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Pediatric caries risk assessment as a predictor of caries outcomes: a retrospective cohort study

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Abstract

Purpose—Determine cumulative dental treatment experience in a retrospective clinical cohort, according to baseline caries risk assessment (CRA) information.

Methods—We evaluated electronic records of new continuing patients age six to 72-months at a university pediatric dental clinic (2009–2014) not treated under sedation or general anesthesia (N=750). Mean number of teeth restored or extracted (two-year total and omitting the first 190-days post-baseline to discount initial treatment needs) was compared by baseline CRA category and CRA items (yes/no for caries risk indicators, protective items, and clinical disease indicators).

Results—CRA category was associated with mean treated teeth over two-years (low 0.53, moderate 1.02, high/extreme 4.47) and post-190-days (low 0.51, moderate 0.89, high/extreme 2.11). Any treatment probability was greatest for high/extreme-risk children (two-year: 70.0 percent; post-190-days: 52.5 percent) but not statistically significantly different between low- and moderate-risk (2-year: low 19.4 percent, moderate 25.8 percent; post-190-days: low 19.4 percent, moderate 22.6 percent). Age-standardized means were greater with positive responses for all individual baseline clinical indicators, most risk indicators, but lower for most protective items (not statistically significantly for all items). Clinical indicators were the strongest outcome correlates.

Conclusions—In this population, baseline CRA information was associated with clinical outcomes. CRA could help identify patients needing more intensive caries prevention.

Keywords

dental caries; caries risk assessment; children; pediatric dentistry

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Author contributions

All authors have made substantive contribution to this study and/or manuscript, and all have reviewed the final paper prior to its submission. BWC contributed to study design, conducted the data analysis, and drafted the manuscript. JDBF and LZ contributed to study design, data interpretation, and critically reviewed and revised the manuscript.

Introduction

Caries risk assessment (**CRA**) is considered an essential element of caries prevention for children in clinical settings.[1,2] Risk assessment includes identifying clinical and non-clinical indicators related to future caries development, within a broader caries management strategy embracing individualized, prevention-focused, and minimally invasive care.[1] Numerous instruments exist to help clinicians assess and document caries risk in children, including expert-designed forms[3–5] and computer algorithms.[6,7] These systems are designed to help dental providers identify relevant information for patient-specific caries prevention.[8]

Multiple studies have evaluated various CRA instruments in predicting caries outcomes in children younger than age six-years.[9–11] While risk prediction alone does not measure the usefulness of CRA to guide clinical decision-making or enhance caries prevention,[1] recent prospective studies suggest reasonable predictive accuracy across existing instruments,[9,10] with no clearly superior approach.[11]

Most CRA prediction studies compare outcomes according to overall risk category (e.g. high or low), not the individual items in CRA instruments. Additionally, prior studies primarily investigate only dichotomous outcomes (e.g. any tooth decay vs. none). Dichotomous outcomes lend themselves to traditional measures of diagnostic accuracy (e.g. sensitivity and specificity), but may obscure clinically relevant differences in caries severity. Here, we examine the associations of both overall CRA category and individual CRA items with accumulated restorative dental treatment over two years.

The objective of this observational retrospective cohort investigation was to determine the two-year cumulative dental treatment experience among continuing pediatric patients (age six to 72-months), according to CRA information collected at the initial oral examination at a university pediatric dentistry clinic. Specifically, we compared the mean number of teeth subsequently restored or extracted among children by baseline caries-risk category (low, moderate, high or extreme) and differences mean treated teeth according to the presence of individual baseline CRA risk indicators, protective items, or clinical disease indicators.

Methods

Setting

The University of California San Francisco (**UCSF**) School of Dentistry Pediatric Dentistry Program provides post-doctoral residency training and emphasizes risk-based, prevention-focused care, based on principals of Caries Management by Risk Assessment (**CAMBRA**).[3,8] The patient population is primarily low-income and from the surrounding San Francisco Bay Area. During this study, pediatric dentistry residents completed 90% of new examinations for patients age six to 72-months (faculty: six percent; pre-doctoral dental students: four percent).

