Underutilization of Dental Care When It Is Freely Available: A Prospective Study of the New England Children's Amalgam Trial

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Abstract

Objective**: This study aims to prospectively examine the trends and reasons for the underutilization of free semiannual preventive dental care provided to children with unmet dental needs who participated in the 5-year New England Children's Amalgam Trial.* ***Methods: *Children aged 6 to 10 at baseline (1997-99) with ≥2 posterior carious teeth were recruited from rural Maine (*n *= 232) and urban Boston (*n *= 266). Interviewer-administered questionnaires assessed demographic and personal characteristics. Reasons for missed appointments were recorded during follow-up and are descriptively presented. We used an ordinal logistic regression to analyze the utilization of semiannual dental visits.* ***Results:*** *On average, urban children utilized 69 percent of the visits and rural children utilized 82 percent of the visits. For both sites, utilization steadily decreased until the end of the 5-year trial. Significant predictors of underutilization in the multivariate model for urban children were non-White race, household welfare use, deep debt, and distance to dental clinic. Among the relatively less-diverse rural children, caregiver education level and a greater number of decayed tooth surfaces at baseline (i.e., need for care) were significantly associated with underutilization. Among all children, the common reasons for missed visits included guardian scheduling and transportation difficulties; reasons among urban participants also indicated a low priority for dental care.* ***Conclusions:*** *Among these children with unmet dental needs, the provision of free preventive dental care was insufficient to remove the disparities in utilization and did not consistently result in high utilization through follow-up. Differences between educational levels, ethnicities, and rural/urban location suggest that public health programs need to target the social settings in which financial burdens exist.*

Key Words: utilization, disparities, dental care delivery, dental care for children, oral health

Introduction

The United States' *Healthy People 2010* objectives emphasize the need to reduce disparities in health, partly by increasing access and service utilization for certain racial/ethnic groups and lower socioeconomic status levels (1). To this end, the oral health component of the report aims specifically to increase the proportion of low-income children that receive preventive dental services annually from 20 to 57 percent, with the assertion that professional dental care is essential to the maintenance of oral health (1). Dental caries remains the most prevalent childhood disease for which the lack of prevention or treatment allows problems to progress to conditions that may be even less likely to be treated because of increased costs and complexity (2,3). To avoid a further widening of disparities, an understanding of the utilization of preventive dental care among those at greatest risk for unmet needs is fundamental.

Inadequate rates of dental care utilization are generally most common among uninsured and low-income children (1,4-6). In a review of national surveys, Edelstein points out that children without dental insurance are three times more likely to have unmet dental needs than children with public or private insurance (7). The 2002 Oral Health US report showed that among children aged 6 to 8 years falling below the federal poverty level, 47.3 percent had untreated caries, compared with 21.6 percent of those at or above the federal poverty level (8).

A seemingly logical presumption is that the removal of financial barriers, through the provision of free dental care or insurance, would increase utilization rates and avoid a further widening of disparities in oral health needs. However, children from low-income families who are entitled to comprehensive oral health coverage through Medicaid are less likely to utilize dental care than children from higher-income families (4,6,7). Furthermore, evaluations of the impact of various State Child Health Insurance Programs on access to dental care have had mixed results. While most states found increased utilization for all participants (9-11), insurance programs did

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little to decrease disparities between lower- and higher-income children in utilization or unmet dental needs (5,12). Countries with universal health care similarly continue to see socioeconomic disparities in access and utilization (13,14).

The reasons for discrepancies in dental care utilization remaining after the removal of financial barriers remain unclear, partly because of the complexity of utilization analyses (15,16). Utilization studies have the potential to guide future policies and programs for vulnerable populations or certain geographical areas (16), but results of previous studies are likely to be confounded by within-system variations in the delivery systems themselves. That is, studies of utilization among participants of insurance programs, including Medicaid and State Child Health Insurance, have not been able to sufficiently account for complexities such as availability of participating dentists, discriminatory treatment, and caregiver or provider knowledge of eligibility and benefits (6,7,17-19). Most studies assessed utilization retrospectively, cross-sectionally, or within the first year of an initiative, such as Michigan's Healthy Kids Dental program (18). Findings from one longitudinal study in North Carolina that 46 percent of Medicaid children sought dental care for only 1 year but just 14 percent used services for 4 or more years indicate that studies comparing utilization before and soon after the start of insurance programs are unlikely to represent the long-term utilization patterns that are important to oral health maintenance (20). Considering the inadequate longitudinal data, together with findings that current dental programs have done little to remove disparities, an examination of the determinants of long-term utilization in those with unmet needs, over and above cost of care and delivery system-related difficulties, would globally serve policymakers well.

In the New England Children's Amalgam Trial (NECAT), children aged 6 to 10 with unmet dental needs were recruited from both rural and urban locations to participate in a study that provided free preventive and restorative dental care semiannually for 5 years. During the course of the trial, the same protocol for dental procedures was followed by all participating clinics (21); thus, the contextual factors of the delivery system and financial arrangement were constant.

