and Health Informatics, University of Texas Health Science Center at Houston, Houston, TX, USA

Abstract

Background: Dental sealants are effective in the prevention of dental caries in children at elevated risk levels and are a Healthy People 2030 objective. Electronic health record (EHR)-based clinical decision support systems (CDSS) have demonstrated the ability to improve patient care provided. A dental quality measure (DQM) related to dental sealant placement for children at elevated risk of caries was targeted for improvement using a CDSS.

Methods: A validated DQM was adapted to assess an individual patient's need for dental sealant placement. A CDSS was implemented to advise the care team if a child was at elevated caries risk and had sealant-eligible first or second molars. Data on dental sealant placement at examination visits over a 5-year period were analysed, including 32 months prior to CDSS implementation and 28 months post-implementation.

Results: Between January 1, 2018, and December 31, 2022, 59,047 examination visits for children at elevated caries risk with sealant-eligible teeth were assessed. With the implementation of CDSS and training to support the clinical care team in September 2020, the appropriate placement of dental sealants at examination visits increased from 27% to 60% ($p < 0.00001$).

jmullins@willamettedental.com .

JM contributed to conceptualization, design, methodology, data interpretation, drafted and critically revised the manuscript; RB contributed to conceptualization, design, methodology, data acquisition and interpretation, analysis, drafted and critically revised the manuscript; NS contributed to conceptualization, design, methodology and critically revised the manuscript; EK contributed to design, methodology and critically revised the manuscript; MW contributed to design, methodology and critically revised the manuscript. All authors gave their final approval and agree to be accountable for all aspects of the work.

All authors declare no conflicts of interest.

Conclusion: Integration of CDSS into an EHR as part of a quality improvement program was effective in increasing the delivery of sealants in eligible first and second molars of children aged 5–15 considered at high caries risk.

Practical Implications: EHR-based CDSS can be implemented that improve standardization and the provision of timely and appropriate patient care in dental practices.

Keywords

Preventive care; Evidence-based dentistry; Decision Support Systems; Dental Caries; Sealants; Quality Improvement; High caries risk

INTRODUCTION

Dental sealants are effective in the prevention of dental caries in adolescents with elevated caries risk during the formative years of adult dentition. When sealants are placed appropriately on the first and second molars of children with elevated risk of caries, including molars with deep pits and fissures, they have been proven to reduce the development of caries on these teeth.¹ Sealants placed on children at low risk of caries do not provide similar benefits and have no measurable impact on the prevention of caries.²

Given that sealants are an evidence-based treatment in preventing and arresting pit and fissure occlusal caries in molars, increasing the proportion of children and adolescents who have dental sealants on one or more molars is a Healthy People 2030 objective with a 42.5% target.³ However, even with this focus from the US Department of Health and Human Services, only 37% of children and adolescents aged 3 to 19 had received dental sealants during reporting years of 2013–2016, regardless of caries risk status.³

Willamette Dental Group (WDG) is a privately held, accountable care, risk-bearing entity that provides oral health care for more than 450,000 members at 50 practices across Oregon, Washington, and Idaho. Delivery of high-quality evidence-based and preventative care has been a core practice and expectation of WDG dental providers for decades. Historically, adherence to guidelines for placement of dental sealants at WDG has been measured through annual metrics supplemented by a manual chart audit process with follow up training and mentorship as needed.

Dental quality measures (DQMs) provide a valuable tool to assess and analyze the performance of a practice, population, or individual care provider. The Dental Quality Alliance (DQA) has taken leadership in development and promotion of DQMs. The DQA has published measures that rely primarily on claims-based data to report results related to utilization and quality of dental services for adults and children enrolled in public and private insurance programs.⁴ When assessed across an enterprise, DQMs reveal trends, inconsistencies, and disparities in care that can be acted upon as part of a quality improvement process. While DQMs can provide accurate results upon the end of the measurement period, they are commonly unable to accurately assess results during the measurement period. This limits the ability of DQMs to deliver real time evidence to aid

in the regular cycle of a quality improvement program and improve timely delivery of appropriate care.

