Epidemiological evaluation of the outcomes of initial root canal therapy in permanent teeth of a publicly insured paediatric population

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Abstract

Background: Previously published epidemiological outcome studies of nonsurgical root canal therapy (NSRCT) in the United States utilize data only from a single, private dental insurer for adult populations.

Aim: This study aimed to investigate the outcomes of initial NSRCT, performed on permanent teeth, in a publicly insured paediatric population.

Design: New York State Medicaid administrative claims were used to follow 77,741 endodontic procedures in 51,545 patients aged 6–18, from the time of initial NSRCT until the occurrence of an untoward event (retreatment, apicectomy, and extraction). The initial treatment and untoward events were identified by Current Dental Terminology codes. The Kaplan–Meier survival estimates were calculated at 1, 3, and 5 years. Hazard ratios for time to permanent restoration and restoration type were calculated using the Cox proportional hazards model.

Results: The median follow-up time was 44 months [range: 12–158 months]. Procedural, NSRCT, survival was 98% at 1 year, 93% at 3 years, and 88% at 5 years. Extraction was the most common untoward event. Teeth permanently restored with cuspal coverage had the most favorable treatment outcomes.

Conclusions: Overall, 89% of teeth were retained and remained functional over a minimum follow-up time of 5 years. These results elucidate the expected outcomes of NSRCT in permanent teeth for paediatric patients with public-payer dental benefits.

KEYWORDS
endodontics, medicaid, paediatric dentistry, root canal therapy, survival analysis, treatment outcomes
1 | INTRODUCTION

The success of endodontic procedures, including nonsurgical root canal therapy (NSRCT), is of interest to dentists, patients, and third-party payers. Typically, the outcomes of endodontic procedures are evaluated through the presence of clinical signs and symptoms, along with radiographic interpretation. Reported success rates based on these criteria have ranged from 31% to 98%. The outcomes of initial NSRCT also have been evaluated using epidemiological methods, with survival rates of 94% and higher in studies based in the United States. Epidemiological or health services research methods that leverage the use of administrative claims data allow for the simultaneous study of very large cohorts and multiple variables potentially associated with treatment outcomes. Variables shown to be associated with the success of NSRCT include time to the placement of permanent restoration and type of permanent restoration. Both clinical- and population-level analyses of the outcomes of endodontic treatment are important to dental practitioners and oral health advocates alike, as findings from these studies can be used to inform clinical recommendations and policy.

Dental coverage and dental care utilization by children (age 0–18) in the United States are at their highest-ever levels, since tracking began in 1999. This increase in dental care utilization correlates with expansions in dental coverage through the Children's Health Insurance Program (CHIP) and the passage of the Affordable Care Act (ACA). As of 2015, 90% of children in the United States had dental coverage, with 39% overall covered by public insurers (Medicaid/CHIP). Currently, Medicaid provides dental coverage for income-eligible children up to the age of 21 and "at a minimum, dental services include relief of pain and infections, restoration of teeth, and maintenance of dental health." CHIP covers income-eligible children up to the age of 19 or 21, depending on the state, and provides dental services "necessary to prevent disease and promote oral health, restore oral structure to health and functions, and treat emergency functions." These definitions of covered services do not specify procedure codes, leaving this decision largely up to individual states.

Children experiencing dental pain and infection that require root canal therapy in permanent teeth may present with unique root canal anatomy and behavioral considerations compared with adults. These differences often require distinct considerations and expertise, such as the ability to manage the behavior of children and adolescents and the required proficiency to perform the technical aspects of endodontic treatment. There is currently a dearth of literature assessing the outcomes of root canal therapy performed on permanent teeth in pediatric populations. Previously published epidemiological outcome studies of root canal therapy in the United States utilize data from a single, private dental insurer focused on adult populations. The adult-focused epidemiological literature reports tooth survival rates to be above 90% five years after the initial root canal therapy. These findings may not be applicable to the pediatric population.

Motivated by the gaps in both the endodontic and pediatric dental literature and the increasingly large population of children with a public-payer dental insurance in the United States, the purpose of this study was to retrospectively investigate the survival of initial NSRCT performed on permanent teeth in a publicly insured pediatric population by using long-term, large-scale claims data.

