

Patterns of fluoride dentifrice use among infants

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Abstract

The early use of fluoride dentifrice and use of larger quantities recently have been identified as risk factors for dental fluorosis. However, little is known about fluoride dentifrice use and ingestion among infants and young children whose developing permanent teeth are at risk for dental fluorosis. This paper reports on patterns of fluoride dentifrice use among a birth cohort up to 12 months of age as reported by mothers by written questionnaire. Among those with teeth, percentages whose teeth were brushed at age 6, 9, and 12 months were 12.9%, 36.7%, and 64.5%, respectively. Percentages brushing with fluoride dentifrice were 1.9%, 11.7%, and 31.7%. Among those using dentifrice, the percentages using fluoride dentifrice were 94–97%. Among those using dentifrice, mean estimated quantities of fluoride from dentifrice used per brushing were 0.11, 0.14, and 0.17 mg F (range up to 0.88 mg). Among users, mean quantities of fluoride from dentifrice used per day were 0.21, 0.20, and 0.19 mg F (range up to 1.75 mg). Results suggest that fluoride dentifrice use among infants varies greatly, can be substantial, and can be a risk factor for dental fluorosis. (Pediatr Dent 19:50–55, 1997)

Along with the decline in dental caries in the United States, Canada, and other westernized nations over the past 20 or more years,^{1–3} there is also evidence that there has been an increase in the prevalence of dental fluorosis.^{4–6} Water fluoride^{7–12} and dietary fluoride supplements^{11–16} have been studied most and have been consistently identified as risk factors for dental fluorosis. However, more recently, a number of studies have identified early or increased use of fluoride dentifrice as an important additional risk factor for dental fluorosis,^{10, 16–18} sometimes including dentifrice use younger than age 24 months.^{16, 18}

Many of the studies of fluoride dentifrice use were conducted with older children or outside of North America.¹⁹ While several studies have investigated dentifrice use among the young children at greatest risk for dental fluorosis of the early-erupting permanent teeth,^{21–35} relatively few studies have investigated fluoride dentifrice use and ingestion among infants.^{20–22} Several recent studies of preschool children in Canada^{24, 26, 27, 31} and the United States^{20, 21, 25, 35} have established that fluoride dentifrice use and ingestion is often substantial and variable.

The 1989 National Health Interview Survey (NHIS) found that 11% of infants (younger than age 1) and 59% of those age 1 in the United States used fluoride dentifrice.²² In an early longitudinal study of 107 infants and 1-year-olds,²⁰ we reported that the proportion of children ever having had teeth brushed increased from 43% (at 9 months) to 69% (12 months), 84% (15 months), and 93% (18 months). At 9 months, only 23% had their teeth brushed at least once per day, increasing to 43% (12 months), 59% (15 months), and 69% (18 months). We recently reported on fluoride dentifrice ingestion as a component of estimated total fluoride ingestion among a birth cohort followed until age 9 months.³⁶ Only about 15% of the 75 9-month-olds were receiving fluoride dentifrice, and its ingestion constituted an average of only 2.4% of estimated total daily fluoride intake. However, among those receiving fluoride dentifrice, ingestion constituted an average of 19.4% of total daily fluoride intake. There are no other published studies of fluoride dentifrice use among infants. The purpose of this paper is to report patterns of fluoride dentifrice use among a birth cohort up to 12 months of age.

Methods and materials

Prior to their discharge from the hospital postpartum, 1,882 mothers with newborns were recruited from eight eastern Iowa hospitals as part of a larger study of fluoride exposures and ingestion and dental fluorosis and caries (the Iowa Fluoride Study). Appropriate informed consent procedures were used and participants received small gifts, including adult- and child-sized toothbrushes as incentives. Demographic information was obtained at recruitment. Pretested^{20, 23, 25, 35, 36} questionnaires then were sent to the participants when the infants were 6 weeks and 3, 6, 9, and 12 months of age. Follow-up mailings were sent after 3 weeks and telephone follow-up was conducted after 6 weeks.

