A Quality Improvement Project to Optimize Fluoride Varnish Use in a Pediatric Outpatient Clinic with Multiple Resident Providers

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Abstract

The pediatric clinic at Kapi'olani Medical Center provides dental varnish to prevent decay. A chart review (conducted August 1-31, 2017) revealed that only 49.6% of eligible children received varnish. Among those who did not receive varnish, no explanation was provided in 83.9% of the charts. This quality improvement project was designed to increase delivery and documentation of dental varnish. The participants were 14-15 pediatric and psychiatry residents (11 present for all cycles). Cycle 1 interventions were a 5-minute resident educational session on the importance and process of fluoride varnish, and visual reminders on all order entry computers in the clinic. Cycle 2 intervention consisted of a prompt added to the clinic's default well child visit templates requiring notation of whether varnish was given and a reason if not. Data for cycle 2 was collected over 6 weeks as some residents chose to use their own templates, serving as an unplanned comparison group. Application of varnish increased to 77.7% (P < .001) after cycle 1, and was statistically unchanged for cycle 2 (74% (P = .24)). Documentation of reason for lack of varnish was missing in 80% (P = .59) after cycle 1 and 17 % (P < .001) after cycle 2 (with prompt). In the cycle 2 comparison group using their own templates, the varnish application rate was 71% (P < .001) with no explanation for lack of varnish 84% of the time (P = .95). Brief educational interventions may result in increased use of fluoride varnish in resident-based clinics. Task based prompts or stop measures in electronic medical record templates can improve documentation, which can inform efforts to improve varnish application.

Keywords

fluoride varnish, quality improvement, educational intervention, early childhood caries, resident clinic

Abbreviations

AAP = American Academy of Pediatrics
CDC = Centers for Disease Control and Prevention
EMR = Electronic medical record
KMCWC = Kapi'olani Medical Center for Women and Children
PCP = Primary care physicians
PDSA = Plan-Do-Study-Act
QI = Quality improvement
USPSTF = United States Preventative Services Task Force
WCC = Well child checks

Introduction

Early childhood dental decay is the most common chronic disease of preschool children, estimated to affect up to 22.7% of 2-5 year-olds in a 2011-2012 study[1] and up to 53% in those 6-8 years old.[2] Fewer than 50% of young children received dental care in 2009, with only 7% of those ages 0-2 years old and only 43% of those ages 3-5 years old having access to dental care.[3] According to Bright Futures, the younger the age at which tooth decay begins, the greater the severity as well as the risk of future decay.[4] The Hawai'i State Department of Health in 2014-2015 collected data from elementary schools and found that Hawai'i third graders have the highest prevalence of caries in the nation (71% vs the national average of 52%). Among children living in Hawai'i, there are significant disparities with Pacific Islanders and children living in poverty at highest risk.[5] The Centers for Disease Control and Prevention (CDC) reports that 60.9% of Hawai'i's Head Start students have dental caries.[6] This economic disparity is consistent with national data where nearly two-thirds of children under 200% of the federal poverty level experience caries in their primary teeth by 8 years old.[2] At least part of the disparity between the dental health of Hawai'i's children and that of the rest of the nation can be attributed to the lack of community water fluoridation. The CDC lists community water fluoridation as one of the 10 great public health achievements of the 20th century due to its reduction in childhood tooth decay (40%-70%) and in adult tooth loss (40%-60%).[7]

Children under the age of 5 years are more likely to be seen by primary care physicians (PCP) than dentists.[2] The children who are seen in the pediatric residency outpatient clinic are at particularly high risk of dental disease. Over 90% are on public insurance, and over 50% of the families are Pacific Islander. Anecdotally, they have difficulty accessing dental care, particularly before the age of 3. Oral fluoride supplementation (with suboptimal systemic rather than topical delivery of fluoride) is a poor substitute for water fluoridation as it requires a prescription and family adherence.