2 | MATERIALS AND METHODS

The data for this study are the electronic insurance claims records and enrollment database of the New York State Medicaid program. Limiting the search to enrollees aged 6–18 with at least one year of continuous enrollment, the database yielded 2,027,196 individuals with patient encounters that occurred between January 1, 2006, and December 31, 2018. Of the total individual enrollees, 51,545 had initial NSRCTs in the permanent dentition, and 77,741 relevant procedures/teeth were available for analysis.

Codes on Dental Procedures (CDTs) were used to identify the endodontic therapy procedures (initial NSRCT) for analysis (D3310, D3320, and D3330). Further, CDTs

Why this paper is important to pediatric dentists

- Pediatric patients are limited with regard to tooth replacement options after the extraction of compromised permanent teeth.
- It is useful to understand the efficacy root canal therapy as a treatment option to help maintain the permanent dentition.
- The findings of this study report 1, 3 and 5-year outcomes of initial root canal therapy in a publicly insured cohort of pediatric patients.
- Further, the study findings reaffirm the importance of the permanent restoration as a continuum of endodontic treatment.
were used to identify the placement of a permanent restoration after endodontic treatment and/or the incidence of an untoward event. Relevant permanent restorations (D2000-D2999) were categorized as buildups, amalgam, composite, or cuspal coverage. In cases where multiple restoration types were placed (eg, buildup followed by cuspal coverage), priority categorization was given to cuspal coverage. Untoward events were defined as nonsurgical retreatment (D3346, D3347, and D3348), apicoectomy (D3410, D3421, and D3425), or extraction (D7140 and D7210), and these indicated the failure of initial NSRCT. Initial NSRCTs were considered to be successful until the occurrence of an untoward event or censored at an identified lapse in the patient’s enrollment status.

The following information was collected for each initial NSRCT procedure: patient identification number, tooth number, date of initial NSRCT, patient age, patient gender, race or ethnicity, zip code, date of patient disenrollment in Medicaid, date of final restoration, type of final restoration, type of untoward event (up to the third), and date(s) of the untoward event(s). Zip codes were used to identify areas of “high poverty,” rural status, and dental health provider shortage areas (DHPSAs); poverty and rural status were merged using data from the 2008-2012 American Community Survey of the 2012 US Census. Enrollees who resided in a zip code where more than 20% of the population lived below the federal poverty level (FPL) were classified as “high poverty.” Rural areas were defined according to the Federal Office of Rural Health Policy. For the purposes of this study, patients were classified as living in a DHPSA if their census tract, county, or county subdivision was deemed a geographic DHPSA at any point within our study period. The Kaplan–Meier survival estimates were calculated for 1-, 3-, and 5 years outcomes of NSRCTs, with subset analyses stratified by tooth type, time until restoration, and restoration types. The data allowed for up to 12 years of follow-up after the completion of initial NSRCT. To account for the effects of patient age, tooth type, time until restoration, and restoration type, adjusted hazard ratios (aHRs) were estimated by fitting a multivariable Cox proportional hazards model on the subsample where all treated teeth had permanent restoration placed (N = 63 128). A sensitivity analysis was conducted to evaluate the potential bias resulting from censored enrollees on the survival estimates and aHR. The use of robust standard errors accounted for potential dependence between teeth within an individual. Data analysis was completed using SAS 9.4 (SAS Institute Inc, Cary, NC) software and R 4.0 (R Core Team, Vienna, Austria).

This study was approved by New York University School of Medicine’s Institutional Review Board (i19-01436), under the expedited status (category 5).

3 RESULTS

A total of 51 545 patients and 77 741 procedures were evaluated. Of the 51 545 patients, 44.1% were male and 55.9% were female. Over half (53.3%) of those included in the study resided in a zip code area where more than 20% of the people lived below the federal poverty level. Rural–urban indicators revealed that 7.0% lived in rural areas. Patients were classified by the following race/ethnicities: White/Caucasian (31.6%); Hispanic/Latino (23.3%); Black/African American (17.8%); Asian (11.1%); American Indian/Alaska Native (1.2%); or Native Hawaiian/Pacific Islander (0.3%). Race/ethnicity data were unknown/missing for 14.6% of patients.

The median number of initial NSRCTs per patient in this population was 1.51 with a standard deviation of 1.01 [median: 1; IQR: 1–2; range: 1–18]. The median patient age was 15 years [IQR: 13–16]. Patients aged 6–9 made up 4.0% of cases, those aged 10–12, 19.5%; the ones aged 13–15, 38.7%; and the ones aged 16–18, 37.9% of cases (Table 1). As patient age increased, there was a reduced risk of failure (Figure 1). Molars (lower first molars) were the most frequently treated tooth type (Table 1).