With the implementation of DQMs for dental sealants, the sealant placement rate at WDG, while meeting national benchmarks, was assessed as both generally lower than expectations and inconsistent across the organization, with variation of rates between offices.⁵ Inconsistent results across offices or longitudinally over time present opportunities for quality improvement in attempts to reduce this variation.⁶ The appropriate placement of sealants was identified as an opportunity for an organizational quality improvement effort.

A key challenge to increasing the appropriate placement of dental sealants was identified for patients who were planned for sealants but did not return for the procedure. Placing dental sealants is a relatively quick procedure and can often be delivered as a same-day service during a routine recall visit. This is time saving and cost-effective for the patient and office, preventing the need for an extra visit, and hence could increase the placement rate of sealants.

With the objective to increase the rate of appropriate sealant placement and ultimately lower the incidence of dental caries in their pediatric (ages 5 to 15) population, an electronic health record (EHR)-delivered clinical decision support system (CDSS) was implemented. We evaluated the impact of this CDSS to assist the WDG clinical care team to provide same-day sealants when appropriately indicated for children at an elevated risk for caries. A CDSS seeks to provide actionable information at the point of care to make it easier to provide the right care.⁷ We know from multiple randomized controlled trials that well-implemented CDSSs, employing suitable patient data, derived from rich EHR repositories, can produce large and important improvements in care processes.⁸ Notably, CDSSs are thought to mitigate medication errors, improve patient safety through reminder alerts, increase adherence to clinical guidelines, reducing test duplication, and can provide support for diagnostic coding and ordering of tests.⁹

METHODS

A team of oral health care professionals and informatics analysts adapted the logic from an earlier developed DQM for dental sealant placement,⁵ to a per visit measure to assess an individual patient's need for sealants at each visit. The DQM for sealant placement provided logic to assess if patients with sealable teeth received a sealant during the annual reporting period.¹⁰ To provide the clinical care team with decision support at the time of visit, this logic was adapted to automatically assess a patient's appropriateness for sealant placement at each exam visit. The CDSS identified patients meeting the criteria of age, between 5 and 15 years, and elevated caries risk assessment (CRA), moderate, high, or extreme, and further evaluated each case for any sealant-eligible teeth. IRB approval was obtained to conduct this study and STROBE guidelines were followed.

Sealant-eligible teeth were determined from the EHR data as any fully erupted first or second permanent molars that had not previously been sealed, treated, planned for treatment, or diagnosed with caries. Past and planned treatment included any restoration, except for

class V buccal or facial surface restorations, endodontic procedure, including pulpotomy, pulpectomy or root canal therapy, extraction or fixed prosthodontic procedure that was either previously completed or was planned for the tooth. Diagnosis of caries was assessed based on the documentation of active caries on the tooth except for buccal and facial surface caries only. Active caries and planned and completed restorations on the buccal and facial surface were excluded as their presence alone, in absence of any occlusal caries or procedure, should not preclude the placement of dental sealants on a tooth.

At examination visits, children meeting the criteria for age and elevated CRA with at least one sealant-eligible tooth activated the CDSS to remind the clinical care team of the indication for placement of dental sealants. The CDSS is implemented as a passive checklist of process and disease-prevention tasks for the care team to review and complete at each visit. The checklist is automatically updated from EHR data as tasks are completed for the visit. The CDSS includes process measures to enforce completion of CRA, “base” charting including dentition, existing restorations and findings, and planned procedures recorded with a dental diagnosis. Overall, the WDG providers routinely complete over 98% of these process measures.¹¹ The process measures are supplemented with a Quality Improvement Score (QIS) comprised of several measures for appropriateness of care including prevention metrics for completion of sealants and fluoride.