Inclusion criteria

Included were all new patients who completed a comprehensive oral evaluation that entailed CRA with an assigned risk category (low, moderate, high, or extreme) and were age equal to or greater than six-months and less than 72-months at this baseline examination (Figure 1). Initial examinations were performed from January 13, 2009 to February 28, 2014 (CRA was incorporated into the clinic's electronic dental records in 2009; the 2014 end-date allowed every patient opportunity for two-years of follow-up, ending February 29, 2016). Only continuing patients were included (completed recall examination within two-years of baseline). Patients treated under general anesthesia or conscious sedation were excluded from primary analyses but included in secondary analyses. Patients needing treatments under general anesthesia or sedation are often referred from other primary dental care teams, travel long distances to appointments, have considerable baseline treatment needs, or have special needs and behavior management problems. The primary analytic sample included 750 non-general anesthesia/sedation patients, whose baseline examinations were completed by 78 unique providers (mean patients/provider: 9.6; range: one to 48). Excluding pre-doctoral dental students, the remaining 39 providers (residents and faculty) accounted for 710 patients (mean patients/provider: 18.2).

Caries risk assessments

CAMBRA principals were stressed in didactic and clinical curricula for dentistry residents and students and during faculty calibration. CAMBRA involves evaluating and documenting each patient's caries risk, followed by prevention-oriented treatment planning.[12] Drawing from expert consensus,[3,12] the CRA form used for UCSF patients under six-years-old includes 17 individual yes/no items: risk indicators: bottle use in bed, bottle use continuously during the day, bottle use with contents other than milk or water, caregiver or sibling tooth decay, frequent snacking (equal to or greater than three times daily), inadequate salivary flow, low socio-economic status, saliva-reducing medications, and special care needs (e.g. developmental impairment); protective items: brushes daily with fluoride dentifrice, caregiver uses xylitol, drinks fluoridated water, fluoride varnish (past 6-months), and lives in fluoridated community; and clinical disease indicators: evident (visually obvious) tooth decay or white spot lesions, heavy dental plaque, and recently placed restorations (within two-years). Based on CRA findings, dental providers judge the overall balance between risk indicators, protective items, and clinical indicators to assign a patient into one of the four risk categories.[3,8,12] CAMBRA risk assessment guidelines stress that patients with existing carious lesions and/or an unfavorable balance of risk indicators and protective items be placed in the high-risk category, whereas the extreme-risk category includes otherwise high-risk patients with additional saliva deficiency.[8,13] However, no rigid algorithm dictates which category providers may assign. CRA information was entered directly into standardized electronic forms during patient care. Data were analyzed as entered by providers, without recalculation.

Outcome measures

The cumulative number of treated (restored or extracted) teeth was based on procedure codes entered by providers in electronic charts during routine patient care. Providers were not masked to collected CRA information. Restorative treatment experience was calculated at the tooth-level: multiple procedures performed on the same tooth (e.g. pulpectomy and crown) counted as a single treated tooth; however, if the same tooth was treated again greater than 180 days later, the new treatment contributed to the cumulative total. We calculated two measures of cumulative treatment experience: 1) the two-year total included all treatment from the initial CRA to 730-days post-baseline; and 2) the 190-days post-baseline total, which excluded any treatments provided within the first 190 days from baseline. The rationale was to separate treatment presumably delivered in response to restorative needs present at baseline from later treatment that was more likely to represent incident tooth decay. We explored sensitivity to different cut-points between 110 to 250-days: while the magnitude of absolute differences was smaller at later cut-points (i.e. shorter observation periods), associations on a relative scale were generally robust to cut-point choice. Additionally, we used codes for topical fluoride (near exclusively delivered as fluoride varnish) to identify children who received preventive fluoride treatment within two-weeks of the baseline examination.

Analytic approach

Demographic characteristics were compiled for the total clinic population (age less than six-years) and for the continuing patients included in analysis. We compared baseline prevalence of each of the 17 CRA items according to assigned caries risk category (chi-squared test). Then, we calculated the cumulative number of treated teeth and the probability of ≥1 treated tooth in each baseline CRA category. High- and extreme-risk categories were combined due to the small number of extreme-risk patients.

