Clinical Article

# Factors Associated With Sealant Outcome in 2 Pediatric Dental Clinics: A Multivariate Hierarchical Analysis

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**Abstract:** ***Purpose:*** *This study's purpose was to determine whether one-time sealants placed by pediatric dental residents vs dental students have different outcomes. The effect of isolation technique, behavior, duration of follow-up, and caries history was also examined.* ***Methods:*** *Records from 2 inner-city pediatric dental clinics were audited for 6- to 10-year-old patients with a permanent first molar sealant with at least 2 years of follow-up. A successful sealant was a one-time sealant that received no further treatment and was sealed or unsealed but not carious or restored at the final audit.* ***Results:*** *Charts from 203 children with 481 sealants were audited. Of these, 281 sealants were failures. Univariate analysis revealed longer follow-up and younger age were associated with sealant failure. Operator type, child behavior, and isolation technique were not associated with sealant failure. After adjusting for follow-up duration, increased age at treatment reduced the odds of sealant failure while a history of caries reduced the protective effect of increased age. After adjusting for these factors, practitioner type, behavior, and type of isolation were not associated with sealant outcome in multivariate analysis.* ***Conclusions:*** *Age at sealant placement, history of caries prior to placement, and longer duration of follow-up are associated with sealant failure.* *(Pediatr Dent 2011;33:333-7) Received December 23, 2009 / Last Revision October 12, 2010 / Accepted October 17, 2010*

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Dental caries is the most prevalent chronic disease affecting children.[1] Approximately 42% of 6- to 19-year-olds have at least 1 cavity or restoration in a permanent tooth.[2] Pit and fissure caries continues to account for most caries in children, comprising 90% of all caries in permanent posterior teeth.[2]

In 1976, The Council on Dental Materials of the American Dental Association approved sealants as a safe and effective means to prevent pit and fissure caries.[3] Today, sealants are considered an essential component of preventive dentistry. It has been reported, however, that sealant use is not widespread.[4] Based on the fourth National Health and Nutrition Examination Survey, only 30% of US children and adolescents between the ages of 6 and 11 years had 1 or more dental sealants. Furthermore, only 21% of children residing in families at less than 100% of the federal poverty level—including those likely insured by Medicaid—have received sealants.[5]

Poor long-term retention has been quoted historically as one of the reasons for limited use.[6] Studies from the last decade, however, report generally good retention rates of 65% to 82%.[7] There are a number of factors thought to influence sealant outcomes, some of which include method of isolation, use of bonding agent, previous caries experience, patient age, patient behavior, and diet. Another factor to consider is that many of the studies reporting good retention rates have used small numbers of experienced clinicians in optimal clinical conditions with highly controlled selection of patients and teeth.[8] Under more typical practice situations, operator skill and knowledge may vary, thereby affecting sealant outcomes.

A survey of private pediatric practitioners and dental schools reported estimated 1- and 3-year retention rates of 89% and 78%, respectively, for private dentists and retention rates of 83% and 71%, respectively, for dental schools.[9] Other studies using dental students as operators reported retention rates of 30%,[10] 52%,[11] 70%,[12] and 76%[13] after approximately 2 years. Studies involving pediatric dental residents as operators could not be located. Few studies that compare the effect of different operator types on sealant retention exist.

One such study concluded that there were no significant differences between dentists and auxiliaries in sealant retention over a 2-year period.[14] Other papers have found that hygienists have higher reported retention rates than dentists,[4] and dental assistants have higher retention rates than hygienists.[15] No studies were located that compared dental students or residents with each other or with other provider types.

The present study will determine whether one-time sealants placed on inner-city children attending a pediatric dental clinic by residents vs dental students have different clinical outcomes. The study will also examine whether method of isolation, behavior, duration of follow-up, and previous caries experience affect sealant outcomes.

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## Methods

This retrospective study examining permanent first molar sealants utilized patient records selected from the University of Connecticut School of Dental Medicine's (**UCONN**) pediatric dental clinics at the Connecticut Children's Medical Center (**CCMC**) and the Burgdorf Clinic, both located in Hartford, Conn. The patient populations at the 2 clinics are similar, comprising predominantly minority children on Medicaid insurance. Pediatric dental residents staff the CCMC clinic, while the Burgdorf clinic is primarily staffed by dental students. The dental students were a mix of third- and fourth-year students. The third-year year students, however, did not enter the pediatric clinic until the second half of the year, and the fourth-year students were in the pediatric clinic primarily in the first half of the year. UCONN pediatric faculty oversees clinical activities at both clinics.