Survival rates of initial NSRCTs were evaluated at 1 year, 3 years, and 5 years. The median follow-up period in this cohort was 44 months [IQR: 26–79; range: 12–158]. The median follow-up time was 42 months [IQR: 25–73] for initial NSRCT procedures on teeth that did not experience an untoward event and 75 months [IQR: 45–113] for teeth with initial NSRCTs that did experience an untoward event. At 1 year, 76,171 primary root canal therapies could be evaluated, with a survival rate of 98% [95% CI: 97.9–98.1]. At 3 years, 44 052 procedures could be evaluated, with a survival rate of 92% [95% CI: 91.9 92.3]. At 5 years, 23 080 procedures could be evaluated, with a survival rate of 88% [95% CI: 87.2 87.8] (Table 2, Figure 2). Tooth retention was 98.3% at 1 year, 93.1% at 3 years, and 89.2% at 5 years.

A sensitivity analysis on the Kaplan–Meier survival estimates and adjusted hazard ratios, which removed all eligibility-censored cases, did not result in any statistically or clinically significant differences in treatment outcomes. Clustering teeth at the person level yielded slightly more conservative standard error estimates (Tables 2 and 3), with no clinically meaningful differences compared with regular, nonrobust standard errors.

3.1 Tooth type

The case distribution consisted of 11 272 (15%) anterior teeth, 10 681 (14%) premolars, and 55 788 (72%) molars (Table 1). There was a significant difference in survival
based on tooth type \((p < .0001)\) (Figure 1). Compared with molars, premolar \((aHR = 0.65 \ (p < .001))\) and anterior \((aHR = 0.58 \ (p = .007))\) teeth both had a reduced risk of failure, controlling for the presence of a permanent restoration (Figure 1).

The survival of initial NSRCT for all anterior teeth was 99% [95% CI: 98.7–99.1] at 12 months; 96% [95% CI: 96.0–96.7] at 36 months; and 94% [95% CI: 93.8–94.8] at 60 months. For all treated premolars, the survival of initial NSRCT at 12 months was 99% [98.3–98.7]; at 36 months, 94% [93.9–94.9]; and at 60 months, 91% [90.5–91.9]. For all molars, the survival of initial NSRCT at 12 months was 98% [97.6–97.8]; 36 months, 91% [90.5–91.0]; and 60 months, 85% [85.0–85.7] (Table 2, Figure 3).

### 3.2 Coronal restoration

Teeth without the placement of a permanent restoration after initial NSRCT represented 14 613 (19%) of all cases (Table 1). There was a statistically significant difference in survival, at every time point, when permanent restorations were not placed \((p < .001)\) (Table 2). The mean time from the completion of initial NSRCT to the placement of a permanent restoration was 93 days, with a median of 20 days (range: 0 days–158 months). There was a significant difference in procedural survival by time until restoration, but the association was not monotonic (Figure 1). The majority of teeth with permanent restorations did not have cuspal coverage (68%) (Table 1). Compared to teeth with cuspal coverage, the teeth with composite or amalgams as final restorations, but without cuspal protection, had a greater risk of failure \((aHR = 1.36 \ (p < .001))\) or \(aHR = 1.17 \ (p = .010))\) (Figure 1).

### 3.3 Untoward events

For initial NSRCTs that did not have the survival rate of at least 1 year, the untoward events included surgical retreatment \((n = 85, 0.1\%)\), nonsurgical retreatment \((n = 142, 0.18\%)\), or extraction \((n = 1157, 1.49\%)\).

For all of the treated teeth \((n = 26 245)\) of patients continuously enrolled in Medicaid for at least five years, the incidence of surgical retreatment was 173 (0.66%); nonsurgical retreatment, 406 (1.6%); and extraction, 3065 (12%). Eighty-four teeth (0.32%) underwent endodontic retreatment (nonsurgical or surgical) prior to extraction. The number and type of untoward events per year in patients followed at least 5 years are shown in Table 4. Untoward events by tooth type were analyzed for this subset of cases. Of the treated anterior teeth \((n = 3874, 15\%)\),