We determined the difference in the cumulative number of treated teeth between patients with and without each of the 17 CRA items. Differences were age-standardized (direct method) to account for confounding by age (e.g. bottle use and tooth brushing are strongly age-related). We explored using generalized linear mixed models and generalized estimating equations to address potential intra-provider clustering. In both approaches, estimated intra-provider correlation was minimal and not statistically significant. We concluded that the extent intra-provider clustering did not justify the added complexity and assumptions of parametric modeling. Additionally, to assess sensitivity to losses to follow-up, we performed additional analyses using inverse probability of censoring weights (Supplemental Tables 1 and 2).

Finally, to visualize the associations between cumulative treated teeth and the sum of baseline risk indicators, protective factors, and clinical indicators, a matrix diagram displayed the mean number of treated teeth according to various combinations of CRA items. We tested the statistical significance of linear trends in mean treated teeth as the baseline number of risk, protective, or clinical CRA items increased.

Missing values for individual CRA items (3.1 percent- missing) were multiply imputed (chained equations, formula approach), with standard error adjustment.[13] Nonparametric 95 percent confidence intervals (**CI**) for the age-standardized mean differences in treated teeth were obtained by bootstrap (5000 resamples). Differences were considered statistically significant ($P \leq .05$) if 95 percent CIs excluded the null value. Analyses were completed using Stata 14.1 and R 3.2.0. The UCSF Institutional Review Board approved the study protocol.

Results

Study population

The majority of patients were classified as high risk at baseline (Table 1). Most were Medicaid enrolled and resided in San Francisco or surrounding areas (Table 1). Of all patients age six- to 72-months with a baseline CRA, 58 percent (1269 of 2188) returned for a follow-up examination within two-years, and of these, 59 percent (750 of 1269) did not undergo general anesthesia or sedation. Patients without a follow-up examination were older at baseline and more likely to reside outside San Francisco or be classified as high risk (Table 1). Likewise, continuing patients treated under general anesthesia or sedation were, on average, older at baseline and more likely to reside outside San Francisco and be classified as high risk (Table 1). There were not substantial differences among the groups by sex, race/ethnicity, or payer type.

Caries risk items and CRA categories

Individual CRA items and overall caries risk were strongly associated (Table 2): unsurprisingly, given that providers were trained to use CRA items in classifying risk. All clinical indicators and all risk indicators with greater than 10 percent prevalence, excepting low socioeconomic status, were statistically significantly associated with risk category, increasing in prevalence from low to moderate to high/extreme risk (Table 2). No protective item was statistically significantly associated with risk category. Some CRA items were common in this population, regardless of risk category (Table 2), such as community water fluoridation (94percent) and drinking fluoridated water (90 percent), while other items were comparatively rare, including special care needs (seven percent), inadequate salivary flow (two percent), and salivary-reducing medications (two percent). Clinical disease indicators were much more common in high-risk children (Table 2). A small number of children were classified as low or moderate risk despite the presence of evident tooth decay, contrary to CAMBRA guidelines. However, an exploratory analysis excluding these children did not yield meaningfully different results.

The distribution of CRA items by risk category was similar when general anesthesia and sedation patients were included (Supplemental Table 1). However, the prevalence of some items, including evident tooth decay and frequent snacking, were notably higher in this group (Supplemental Table 2).

Nearly all children received topical fluoride at the time of the baseline examination. Fluoride provision was slightly lower for low-risk children (90.0 percent) than moderate-risk (96.2 percent) or high/extreme-risk children (93.9 percent), just reaching statistical significance over the three categories (P=0.05). Median time to recall examination was not statistically significantly different by risk category (P=0.23): low-risk (229 days), moderate-risk (223 days), high/extreme-risk (244 days); however, many high-risk patients returned for additional CRA and fluoride before the recall exam.