The study received Institutional Review Board expedited approval and a Health Insurance Portability and Accountability Act waiver under the agreement that all patient identifiers were to be eliminated from the study database after the initial data collection. All patient records were audited from 6- to 10-year-olds who had an initial permanent first molar sealant placed between July 1999 and June 2003 with at least 2 years of follow-up. Patients with medical histories that might affect sealant outcome, such as intellectual disability, severe seizure disorder, and gastric reflux, were excluded. Records were audited by 2 cross-trained reviewers, and data were entered directly into a computer database.

Data collected from the records included: date of birth; previous caries experience; teeth sealed; date of initial treatment; provider type (student or resident); date and type of subsequent treatments; isolation technique (rubber dam isolation or cotton roll isolation); behavior rating using the Frankl behavioral scale[16]; and tooth status at final chart audit. Radiographs were not available for all charts at the final audit and, therefore, were not reviewed. The sealant material used in both clinics was light-cured Helioseal for the duration of the period under study. Bonding agent was not used with sealants during the period audited. During sealant placement, students at the Burgdorf clinic often did not have dental assistants while residents at CCMC consistently had dental assistants.

A successful sealant outcome was defined as a one-time sealant that did not receive any further treatments (including

Table 1. CHARACTERISTICS OF SEALED TEETH IN STUDY COHORT

| | Resident | Student | *P*-value* |
|---|---|---|---|
| *Teeth sealed* | | | |
| Number | 287 | 194 | |
| *Age at treatment* | | | |
| Mean (ys) | 7.9±1.0 | 8.2±1.1 | .002 |
| 6-7.9 ys [N (%)] | 159 (55) | 95 (49) | .09 |
| ≥8 ys [N (%)] | 128 (45) | 99 (51) | .09 |
| *Isolation technique* | | | |
| Cotton [N (%)] | 45 (16) | 40 (21) | .09 |
| Rubber dam isolation [N (%)] | 223 (78) | 132 (68) | .03 |
| Unknown [N (%)] | 19 (6) | 22 (11) | .31 |
| *Frankl scale at treatment* | | | |
| 4 [N (%)] | 242 (84) | 134 (69) | <.05 |
| <4 [N (%)] | 32 (11) | 27 (14) | .98 |
| Unknown [N (%)] | 13 (5) | 33 (17) | .002 |
| *Duration of follow-up* | | | |
| Mean (ys) | 3.8±1.0 | 4.8±1.2 | <.001 |
| 2-3 ys [N (%)] | 159 (55) | 53 (27) | <.001 |
| ≥4 ys [N (%)] | 128 (45) | 141 (73) | <.001 |
| *Outcome* | | | |
| Successful sealants [N (%)] | 128 (45) | 72 (37) | .17 |

* *P*-values are for comparison of variables between residents and students.

Table 2. TEETH WITH SUCCESSFUL SEALANT OUTCOME VS SEALANT FAILURE

| | Successful outcome | Failure | *P*-value |
|---|---|---|---|
| *Teeth sealed* | | | |
| Number | 200 | 281 | |
| *Age at treatment* | | | |
| Mean (ys) | 8.2±1.2 | 7.8±1.0 | .004 |
| 6-7.9 ys [N (%)] | 93 (45) | 161 (58) | .047 |
| ≥8 ys | 107 (53) | 120 (43) | .047 |
| *Isolation technique* | | | |
| Cotton [N (%)] | 29 (14) | 56 (20) | .30 |
| Rubber dam isolation [N (%)] | 150 (75) | 205 (73) | .82 |
| Unknown [N (%)] | 21 (11) | 20 (7) | .32 |
| *Frankl scale at treatment* | | | |
| 4 [N (%)] | 163 (81) | 213 (76) | .38 |
| <4 [N (%)] | 18 (9) | 41 (15) | .09 |
| Unknown [N (%)] | 19 (9) | 27 (10) | .50 |
| *Duration of follow-up* | | | |
| Mean (ys) | 4.0±1.2 | 4.3±1.2 | .007 |

Table 3. TWO-LEVEL HIERARCHICAL LOGISTIC REGRESSION MODEL FOR SEALANT FAILURE

| | Odds ratio | 95% confidence interval | *P*-value |
|---|---|---|---|
| *Duration of follow-up (ys)* | 1.29 | 1.06, 1.57 | .01 |
| *Age at treatment per year* | | | |
| Without caries | 0.77 | 0.62, 0.95 | .02 |
| With caries | 0.84 | 0.79, 0.9 | .005 |

additional sealant application) on the occlusal surface and was sealed or unsealed but not carious or restored at the final chart audit. Any sealed tooth that was resealed, restored, or had frank caries at the final audit was considered a failure. Descriptive, univariate, and multivariate analyses were performed. Children in the study were compared in univariate analyses using Student's *t* test or Mann-Whitney U test for continuous variables and chi-square test for categorical variables.