There were 508 mothers who were recruited, but were dropped from the study because they did not respond to contact at either 6 weeks or 3 months. At the time of this paper, there were 1,217 respondents at age 6 weeks, 1,112 at 3 months, 899 at 6 months, 665 at 9 months, and 508 at 12 months. (Note that some children in the cohort had not yet reached these ages.) Mothers

TABLE 1. DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS (N = 1,374*)

Variable	Percentage
<i>Mother's Age</i>	
< 20	7.4
20-24	20.7
25-29	31.0
30-34	27.4
35+	13.6
<i>Father's Age</i>	
< 20	1.2
20-24	11.8
25-29	29.6
30-34	32.5
35+	24.9
<i>Mother's Education</i>	
Up to high school	30.5
Some college	32.3
College graduate or more	37.3
<i>Father's Education</i>	
Up to high school	34.5
Some college	27.8
College graduate or more	37.6
<i>Family Income</i>	
< \$20,000	24.1
\$20,000-39,999	35.5
\$40,000+	40.4
<i>Race</i>	
White	95.1
Other	4.9
<i>First Child</i>	
Yes	43.9
No	56.1

* Among the 1,374 recruited who provided at least one follow-up response.

answered a series of questions about their infants' feeding patterns, water sources, food and beverage intake, use of dietary fluoride supplements, toothbrushing, and use of fluoride dentifrice. At each time point from 6 months on concerning the preceding 3-month interval, mothers were asked to report whether their infants' teeth were brushed and, if so, what kind (brand and flavor) of dentifrice was used, how frequently teeth were brushed, who placed the dentifrice on the brush, and who brushed the infant's teeth. Also, they estimated quantities of dentifrice used by selecting from pictures depicting children's toothbrushes with different quantities of dentifrice on them.^{20, 23, 25, 35, 36} From these variables, estimated quantities of fluoride dentifrice used per brushing and per day were calculated. No validation of the mothers' responses was done for this study, but when it was necessary to clarify responses, mothers were contacted by mail or telephone.

Two staff members sequentially reviewed the data for accuracy and completeness and data were double entered and verified. Descriptive statistics were gener-

ated using SAS,³⁷ and statistical analyses were conducted using Generalized Estimating Equations (GEE) to relate use of dentifrice to the possible explanatory variables of infant's age, mother's age, father's age, mother's education, father's education, family income, and whether the study child was a first child.^{38, 39} This regression method for data with repeated measurements from the same individuals accounts for correlated outcomes within an individual and different numbers of measured outcomes among individuals. The SAS macro of Karim and Zeger⁴⁰ was used to perform the computations, with $P < 0.05$ considered statistically significant.

Results

Table 1 shows the demographic characteristics of the study respondents. The majority of mothers were 20-29 years old and the majority of fathers were aged 25-34 at the birth of the child. About two-thirds of mothers and fathers had at least some college education. Most had a family income (at recruitment) of \$20,000 or greater, almost all were white, and more than half had other children.

Table 2 summarizes by time period the percentages of infants who had teeth and the numbers, methods of cleaning their teeth, and daily brushing frequency. Percentages of 6-, 9-, and 12-month-olds with teeth were 34.6, 83.6 and 98.0%, respectively. At age 6 months, use of a cloth was predominant among those who were cleaning their child's teeth. Among those with teeth at age 9 months, 37% had their teeth brushed and 36% cleaned with a cloth. Almost two-thirds of 12-month-olds had their teeth brushed with a toothbrush, while about one-quarter did not have their teeth cleaned at all. The majority at each age group brushed daily or less frequently.

At all three time points, all infants whose teeth were being brushed reportedly were having their teeth brushed with child-sized toothbrushes. Percentages reportedly using primarily a single brand and specific formulation/flavor of dentifrice were 71, 86, and 85%. Approximately 59, 78, and 70% of the dentifrice reportedly was regular-flavored, while 41, 22, and 30% received dentifrice flavored for children, respectively. The number of different brands (e.g., Crest®, Colgate®, Aim®, Aquafresh®, etc.) and specific formulations and flavors (e.g., Sparkle, Junior, Regular Paste, Mint Paste, Tartar Control Paste, Mint Gel, Winterfresh Gel, etc.) of dentifrice increased dramatically with increasing age, in part due to more children using dentifrice. At 6 months, there were five different brands reported and 16 different formulations, at 9 months there were nine brands and 32 formulations, and at 12 months there were 13 brands and 43 formulations. The two most commonly used brands accounted together for 55, 64, and 64% of use at the different time points, respectively. Among those using dentifrice, 94-97% was fluoridated dentifrice, constituting 1.9, 11.7, and 31.7% of all chil-

TABLE 2. PRESENCE OF TEETH, PATTERNS OF CLEANING TEETH, AND BRUSHING FREQUENCY

Variable	Time Period		
	6 Months	9 Months	12 Months
Sample size	899	665	508
Percentage with erupted teeth	34.6	83.6	98.0
Range/mean number of teeth among those with teeth	0-8/2.1	0-14/4.0	0-16/6.3
Teeth cleaned among those with teeth (%) [*]	(N = 311)	(N = 556)	(N = 497)
Yes, with toothbrush	12.9	36.7	64.5
Yes, with cloth	76.8	36.2	19.9
No	12.9	53.8	25.3
Daily cleaning frequency among those with teeth cleaned (%)	(N = 271)	(N = 348)	(N = 373)
Less than daily	31.4	33.2	37.0
Once per day	41.2	45.5	44.8
Twice per day	16.9	17.0	14.7
Three times per day	6.3	3.1	3.5
More than three times per day	6.3	1.1	—

* Note: totals exceed 100% since some people reported using both.