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**Table 1** Description of study cohort (A. tooth level; B. patient level)

| A | Patient sample \((n)\) | 51 545 |
|---|----------------------|--------|
| Age category (%) | 6–9 | 2065 (4.0) |
| | 10–12 | 10 039 (19.5) |
| | 13–15 | 19 928 (38.7) |
| | 16–18 | 19 513 (37.9) |
| Age (median [IQR]) | 15.00 [13.00, 16.00] |
| Gender (% male) | 22 753 (44.1) |
| Race or ethnicity (%) | 16 367 (31.8) |
| | Hispanic | 12 069 (23.4) |
| | Black or African American | 9241 (17.9) |
| | Asian | 5812 (11.3) |
| | Other | 499 (1.0) |
| | Missing | 7557 (14.7) |
| High poverty (%) | No | 23 968 (46.5) |
| | Yes | 27 363 (53.1) |
| | Not reported | 214 (0.4) |
| Rural (%) | No | 47 881 (92.9) |
| | Yes | 3606 (7.0) |
| | Not reported | 58 (0.1) |
| HPSA (%) | No | 597 (1.2) |
| | Yes | 50 894 (98.7) |
| | Not reported | 54 (0.1) |
| B | Entire Sample \((n)\) | 77 741 |
| Tooth type (%) | Anterior | 11 272 (14.5) |
| | Molar | 55 788 (71.8) |
| | Premolar | 10 681 (13.7) |
| Time until restoration (%) | 0–14 days | 28 489 (36.6) |
| | 15–59 days | 17 248 (22.2) |
| | 60 + days | 17 391 (22.4) |
| | Never placed | 14 613 (18.8) |
| Restoration type (%) | Amalgam | 3845 (4.9) |
| | Buildups | 37 827 (48.7) |
| | Composite | 7472 (9.6) |
| | Cuspal | 13 984 (18.0) |
| | Never placed | 14 613 (18.8) |
the incidence of nonsurgical retreatment was 51 (1.3%); surgical retreatment, 79 (2.0%); and extraction, 123 (3.2%). Of the treated premolars ($n = 3235$, 12%), 41 (1.3%) underwent nonsurgical retreatment; 18 (0.6%), surgical retreatment; and 263 (8.1%), extraction. Of the treated molars ($n = 19,136$; 72.9%), the incidence of nonsurgical retreatment was 314 (1.6%); surgical retreatment, 76 (0.4%); and extraction, 2679 (14%).

4 | DISCUSSION

Recent increases in dental care utilization by children in the United States are largely a result of the passage of the Affordable Care Act (ACA) and coincide with increased government spending on dental care. As state and federal governments continually re-evaluate their commitments to dental spending, the impact and outcomes of various aspects of dental treatment should be assessed for these large populations undergoing care provided in communities.

This study analyzed the outcomes of initial NSRCT of over 50,000 children (and over 77,000 permanent teeth) who were continuously enrolled in the New York State Medicaid for at least 1 year. The survival rate of initial NSRCT was 98% at 1 year, 92% at 3 years, and 88% at 5 years for those with a long enough follow-up. At 10 years, 6422 teeth could be evaluated and the survival rate was 80.3% [95% CI: 79.8–80.8]. The 10 years data were not included in the results due to the comparatively small sample size.