CRA and dental treatment

The cumulative number of treated teeth was notably highest in the high/extreme categories (Figure 2; Supplemental Tables 3 and 4). Approximately 50 percent of cumulative treatment in the high/extreme categories occurred in the six-months after the initial examination, presumably reflecting existing treatment needs at clinic entry (Figure 2A). However, treatment experience continued to be greater in the higher risk categories after 190-days, suggesting that baseline risk category was also associated with new decay (Figure 2B). The mean number of treated teeth by CRA category was: low (0.53), moderate (1.02), high/extreme (4.47) over two-years; and low (0.51), moderate (0.89), high/extreme (2.11) after 190-days post-baseline (Figure 2; Supplemental Table 3). High/extreme categories were associated with the greatest probability of ≥1 treated tooth (two-years: 70.0 percent; 190-days post-baseline: 52.5 percent); however, the difference in treatment probability between low (two-years: 19.4 percent; 190-days post-baseline: 19.4 percent) and moderate categories (two-years: 25.8 percent; 190-days post-baseline: 22.6 percent) was not statistically significant (Supplemental Tables 3 and 4). Results were similar when age-standardized and weighted for losses to follow-up (Supplemental Tables 3 and 4).

Generally, each individual baseline CRA risk and clinical indicator was associated with greater treatment experience, while the presence of each protective item was associated with less cumulative treatment (Figure 3). Baseline evident decay, recent restorations, plaque, frequent snacking, bottle for non-milk/water, low socioeconomic status, and caregiver/sibling tooth decay were statistically significantly associated with greater cumulative treatment experience (Figure 3). Caregiver xylitol use was statistically significantly associated with less post-190 day treatment. Notably, fluoride varnish in the past 6-months was associated with greater treatment over the next two-years, but nearly all treatment occurred relatively soon after baseline, presumably reflecting existing conditions. Relationships remained similar when general anesthesia/sedation patients were included but with more statistically significant associations (Supplemental Figure 1).

The mean number of treated teeth, both the two-year total and 190-days post-baseline, was higher among children with more baseline clinical (disease) indicators, including at a constant number of risk indicators or protective items (Supplemental Figure 2). For example, among children with two baseline risk indicators, two-year treatment experience was greater with each higher number of clinical indicators: from 0.94 at zero clinical indicators to 9.47 at three clinical indicators (Supplemental Figure 2). Similarly, treatment experience was higher among children with more baseline risk indicators (Supplemental Figure 2), although this trend was consistent and statistically significant only when general anesthesia/sedation patients were included (Supplemental Figure 3). There was no consistent association between treatment experience and the number of baseline protective items.

Discussion

In this study, caries risk assessment information was associated with longitudinal restorative burden in continuing dental patients under age six-years. Differences were evident in the severity of caries outcomes according to overall caries risk categories and the presence of individual CRA items. Study results do not necessarily generalize to other settings.

However, as used during routine patient care in this clinic and patient population, there appeared to be potential utility in collecting CRA information. CRA data may illuminate potentially modifiable variables for bringing a patient into favorable balance between caries predisposing and preventive factors, such as through behavior modification or anti-caries chemical therapy.[12] CRA has been proposed as standard care in pediatric dentistry[2,14] and a central dental education competency.[15]

The rationale for a multiple-item CRA form **is to encourage** practitioners to consider a range of patient behaviors, circumstances, and clinical findings. Many practicing dentists report performing informal risk assessments, based on experience and intuition, but are unlikely to document caries risk information without a specific form or protocol in place.[16] Previous work showed that most items in the pediatric CAMBRA CRA form were independently associated with dental providers' risk classifications, suggesting that those items could factor into caries management treatment planning.[17] Further investigations are needed to assess the effectiveness of preventive regimens under risk-based caries management programs, such as CAMBRA.

It is plausible that delivery of preventive treatments according to baseline risk status may have affected the observed caries outcomes in this study. High-risk children were similarly likely to receive topic fluoride and achieved similar-length recall intervals as low-risk children. Reimbursement limits for recall frequency under Medicaid complicate the measured recall interval, especially if patients returned for risk assessment or fluoride without registering a recall examination. Understanding barriers to delivering sufficient caries prevention to high-risk children is a topic for exploration using mixed-methods approaches.