Despite the provision of free care, available facilities, willing providers, and minimal language barriers, NECAT children often missed preventive dental visits. The aim of the current prospective cohort analysis is to describe the extent to which NECAT participants utilized free dental services during 5 years of follow-up and to examine the factors that may explain disparities in utilization.

Methods

Study Population: NECAT. Participants for this analysis were obtained from all children enrolled in NECAT, a randomized controlled trial of neuropsychological and renal effects of dental amalgams in children, regardless of their treatment assignment (preliminary analyses showed no difference in utilization by randomized treatment). Details of the study design and main results have been published (21,22). Briefly, English-speaking children aged 6 to 10 years with ≥2 posterior carious teeth and no neuropsychological or renal disorders were eligible. Enrollment occurred from 1997-99, and follow-up lasted 5 years. Of the 5,116 children screened, 598 were eligible and 534 provided written parental consent and child assent. The study was approved by the institutional review boards of all participating sites.

NECAT recruited urban children ($n = 291$) from Boston, Massachusetts, and rural children ($n = 243$) from Farmington, Maine. Primarily because of the eligibility criteria of untreated caries, participants from both sites tended to be from lower socioeconomic backgrounds and had greater unmet dental needs than children in the general US population. Considering the disparate urban/rural settings and significant demographic differences between Boston and Maine participants (e.g., 98 percent of Maine children were non-Hispanic White, whereas Boston children were racially diverse; Boston caregivers were more likely to be poor, single parents, and immigrants), the current analysis was conducted separately for Boston and Maine. Children who moved out of state during follow-up or withdrew from the trial to see out-of-study dentists were excluded. The primary analyses included 232 rural children and 266 urban children.

Dental Clinics and Procedures. Participants were offered free comprehensive dental care, which included semiannual dental examinations, bitewing X-rays, prophylaxis, application of fluoride treatments, resin-based sealants, and restoration of caries. Oral health education was given to children and caregivers at every preventive visit they attended. In Maine, children were seen at the nonprofit Franklin County Dental Center (Mt. Blue Health Center, Farmington). Boston clinics included three private, nonprofit community health centers (Codman Square Health Center, Dorchester; South Boston Community Health Center, South Boston; Windsor Street Health Center, Cambridge), as well as the Children's Hospital Boston and the independent Forsyth Institute. At baseline, participants chose which clinic to attend. All Boston clinics were accessible by public transportation. Although NECAT did not organize transportation, participants attending Boston's Forsyth clinic often had community-organized transportation. One primary dentist treated all Boston-area participants, and three dentists treated rural Maine participants over the course of the trial. Clinical variability was minimized by the centralized training of all dental personnel and the use of standard pediatric dental procedures specified in the NECAT protocol and procedures manual.

Clinic coordinators scheduled preventive dental appointments by

phone every 6 months. If multiple phone calls resulted in no contact, postal reminders were sent. Alternatively, at a visit's end, coordinators scheduled the subsequent visit if participants/guardians were willing to do so. Appointments were generally available from 7 AM to 5:30 PM in Maine and until 7 PM in Boston, thereby minimizing potential conflicts with school or work schedules. Reminders for appointments were made by phone 1 day before the appointment (7 AM to 8 PM, 7 days/week). Reasons for missed/canceled appointments were recorded by clinic coordinators, and appointments were rescheduled as soon as possible.

For participation in NECAT, a monetary incentive of $40 was provided to guardians at annual study visits, because data for NECAT's primary outcome was collected at annual visits only (i.e., no monetary incentive for 6-month visits). In addition, it is possible that clinic coordinators promoted attendance at annual visits (e.g., made more attempts to contact participants or reschedule appointments) more so than 6-month visits, in an attempt to complete the annual NECAT data collection, but the extent of differential attempts for 6-month versus annual visits is unknown. There were no special incentives to attend 6-month dental visits.

Measurement of Utilization. The number of attended routine preventive dental visits during 5 years of follow-up was summed over nine possible visits. Two visits were excluded from the analyses because of funding uncertainty that resulted in the severe curtailment of data collection in 2001. Because of the skewed nature of the distribution and to optimize the practical utility of results, utilization was separated into three categories: low (one to four visits), medium (five to seven visits), and high (eight to nine visits).

Considering the differential incentives for 6-month versus annual visits, in the secondary analyses, we separately analyzed the utilization of 6-month (maximum = four possible) visits versus annual (maximum = five possible) visits. Here, utilization of 6-month visits, which may resemble a more natural procedural setting, was categorized as low (one or two visits), medium (three visits), and high (four visits). Utilization of annual visits, which had a more skewed distribution, was categorized as low (one, two, or three visits), medium (four visits), and high (five visits).