For all analyses, observation of sealant failure was the outcome examined. Univariate comparisons of teeth characteristics associated with sealant outcome as well as comparisons of teeth treated by the 2 provider types (resident vs student) from the 2 study locations were performed using univariate 2-level hierarchical models to adjust for clustering of teeth within children. Tooth and child characteristics associated with sealant outcome were identified with 2-level multivariate hierarchical logistic regression.

Tooth characteristics tested included: isolation technique; Frankl behavior score; child age; and duration of follow-up. Child-level characteristics tested included a positive caries history and provider type. Adjusted odds ratios and 95% confidence intervals for factors significantly associated with sealant failure were calculated. A *P*-value of <.05 was considered significant. Statistical analyses were performed with SPSS (SPSS Inc, Chicago, Ill) and HLM (SSI Scientific Software, Lincolnwood, Ill) software.

## Results

Data were analyzed for 481 sealants placed in 203 children. Of these, 77 children were treated in the student clinic and 126 at the resident clinic, and 73% had a history of previous caries. The average age at treatment was 8.0-years-old, and the duration of follow-up ranged from 2.0 to 6.7 years with a mean of 4.2 years. The median number of teeth treated per child was 3 and did not vary significantly by study location. Of the sealants placed, 42% were categorized as having a successful outcome. Five patients were excluded from the study due to intellectual disability, seizure disorders, or severe bruxism. Select characteristics of the study children and the sealed teeth by provider type are shown in Table 1.

Utilizing univariate analyses, it was determined that sealants with successful outcomes were more likely to have been placed on older children and had a significantly shorter duration of follow-up than failures. Isolation technique and behavior were not significantly associated with outcome (Table 2).

Several differences were found between sealants placed in children by residents vs students. Patients treated by students were less likely to have a history of caries (57% vs 83%) and less likely to have received rubber dam isolation (*P*<.001). The students' patients, however, were likely to be older, deemed to be less cooperative, and were followed longer (Table 1). Documentation of isolation technique by students vs residents was slightly less thorough (11% vs. 6% missing data), and documentation of Frankl scale score by students was significantly less thorough than by residents (17% vs. 5%, *P*=.002). There was no detected difference between the 2 types of practitioners regarding successful outcomes.

Multivariate hierarchical logistic regression analysis demonstrated that a history of caries at sealant placement, age at treatment, and duration of follow-up were significantly associated with sealant failure (Table 3). Each year of follow-up increased adjusted odds of observing sealant failure by 29%. After adjusting for this effect, advancing age at treatment reduced the odds of observing sealant failure; however, this effect varied depending on caries history.

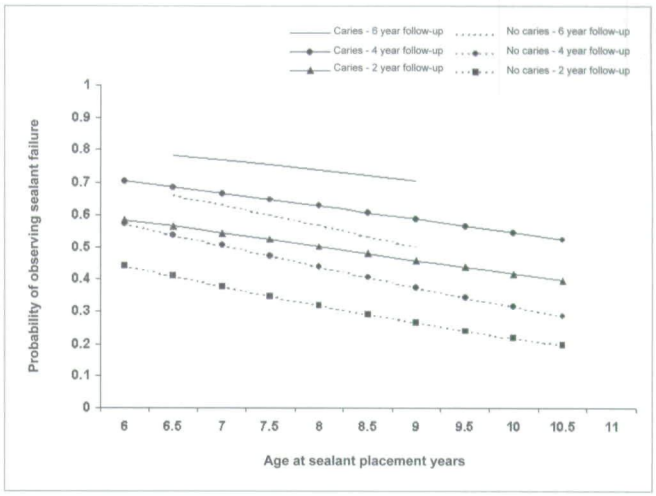


Figure 1. Predicted probability of observing sealant failure, based on regression model.

For children without a history of caries, each increase in age by 1 year at sealant placement decreased the odds of observing failure by 23% after adjusting for duration of follow-up. A history of caries, however, reduced the protective effect of advancing age of treatment, so that for children with a history of caries, each increase in age by 1 year at sealant placement only decreased adjusted odds of observing failure by 16%. After adjusting for the effect of these factors in this model, factors not significantly associated with sealant outcome in multivariate analysis included practitioner type, Frankl behavior score, and type of isolation. Predicted probabilities of sealant failure based on this model are illustrated in Figure 1.

## Discussion

This study's purpose was to examine the outcomes for a one-time sealant application in a clinical setting staffed by a range of providers. A variety of methods for determining sealant outcomes are possible, including assessing complete retention, partial retention, or healthy outcomes. Prospective sealant studies often use retention as the definition of success. Retrospective chart studies, however, limit the choice, as outcomes must be derived from the information recorded by the providers. This information typically does not provide consistent details on full retention vs partial retention vs loss. Typically, the most reliable information available is whether the tooth is carious, restored, or healthy (with or without sealant present).