There is substantial evidence that fluoride varnish can prevent the development of dental caries. Prior systematic reviews have found that fluoride varnish may decrease caries in permanent dentition by up to 38%,[8]and can reduce decayed and filled tooth services by up to 37%.[9] It can even reverse early carious lesions,[10] and is recommended by the American Academy of Pediatrics (AAP), the American Academy of Pediatric Dentistry, the CDC as well as the US Preventative Services Task Force (USPSTF). Several organizations such as the AAP have free online oral health risk assessment questionnaires that PCPs may utilize should they need help in determining who is at high risk of dental caries. The USPSTF has recommended since 2016 that fluoride varnish be applied in the primary care setting 2-4 times per year. Application involves painting of topical fluoride on teeth with a small brush. It takes from 1-5 minutes to apply; families are asked to eat soft foods and not drink hot liquids

or brush their teeth for several hours afterwards.[2,11] Reported barriers to implementation include time constraints, lack of oral health training, parental refusal, and concerns about financial costs to the practice due to impaired work flow.[2]

Fluoride varnish is covered by most private insurers and has been covered by Medicaid in all states since 2017.[2,12] A Monte-Carlo cost-benefit simulation by Scherrer &Naavaal found that applying this resource to Medicaid insured children under 3 years old in Virginia could reduce the proportion of 7.5-year-olds with decay from 63.2% to 39.8% and save Virginia Medicaid $75.32 per child, an estimated $2 million per year.[2] Accounting for application time and labor and material costs, the return on investment for fluoride varnish was deemed to be 4-12 times the direct fluoride varnish application cost. Prior oral health prevention initiatives have shown via cost/revenue analysis that such programs can contribute to the financial viability of a clinic.[13] The average reimbursement rate for fluoride varnish is $18.90.[2] Reimbursement in Hawai‘i is $4.16 per application up to twice a year.[14]

Kapi‘olani Medical Center for Women and Children’s (KMCWC) outpatient pediatric clinic is primarily staffed by residents who are overseen by attending physicians. Fluoride varnish has been available in the clinic since 2013 and is provided free of cost to the patients, but anecdotally seemed to be underused. The clinic’s goal is to offer varnish at well visits up to every 3 months to children between the age of 6 months and 5 years. Prior studies have documented success with educational interventions as well as alteration of the electronic medical record (EMR), ultimately increasing varnish application rates as well as dental referrals.[15,17] However, these studies were not conducted in populations such as Hawai‘i where children are at higher risk due to lack of fluoride in the public water. The authors sought to utilize quality improvement (QI) methods to increase fluoride varnish application to reach 85% of eligible well checks at the clinic.

Methods

A pre-intervention chart review of eligible Well Child Checks (WCC) over a 1-month period (August 1-31, 2017) was conducted to assess current fluoride varnish application rates. An eligible WCC was defined as a patient between the ages of 6 months to 5 years old who had teeth and who had not received fluoride varnish within the preceding 3 months (either on review of clinic visits in EMR or per parental report). This age group was in alignment with the recommendations of the USPSTF.[9] There are 9 scheduled well child checks in this age range, during which time children typically lack an established dental home, providing ample opportunity for intervention. Due to the high percentage of Pacific Islander patients and patients on Medicaid, it was decided that most of the patients are high risk. Therefore, a formal risk assessment was not performed. To minimize collection of patient identifiers, individual insurance coverage and ethnicity information were not collected. This study was reviewed by the Hawai‘i Pacific Health Institutional Review Board and found to be exempt (2017-130).

