Scientific Article

Prevalence of Dental Caries in Early Head Start Children as Diagnosed Using Teledentistry

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Abstract: ***Purpose:*** *This study's purpose was to assess caries prevalence by means of teledentistry in 12- to 60-month old children enrolled in Early Head Start inner-city child care centers.* ***Methods:*** *Images of the primary dentition were obtained by trained telehealth assistants using an intraoral camera. Images were entered into a Web-based storage and retrieval program. They were transmitted to a secure, remote-site computer and evaluated by a calibrated pediatric dentist.* ***Results:*** *Of 162 children screened, 93 were caries free and 69 had early childhood caries (ECC). Of these, 28 had severe early childhood caries (S-ECC). The mean dfs score for all 162 children was 1.88. The mean dfs score for the 69 ECC children was 4.42. The mean dfs for the subgroup of 28 S-ECC children was 7.61. Caries scores of S-ECC children were statistically significantly different from caries scores of the entire cohort and from caries scores of the ECC children.* ***Conclusions:*** *This study's results show that: (1) almost half of the preschoolers enrolled in the study were affected by dental caries; (2) only a few children had ever had a dental visit; and (3) teledentistry offers a potentially efficient means of screening high-risk preschool children for signs of early childhood caries.* *(Pediatr Dent 2008;30:329-33) Received May 4, 2007 / Last Revision August 10, 2007 / Revision Accepted August 29, 2007*

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Dental caries is a preventable and treatable oral condition that remains the most common chronic childhood disease. It is estimated that over 40% of US children have dental caries before reaching kindergarten.[1] Findings from the 1988-1994 National Health and Nutritional Examination Survey (**NHANES III**) show that the prevalence of caries in the primary dentition of 2- to 5-year-old children is 24%.[2] Moreover, almost 50% of 6- to 11-year-old children have caries in their primary dentition.[2] The data from the NHANES 1999-2002 show that the prevalence of caries in the primary dentition is not decreasing; almost 28% of 2- to 5-year-old children and 49% of 6- to 11-year-old children were found to have caries in their primary dentition.[2] Although the American Academy of Pediatric Dentistry (AAPD) recommends that a child establish a dental home by 1 year of age, studies have suggested that only 2% of US children have seen a dentist by 1 year of age, 11% by 2 years of age, and 19% by 3 years of age.[3]

Analysis of National Health Interview Survey data from 1993 to 1996 revealed that dental care was the most prevalent unmet health need among US children. Near-poor and poor children were about 3 times more likely to have an unmet health need as privately insured children.[4] Vargas and Ronzio found that poor US children were more likely to be episodic users of dental care than their more affluent counterparts.[5] Moreover, 2- to 5-year-old children were almost 6 times more likely as older children to have never visited the dentist. Approximately 80% of childhood tooth decay is concentrated in 20% of the US child population, with children of low socioeconomic status 32 times more likely to develop caries than children of the general population.[6,7]

Early childhood caries (**ECC**), as defined by the AAPD, is the presence of ≥1 decayed, missing, or filled tooth surfaces in a child ≤71 months of age. Severe early childhood caries (**S-ECC**) is defined as the presence of any sign of smooth-surface caries in children younger than 3 years old and ≥1 cavitated, missing (due to caries), or filled smooth surfaces in primary maxillary anterior teeth from ages 3 through 5, or dmfs ≥4 (age 3), ≥5 (age 4), or ≥6 (age 5).[8]

ECC has been linked to failure to thrive, a decreased ability to learn, an increased risk of caries development in the permanent dentition, and an increase in the likelihood of enamel defects on the successors of carious primary teeth.[9-11]

The purpose of this cross-sectional study utilizing teledentistry technology was to assess the prevalence of dental caries in 12- to 60-month-old children enrolled in inner-city child care centers in Rochester, NY.

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Methods

Study population. The population from which the study sample of 162 12- to 60-month-old preschool children was drawn consisted of approximately 700 total children who were available during the 2004-2006 years of recruitment and who attended inner-city child care centers located in the northeast quadrant of Rochester, NY. Due to the telehealth assistants' (**TA***s*')time constraints, our sample size was limited to children who could be imaged during the time between telemedicine visits and their other health-related responsibilities. The study sample consisted of Hispanic American, African American, and Caucasian children. All study participants were Medicaid- or Child Health Plus-eligible. Children enrolled in our study lived in the most impoverished area of Rochester. No data were available on the caries status of preschool children from this area. Data from our pilot study that tested the feasibility of teledentistry for use as an oral health screening tool suggested that a high prevalence of oral disease existed in this population of very young inner-city children.[12]

Training of telehealth assistants. Six telehealth assistants from the 6 child care centers participating in the study were trained in the use of the intraoral camera. Subsequently, each telehealth assistant practiced with the intraoral camera on an adult volunteer until proficiency was demonstrated. The time commitment for training was approximately 1 hour initially. Training to proficiency required an additional 30-minute follow-up practice session, depending on the skill of the operator.

