# Physicians' Roles in Preventing Dental Caries in Preschool Children: A Summary of the Evidence for the U.S. Preventive Services Task Force

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## Introduction

Issues of oral health in children revolve principally around dental caries. In the United States, dental caries is the most common chronic childhood disease,[1] and its treatment is the most prevalent unmet need.[2] Dental caries can occur soon after eruption of the primary teeth, starting at 6 months of age, and 19% of children aged 2 to 5 have at least 1 primary tooth with untreated decay.[3] Dental caries is unequally distributed among the population, with caries incidence, prevalence, and severity being greater among minority and economically disadvantaged children than among other groups.[2–5]

A first dental visit when a child is approximately 1 year of age is now widely recommended.[6] Data from the Medical Expenditures Panel Survey (MEPS) and the National Health and Nutrition Examination Survey (NHANES) indicate that 20%[7] and 30%,[8,9] respectively, of the child population aged 2 to 5 years had a dental visit in the past year, suggesting that the mean age at first visit is more likely between 3 and 5 years. Access to dental care for young children enrolled in Medicaid is a particularly severe problem. Of children aged 1 to 5 years enrolled in the Early and Periodic Screening, Diagnostic, and Treatment Program (EPSDT), 16% receive any preventive dental care even though all are eligible for these benefits.[5] Reasons for this level of access include lack of parental awareness of recommended early visits, the reluctance of general dentists to treat young children, and a limited supply of dentists with specialty training in caring for young children.

Problems with access to dental care underscore the role that primary care physicians and other child health care providers can play in providing access to preventive dental services, particularly for very young children.[3] Although the complete scope of opportunities for physician intervention for the prevention of dental diseases is much wider than simply the prevention of dental caries in preschool children, the rationale for focusing on preschool children and dental caries is compelling. Among young children who have experienced dental caries, a professional, preventive intervention presumably might have reduced or eliminated the incidence of disease and averted substantial interference with quality of life. Yet, many children do not make a dental visit until well after the disease has progressed beyond the reversible stage. Children least likely to make an early dental visit are also those most likely to have dental caries. Physicians and other primary care clinicians usually see children during this at-risk age before the first dental visit, providing an opportunity for them to take preventive action.[10] Well-defined preventive procedures within the scope of medical practice are available for primary care clinicians to use in this preschool population. We reviewed the evidence for the effectiveness of primary care clinician-based interventions to prevent dental caries in preschool children.

# Methods

## Analytic Framework and Key Questions

Figure 1 provides an analytic framework for this review. It represents a risk-based approach to the