For each visit, the CDSS (Figure 1) presents the clinical care team with a set of tasks appropriate for the type of visit, examination, operative, hygiene or emergency, and patient factors considering age, dentition, risk factors and history. Feedback clearly highlights any outstanding or overdue tasks and includes evidence to support the suggested care. The format is educational for the care team, supporting their delivery of care meeting evidence-based standards adopted by the organization while also aiding with communication with the patient. Additionally, a clinical dashboard is available to monitor performance and trends and identify opportunities for improvement for each office/provider (Figure 2).

Rather than employing pop-up messages that have been commonly used for CDSS interventions and have shown to contribute to provider fatigue,¹² the system is passive allowing the care team to work through each visit, reviewing and completing tasks as needed. A percentage completion indicator, showing visit progress as a number between 0 to 100% is displayed in the EHR’s task bar. As tasks are completed, the progress indicator increases, and the care team’s goal is to achieve the 100% completion for each visit before the patient leaves. A summarized view of daily patients seen, with analysis to the patient level, allows the office to manage their cases effectively.

Data on pediatric examination visits over a 5-year period, January 1, 2018, to December 31, 2022, were queried directly from the EHR database. The CDSS for sealant placement was implemented in September 2020, providing 32 months of pre-implementation data and 28 months post-implementation data to compare. The rates of sealant placement, as a percentage of sealant-eligible examination visits for children with elevated CRA, were calculated pre- and post-implementation of CDSS, and rate comparisons were completed by office with a paired-samples t-test. Appropriate dental sealant placement in eligible patients’ rates by month were calculated and included in a p control chart (Figure 3) with upper

and lower control limits (± 2 standard deviations). Patients were excluded from the analysis if CRA was low or not documented or if no sealant-eligible teeth were present at the examination visit.

RESULTS

Placement of sealants at comprehensive and periodic examination visits on children aged 5–15, with elevated caries risk, with first or second molars eligible for sealant(s), were measured pre- and post-implementation of the CDSS tool across a large network of nearly 50 clinics across Oregon, Washington, and Idaho. Over the 5-year period between January 1, 2018 and December 31, 2022, 59,047 examination visits (33,640 pre-implementation and 25,407 post-implementation) with children at elevated caries risk and sealant-eligible teeth were assessed.

Compliance with the evidence-based guidelines for appropriate sealant placement showed significant improvement across the entire organization following the CDSS implementation in September 2020. Overall, appropriate sealant placement at recall visits increased from an average below 30% (95% CI [22.8, 32.8]) prior to implementation of the CDSS to over 55% in the month following the CDSS implementation and maintaining consistently over 60% (95% CI [50.3, 70.6]) (Figure 3).

Based on this increased rate of appropriate sealant placement at examination visits, over the 28 months post-implementation, over 7,500 children at elevated risk of caries received sealants at their examination visit who may not have without the CDSS implementation.

A comparison of sealant placement by office for pre- and post-implementation of CDSS showed significant improvement in each of the offices that saw patients across the entire 5-year period (Figure 4). The mean pre-CDSS for sealant placement is 26.74%, while the mean post-CDSS is 58.74%. These data were subjected to the t test for paired samples, with the results showing a statistically significant improvement with a mean 32 percentage points ($t = 14.14$; $n = 46$; $p < 0.00001$) and Cohen's d effect size of 2.08.