Six intraoral images were required for the dental screening examination. These usually consisted of 2 labial anterior images and 4 occlusal posterior images. If needed, additional views of the posterior buccal surfaces, posterior lingual surfaces, or lingual views of the anterior teeth were obtained if recommended by the dentist who reviewed the images. A full complement of 6 images could be obtained in approximately 5 minutes or less.

Informed consent. The University of Rochester Medical Center Research Subject Review Board approved the study prior to its initiation. Informed consent was obtained from parents of participating children prior to the study. Children older than 1 year of age and younger than 6 years old, regardless of gender, ethnic origin or race, were eligible to participate in the study. There were no other exclusionary criteria.

Examination procedures. The TAs, who were child care center employees, were trained to image children's teeth by the study's principal investigator at each participating daycare center. The recorded digital images obtained by the TAs were transmitted via a secure Internet connection to a dedicated computer at the remote dental site (Division of Community Dentistry and Oral Disease Prevention, Eastman Department of Dentistry, University of Rochester, Rochester, NY). For study purposes, all identifiers were removed. Six images of the labial/buccal and occlusal surfaces of each child's teeth were recorded, including 2 anterior and 4 posterior views. Additional views of the posterior buccal/facial surfaces and anterior/posterior lingual surfaces were obtained, as necessary. Figure 1 depicts 2 images taken during the study. The first shows a healthy smile, and the second shows a child with S-ECC. The validity and reliability of digital images was assessed in a previous study.[16]

The existing computer hardware and software infrastructure of Health-e-Access was utilized for this study (Teleatrics Inc, Rochester, NY). The Dr. Camscope intraoral camera (Sometech Inc, Seoul, South Korea) was used to image the oral hard and soft tissues.

Caries measurement. Decayed and filled surfaces (dfs) were recorded on individualized prelabeled caries exam forms for the teledentistry examination; dfs scores were calculated for

Figure 1. Two teledentistry images taken during the study: top - a healthy smile, bottom - a child with severe early childhood caries.

each child. The dental examiner examined all dental images obtained on the participating children. We used the most recent definition of ECC for this study.[8]

Data analysis. As the primary measure, each child was scored as having caries experience or not (dfs>0 or dfs=0). As a secondary measure, we classified children with caries as "ECC" or "S-ECC" based on caries severity according to the most recent AAPD definition of ECC.[8] Mean caries scores were calculated based on age, gender, and ethnicity. Data management and processing were done by means of SAS statistical software (v. 9.1, SAS Institute Inc, Cary, NC). Student's *t* test and analysis of variance (ANOVA) were used to assess statistical differences (P=.05).

Results

Of 162 children screened with the intraoral digital camera, 69 children (43%) had caries experience—either ECC or S-ECC. The mean dfs score for all children enrolled in the study (N=162) was 1.88 (±3.49 SD), with a range of 0 to 20 carious surfaces. The mean dfs score for the 69 ECC children was 4.42 (±4.18). Twenty-eight of the 69 ECC children were classified as having S-ECC. Their mean S-dfs (decayed and filled surfaces for children identified with S-ECC) score was 7.61 (±4.92). Caries scores of the S-ECC children were significantly different statistically from caries scores of the entire cohort and from caries scores of the children with ECC (ANOVA, P<.001).

Table 1. DECAYED AND FILLED PRIMARY TOOTH SURFACES (dfs) BY ETHNICITY FOR 162 CHILDREN ENROLLED IN THE STUDY

Ethnicity (N)	Mean dfs±SD	dfs range	*P*-value (ANOVA)
Caucasian (4)	1.50±1.73	0.00-4.00	=.11
Hispanic American (47)	0.91±1.95	0.00-10.00	
African American (108)	2.26±3.92	0.00-20.00	
Other (3)	4.00±5.29	0.00-10.00	

Table 2. DECAYED AND FILLED PRIMARY TOOTH SURFACES (dfs) BY ETHNICITY FOR 69 CHILDREN WITH EARLY CHILDHOOD CARIES (ECC) AND DECAYED AND FILLED SURFACES (s-dfs) FOR 28 CHILDREN WITH SEVERE ECC (S-ECC)