Three residents were shadowed in clinic and subsequent discussion regarding missed fluoride varnish opportunities revealed time, distraction, and lack of knowledge as potential barriers. The team then sought to assess all residents’ understanding regarding fluoride varnish objectives. Subsequently, 22 of the 24 pediatric residents (excluding the two residents involved in the project) were surveyed pre-intervention to assess knowledge and confidence about clinic goals of fluoride varnish use (Figure 1). The resident survey revealed that 18% (4/22) were not at all confident about their varnish knowledge or when to apply it. Although 36% (8/22) were fairly to very confident about their knowledge, only 23% (5 out of 22) correctly reported the clinic’s target varnish frequency of every three months. Fifty-five percent (12 out of 22) knew the clinic’s target age range. The results of both the survey and observations were used to identify secondary drivers in the key driver diagram (Figure 2), which the authors used to develop interventions. While the framework of a key driver diagram is standard among many QI references, the content used to fill it in were the authors’ own creation.[16]

The intervention ideas developed from the key drivers were implemented using a Plan-Do-Study-Act (PDSA) approach. PDSA is a cyclical process that allows observation of a current approach to pursue opportunities for improvement. It proceeds with establishment of baseline function or data, an intervention identified based on a specific aim or goal with defined measures, and a subsequent assessment of effect with either ongoing adoption of the test change or adaptation and repetition of the cycle. It often entails small and frequent interventions for quick adjustment that can then be applied on a larger scale.[16] The first PDSA cycle consisted of a 5-minute-long resident educational session via PowerPoint highlighting research on the impact of fluoride varnish on dental health and specifying clinic goals for use, coupled with bright orange reminders taped to the bottom of the monitors of all order entry computers. The residents were encouraged to ask if the patient had received varnish within the last three months to determine eligibility. There was no standardization in how the topic of varnish was broached with parents. A chart review was conducted after one-month of implementation (February 1-28, 2018) and the percentages or proportions of varnish delivery were calculated.

PDSA cycle 2 consisted of incorporation of a dental health history section and a fluoride varnish prompt into the plan section of default Epic EMR WCC templates. All well visits (6 months-5 years) contained the same varnish prompt which requires the physician to either fill in the information or delete the section to close the encounter. Providers simply had to click a yes or no drop-down option. If they selected “no varnish” the three asterisks encouraged them to fill in the reason why it was not

RESIDENCY YEAR (i.e. PGY1) _____

How confident do you feel about your knowledge of fluoride varnish and when to use it? (circle)
Not at all confident somewhat unconfident neutral fairly confident very confident

Technically fluoride varnish can be applied at any age. **For what age range is fluoride varnish recommended in our clinic to help minimize early childhood caries?**
a) 12 months – 4 years b) 9 months – 6 years c) 6 months – 5 years d) 4 months to 4 years

You can varnish any number of teeth (circle) TRUE FALSE

At KMCWC Clinic, how frequently can fluoride varnish be applied?

a) As frequently as you want b) every year (q12 months) c) every 6 months d) every 3 months