DISCUSSION

Many barriers to appropriate placement of sealants and guideline implementation have been identified from private practice to large group practices. For providers, these include personal clinical experiences, concerns over liability, lack of understanding of standard of practice, being unaware of expectations, and knowledge and attitude regarding sealants.^{13,14} In general, parents' attitude towards the use of caries preventive measures, including placement of sealants is significantly correlated to their gender, dental experience, level of education and size of the family.¹⁵ Additionally, concerns regarding the materials used represent some common reasons for not proceeding with sealant placement.^{16,17} Changing dentists' behavior around adoptions and implementation of clinical guidelines for the placement of sealants is not straight forward or obvious. Indeed, Carney concluded that publishing and emphasizing evidence-based guidelines, even from established and respected sources are not enough to guide change.¹⁸ Additionally, efforts in quality improvement

through focusing on provider education alone have shown limited effectiveness and decreased compliance over time.¹⁹

Evidence-based guidelines and readily accessible educational materials are clearly not enough to assure that all children in need of dental sealants have sealants placed, although some progress has been made as an objective for Healthy People 2020 and 2030. DQMs while a good starting place to initiate and measure the success of quality improvement programs, cannot provide CDSS to directly assist clinical care teams in the timely delivery of appropriate care. However, DQMs can be easily adapted to provide care teams with CDSS to aide in quality of care provided on a per visit basis. Through the implementation of systems that deliver timely, accurate, and appropriate evidence-based information, CDSS provide significant advantages in practice. These include improved clinical efficiencies, a more engaged care team and patient, that are both supplied with the additional support of evidence and consistent standards of care. Ultimately, the result is an increased likelihood of favorable health outcomes.

CDSS that are both intelligent and easy to interpret can be effective in augmenting clinical decision making, hence improving the quality of care provided to the patient. CDSS can be classified as either active or passive depending on the level of interruption to the providers' natural workflow.²⁰ Passive CDSS typically have minimal impact to workflow and serve as a gentle reminder to consider a suggested intervention.¹⁹ Passive CDSS can be introduced with subtle changes in note templates or other areas and have been shown to improve compliance with preventive services and standards of care over time.^{19,21,22} Studies have shown that active CDSS pop-ups are a nuisance, leading to "alert fatigue" and diminished physician adherence over time.¹² WDG has experienced with different methods of CDSS, including pop-up reminders, and have found these systems struggle with providing the right information to the right user at the right time. WDG's passive CDSS that summarizes the visit progress and details of incomplete tasks, provides the care team with a simple yet effective interface to review as needed during the delivery of care.

A review of the current clinical workflow was completed to fully assess the problem of why sealants were not being placed. Several factors were identified, including patients not returning for planned care, other treatments taking precedence, and patients changing providers or insurance plans. This investigation led to updating workflows, guidelines, expectations and the CDSS with recommendations to complete the sealants on the same day whenever possible. Placing sealants while the patient is already in the chair for a routine examination visit would remove some of the identified barriers to support increased sealant placement. Doing so is also a benefit for the organization and patient alike in saving time and cost of return visits while ensuring appropriate prevention was delivered as soon as possible.

To address the opportunity for improvement and consistency across the offices, WDG implemented CDSS to advise the clinical care team. For children at elevated caries risk with sealant-eligible first or second molars, CDSS suggested that the child met the clinical guidelines for placement of dental sealants. Additionally, an easily accessible dashboard was made available to show daily and weekly progress for each office/provider, allowing for

review and adjustment as part of the quality improvement cycle. The CDSS in conjunction with the dashboard had a positive effect on number of sealants placed as part of the examination visit, significantly increasing the overall placement of appropriate dental sealants. Despite not implementing this change with a control group, there were no other operational, clinical, financial, or environmental changes occurring during this period that would contribute to the increase in sealant placement at examination visits.

The logic behind the CDSS for appropriate sealant placement is complex, with well thought out parameters to consider patient appropriateness and visit needs as they relate to evidence-based standards of care. A significant challenge of measuring appropriate sealant placement is in the assessment of teeth eligible for sealants. This requires complete baseline charting and confirmation of the full eruption of the first and second molars. WDG completes full charting of all patients, yet there are still cases where documentation of eruption status is incomplete.