ECC children (N=69)			
Ethnicity (N)	**Mean dfs±SD**	**dfs range**	***P*-value (ANOVA)**
Caucasian (3)	2.00±1.73	1.00-4.00	
Hispanic American (13)	3.31±2.46	1.00-10.00	=.46
African American (51)	4.78±4.54	1.00-20.00	
Other (2)	6.00±5.66	2.00-10.00	
S-ECC children (N=28)			
Ethnicity (N)	**Mean dfs±SD**	**dfs range**	***P*-value (ANOVA)**
Caucasian (0)	—	—	
Hispanic American (4)	5.50±3.42	2.00-10.00	=.61
African American (23)	7.87±5.19	2.00-20.00	
Other (1)	10.00±0	10.00-10.00	

Table 3. DECAYED AND FILLED PRIMARY TOOTH SURFACES (dfs) BY AGE FOR 162 CHILDREN ENROLLED IN THE STUDY

Age in ys (N)	Mean dfs±SD	dfs range	*P*-value (ANOVA)
1 (24)	0.08±0.42	0.00-0.42	<.001
2 (27)	1.44±3.82	0.00-3.82	
3 (46)	1.70±3.52	0.00-3.52	
4 (43)	2.14±3.08	0.00-3.08	
5 (22)	4.27±4.41	0.00-4.41	

African American children (N=108) had the highest mean dfs score of 2.26 (±3.92), followed by Caucasian children (N=4, dfs=1.5) and Hispanic American children (N=47, dfs=.91). Three children were classified as "other" due to missing or questionable ethnicity data. Their mean dfs score was 4.0 (Table 1). Differences by ethnicity were not statistically significant (ANOVA, P=.11). Fifty-one of 69 ECC children were African American, followed by Hispanic American (N=13) and Caucasian (N=3) children. There were 2 ECC children with questionable ethnicity data (Table 2).

S-ECC children were mainly African American (23 of 28), with 4 being Hispanic American. There was 1 child with questionable or missing ethnicity that fell into this category. No Cau-casian children were identified with S-ECC (Table 2).

The number of surfaces affected by caries in the study population varied from 1 (N=13) to 20 surfaces (1). The largest number of children (20), representing 12% of the sample, had a dfs score of 2, followed by 13 children with a dfs score of 1 (8% of the sample). Seventeen children (approximately 10% of the sample) had a dfs score of 6 or greater.

As would be expected, 5-year-old children were found to have the highest mean caries scores, followed by 4-year-olds, 3-year-olds, 2-year-olds, and 1-year-olds (Table 3). Differences based on age were statistically significant (ANOVA, P<.001). Among ECC children, the oldest had the highest mean caries scores and the youngest had the lowest mean caries scores. Differences in ECC based on age were not statistically significant (Table 4). Among S-ECC children, 5-year-olds were found to have the highest mean caries score, followed by 4-year-olds, 3 year-olds, 2 year-olds, and 1 year-olds (Table 4). Differences in S-ECC based on age were not statistically significant (ANOVA, P=.27).

Females had a higher mean dfs score than males. This difference, however, was not statistically significant

Table 4. DECAYED AND FILLED PRIMARY TOOTH SURFACES (dfs) BY AGE FOR 69 CHILDREN WITH EARLY CHILDHOOD CARIES (ECC) AND DECAYED AND FILLED SURFACES (S-dfs) FOR 28 CHILDREN WITH SEVERE ECC (S-ECC)

ECC children (N=69)			
Age in ys (N)	**Mean dfs±SD**	**dfs range**	***P*-value (ANOVA)**
1 (1)	2.00±0	2.00-2.00	=.24
2 (7)	5.57±6.02	2.00-17.00	
3 (19)	4.11±4.53	1.00-20.00	
4 (27)	3.41±3.30	1.00-15.00	
5 (15)	6.27±3.97	2.00±14.00	
S-ECC children (N=28)			
Age in ys (N)	**Mean dfs±SD**	**dfs range**	***P*-value (ANOVA)**
1 (1)	2.00±0	2.00±0	=.27
2 (7)	5.57±6.02	2.00-17.00	
3 (9)	7.00±5.29	4.00-20.00	
4 (5)	9.20±3.56	6.00-15.00	
5 (6)	10.50±2.59	7.00±14.00	

Table 5. DECAYED AND FILLED SURFACES (dfs) BY GENDER FOR 162 CHILDREN ENROLLED IN THE STUDY

Gender (N)	**Mean dfs±SD**	**dfs range**	**P-value (ANOVA)**
Female (95)	1.99±3.64	0.00-20.00	=.64
Male (67)	1.73±3.28	0.00-17.00	

(*t* test, *P*=.64). These data are presented in Table 5. Nineteen girls and 9 boys were classified as having S-ECC. The mean S-dfs score for girls was 8.11 (±4.99 SD), and the mean S-dfs for boys was 7.37 (±5, SD). This difference, however, was not statistically significant (*t* test, *P*=.72). Only African American children showed evidence of being treated for caries (<5%). Less than 5% of all children showed evidence of being treated for caries, based on the presence of restorations.