Figure 1. Analytic Framework for the Physician's Role in Caries Prevention in Preschool Children
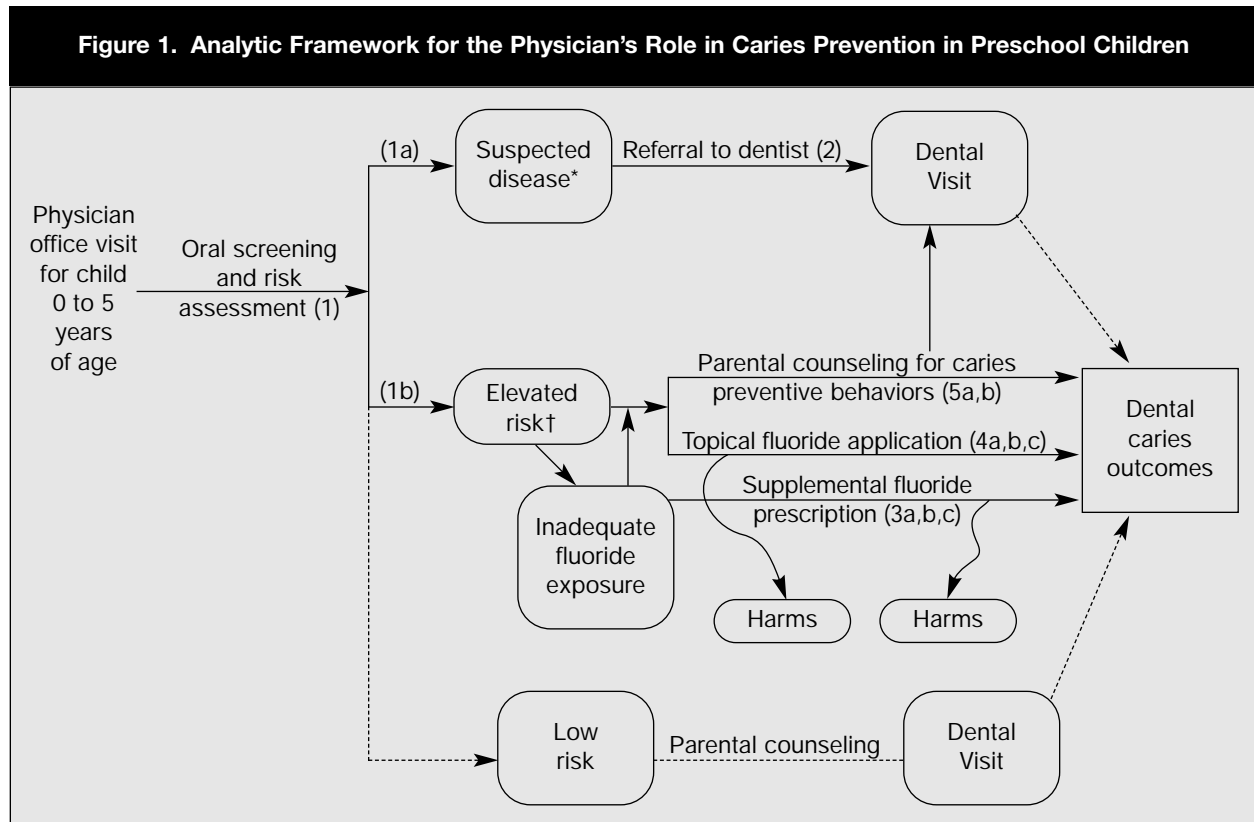
\* Suspected disease: the primary care clinician either visually identifies one or more cavitated lesions or suspects that such a condition is present.

† Elevated risk: the primary care clinician identifies one or more risk indicators, such as inadequate fluoride exposure, caries in siblings or parents, irregular brushing/plaque retention, white spots on smooth tooth surfaces, frequent/prolonged carbohydrate exposure, special needs/medical conditions that increase risk, or lower socioeconomic status.

**Note:** See "Methods" for a list of key questions addressed in this review.

prevention and management of dental caries. It begins with a child's visit to a primary care clinician, presumably a well-child visit. A primary care clinician screens the child for both the presence of dental caries and risk indicators for dental caries. On the basis of the results of the screening (either identification of suspected caries lesions or recognition of elevated risk for dental caries), the physician refers the child to a dentist or initiates one or more preventive interventions (eg, application of fluoride varnish in the office, counseling the parents concerning caries preventive behaviors). If the child has inadequate exposure to fluoride, fluoride supplementation is another possible intervention. The counseling intervention may include referral to a dentist as well. If no disease or risk factors are identified, the primary care clinician may also undertake counseling for reasons that include health promotion and parental education. This arm and the outcomes of treatment by dental professionals are shown in Figure 1 by dotted lines, indicating that they are not evaluated in this review.

The framework is intended to outline general types of interventions provided by primary care clinicians that are appropriate to children between birth and 5 years of age. Although prenatal counseling is recommended by some professional health-care organizations and might be appropriate, it is not a focus of this review. Similarly, application of dental sealants, another effective preventive dental care service, is outside the scope of this review because it is unlikely to be feasible for primary care clinicians to provide this service.

The 5 key questions for physicians' roles in preventing dental caries in preschool children, which were developed to direct this review, are as follows:

1. How accurate is screening by the primary care clinician in identifying children aged from birth to 5 years who

    a. have dental caries requiring referral to a dentist?

    b. are at elevated risk for future dental caries?