Figure 1. Survey Distributed to Hawai'i Residency Program Pediatric Residents

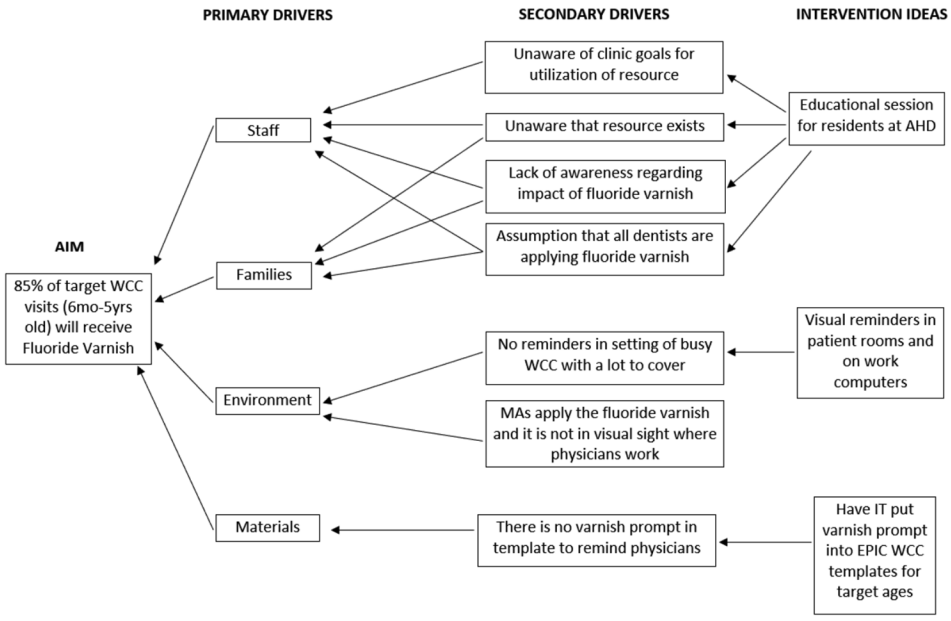

Figure 2. Key Driver Diagram of Fluoride Varnish Application at KMCWC Outpatient Pediatric Clinic

delivered. Standard templates were available to all clinic physicians and simply required typing "WCC" followed by the age of the well child check (ie, "WCC6mo" for a 6-month WCC) where the template would then auto-populate. All residents were encouraged to use the new template; however, a subset of self-selected residents opted to continue to use their own previously created personalized templates that did not have the prompts. The chart review after PDSA cycle 2 consisted of a 1.5-month period (March 1 to April 15, 2018), to allow for a larger sample size in response to the reduction in the number of residents using the new standard template.

Participants were 14-15 pediatric and psychiatry residents (11 present for all cycles). Variables collected included date of visit, age, sex, whether the patient had seen a dentist in the year prior, varnish application within the last three months, and any documentation for why varnish was not applied. We used the χ^2 test of independence with $\alpha = .05$ as criterion for statistical significance to look for differences in proportions between groups. Analysis was conducted using SAS software, version 9.4 (SAS Institute Inc.: Cary, NC).

Results

The age distributions in the pre-intervention, PDSA cycle 1 and 2 samples differed, with overrepresentation of 6-12-month-olds and under representation of 2-5-year-olds in cycles 1 and 2 ($\chi^2(4, N=603) = 11.34$, $P = .02$) (Table 1). Of the eligible visits (N = 202) in the pre-intervention chart review, 49.6% were varnished (Table 2). There was no documentation of a reason in

Table 1. Chart Reviewed Eligible Patients in Each Cycle by Age and Explanations for Why Eligible Patients Did Not Receive Fluoride Varnish			
	Pre-Intervention N (%)	**PDSA Cycle 1 N (%)**	**PDSA Cycle 2 N (%)**
Total WCC*	202 (100)	157 (100)	244 (100)
Age 6-12 months old	44 (21.8)	44 (28)	85 (34.9)
Age >1 yr to 2 yrs old	80 (39.6)	67 (43)	85 (34.9)
Age >2 yrs to 5 yrs old	78 (38.6)	46 (29)	74 (30.3)
Total unvarnished	112 (100)	35 (100)	67 (100)
Parental refusal	7 (39)	3 (43)	10 (30)
Deferred to dental visit	10 (56)	2 (28)	23 (70)
The family left or provider did not place the order	1 (5)	2 (28)	0 (0)
No explanation	94 (84)	28 (80)	33 (49)

PDSA = Plan-Do-Study-Act. WCC = Well child check.
* $\chi 2\,(1, N = 359) = 40.15$, $P < .001$. Comparing all three groups: * $\chi 2\,(4, N = 603) = 11.34$, $P = .02$.