The measure is further complicated by the dependency on the CRA to determine that the patient would benefit from the sealant placement. Risk assessments are mostly clinician-dependent and are subject to incomplete and inaccurate data collection. Electronic data is vital to the ability to measure and provide accurate CDSS. WDG has implemented an effective CDSS for process management to ensure that each patient visit is thoroughly documented, including CRA and diagnoses for all patients and procedures. The completeness of the data allows for the assessment of appropriate care, such as the placement of sealants, and outcomes of care.

Most EHRs have built-in facilities to support CDSS, however, their implementation has been limited by challenges in developing standards, associated costs and provider skepticism about its value and feasibility.²³ While current EHR systems are limited in their ability to assess the accuracy of data collected, future systems involving artificial intelligence (AI) could help to alleviate the need for relying solely on manual chart review and data entry. These AI systems could interpret digital radiographs and intraoral scans to identify erupted and restored teeth to help with assessing and/or confirming sealant-eligible teeth. It is expected that EHRs will evolve to integrate these rapidly evolving AI technologies and make advancements that deliver better CDSS to providers that are easier to implement.²⁴ However, the use of DQMs has been slow among independent dental providers, and adoption of CDSS for quality improvement efforts will be hindered by reimbursement models still focused on procedures instead of oral health outcomes.²⁵

The next steps as part of the quality improvement cycle will be to solicit and interpret provider and patient feedback, monitor the success of the same-day sealant intervention, identify specific initiatives to address, and adjust training and ongoing refinement of the CDSS itself as necessary. One consideration is assessing ways to keep the benefits of the passive CDSS that providers do not find as a nuisance, but also making it more visible and accessible to interact to improve rates of appropriate care. With continued improvements in the delivery of preventive services, further assessment of patient health outcomes, e.g., lower caries risk and fewer new caries, will be evaluated to show the net effect of the increased delivery of appropriate sealants.

CONCLUSION

An effective CDSS around sealant placement can be integrated into a dental quality improvement program to successfully implement evidence-based guidelines that facilitate and improve the delivery of timely and appropriate patient care.

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Process of Care Summary														
Process of Care										Quality Improvement Score (GIS)				
Total Visits	NP	CO	Hyg	Op	CRA	Knee	Post SRP	Process of Care	Appr. Phase Tx	Fluoride	Sealant	X-Ray Interval	X-Rays Taken	6 Mo. Prophyl
Number of Incomplete Visits	0	4	1	3	0	0	0	Avg. %: 93.5%	0	1	1	1	0	0
Number of Visits	25	15	3	6	0	1	0	% of Visits at 100%: 68.0%	1	11	2	15	13	11
PI Chart#	PI Name	Visit Type	Process of Care %	Appr. Phase Tx	Fluoride	Sealant	X-Ray Interval	X-Rays Taken	6 Mo. Prophyl					
C-Care Visit				100.0%	Y	N	Y	Y	Y					
Medical History	100.0% All questions have been answered and/or updated.													
Dental History	100.0% All questions have been answered and/or updated.													
Head and Neck Exam	100.0% Head and Neck Exam has been completed.													
CAMBRA Tab	100.0% All questions have been answered and/or updated.													
CAMBRA Tab - CRA Calculation	100.0% There is a calculated Caries Risk Level for the visit.													
PEMBRA Tab - Perio Risk	100.0% Perio Risk questions have been answered and/or updated.													
GIS Measures:														
Fluoride Sealant	Sealant			0.0%	The patient is moderate or high Caries Risk and should receive Sealants.									
Radiograph Interval	100.0% The radiograph interval is appropriate for the patient.													

Figure 1:
CDSS: Process of Care summary, highlighting the Sealant measure.