The families of all children with urgent oral care needs were referred for treatment, and families without a dentist were helped to find a dental home.

Discussion

Water fluoridation, fluoridated toothpaste, placement of sealants, and other public health measures have helped decrease the prevalence of caries in US children over the past several decades. Nevertheless, caries is still a major public health concern, especially in lower socioeconomic groups. In this study, 43% of the children had at least 1 surface in the primary dentition affected by dental caries. As our results indicate, 5-year-old children enrolled in this study had the highest caries rate with only a minimal indication of dental treatment. This is troublesome, as primary teeth in preschool-age children must last several years until the permanent dentition has emerged. The premature loss of primary teeth due to dental caries or infection can have a profound effect on dental arch status. Maintaining the primary teeth in place until their replacement by the permanent teeth is important to the child's developing occlusion.[13]

It has been estimated that over 51 million hours of school have been missed by children each year due to dental caries.[14] Dental pain may cause a child to be irritable or unable to concentrate and may negatively affect academic achievements.[15] Only 20% of Medicaid-eligible children have ever visited the dentist, and approximately 20% of economically disadvantaged children under the age of 5 have been treated for dental caries.[16,17] Results from NHANES I, conducted between 1971 and 1974, and NHANES III, conducted between 1988 and 1994, suggest that the level of treated and untreated caries in the primary dentition in 2- to 5-year-old US children living at or below the federal poverty level has not changed.[18] According to the Centers for the Disease Control and Prevention, the prevalence of dental caries in primary teeth among 2- to 5-year-old children has increased over the last decade.[2] NHANES III data show that 24% of 2- to 5-year-old children had caries experience in their primary teeth. Data from NHANES 1999-2002, conducted between 1999 and 2002, show that 28% of children in the above 2- to 5-year-old age group had caries experience in their primary teeth.

Our results are even more troubling. We found that almost 43% of the preschoolers screened in this study had caries experience and more than 17% of the children were classified as having S-ECC. Only the African American children enrolled in our study showed some evidence of being treated for caries. All others had untreated decay. This observation suggests that children under study had low utilization of dental care. We speculate that this apparent lack of care may, in part, be due to limited access to dental care and a lack of knowledge or appreciation for the significant role primary teeth have in the development of the permanent dentition.

The developing field of teledentistry has the potential to benefit dental care by enhancing early diagnosis, timely treatment of oral diseases, improved utilization of dental services, and access to care. In the long term, teledentistry also may help to establish a "dental home" for participating children. Additionally, the process of obtaining images using the intraoral camera is nonthreatening and less stressful for small children than is the traditional oral examination. Increased child comfort and cooperation is especially likely when the teledentistry exam is conducted in a familiar environment, such as the day care center.

Teledentistry examinations offer an efficient initial assessment of the oral health of very young children. We believe teledentistry has the potential to save time and resources and to enhance access to care, particularly in urban inner-city areas. Further, teledentistry may be particularly useful in remote rural

areas or in other areas where there are few dental practitioners (ie, urban inner-city areas and federally designated "dental health professional shortage areas"). Digital images have great potential to accurately identify oral conditions that may be used for referral and treatment recommendations, as well as for consultation among specialists and primary oral health care providers. Images can be sent to a remote location for analysis, diagnosis, and referral. Parents of enrolled children were provided with a list of care providers who accept Medicaid-eligible children as young as 1 year of age and were assisted in finding a dental home. All children requiring urgent attention were referred for dental treatment.

A major advantage of teledentistry is that children can be easily reimaged to determine if treatment has been initiated or completed. Families of children who did not receive care can be further assisted in finding care, as appropriate or necessary. Longitudinal studies are planned to assess both the cost-effectiveness of teledentistry and the full extent of its capability to enhance dental care utilization, especially in families with limited access to care.

Conclusions

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

1. Among inner-city preschoolers attending child care centers, dental caries was present in almost half of the children screened in this study.
2. Very few children appeared to have ever been to a dentist or received treatment for caries.
3. Teledentistry offers a potentially efficient and cost-effective means of screening and tracking very young children with early childhood caries or who are at high risk for ECC, and it may be an excellent way to help families lacking regular access to dental care to find a dental home.

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