Measurement of Possible Predictors of Utilization. Predictors of utilization were measured during interviewer-administered questionnaires at baseline. In the framework of the behavioral utilization model (23,24), the predisposing factors included demographics of age and gender and social structure indicators of race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, other), caregiver's immigration status (US born versus non-US born), education level (<high school, high school degree, >high school), and unemployment. Additional social structure characteristics included married couple/equivalent versus single-headed household, and caregiver reports of the following major life events occurring in the 12 months prior to baseline: divorce, separation, marriage, pregnancy, going deeply into debt, starting a new job, income decreasing substantially, moving, death of a friend, or death of a family member. Enabling resources were measured by distance from home to dental clinic (quartiles; ArcGIS v.9.1 geocoding software, ESRI, Redlands, CA), household income (≤$20,000, $20,001 to $40,000, ≥$40,000), meeting the federal poverty level, Medicaid/Medicare use, receiving welfare/public financial assistance, and caregiver's regular personal dental visits. Need for care was measured by professionally diagnosed adverse health conditions (asthma, diabetes, allergy, or migraine headaches), which may affect both perceived and evaluated need, and by the number of untreated surface caries at baseline.

Statistical Analysis. Considering the nonnormal distribution of utilization rates, we used an ordinal logistic regression to model the predictors of utilization in three levels. The score test for the proportional odds assumption was satisfied for all models (Maine $P = 0.68$, Boston $P = 0.59$), and the odds ratios (OR) represent the odds of being in a lower utilization category (i.e., either medium versus high, or low versus medium).

We first analyzed the association between each potential predictor and utilization in unadjusted univariate models. Next, we examined the correlations among the predictors of utilization to understand how the statistical importance of factors may be affected by control for other factors in multivariate models. We then used stepwise selection (using an entry criterion of $P < 0.2$ and a stay criterion of $P \leq 0.05$) to determine which variables were the most statistically important predictors of utilization. Stepwise procedures were conducted manually and then confirmed with automated software. We then reentered variables that were statistically weaker predictors but also confounders into the model, as defined by variables that changed the estimate of another predictor by more than 10 percent. In an additional analysis of the Boston data, we further controlled for dental clinic to consider a possible variation in dental office environment, but the results were not appreciably changed (data not shown). Because children attending Boston's Forsyth clinic ($n = 28$) often had organized transportation from their community, a subanalysis excluded these children. Sensitivity analyses also evaluated the effects of correlations among siblings ($n = 83$ in Boston, $n = 46$ in Maine) by excluding them, and the results were similar (data not shown). Lastly, secondary analyses of each study site separately examined the predictors of utilization for annual visits and for 6-month visits because of the aforementioned greater incentives to attend annual visits. All analyses used SAS v.9.1 (SAS Institute, Cary, NC).

Results

Of the nine possible preventive dental visits during 5 years of follow-up, the average number of attended visits was 6.2 ± 2.5 (69 percent) in Boston and 7.4 ± 2.1 (82 percent) in Maine. Figure 1 displays a notable difference in utilization, depending on whether the visit was an annual visit (i.e., occurring yearly after baseline) with monetary incentive or a 6-month visit (i.e., occurring at a 6-month interval within annual visits) without monetary incentive. The average percentage attendance was approximately 20 percent lower at 6-month visits (6-month versus annual: Boston, 49 versus 72 percent; Maine, 66 versus 86 percent). Despite higher utilization in Maine, both Boston and Maine participants had a similar pattern of utilization throughout the study. Utilization was generally highest in the first year, but then decreased until the last visit, when NECAT's protocol led to a strong push for attendance.

Predictors of Underutilization of Preventive Dental Care

Urban Boston area. Baseline characteristics of Boston-area participants are displayed in Table 1 by level of attendance, along with the results from unadjusted and multivariate analyses. The strongest univariate predictors were race/ethnicity, welfare use, and distance from home to dental clinic. Despite the statistically significant associations with welfare, household debt, and being at or below the poverty threshold, the association between household income and utilization was not statistically significant. There was no difference in attendance between children whose primary caregivers had not completed high school compared with those with high school degrees [OR = 0.94; 95 percent confidence interval (CI) = 0.50, 1.78; $P = 0.9$]; thus, these categories were combined and compared with having any post-high school education. In addition to the variables presented in Table 1, no associations were apparent for adverse health conditions, household Medicaid/Medicare use, or other serious life events in the unadjusted analyses.

The variables that remained statistically significant in the multivariate model were welfare use, distance from home to clinic, race, and borderline significant, household debt. Children from households using welfare were four times as likely to underutilize dental care, and household debt doubled the odds. Compared with children who lived <0.4 miles (0.6 km) from the dental clinic, children at 1.0 to 2.9 miles (1.6 to 4.7 km) were three times as likely to underutilize preventive care ($P = 0.002$). Also important, as it affected other estimates, but just above the statistical significance, was education; the likelihood of underutilization was 60 percent greater when caregivers had no post-high school education.

Compared to non-Hispanic White children, all other races were more likely to underutilize the dental care. In the additional analysis excluding children seen at the Forsyth clinic (62 percent of whom were Hispanic), the association with race increased in statistical significance ($P = 0.008$) and was stronger particularly for Hispanic children (Hispanic versus White: OR = 2.84; 95 percent CI = 1.03, 7.84; $P = 0.04$).