FIGURE 1 Hazard ratio forest plot based on the Cox proportional hazards model
| Time (year) | Group     | Category | Cases | Survival distribution function estimate | Lower 95% confidence interval | Upper 95% confidence interval |
|------------|-----------|----------|-------|------------------------------------------|------------------------------|------------------------------|
| 1          | Overall   |          | 76 378| 0.980                                    | 0.979                        | 0.981                        |
|            | Tooth type|          |       |                                          |                              |                              |
|            | Anterior  |          | 11 166| 0.989                                    | 0.987                        | 0.991                        |
|            | Premolar  |          | 10 535| 0.985                                    | 0.983                        | 0.987                        |
|            | Molar     |          | 54 677| 0.977                                    | 0.976                        | 0.978                        |
|            | Time to permanent restoration |       |       |                                          |                              |                              |
|            | 0–14 days |          | 28 269| 0.991                                    | 0.990                        | 0.992                        |
|            | 15–59 days|          | 17 125| 0.992                                    | 0.990                        | 0.993                        |
|            | 60+ days  |          | 17 216| 0.988                                    | 0.987                        | 0.990                        |
|            | never placed |      | 9362  | 0.933                                    | 0.929                        | 0.938                        |
|            | Restoration type |        |       |                                          |                              |                              |
|            | Amalgam   |          | 3808  | 0.988                                    | 0.984                        | 0.991                        |
|            | Buildups  |          | 37 560| 0.992                                    | 0.991                        | 0.993                        |
|            | Composite |          | 7375  | 0.985                                    | 0.982                        | 0.988                        |
|            | Cuspal    |          | 13 867| 0.991                                    | 0.989                        | 0.992                        |
|            | Never placed |       | 9362  | 0.933                                    | 0.929                        | 0.938                        |
| 3          | Overall   |          | 44 052| 0.921                                    | 0.918                        | 0.923                        |
|            | Tooth type|          |       |                                          |                              |                              |
|            | Anterior  |          | 6885  | 0.964                                    | 0.960                        | 0.967                        |
|            | Premolar  |          | 5912  | 0.944                                    | 0.939                        | 0.949                        |
|            | Molar     |          | 31 255| 0.907                                    | 0.905                        | 0.910                        |
|            | Time to permanent restoration |       |       |                                          |                              |                              |
|            | 0–14 days |          | 16 737| 0.956                                    | 0.953                        | 0.959                        |
|            | 15–59 days|          | 10 297| 0.961                                    | 0.958                        | 0.965                        |
|            | 60+ days  |          | 10 691| 0.947                                    | 0.944                        | 0.951                        |
|            | never placed |       | 6327  | 0.767                                    | 0.759                        | 0.775                        |
|            | Restoration type |        |       |                                          |                              |                              |
|            | Amalgam   |          | 2584  | 0.944                                    | 0.936                        | 0.952                        |
|            | Buildups  |          | 22 265| 0.959                                    | 0.956                        | 0.961                        |
|            | Composite |          | 4303  | 0.936                                    | 0.930                        | 0.943                        |
|            | Cuspal    |          | 8573  | 0.958                                    | 0.954                        | 0.962                        |
|            | Never placed |       | 6327  | 0.767                                    | 0.759                        | 0.775                        |
to those reported at 1, 3, and 5 years (76,171; 44,052; and 23,080 teeth, respectively). The subset cohort with at least 5 years of follow-up showed tooth retention of 89% at 5 years. In comparison with other epidemiological studies of root canal therapy outcomes in US populations, we found generally lower procedural survival and tooth retention rates five and ten years after treatment. When assessing the clinical significance of this study and contextualizing its findings, several things should be considered: (1) the patient population and (2) reported clinical trends.

First, it is important to note that the patient population in this study differs from previous studies with regard to patient age and type of insurance coverage. For example, the median patient age in this study was 15 years. In the previously referenced epidemiological studies of root canal therapy outcomes in US populations, the median age of the patients was over 40 years or not reported. Further, the patient population in this study had public-payer dental coverage (Medicaid). All of the previously mentioned studies report the outcomes of patients covered by a single private-payer dental insurance (Delta Dental). Future research into the outcomes of endodontic treatment in a paediatric patient cohort with a private-payer dental insurance would allow for a more direct comparison of outcomes between paediatric and adult populations and highlight potential disparities in treatment outcomes between beneficiaries of public-payer and private-payer dental benefits. A comparison of the outcomes of endodontic treatment in both paediatric and adult cohorts insured by a public-payer dental insurance would be more difficult, as many states do not cover endodontic treatment for Medicaid-eligible adults. In New York State, NSRCTs of anterior and premolar teeth are covered. Molar root canal therapy in the overwhelming majority of this study’s sample (71.8%), however, is not covered for Medicaid beneficiaries aged 21 years and older. Exceptions are made when tooth extraction would be medically contraindicated or the tooth is a critical abutment for an existing serviceable prosthesis provided by the New York State Medicaid program.

Second, although the overall long-term survival rates in this study were lower than the outcomes reported in other epidemiological studies in US populations, several clinical trends corresponded. Consistent with previous studies, molars had the poorest outcomes and extraction was the most common type of untoward event, immediately following the failure of the initial nonsurgical root canal therapy. Our findings on permanent restorations coincide with Lazarski et al, which state that teeth with no subsequent restoration after NSRCT had the lowest survival rates. Further, similar to Salehrabi and Rotstein, we found that teeth restored with cuspal coverage had better outcomes than teeth without cuspal coverage after