TABLE 3. PERSON CLEANING TEETH AND PLACING DENTIFRICE ON TOOTHBRUSH (%)

Person Cleaning Teeth	Time Period		
	6 Months (N = 262)	9 Months (N = 340)	12 Months (N = 345)
Mother	89	89	81
Father	2	2	4
Baby	3	5	8
Sibling	< 1	< 1	—
Other	6	3	7
Person Placing Dentifrice	(N = 18)	(N = 77)	(N = 149)
Mother	78	96	95
Father	—	1	3
Baby	6	—	—
Sibling	—	1	—
Other	17	1	2

dren at ages 6, 9, and 12 months, respectively. All dentifrice reported was fluoridated at 1000-1100 ppm (regular strength), except for one child only at 12 months receiving 1500 ppm Extra-Strength Aim® and one child (6%) at 6 months, five (6%) at 9 months, and five (3%) at 12 months receiving nonfluoridated dentifrice.

Table 3 summarizes data concerning the person cleaning the infants' teeth and placing dentifrice onto the toothbrush. Mothers reportedly did more than 80% of the tooth cleaning, with a slight decline at 12 months ($P < 0.05$ using GEE). No other demographic factors were significantly related to person cleaning the teeth.

Among the smaller numbers using dentifrice, the mothers placed the dentifrice 78, 96, and 95% of the time.

Table 4 summarizes the results concerning dentifrice use among those whose teeth were cleaned. The majority at each age group did not use any dentifrice, and the percentages using dentifrice occasionally and regularly increased with age to 17.8% and 24.3% respectively at 12 months. Older children and younger mothers were significantly associated with higher dentifrice use. Most 6-, 9-, and 12-month-olds receiving dentifrice used an estimated quantity of ≤ 0.25 g (about 0.25 mg of fluoride if fluoridated dentifrice), which is about one-fourth of a child-sized toothbrush covered with dentifrice.

Table 5 summarizes the distribution of estimated average quantity of fluoride dentifrice used per brushing, with results adjusted to consider that some using fluoride dentifrice also sometimes brushed without dentifrice or occasionally received nonfluoride dentifrice. Estimated quantities of fluoride dentifrice per brushing ranged from 0.02-0.88 mg, with means from 0.11 to 0.17 mg. Significantly larger quantities were used by older children and those with younger mothers. Quantities per day ranged from 0.01-1.75 mg, with mean use of about 0.20 mg fluoride. Those with younger mothers used significantly more fluoride dentifrice per day. For each of these variables at each time point, the distributions were

skewed with the means exceeding the median.

For each time period, those using dentifrice flavored for children were reported to have used more dentifrice per brushing and per day. However, none of the differences was statistically significant.

Discussion

Several caveats are necessary concerning these study results. First, despite the large size of the cohort and large number of respondents at each time point, respondents are not truly representative of any defined population. Those who agreed to join the study were

TABLE 4. USE OF DENTIFRICE (AMONG THOSE WITH TEETH BRUSHED OR CLEANED)

Variable	Time Period		
	6 Months (N = 272)	9 Months (N = 367)	12 Months (N = 383)
Use of dentifrice (%)			
No	93.8	78.7	58.0
Yes, occasionally	3.7	11.4	17.8
Yes, regularly	2.6	9.8	24.3
Estimated quantity of dentifrice typically used (g of dentifrice)			
	(N = 16)	(N = 79)	(N = 159)
0.06	31.3	25.3	27.7
0.13	31.3	30.4	33.3
0.25	25.0	25.3	21.4
0.50	12.5	12.7	10.7
0.75	—	1.3	3.1
0.88	—	5.1	3.8
1.00	—	—	—

TABLE 5. ESTIMATED QUANTITIES OF FLUORIDE FROM DENTIFRICE USED PER BRUSHING AND USED PER DAY (MG)