Table 2. Results of the Plan-Do-Study-Act Cycles Compared to Pre-intervention Chart Review					
	Pre-Intervention N (%)	**PDSA Cycle 1 N (%)**	**PDSA Cycle 2 N (%)**	**Cycle 2 with varnish prompt N (%)**	**Cycle 2 without varnish prompt N (%)**
Total WCCs	207	160	275	159	116
Total WCCs (% male)	(44)	(51)	(42)		
Eligible who had not seen a dentist in the last year**	(51)	(31.6)	(48)	(42)	(56)
*Eligible WCCs	202	157	244	135	109
Offered fluoride varnish	108 (53.5)	159 (96)		129 (96)	89 (75)
*Eligible varnished	90 (44.6)	122 (78)†	177 (72.5)	100 (74)^	77 (71)‡‡
*Eligible unvarnished with no documented reason	94 (84)	28 (80)††	33 (49)#	6 (17)^^	27 (84)§‡

* Eligible patients were defined as those between 6 months and 5 years old, with teeth and whom did not receive fluoride varnish within the last three months
** Due to the recommendation that the first dental visit occur at age 1, this does not include the 12, 9 and 6 months well child check patients
Compared to pre-intervention group:† $\chi 2\,(1, N = 359) = 40.15$, $P < .001$ †† $(\chi 2\,(1, N = 147) = 0.2916$, $P < .59$
^ $\chi 2\,(1, N = 337) = 28.67$, $P < .001$ ^^ $\chi 2\,(1, N = 70) = 27.67$, $P < .001$ §$\chi 2\,(1, N = 144) = 0.0037$, $P = .95$
Compared to cycle 1: # $(\chi 2\,(1, N = 401) = 1.34$, $P = .24$
Compared to cycle 2 with varnish prompt: ‡ $\chi 2\,(1, N = 67) = 30.23$, $P < .001$ ‡‡ $\chi 2\,(1, N = 244) = 0.3566$, $P = .55$
PDSA = Plan-Do-Study-Act WCC = Well child check

84% of the unvarnished. There were 157 eligible visits in PDSA cycle 1, 22% of which did not receive fluoride varnish. There was no explanation for the omission in 80% of the unvarnished patients. There was a statistical difference between preintervention and cycle 1 varnish rates ($\chi^2(1, N = 359) = 40.15$, $P < .001$) but not documentation rates ($\chi^2(1, N = 147) = 0.2916$, $P < .59$).

In PDSA cycle 2 (N = 244), 135 were documented on the updated template and 109 were on personalized templates without the varnish prompt. In those with the prompt, 74% were varnished; there was no explanation for omission in 17% of those unvarnished. In those who used a template without a varnish prompt 71% received fluoride varnish and there was no explanation in 84% of unvarnished. There was a statistically significant difference in varnish rates ($\chi^2(1, N = 337) = 28.67$, $P < .001$) as well as documentation rates between the preintervention group and the cycle 2 group that used the new template with varnish prompt ($\chi^2(1, N = 70) = 27.67$, $P < .001$). There was no statistical difference in documentation rates comparing preintervention to cycle 2 where residents used their own template without the fluoride varnish prompt ($\chi^2(1, N = 144) = 0.0037$, $P = .95$). The cycle 1 and cycle 2 varnish rates were not significantly different ($\chi^2(1, N = 401) = 1.34$, $P = .24$). However, when comparing the two groups in PDSA cycle 2, there was a statistically significant difference in documentation rates ($\chi^2(1, N = 67) = 30.23$, $P < .001$) but not varnish rates ($\chi^2(1, N = 244) = 0.3566$, $P = .55$). For those unvarnished with some explanation, the most common reason was deferral to dentist followed by parental refusal (Table 1). In the majority of cases, there was no documentation of why the parent refused.

Discussion

The significant improvement in varnish application from 44.6% (pre-intervention) to 74%-78% in the PDSA cycles fell short ofthe goal of applying fluoride varnish in 85% of eligible WCC. However, the improved documentation in PDSA cycle 2 revealed that it had been offered to 95% of families. Varnish application was limited primarily by the presence of a dental home or parental preference.

The WCC visit can be difficult to navigate, especially for the new learner, imparting a large breadth of information over a relatively brief time. Education and visual reminders remain important tools for increasing preferred practices, especially one such as fluoride varnish which is not universally offered in the outpatient clinic setting or traditionally associated with the WCC visit. The effectiveness of educational interventions to promote fluoride varnish by pediatric residents has been demonstrated previously.[15,17] The QI project demonstrated the effectiveness of an exceptionally short educational session when coupled with EMR templates and visual reminders.