| Time (year) | Group | Tooth type | Cases | Lower 95% confidence interval | Upper 95% confidence interval | Survival function estimate | Lower 95% confidence interval | Upper 95% confidence interval |
|------------|-------|------------|-------|-----------------------------|-----------------------------|---------------------------|-----------------------------|-----------------------------|
| 5          | Overall |             | 23,080 | 0.978                       | 0.974                       | 0.981                     | 0.977                       | 0.984                       |
| 5          | Tooth type | Anterior  | 36,880 | 0.943                       | 0.936                       | 0.950                     | 0.939                       | 0.953                       |
| 5          | Tooth type | Premolar  | 29,672 | 0.912                       | 0.904                       | 0.919                     | 0.907                       | 0.921                       |
| 5          | Tooth type | Molar     | 16,425 | 0.916                       | 0.912                       | 0.921                     | 0.909                       | 0.929                       |
| 5          | Time to permanent restoration | 0–14 days | 8,690  | 0.924                       | 0.919                       | 0.929                     | 0.915                       | 0.933                       |
| 5          | Time to permanent restoration | 15–59 days | 5,941  | 0.924                       | 0.919                       | 0.929                     | 0.915                       | 0.933                       |
| 5          | Time to permanent restoration | 60 + days | 5,941  | 0.924                       | 0.919                       | 0.929                     | 0.915                       | 0.933                       |
| 5          | Time to permanent restoration | never placed | 2,956  | 0.924                       | 0.919                       | 0.929                     | 0.915                       | 0.933                       |
| 5          | Restoration type | Amalgam | 16,35 | 0.893                       | 0.889                       | 0.903                     | 0.885                       | 0.911                       |
| 5          | Restoration type | Buildups | 22,79 | 0.897                       | 0.892                       | 0.914                     | 0.888                       | 0.921                       |
| 5          | Restoration type | Composite | 45,13 | 0.891                       | 0.890                       | 0.913                     | 0.886                       | 0.916                       |
| 5          | Restoration type | Cuppal | 45,13 | 0.891                       | 0.890                       | 0.913                     | 0.886                       | 0.916                       |
| 5          | Restoration type | Never placed | 2,956 | 0.891                       | 0.890                       | 0.913                     | 0.886                       | 0.916                       |

TABLE 2 (Continued)
Lastly, we found that time to final restoration influenced the survival rate of primary NSRCT, similar to Yee et al. The primary limitation of this study is one that applies to other outcome studies utilizing administrative claims: the nonclinical nature of the data. It is possible that data are missing resulting from events that may not be captured in the claims, such as out-of-pocket payments to providers who do not participate in Medicaid. This would result in an overstatement of successful outcomes. Additionally, incorrect coding may contribute to potential errors in the data. Another limitation related to dental claims specifically is the absence of diagnostic codes. The lack of diagnostic information results in the inability to evaluate prognostic predictors that impact endodontic treatment outcomes, including preoperative pulpal and periapical diagnosis, or reasons for treatment failure, such as recurrent decay, tooth fracture, tooth restorability, or quality of the initial endodontic treatment/coronal restoration. The large sample size, however, allows us to draw broad conclusions in an important cohort to evaluate for its policy implications.

This study is the first of its kind to explore survival rates of initial nonsurgical root canal therapy in a paediatric population in the United States and include a person-level analysis. The findings demonstrate that endodontic treatment maintains the permanent dentition in the long term. This is particularly important for paediatric patients who
are limited with regard to tooth replacement options after compromised permanent teeth are extracted. Further, the findings reaffirm the importance of the final restoration as a continuum of endodontic treatment. Clear opportunities for improvement in the treatment of this paediatric population are apparent and include the following: (1) increased frequency in the placement of permanent restorations after root canal therapy; (2) decreased time to the placement of definitive restorations after the completion of endodontic treatment; and (3) increased use of cuspal coverage, when definitive restorations are placed.

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Represent the official views of the National Institutes of Health. The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the New York State Department of Health. Examples of analysis performed within this article are only examples. They should not be utilized in real-world analytic products.

AUTHOR CONTRIBUTIONS
LEB, AS, and HTG conceived the ideas; KT and CS cleaned the data or organized analytic data set; YW and LEB analyzed the data; and LB and HG led the writing.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are provided to the Health Evaluation and Analytics Lab at the New York University by the New York State Department of Health. The Department of Health restricts the use of the data and authorized its use for this study. Hence, any use of the data requires permission from the New York State Department of Health.

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