Stratification by 6-month versus annual visits in the urban Boston area. Forty-one percent of Boston-area participants had low utilization of 6-month visits, and only 21 percent of Boston-area participants attended every possible 6-month dental visit. In the secondary multivariate analyses of 6-month visits only, Hispanic and other races were considerably more likely to underutilize 6-month visits compared with non-Hispanic White participants (Hispanic multivariate OR = 2.43; 95 percent CI = 1.06, 5.61; $P = 0.04$; others multivariate OR = 2.38; 95 percent CI = 1.19, 4.79; $P = 0.01$); the comparison between Black and White participants was similar to the main analysis. Caregiver education was strongly associated with 6-month visit utilization, as those with no post-high school education were 2.6 times as likely to underutilize 6-month visits (multivariate OR = 2.56; 95 percent CI = 1.49, 4.37; $P < 0.001$). The association with distance from home to clinic was slightly stronger than in the main

Figure 1
Trends in the utilization of preventive care during 5 years of follow-up, by study site, in the New England Children's Amalgam Trial, 1997-2005. Visits in year 2 were excluded from analyses because of funding uncertainty and severe curtailment of data collection

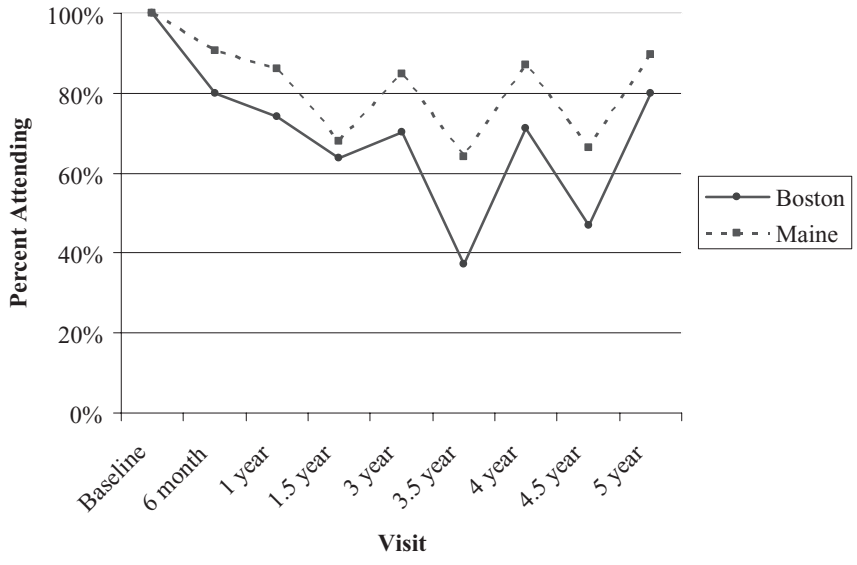

Table 1
Baseline Characteristics of 266 Urban Boston-Area Participants of the New England Children's Amalgam Trial, by Level of Attendance at Nine Free Semiannual Preventive Dental Visits during 5 years of Follow-Up, and Odds Ratios for Lower Utilization*