2. How effective is referral by the primary care clinician of children aged from birth to 5 years

to dentists in terms of the proportion of referred children making a dental visit?

3. How effective is the prescription of dietary supplemental fluoride by the primary care clinician in terms of

    a. appropriateness of supplementation decision?

    b. parental adherence to the dosage regimen?

    c. prevention of dental caries?

4. How effective is application of fluoride by the primary care clinician in terms of

    a. appropriateness of application decision?

    b. achieving parental agreement for the application?

    c. prevention of dental caries?

5. How effective is counseling by the primary care clinician for caries-preventive barriers, as measured by

    a. adherence to the desired behavior?

    b. prevention of dental caries?

Note: For question no. 5, the caries-preventive behaviors of interest relate to diet (reduction in frequency and amount of sucrose, appropriate use of the bottle), oral hygiene (brushing frequency and efficacy), dental attendance (regular dental examinations and first visits for assessment of risk for disease), appropriate use of fluoride (accepting professional recommendations, use of fluoride dentifrice at home), and implications of caregiver oral health (possible transmission of cariogenic bacteria).

## Literature Search and Analysis Strategy

For each key question, the literature was searched for studies that involved primary care clinicians and children of the target age. Because we anticipated finding only a limited number of studies addressing the performance of primary care clinicians in these essentially dental roles, we also planned from the outset to address key questions

3, 4, and 5 using dental literature. Our approach was to base the appraisal of the evidence on existing systematic and traditional reviews of the literature whenever possible. We used separate searches for 3 of the 5 key questions; we combined the 2 fluoride-related questions (key questions 3 and 4) into a single search.

We searched the English language literature in MEDLINE from 1966 to October 2001. We used combinations of (1) terms defining primary care providers or primary care sites and (2) terms defining the dental topics embodied by the individual questions. These searches included terms capturing a wide range of research designs, from randomized controlled trials (RCTs) through questionnaire surveys. We then added any studies identified in the Cochrane Controlled Trials Register and those identified through review of the references in papers found by the searches and through personal knowledge.

For each of the resulting 4 sets of papers, 2 reviewers independently reviewed each abstract to identify those studies eligible for full review. Criteria for this level of review were simply that the study addressed the key question, reported original data, and involved primary care practitioners. Papers undergoing full review for inclusion were subjected to the same set of criteria. When studies were identified, we prepared abbreviated evidence tables that summarized their content.

Because of the small number of studies identified that involved primary care clinicians, we pursued our planned strategy of using a combination of existing reviews and new searches in the dental literature to provide necessarily collateral evidence of effectiveness for 3 questions: studies relating to supplemental fluoride, applied fluoride, and counseling for caries-preventive behaviors. We identified recent systematic reviews that addressed the effectiveness of applied fluoride and counseling. The existing review on applied fluoride was updated by searching MEDLINE from the date of the most recent publication in the review.

We could not identify an appropriate review for the effectiveness of prescribed supplemental fluoride for caries prevention in primary teeth, regardless of who made the prescription. Although reviews on the topic were numerous, none included the collection of studies that we thought pertinent to the key question. Therefore, we performed a modified systematic review for this question wherein we identified all possible studies by searching for and examining reviews of the topic and then searching forward from the most recent review. We included controlled prospective studies in English in which the intervention began before 5 years of age and outcomes were assessed for primary teeth and/or permanent teeth. We accepted the absence of baseline caries prevalence data when initiation of supplementation occurred before eruption of the primary teeth. The controlled, prospective study criterion excluded more than half of the English language studies traditionally cited in support of the effects of fluoride supplementation in primary teeth, which employed retrospective or cross-sectional designs with no assignment or baseline examination. We used a separate recent systematic review of fluorosis associated with fluoride supplements to assess the harms associated with their use, as most of the included studies did not address this outcome.[11]