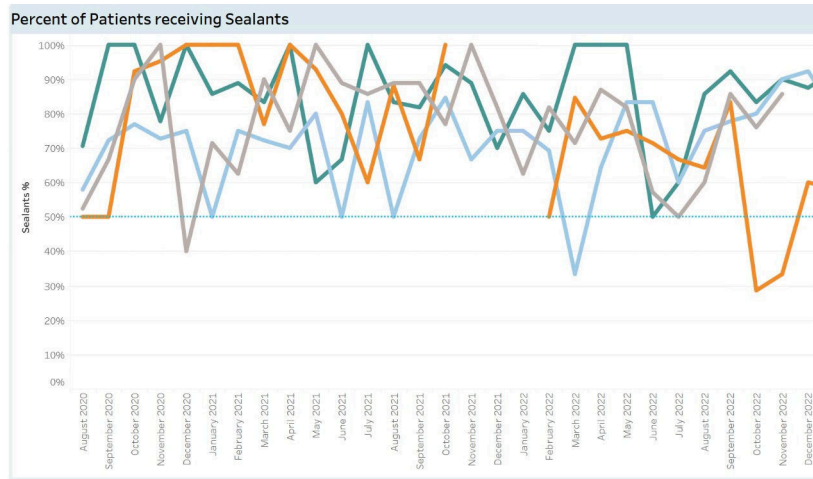


Figure 2: Dashboard to monitor sealant placement performance and trend for individual doctors at an office. Colored lines on the chart each represent a provider.

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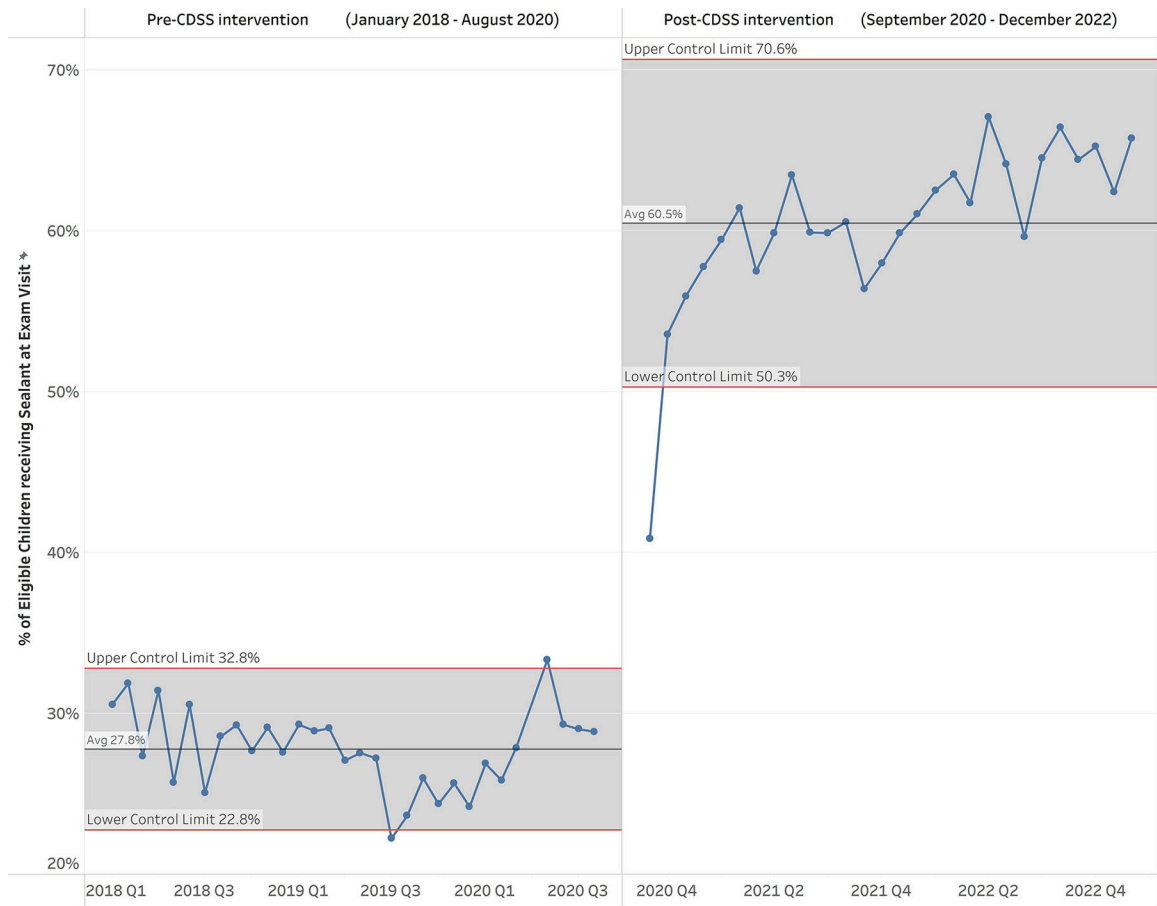