	Time Period		
	6 Months (N = 15)	9 Months (N = 74)	12 Months (N = 153)
<i>Fluoride from Dentifrice Used Per Brushing</i>			
Range	0.02–0.50	0.02–0.88	0.02–0.88
Mean	0.11	0.14	0.17
Median	0.06	0.08	0.08
SD	0.13	0.16	0.20
<i>Fluoride from Dentifrice Used Per Day</i>			
Range	0.02–1.50	0.01–1.75	0.01–1.75
Mean	0.21	0.20	0.19
Median	0.04	0.08	0.08
SD	0.40	0.30	0.28

more educated than those who declined. Second, data were collected by parent self-report without direct validation. Third, the actual ages of the infants at each time point varied by a few days to a few weeks, with most children slightly older than the stated ages of 6 months, 9 months, and 12 months. Fourth, although the Iowa Fluoride Study is not interventional, and is only a surveillance study, the parents' behaviors concerning their infant's tooth cleaning and dentifrice use may have been affected by their participation in the study and their knowing questions would be asked about fluoride use (a form of the Hawthorne Effect).⁴¹ Fifth, a small number (< 2–3%) of families made direct, unsolicited requests for our advice about fluoride dentifrice use. In these cases, we felt obligated to explain the desirability of prudent use of small quantities of fluoride dentifrice with infants and young children due to concerns

about dentifrice ingestion. Thus, these infants probably received smaller quantities of fluoride dentifrice than they might have otherwise.

The results from this study are generally consistent with the overall conclusions of the small number of studies that have investigated tooth cleaning habits and fluoride dentifrice use among infants. Specifically,

1. The percentage of infants whose teeth were brushed with fluoride dentifrice increased substantially from 6 to 9 to 12 months, so that the large majority received some fluoride dentifrice before age 1 year
2. Mothers were responsible most of the time for placing dentifrice onto the toothbrush and actually doing the toothbrushing
3. The frequency and quantities of use of fluoride dentifrice varied considerably
4. Fluoride dentifrice ingestion among infants could contribute to fluorosis etiology.

In addition, the prospective, detailed nature of this study over several time periods allowed for additional details to be reported and additional patterns noticed. First, it is not appropriate to assume that all 6- to 12-month-olds are receiving fluoride dentifrice. In fact, many do not yet have teeth or have very few, and mothers sometimes delay use of fluoride dentifrice until a larger number of primary teeth have erupted. Thus, pediatric dentists, general dentists, and particularly pediatricians/family physicians should be encouraged at each visit to systematically assess current toothbrushing practices and advise appropriate, prudent use of small quantities of fluoride dentifrice. Second, from 9 to 12 months, individuals other than the mother did take on a slightly larger share of responsibilities for cleaning the infants' teeth (although there was no such pattern with regard to the person placing the dentifrice onto the toothbrush), and this pattern would be expected to continue beyond 12 months. Thus, it may be important to emphasize more to the primary caregivers (usually the mother) that they should properly train and monitor the other caregivers involved concerning their consistency in placement of small quantities of dentifrice and thus avoiding overingestion. In some cases, it may be prudent for the dental or medical team to directly instruct several caregivers (e.g., parent, partner, grandparent, aunt/uncle, friend, sibling, etc.). Third, use of dentifrice flavored for children was substantial. Since its use may be associated with increased ingestion of fluoride dentifrice,³⁵ flavored dentifrice use probably should be routinely assessed and monitored, and parents reminded that the dentifrice flavored-for-children may be a factor in some children's excess ingestion of fluoride dentifrice. In some cases, parents might be advised to switch to regular-flavored dentifrice. Fourth, no infants at 6 or 9 months and only one at 12 months was reported to be receiving Extra-

Strength Aim[®], which has higher than "regular" fluoride levels and may result in increased fluoride ingestion. Fifth, we found substantial variation in estimated use and ingestion of fluoride dentifrice, with some receiving several times the mean or median quantities.

Dentifrice is only one of the potentially important sources of fluoride ingestion among infants and young children, and the total quantity ingested is actually the true biological risk factor for dental fluorosis.^{42,43} Thus, one should consider estimated F intake from water at home and at child care;^{42,43} from infant formulas,⁴⁴ baby foods,⁴⁵ and juices;⁴⁶ and from dietary fluoride supplements. Sometimes a quantity ingested from one source seems modest or moderate when considered separately but may be excessive in combination with other sources.^{42,43}

In the future, we hope to be able to continue to follow our cohort and conduct analyses of the actual longitudinal patterns of several important sources of fluoride, including fluoride dentifrice use and estimated ingestion for individual children. In such efforts, we may be able to better understand the level of stability of patterns of fluoride dentifrice use, i.e., whether those receiving larger quantities during infancy continue to receive large quantities thereafter. Such data may help in efforts to identify and target those at greater risk for use of excessive quantities of fluoride dentifrice. However, it will continue to be essential that providers systematically assess individual toothbrushing behaviors on a regular basis in order to both emphasize the advantages of early use of fluoride dentifrice and the need for prudent use of small quantities with proper supervision.

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