Because of these limitations, our study focused on the health status of the tooth to evaluate the outcome of sealant treatment. A successful outcome was defined as a one-time sealant resulting in a healthy tooth, sealed or unsealed, at the final recall appointment.

A drawback of the utilized outcome measure is that children who lost a sealant but had no caries on the tooth may have ended up in the "failure" or "success" category based on individual provider decisions. If the provider determined the

tooth needed resealing, the tooth would have been classified a "failure." If it was determined the tooth did not warrant resealing, the tooth would have been classified as a "success." Although this is a study limitation, the mere fact that the provider determined that the child no longer needed a sealant indicates a successful outcome for that child, meaning that no additional care was needed. Furthermore, it must be remembered that the patients included in the study returned for ongoing care. Such patients may have better oral health care behaviors, which could result in better sealant outcomes than might be expected for the entire clinic population.

This study's results suggest that operator education level was not significantly associated with successful sealant outcomes, as residents had successful outcomes 45% of the time and students had successful outcomes 37% of the time. The duration of follow-up, however, was longer for teeth treated by students, providing a greater opportunity to observe sealant failure. The results of multivariate analysis suggest that the observed sealant success rate may have been lower among residents had the duration of follow-up been equal.

As sealant placement is considered a basic skill, little additional specific sealant education is given to residents, so the main difference between residents and students is additional clinical practice. This study's results suggest that this additional clinical practice is not a major factor in sealant retention. These ideas are supported by the literature, which does not consistently show higher sealant retention rates among dental professionals with a higher level of education and clinical experience. In fact, several studies report that hygienists have better retention rates than dentists, and assistants have better retention rates than hygienists.[4,15]

Increasing age at treatment in the present study reduced the adjusted odds of observing sealant failure (23%), but this effect was less in the presence of a previous history of caries (16%). In other words, teeth in caries-free, older subjects are predicted to be at lowest risk of sealant failure while teeth in younger subjects with a history of previous caries are predicted to be at highest risk for sealant failure. Other studies have shown a similar effect of age,[4,17] perhaps because molars in older children are more fully erupted, thus facilitating isolation and maintenance of a dry working field.

Caries may mitigate this effect, because the risk of developing disease outweighs the benefits of improved isolation. Several studies have shown that caries experience decreases sealant success.[4,18,19] Alternatively, because radiographs were not reviewed, the effect of proximal lesions and their subsequent restoration may also disproportionately affect the findings in older children, as proximal lesions become more prevalent as children age. As only 10% of teeth were noted as restored and most restorations involved only the occlusal surface, however, this is unlikely to be a significant factor.

Based on this study's results, a child's behavior, assessed according to the Frankl behavior scale, did not significantly affect the success of the sealant. Although the Frankl behavior scale is an objective measure, improper or insufficient understanding of the scale could lead to a clinical application that is very subjective. The student and resident providers in this study received basic training in the use of the Frankl scale, but their use in the clinical setting is not standardized. This may explain why significantly fewer students scored their patients as Frankl 4 vs residents and why behavior was not found to be associated with sealant retention in the present study. Folke[5] reported that poor behavior showed a nonstatistical tendency for increased risk of failure.

Rubber dam use, the gold standard in isolation technique, did not have a significant effect on sealant outcomes in the present study. Both rubber dam and cotton roll isolation techniques have their challenges. The isolation achieved by rubber dam is dependent on stage of eruption and skill of the operator in placement. A poorly placed dam can result in saliva leakage.[12] Although it might be tempting to assume that the poor results for rubber dam were attributable to increased use of rubber dam in caries-positive children who have poorer sealant outcomes, this cannot be the explanation as the multivariate analysis accounted for caries status.

Many studies have shown results from rubber dam and cotton roll isolation to be similar[9]; however, some studies have shown enhanced results with rubber dam isolation.[20] The statistical model used in the present study discriminated between sealants that failed vs those that were retained 65% of the time. This is fair model performance, and suggests that other additional factors important to sealant performance were not included in the present model. Few other factors have been routinely studied in the sealant literature beyond those discussed in the present study. Further study is needed to identify other factors important in explaining sealant outcome in clinic populations.

## Conclusions

Based on this study's results, the following conclusions can be made:

1. Operator type (resident vs student) was not significantly associated with sealant failure.
2. A history of caries prior to sealant placement, longer duration of follow-up, and age of child were significantly associated with sealant failure.
3. Type of isolation and patient behavior were not significantly associated with sealant failure.

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