	Utilization			Odds ratio (95% confidence interval) for lower utilization†			
				Unadjusted		Multivariate model	
	Low ($n=67$)	Medium ($n=91$)	High ($n=108$)		*P*-value		*P*-value
Age, mean years (SD)	8.0 (1.3)	8.1 (1.4)	7.8 (1.2)	1.11 (0.93, 1.32)	n.s.¶		
Gender, *n* (%)							
Male	34 (26)	42 (32)	54 (42)	Reference			
Female	33 (24)	49 (36)	54 (40)	1.01 (0.65, 1.57)	n.s.		
Race/ethnicity, *n* (%)							
Non-Hispanic White	12 (15)	25 (31)	45 (55)	Reference		Reference	
Non-Hispanic Black	25 (29)	34 (39)	28 (32)	2.43 (1.37, 4.32)	0.002	2.65 (1.45, 4.83)	0.002
Hispanic	10 (29)	11 (32)	13 (38)	2.13 (1.01, 4.51)	0.05	1.81 (0.81, 4.06)	0.15
Other	20 (32)	21 (33)	22 (35)	2.44 (1.31, 4.54)	0.005	2.06 (1.04, 4.09)	0.04
Distance from home to clinic, miles (quartiles), *n* (%)							
<0.4	14 (21)	20 (30)	32 (49)	Reference		Reference	
0.4-1.0	15 (22)	22 (33)	30 (45)	1.14 (0.60, 2.15)	n.s.	1.10 (0.56, 2.15)	n.s.
1.0-2.9	25 (38)	24 (36)	17 (26)	2.54 (1.34, 4.83)	0.004	3.02 (1.52, 5.98)	0.002
≥2.9	13 (19)	25 (37)	29 (43)	1.12 (0.59, 2.11)	n.s.	1.22 (0.61, 2.44)	n.s.
Education of primary caregiver, *n* (%)							
Post-high school education	28 (23)	37 (30)	59 (48)	Reference		Reference	
≤High School	39 (27)	54 (38)	49 (35)	1.55 (0.99, 2.43)	0.06	1.59 (0.97, 2.62)	0.07
Household income, $, *n* (%)							
≤20,000	27 (40)	27 (40)	13 (20)	1.59 (0.89, 2.86)	0.12		
20,001-40,000	34 (37)	35 (39)	22 (24)	1.32 (0.74, 2.35)	n.s.		
>40,000	34 (31)	43 (40)	31 (29)	Reference			
Poor, *n* (%)‡	26 (31)	29 (35)	28 (34)	1.80 (1.11, 2.93)	0.02		
Household went deeply into debt in the past 12 months, *n* (%)	12 (18)	13 (14)	10 (9)	1.98 (1.02, 3.83)	0.04	2.00 (1.00, 3.99)	0.05
Welfare/public aid recipient, *n* (%)	13 (19)	5 (6)	6 (6)	3.82 (1.71, 8.54)	0.001	3.94 (1.66, 9.39)	0.002
Primary caregiver employed, *n* (%)							
Yes	40 (22)	63 (35)	77 (43)	Reference			
No	16 (23)	24 (35)	29 (42)	1.04 (0.62, 1.74)	n.s.		
Household head, *n* (%)							
Married couple or equivalent	27 (19)	53 (37)	62 (44)	Reference			
Single parent	32 (29)	35 (32)	44 (40)	1.36 (0.85, 2.15)	0.20		
Primary caregiver US-born, *n* (%)							
Yes	37 (24)	46 (29)	74 (47)	Reference			
No	25 (24)	44 (43)	34 (33)	1.46 (0.92, 2.32)	0.11		
Primary caregiver sees dentist regularly, *n* (%)							
Yes	24 (21)	36 (32)	53 (47)	Reference			
No	26 (24)	40 (37)	43 (40)	1.28 (0.79, 2.10)	n.s.		
Carious surfaces, mean (SD)	9.6 (5.8)	10.5 (7.2)	10.3 (7.9)	0.99 (0.96, 1.02)	n.s.		

* All measurements were self-reported by the primary caregiver at the baseline visit (1997-99). For birthplace of primary caregiver, data were available for 260 participants; for employment, 249; for household head type, 253; for debt, 254; for welfare/public aid and poverty, 255; for primary caregiver dental visits, 222. Attendance at dental visits refers to the number of preventive dental visits attended during 5 years of follow-up (excluding two visits during times of limited data collection) and is categorized as low (one to four visits), medium (five to seven visits), or high (eight to nine visits).

† Odds ratios were computed with an ordinal logistic regression model and represent the odds of being in a lower utilization category (i.e., medium versus high, low versus medium). The multivariate model resulted from a stepwise logistic regression (considering the variables that were univariately associated with utilization), followed by a reinsertion of confounding factors.

‡ Poor refers to those living in a household at or below the poverty threshold, which was determined using weighted poverty thresholds 1997-99 based on family size and family income, as in the Social Security Bulletin, Annual Statistical Supplement, 2002 (original source of data: US Census Bureau, current population).

¶ Not significant at the value necessary for initial inclusion in the manual multivariate model building process (*P*-value > 0.20).

SD, standard deviation.

multivariate analysis (6 percent increase in OR). On the other hand, financial stress indicators, including welfare or debt, were not statistically significant and were not included in this multivariate model, although trends were in the same direction as in the main analysis (data not shown).

In contrast, attendance at annual visits was relatively good, with 53 percent of children attending all possible annual visits, and only 29 percent attending fewer than four of the five visits. In the multivariate model for annual visits, the associations with distance from home to clinic and Black race were weaker and of borderline significance, and the comparisons of Hispanic or other races with White were nonsignificant (data not shown). Caregiver education was not associated with annual visit utilization. However, welfare use and reporting that the household income decreased substantially in the past year were significantly associated with underutilization (welfare multivariate OR = 3.15; 95 percent CI = 1.36, 7.33; $P = 0.008$; income-drop multivariate OR = 2.52; 95 percent CI = 1.42, 4.48; $P = 0.002$).

Rural Maine area. Baseline characteristics that appreciably varied among the rural Maine participants are displayed in Table 2 by their level of utilization, along with results from unadjusted and multivariate analyses. Despite the spread of home locations, distance from home to dental clinic was not significantly associated with utilization. There was no difference in attendance between children whose caregivers had completed high school compared with those with any post-high school education (OR = 0.96, $P = 0.9$); thus, these categories were combined and compared with having no high school degree. In both unadjusted and adjusted analyses, the only indicators that were statistically significant were education level and number of carious surfaces at baseline. The odds of underutilization were three times greater among children whose caregivers had not completed high school. Each additional carious surface at baseline increased the odds of underutilization by 6 percent, indicating a 75 percent greater risk of low future utilization for children presenting with an additional 10 carious surfaces (10 surface increase OR = 1.75; 95 percent CI = 1.09, 2.82; $P = 0.02$).