Figure 3:
P control chart of percentage of eligible children receiving dental sealants at examination visits by month. Pre- and Post-CDSS intervention periods are separated.

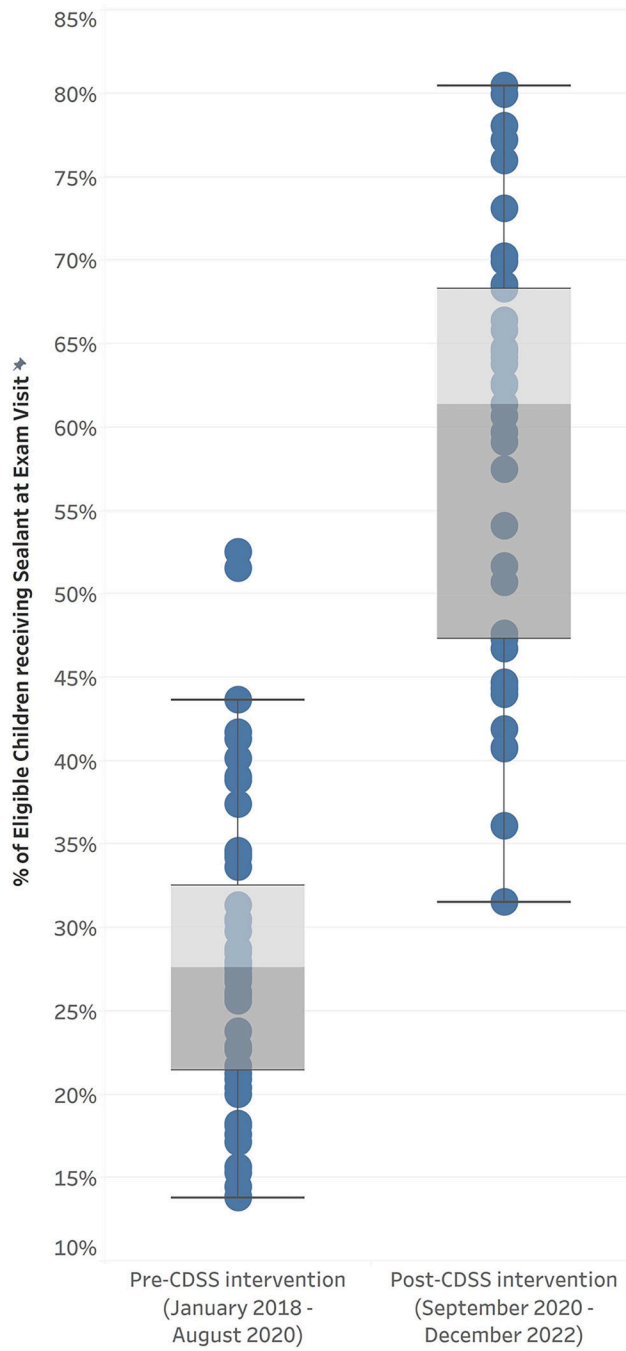


Figure 4: Variation of office performance on sealant placement measure, comparing Pre- and Post-CDSS implementation.