The present investigation revealed a considerable restorative burden for high-risk children in this population, despite receiving fluoride varnish and return visits. Preventing caries effectively for high-risk children may require stronger clinical intervention than is commonly practiced.[18] Fluoride toothpaste[19] and varnish[20] are effective preventatives but may be insufficient to reverse extant lesions or overcome significant bacterial or dietary challenges. Antimicrobial therapies, such as chlorhexidine,[21] povidone-iodine,[22] or xylitol,[23] or silver-containing compounds,[25] as well as motivational interviewing[26], may offer additional benefits, although stronger evidence is required.[18,24]

Clinical disease indicators, particularly existing tooth decay, were the CRA items associated with the largest differences in caries outcomes, consistent with previous CRA evaluations in children.[9,10] While current disease sufficiently predict future caries activity, information gained from other CRA components we speculate could be more helpful in developing caries management plans. Active disease results from a confluence of caries-predisposing factors,[27] and it is those factors that clinicians aim to mitigate or modify to prevent further disease progression.

The present analysis of CRA items was age-adjusted, but correlation between CRA items and confounding by other variables impede causal attribution to individual items. For example, patients traveling from non-fluoridated communities to this safety-net clinic may have presented with greater treatment needs than residents of fluoridated communities nearby. Also, the difference in probability of any treatment between the low- and moderate-risk categories was not statistically significant, although mean number of treated teeth diverged. Potential improvements to CRA forms or procedures to distinguish better between low and moderate risk deserve further consideration.

As a group, baseline protective items were negatively associated with caries experience, although less strongly than risk indicators and clinical indicators were positively associated. In a notable exception, children who had received fluoride varnish within six-months before baseline experienced worse caries outcomes than children who had not received varnish, plausibly due to confounding by indication: children with substantial existing treatment needs may have received varnish from previous care providers. Baseline CRA protective items may help clinicians decide what additional preventive agents to incorporate in individualized caries management but may not be strongly predictive as recorded.

The CAMBRA CRA form is not designed to encompass all potential caries risk factors. Additional patient characteristics, such as genetics[28] and oral bacterial levels,[29] are likely contributors to caries risk. Recently, bacterial measures together with detailed dietary evaluations from an interactive child risk assessment and behavioral intervention tool effectively stratified patient risk within a predominantly low-income patient population.[30] Importantly, while CRA is an evidence-supported tool for individual patient care, it may not be appropriate at the community level.[28,31] Instead, community interventions should be designed for broad reach but with intentional emphasis on the most disadvantaged segments of society.[32]

Among limitations of the present study, results drawn from this high caries risk university clinic might not generalize to other settings. The main results excluded children who required treatment under general anesthesia or sedation to enhance comparability with non-academic practices. Losses to follow-up may have further impaired the generalizability of the analytic sample; however, sensitivity analyses that adjusted for attrition did not yield meaningfully different findings. Outcomes were based only on completed restorative treatment: any untreated pathology was not recorded. Notably, there was no explicit calibration of outcome measures, which were based on treatment decisions of different providers. Although most providers were residents in the same training program, some providers may have opted for more conservative or aggressive restorative care based partly on perceived level of patient risk. It is possible that a tendency for more aggressive restorative care for high-risk patients could have contributed to differences in outcomes. Additionally, in the absence of consistently applied diagnostic codes, a threshold of 190-days was an imperfect but reasonable cut-point to separate baseline treatment needs from incident decay. We did not account for possible variations in the number of at-risk teeth per child due to prior treatment, because previously restored teeth remained at-risk for new decay. Despite limitations, study strengths included the relatively large sample and longitudinal design. The use of count outcomes allowed calculation of differences in caries severity that might not have been apparent for dichotomous outcomes; however, as a limitation, the lack of surface-level outcomes precluded even greater resolution.