Stratification by 6-month versus annual visits in the rural Maine area. Overall, secondary analyses separating 6-month and annual visits had similar results. For either type of visit, the number of carious surfaces at baseline was statistically significant, and its association was of the same magnitude as in the main multivariate analysis (data not shown). Although caregiver education level was nonsignificant for 6-month visits, its association was stronger and of borderline significance for annual visits (less-than-high-school multivariate OR = 2.7; 95 percent CI = 0.98, 7.31; $P = 0.06$). For annual visits, only 12 percent of Maine participants had low utilization; the majority (75 percent) had perfect attendance for all annual visits.

Reasons for Missed Appointments. The number of missed preventive appointments recorded during follow-up was 352 in Boston and 218 in Maine. Although 44 percent of the time no reason was obtained for missed appointments, when provided, reasons somewhat differed for children in Boston versus Maine (Figure 2). In Maine, the most common reason for a missed appointment was a scheduling problem with the child's guardian, followed by weather concerns. While

Figure 2
Reasons for missed preventive dental appointments, by study site, in the New England Children's Amalgam Trial, 1997-2005. Total number of missed preventive dental appointments recorded in urban Boston was 352; of these, 193 (54.8 percent) gave a reason, while 159 (45.2 percent) did not provide a reason for failing to attend the confirmed appointment. Total number of missed preventive dental appointments recorded in rural Maine was 218; of these, 128 (58.7 percent) gave a reason, while 90 (41.3 percent) did not provide a reason for missing the confirmed appointment. Appointments that were canceled by the participant or guardian on the day of the appointment were included as missed appointments. All missed/canceled appointments were rescheduled if possible

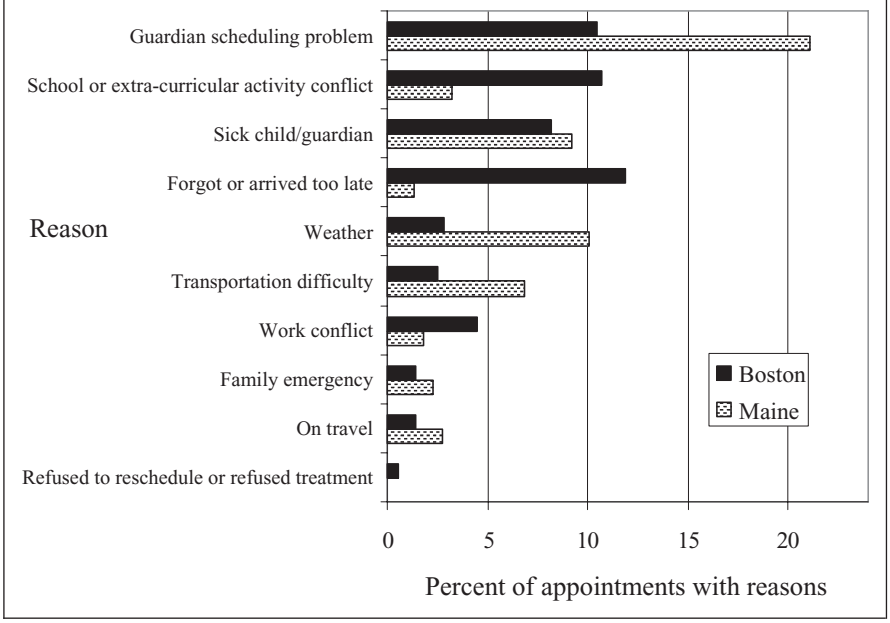

Table 2
Baseline Characteristics of 232 Rural Maine Participants of the New England Children's Amalgam Trial, by Level of Attendance at Nine Free Semiannual Preventive Dental Visits during 5 years of Follow-Up, and Odds Ratios for Lower Utilization*