Given the decline (albeit statistically insignificant) in application noted between PDSA cycle 1 (78%) and the PDSA cycle 2 comparison group (no varnish prompt) (71%), it may be that educational interventions require periodic reinforcement. The increase in varnish application between PDSA cycle 2 comparison group (no EMR prompt in template) and pre-intervention chart review may be partly explained by the overlap in residents between PDSA cycle 1 and cycle 2. Patients in the clinic frequently see different providers for their visits. Incorporation of target objectives into the EMR may improve care by enabling clear communication among numerous providers regarding a prior refusal or omission; this may allow the subsequent physician to plan for time to address fluoride hesitancy if needed. The authors hope the EMR changes help the program persist in its increased use of this dental resource.

There are several limitations to this project. Because the clinic had already committed to offering varnish, the authors did not quantify the time commitment applying fluoride varnish required, which was a barrier to implementation identified by previous studies.[19,20] The application of varnish can be completed within a few minutes; however, the family does have to wait for the medical assistant to get the varnish. In addition, the amount of information provided or the way it was conveyed to parents was not standardized, and there was likely great variability in the way parental refusal was handled.

When the authors realized that certain residents were using their own template without a varnish prompt, the chart review period was extended to 6 weeks instead of 4 to achieve a larger sample size. The authors were interested in comparing the two cycle 2 subgroups but this may have introduced a temporal bias. PDSA cycle 2 utilizing an EMR varnish prompt in the WCC template resulted in the best documentation rate but it is not a perfect system. It can be easily bypassed by simply deleting that section. Residents were not forced to use a certain template. While this allowed an opportunity to compare those who continued to use their own template without an EMR varnish prompt to the new template, this may have introduced some bias as residents using their own templates may differ (ie, personal attitudes about fluoride varnish). Residents who continued to use their own template may have done so out of reluctance to invest the time to change the default template to meet their preferences. Requiring incorporation of the prompts in the future may improve varnish rates and documentation. Finally, many physicians do not refer to the computer while conducting the WCC. They may see the prompt too late to affect care, which may explain the failure to further increase varnish application.

PDSA cycle 1 likely had effects that persisted into cycle 2. The posted visual reminders that fell after PDSA cycle 1 were not replaced. Most, but not all, of the well children are seen by a resident. The attending physicians receive a different online training that is repeated every year to qualify for reimbursement. A research study might include randomization of providers but the purpose of this project was QI and not research testing a novel clinical intervention. The timing of this project was short, in part due to the time-consuming nature of the chart review. Longer observations would better account for any month to month variability and allow providers to determine if improvements persist over time. The temporal nature of PDSA cycles make it possible for other contributing factors, other than the interventions, in explaining the improvement (eg, time in residency). This study did not collect data on resident demographics or patient demographics such as socioeconomic status and ethnicity.

Additional opportunities for improved fluoride varnish application going forward include reinforcement educational sessions for residents, replacement of missing visual reminders and addressing the way in which fluoride varnish is offered to families, and howresistance or hesitance to its application are explored with parents. Since parental refusal has been recognized as a reason why fluoride varnish is not applied,[18] future PDSA cycles could address the reasons for refusal.

Fluoride varnish is cheap, quick, and easy to apply. There is extensive data to suggest it can improve dental health and a child's overall wellbeing. Frequent visits to pediatricians during infancy and early childhood provide an opportunity to affect a child's dental health until, or in addition to, the establishment of a dental home. Education, visual reminders, and prompts may help busy pediatricians increase the delivery of this valuable preventative care. Better documentation from an EMR prompt improves communication between providers and can inform the ongoing efforts to improve performance.

Conflict of Interest

None of the authors identify a conflict of interest.

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