# Results

## Accuracy of Screening

We identified 118 articles, reviewed 12 in detail, and included 2 in our review of reports involving accuracy of the visual examination in identifying untreated decay requiring referral to a dentist (key question 1a).[12,13] Both compared the performance of single primary care clinician visual screeners, a nurse and a pediatrician, with that of a dentist after 5 and 4 hours of training, respectively. Sensitivities were 100% and 92% and specificities were 87% and 99% for the pediatrician (20% prevalence) and nurse (35% prevalence), respectively. We found no studies that examined accuracy by the primary care clinician in identifying children who displayed 1 or more risk indicators other than caries lesions (key question 1b), with the exception of the

studies summarized for key question 3, which examine the appropriateness of decisions by primary care clinicians about fluoride supplements.

## Referral to a Dentist

We identified 102 articles, reviewed 12 in detail, and included a single case study that reported on the effectiveness of referrals by the primary care clinician (key question 2).[14] The study examined the effectiveness of referrals to dentists made by health professional assistants for the Women, Infants and Children (WIC) Supplemental Food Program for eligible children aged 6 months to 5 years. Among 309 children, those who were referred on the basis of non-normal findings during intraoral screening examinations ($n$=89) were almost twice as likely to have made a dental visit in their lifetime (37%) than children who were not referred (19%). The study did not control for time elapsed since the referral had been made. The difference in the visit rates was not significant when controlled in a multivariate analysis for child age, maternal age, household size, presence of dental insurance, and mother's perception of the child's dental needs.

## Fluoride Supplementation

We identified 12 studies that addressed the appropriateness of the prescription of supplemental fluoride by primary care clinicians (key question 3a). Of these, 10 surveys[15–24] were of physicians' knowledge and behavior about fluoride supplementation (Table 1). These studies offer only indirect evidence about the appropriateness of fluoride supplementation in young children because they constitute self-reported physician data and do not assess prescribing behaviors for individual children. Although survey items are too dissimilar and the results too heterogeneous to permit quantitative synthesis, individual questions indicated that physicians were not perfectly informed about community and/or individual fluoridation status, which could have led to inappropriate supplementation decisions. In 2 studies,[16,18] only 69% and 74% of pediatricians and 26% and 58% of family practitioners reported

knowing the fluoridation status of their practice areas. Only small proportions of physicians ever reported using water sample analyses to determine fluoride levels for individual water supplies,[19,20,22,23] and in 1 study, 15% of family physicians and 9% of pediatricians indicated making no inquiries about fluoridation status before prescribing fluoride supplements.[20] In another study,[21] 56% and 71% of physicians practicing in large and smaller cities with fluoridated water, respectively, reported prescribing supplements, signaling possible inappropriate supplementation. These studies did not address the attention paid to other possible fluoride exposures (eg, fluoride dentifrice, alternative drinking sources, or special foods). Two patient-based assessments of management of fluoride supplementation have been reported.[25,26] Twenty family medicine residents appropriately managed about 60% of their patients before and after an education intervention. In a separate study, 88% of children visiting a single family health center were managed appropriately immediately following the institution of a new protocol. The pre-protocol level of appropriate management was estimated to have been no more than 25%. Primary care providers included in the study were 2 family physicians, 1 physician assistant, and an unknown number of medical students.

We found no eligible studies of the effectiveness of the primary care clinician in terms of the level of parental adherence with the daily dosage regimen (key question 3b). Table 2 summarizes 6 clinical trials[27–33] of the effectiveness of fluoride supplements in preventing dental caries in primary teeth when the supplementation was initiated before 5 years of age (key question 3c).[24–29] These studies represent a variety of designs in terms of age at first use of fluoride, dosage, background fluoride level, duration of the trial, and assignment method. Across these differences, use of supplements was consistently associated with reductions in both the number of teeth with caries and tooth surfaces with caries lesions. The ranges of percentage reductions were 32% to 72% for primary teeth and 38% to 81% for primary tooth surfaces.