	Utilization			Odds ratio (95% confidence interval) for lower utilization†			
				Unadjusted		Multivariate model	
	Low ($n = 25$)	Medium ($n = 50$)	High ($n = 157$)		*P*-value		*P*-value
Age, mean years (SD)	8.0 (1.5)	8.1 (1.6)	7.8 (1.4)	1.11 (0.92, 1.34)	n.s.‡		
Gender, *n* (%)							
Male	11 (11)	20 (19)	73 (70)	Reference			
Female	14 (11)	30 (23)	84 (66)	1.21 (0.70, 2.08)	n.s.		
Distance from home to clinic, miles (quartiles), *n* (%)							
<7.4	5 (10)	10 (19)	37 (71)	Reference			
7.4-13.8	5 (8)	15 (24)	43 (68)	1.10 (0.50, 2.43)	n.s.		
13.8-18.7	8 (14)	12 (20)	39 (66)	1.30 (0.59, 2.87)	n.s.		
≥18.7	7 (12)	13 (22)	38 (66)	1.30 (0.59, 2.88)	n.s.		
Education of primary caregiver, *n* (%)							
<High school	4 (25)	5 (31)	7 (44)	2.98 (1.14, 7.76)	0.03	3.06 (1.17, 8.02)	0.02
≥High school degree	21 (10)	45 (21)	150 (69)	Reference			
Household income, $, *n* (%)							
≤20,000	7 (12)	16 (26)	38 (62)	1.01 (0.49, 2.08)	n.s.		
20,001-40,000	11 (10)	19 (17)	82 (73)	0.64 (0.33, 1.24)	0.18		
>40,000	7 (12)	15 (25)	37 (63)	Reference			
Primary caregiver employed, *n* (%)							
Yes	14 (9)	37 (25)	100 (66)	Reference			
No	10 (13)	13 (16)	57 (71)	0.85 (0.48, 1.52)	n.s.		
Household head, *n* (%)							
Married couple or equivalent	16 (10)	34 (21)	113 (69)	Reference			
Single parent	8 (12)	16 (24)	43 (64)	1.26 (0.70, 2.27)	n.s.		
Primary caregiver sees dentist regularly, *n* (%)							
Yes	7 (9)	14 (17)	61 (74)	Reference			
No	15 (11)	33 (23)	95 (66)	1.44 (0.80, 2.62)	n.s.		
Carious surfaces, mean (SD)	11.2 (7.3)	8.9 (6.1)	8.1 (4.9)	1.06 (1.01, 1.11)	0.02	1.06 (1.01, 1.11)	0.02

* All measurements were self-reported by the primary caregiver at the baseline visit (1997-99). Measurements in Table 1 not presented in Table 2 were omitted because the participants did not appreciably vary in the measurement (e.g., race/ethnicity was omitted because 98% of Maine children were non-Hispanic White.) For employment, data were available for 231 participants; for household head type, 230; for primary caregiver dental visits, 225. Attendance at dental visits refers to the number of preventive dental visits attended during 5 years of follow-up (excluding two visits during times of limited data collection) and is categorized as low (one to four visits), medium (five to seven visits), or high (eight to nine visits).

† Odds ratios were computed with an ordinal logistic regression model and represent the odds of being in a lower utilization category (i.e., medium versus high, low versus medium). The multivariate model resulted from a stepwise logistic regression (considering the variables that were univariately associated with utilization), followed by a reinsertion of confounding factors.

‡ Not significant at the value necessary for initial inclusion in the manual multivariate model building process (*P*-value > 0.20).

SD, standard deviation.

Boston participants also had guardian scheduling issues, they most often forgot about the appointment or attended school-related or extracurricular activities instead.

Discussion

In this 5-year prospective cohort analysis of children with unmet dental needs, substantial disparities in the utilization of preventive dental care were observed despite the offer of free comprehensive care. In Boston, children from households on welfare, with deep debt, of non-White race/ethnicity, and at farther distances from the dental clinic were at greater odds of underutilization. In the rural Maine site, where race and economic factors were less variable, disparities remained by education level of the primary caregiver and the child's need for care. While rural children had higher utilization rates than urban children, the overall adequate utilization rates were primarily because of attendance at annual dental visits, for which there was a greater incentive, including a monetary incentive. In contrast, attendance at 6-month visits steadily decreased. Our results indicate that offering reduced-cost care with willing providers is not sufficient in and of itself to eliminate disparities or assure long-term utilization in families with unmet dental needs; the broader social milieu, which includes oral health values and convenient provider locations, should also be targeted.

To our knowledge, this is the first study to follow the same cohort of children after enrollment in a free dental care program and collect extensive data on sociodemographic characteristics with which to analyze utilization over time. Although the self-selection of NECAT participants may limit the generalizability to families who want to receive dental care, our results relate to the target groups of reduced-cost dental care – those with greater unmet dental health needs – to help future policies and programs address disparities in dental care utilization. Furthermore, while NECAT did not collect information on dental insurance, our population had a high prevalence of untreated caries at baseline and consented/assented to have NECAT provide dental care during follow-up, making it unlikely that they regularly had used private or public dental insurance programs. Because we prospectively collected utilization data, common problems of other studies, particularly recall bias and measurement error in the dependent variable (16), were avoided. Still, some secondary analyses had smaller sample sizes, which reduced the power to detect associations of smaller magnitudes between groups.

The time trends we observed in the utilization of 6-month dental visits are similar to the suggested trends in previous studies of children on US governmental health insurance programs (6,17,20,25,26). Considering that NECAT's dental care delivery system was intended to be relatively simple, it is noteworthy that our provider environment did not result in a substantially higher long-term utilization. Only 34 percent of children in Massachusetts or Maine who were enrolled in Medicaid and were eligible for its preventive dental care used it in 1993 (26). Governmental programs have administrative, incentive, and reimbursement issues that are often cited as reasons for their low utilization (26). Improvements in reimbursement and streamlined administration increased utilization during the first year of the Michigan's Healthy Kids Dental program, but utilization rates remained lower than those reported by many studies (44.2 percent of enrolled children and teenagers) (18). Furthermore, utilization during the first year of enrollment may not be indicative of decisions to seek care in the longer term. Our results suggest that factors other than the dental care delivery system gained influence as participants made decisions to seek care in later years. These findings are in accord with studies conducted in countries with universal health care, where disparities in utilization are evident despite the equal access to care extended to all children (13,14).