Conclusion

1. In this population, individual CRA items were longitudinally associated with the cumulative burden of restorative treatment in dental patients younger than six-years, adding evidence that a multi-item CRA tool can provide useful information indicative of future caries severity.
2. **Such evidence** supports the inclusion of caries risk assessment as standard pediatric dentistry practice, **but further studies from more generalizable populations featuring standardized outcome measurement are recommended**.
3. The substantial disease experience among high-risk children, despite near-universal provision of fluoride varnish, highlights a need for stronger caries prevention and management approaches for children with active disease.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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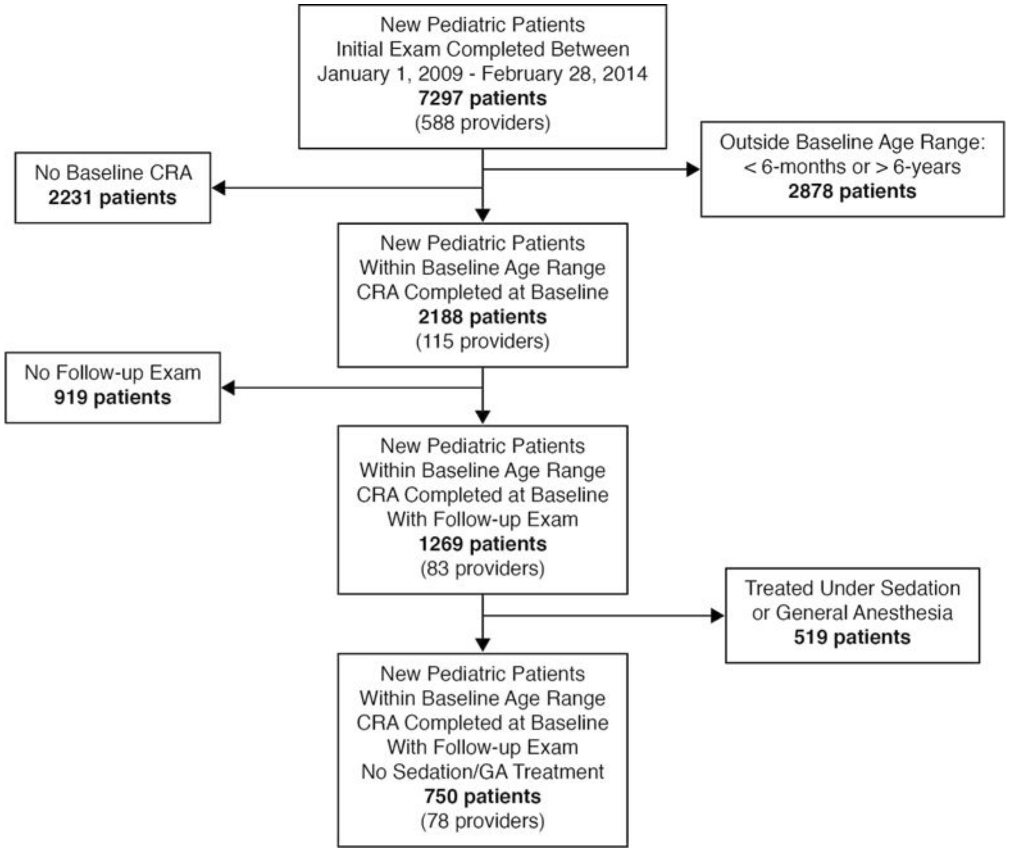

Figure 1. Patient Inclusion and Follow-up Flow Diagram

Diagram depicts the number of eligible patients included in analysis, reasons for exclusion, and the number of providers responsible for baseline examinations for the patients at each stage of the diagram.

Abbreviations: CRA = caries risk assessment; GA = general anesthesia

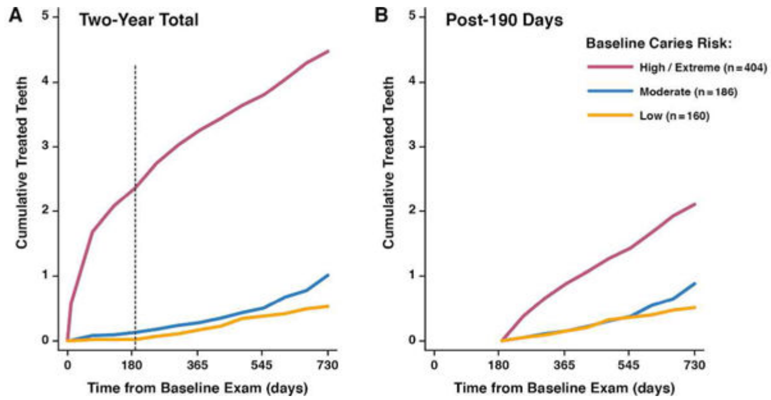

Figure 2. Cumulative Treated Teeth Over Two Years, According to Baseline Caries Risk Designation