The striking difference in utilization between 6-month and annual visits was likely related to the monetary incentive, but it may also result from increased efforts to contact, schedule, and complete annual dental appointments by NECAT personnel, because additional data for NECAT's primary outcome were collected at annual visits only. Thus, there was more than one source of variation comparing 6-month with annual visits, and we are unable to determine their relative contributions. For this reason, our secondary analyses separating 6-month and annual visits were not intended to establish the effect of monetary incentives or efforts of dental personnel per se. Rather, they serve to indicate who might remain underserved even when there are great incentives to attend preventive dental visits. Indeed, because most participants attended the annual visits, the predictors of low utilization of annual visits are extremely telling of the population most at risk for underutilization and missed preventive or restorative treatment.

In this regard, an important predictor of utilization for urban participants, who had more variation in their economic conditions than did rural participants, was financial stress in the forms of debt, welfare use, and recent substantial decreases in income. These factors were the key distinguishing factors for underutilization of annual visits in particular, indicating that seemingly strong incentives may not be enough to encourage utilization when there is financial stress. The importance of financial indicators is consistent with cross-sectional and retrospective studies of various dental care delivery systems, where income and insurance status are established correlates of seeking and receiving care (6,7,17,19,25). There are many reasons that families use public financial assistance. In our stepwise analyses, welfare captured the effects of financial factors (e.g., poor, decreased income) as well as

broader factors, such as lack of a male caregiver and life-changing events (e.g., divorce, unemployment). Many of these factors were moderately correlated in our data. Thus, welfare use per se may not be the most important predictor in the practical sense, but rather, in the statistical model, it most efficiently represented the various individual factors that were associated with utilization. For example, financial stress may be associated with long working hours or lack of help with child care, in which case a $40 monetary incentive and numerous phone calls from the dentist's office may not provide enough incentive to prioritize the time and effort required to attend dental care. Such possible correlates of financial stress may have been reflected in the reasons for missed appointments among urban participants, namely, guardian scheduling problems or forgetting about the confirmed appointment. Clearly, financial stress is unlikely to exist in isolation from other social stresses.

Our qualitative results on reasons for missed appointments suggest that many urban participants and caregivers did not highly prioritize dental care amid their other responsibilities. Previous studies showed that caregivers' dental health beliefs mediate structural barriers to seeking care, such as transportation difficulties, work schedules, school absence policies, and stressful daily life events (27-29). Importantly, our finding that education and race/ethnicity were less relevant in determining utilization of annual visits, compared with 6-month visits in urban participants, suggests that underutilization associated with certain races or educational backgrounds is amenable to change when there is greater motivation to attend the dental visits. Along these lines, the main multivariate model's lack of statistically significant findings for Hispanic ethnicity was related to the fact that 47 percent of Hispanic participants attended the Forsyth dental clinic and used community-organized transportation. The notion that this community's organization helped families access dental care indicates the importance of community assistance and values in facilitating dental care and fostering oral health values in individuals.

Indeed, a noteworthy barrier for NECAT participants was transportation. In Boston, children living <0.4 miles (0.6 km) from their clinic had the highest utilization rates. For urban children who used public transportation, a distance of 1 to 3 miles is enough to warrant bus transfers or an otherwise more cumbersome commute. In a subanalysis that excluded children in the fourth quartile of distance (as many attended the Forsyth clinic), there was a highly significant linear association, where each additional mile doubled the odds of underutilization ($P < 0.001$). Interestingly, the association with distance was weaker in the analyses of annual visits, which suggests that the incentives for annual visits were somewhat successful in this regard. On the other hand, participants in the rural Maine area seemed unaffected by the distance from home to clinic for any visit, despite the wider spread of homes. A plausible explanation for this difference is that caregivers in the rural area are accustomed to driving longer distances as part of their daily routine, whereas urban Boston residents find the commute, albeit comparatively short, troublesome. The finding that transportation difficulties and bad weather were often cited in Maine as the reason for a missed appointment supports the hypothesis that, although geographical differences exist, convenient locations and commutes are important for both urban and rural areas.

Although we do not know the reason why participants had unmet dental needs at the start of NECAT, our results indicate that the factors affecting utilization before enrollment did not fully subside during the course of the trial. Governmental oral health policies hope that reduced-cost care will lessen utilization disparities, but financial barriers are not alone in stopping children from receiving dental care. For many families, the factors at play are related not only to their economic conditions, but also to their broader social milieu, which includes oral health values and convenient provider locations. To prevent the disparities in utilization and oral health status from escalating, public health programs need to target the social settings in which financial burdens are cradled.

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