The cumulative number of treated teeth (restored or extracted) following baseline CRA is shown for children classified at baseline as low, moderate, and high/extreme caries risk. A) All treatment recorded in the two-years following the baseline examination, including in the first 190-days after baseline (left of dotted line); B) Excludes treatment recorded in the first 190-days after baseline.

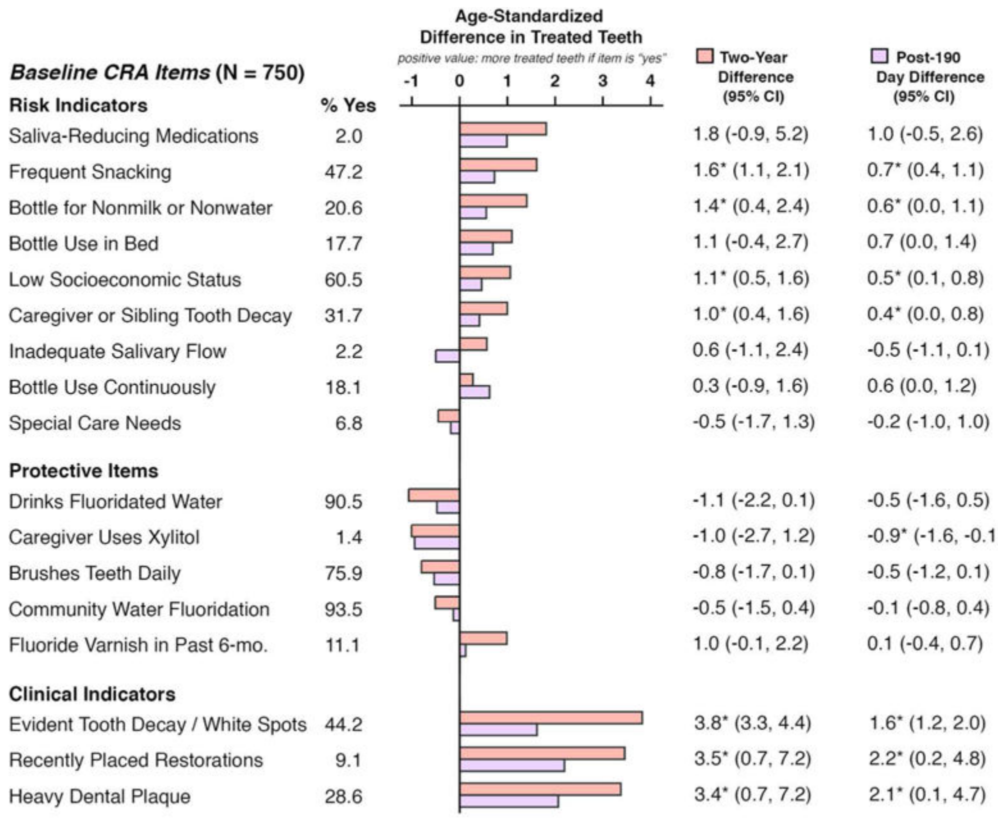

Figure 3. Age-Standardized Difference in Cumulative Treated Teeth Over Two Years, According to Baseline Presence of Individual Caries Risk Assessment Items

Width of bars represents the mean age-standardized difference in treated teeth between patients with a given CRA item present and those without that item.

Abbreviations: CRA = caries risk assessment; CI = confidence interval; * $P \leq 0.05$

Table 1

Baseline Characteristics of Study Population

Patient Characteristic	All Patients with CRA (N = 2188)	Continuing Patients with CRA (N =1269)	Continuing Patients with CRA Non-GA, Non-sedation (N = 750)	p-value*	p-value**
Age (mean, in months)	40.2	38.1	35.7	<0.001	<0.001
Sex (%)				0.02	0.64
Female	45.3	47.5	48.1		
Male	54.7	52.5	51.9		
Race/Ethnicity (%)				<0.001	0.03
Asian	16.9	20.6	20.7		
Black	15.6	15.0	14.9		
Hispanic/Latino	37.0	39.2	38.0		
White	9.3	9.5	11.7		
Other/Not reported	21.3	10.7	14.7		
Geographic residence (%)				<0.001	<0.001
San Francisco (city)	49.2	55.6	71.2		
SF Bay Area	41.4	35.7	24.9		
Outside regions	9.4	8.7	3.9		
Payer Type (%)				0.01	0.001
Medicaid dental	89.3	90.7	88.5		
Other	10.7	9.3	11.5		
Baseline CRA category (%)				<0.001	<0.001
Low	11.3	13.2	21.3		
Moderate	13.4	15.4	24.8		
High	72.6	68.2	52.9		
Extreme	2.7	3.2	0.9		

* Chi-squared test (proportions) or t-test (mean age) for difference between continuing patients and patients without a follow-up examination within two years

** Chi-squared test (proportions) or t-test (mean age) for difference between continuing patients treated under general anesthesia or sedation and non-GA, non-sedation continuing patients Abbreviations: CRA = caries risk assessment; GA = general anesthesia; SF = San Francisco

Table 2

Baseline Prevalence of Individual Caries Risk Assessment Items, According to Assigned Baseline Caries Risk Category

Baseline CRA Items:		Total (N=750)*		Low (n=160)	Moderate (n=186)	High/Extreme** (n=404)	p-value†
Risk Indicators							
Low socioeconomic status	Yes No	441 288	0.605	0.539	0.615	0.626	0.16
Frequent Snacking	Yes No	349 391	0.472	0.171	0.457	0.598	<0.001
Caregiver or sibling tooth decay	Yes No	194 418	0.317	0.194	0.236	0.408	<0.001
Bottle for nonmilk or nonwater	Yes No	152 586	0.206	0.089	0.205	0.253	<0.001
Bottle use continuously	Yes No	129 583	0.181	0.082	0.182	0.219	0.001
Bottle use in bed	Yes No	129 600	0.177	0.059	0.181	0.221	<0.001
Special care needs	Yes No	50 688	0.068	0.044	0.049	0.086	0.11
Inadequate salivary flow	Yes No	16 703	0.022	0.032	0.006	0.026	0.21
Salivary-reducing medications	Yes No	15 720	0.020	0.006	0.016	0.028	0.26
Protective Items							
Community water fluoridation	Yes No	692 48	0.935	0.919	0.941	0.939	0.64
Drinks fluoridated water	Yes No	666 70	0.905	0.917	0.897	0.904	0.81
Brushes daily with fluoride paste	Yes No	564 179	0.759	0.730	0.745	0.778	0.43
Fluoride varnish in past 6 months	Yes No	82 658	0.111	0.101	0.076	0.131	0.13
Caregiver uses xylitol	Yes No	10 725	0.014	0.026	0.016	0.008	0.23
Clinical Disease Indicators							
Evident tooth decay or white spots	Yes No	326 411	0.442	0.032	0.119	0.757	<0.001

Baseline CRA Items:		Total (N=750)*		Low (n=160)	Moderate (n=186)	High/Extreme** (n=404)	p-value†
Heavy dental plaque	Yes No	211 528	0.286	0.051	0.185	0.425	<0.001
Recently placed restorations	Yes No	67 669	0.091	0.006	0.033	0.152	<0.001

*Sample sizes for individual items may be less than total due to missing data

**High- and extreme-risk patients were combined due to small numbers in extreme-risk category (n=7)

†Chi-squared test for difference in CRA item prevalence over the three risk categories

Abbreviation: CRA = caries risk assessment