| | | | | | |
|---|---|---|---|---|---|
| **Table 1. Abbreviated Evidence Table of Physicians' Knowledge and Behaviors Regarding Fluoride Supplementation** | | | | | |
| **Study, year** | **Response rate %, (*n*)** | **Venue, % optimal fluoride** | **Physician type** | **Prescribe fluoride to any patients, %** | **Know fluoride level, status, %** | **Mean % of appropriate responses, *n* items** |
| Margolis, 1980[15] | 49% (1,286) | National, varies | Pediatrician | 81 | 96* | 79, 3 |
| | | | Family physician | 63 | 74* | 68, 3 |
| Siegel, 1982[16] | 56% (238) | Houston, sub-optimal | Pediatrician | 48† | 69‡ | 75, 1 |
| | | | Family physician | 18† | 26‡ | 42, 1 |
| Gift, 1984[17] | 50% (933) | National, varies | All active in child care | 80 | — | 78, 6 |
| Rigilano, 1985[18] | 47% (237) | Air Force, varies | Pediatrician | — | 74‡ | 87, 4 |
| | | | Family physician and obstetrician | — | 58‡ | 64, 4 |
| Levy, 1987[19] | 77% (37) | Acad HC, unknown | Family physician (faculty, resident, affiliated) | ~80 | 67§ | — — |
| Kuthy, 1987[20] | 60% (1,332) | Ohio, varies | Pediatrician | 86 | 91 | — — |
| | | | Family physician | 73 | 83 | — — |
| Margolis, 1987[21] | 45% (1,269) | National, varies | Pediatrician | 90 | 97* | 91, 3 |
| | | | Family physician | 76 | 86* | 91, 3 |
| Dillenberg, 1992[22] | 31% (280) | Arizona, suboptimal | Pediatrician | 70 | NA | 53, 4 |
| | | | Other | 47 | NA | 53||, 4|| |
| Jones, 1992[23] | 62% (95) | Houston, suboptimal | Pediatrician | 97 | NA | 79, 2 |
| Roberts, 1998[24] | 95% (40) | Acad HC, unknown | Pediatrician | 93 | NA | 79, 2 |

* Percentage of patients with municipally fluoridated water.

† Prescribe routinely.

‡ Fluoride concentration of water in practice area.

§ Approximate percentage of patients with fluoridated water.

|| Mean for all appropriate responses, varies by other respondent type.

Acad HC = academic health center; NA = not available.

## Fluoride Supplements and Enamel Fluorosis

Use of dietary fluoride supplements is a risk factor for enamel fluorosis. A recent systematic review[11] examined the risk for fluorosis associated with the regular use of fluoride supplements by children aged from birth to 6 years who resided in nonfluoridated communities. Meta-analyses of results for 10 cross-sectional studies using 3 different approaches (Mantel-Haenszel, generalized variance, and DerSimonian-Laird) gave summary odds ratios of 2.6, 2.6, and 2.4 (widest 95% confidence interval [CI], 1.7–4.1). For 4 follow-up studies in which supplement use had been recorded earlier and outcomes were determined by way of subsequent clinical examinations, the 3 meta-analytic approaches yielded odds ratios of 12.2 (95% CI, 4.9–30.4), 5.6 (95% CI, 3.4–9.4), and 5.5 (95% CI, 2.7–11.4). In general, the dosage(s) used in these studies exceeded current recommendations by a factor ranging from 2 to 4, depending on age.

The prevalence of fluorosis has increased during the past 50 years.[34] The only national survey of fluorosis in the United States[35] found a prevalence of 23.5% for permanent teeth in 18,755 children aged 5 to 17 years (13.5% in children attending schools with <0.3 parts per million [ppm] fluoride [F]; 21.7% with 0.3–0.7 ppm F; 29.9% with 0.7–1.2 ppm F). Almost all cases were of the very mild form, which is most frequently expressed as chalk-like lacy markings on less than one-fourth of the enamel surface of a tooth. The prevalence of cases in children considered to be of some aesthetic consequence by dental professionals or the public,[36] ie, mild or worse according to Dean's fluorosis index, is between 3% and 7%.[37] For this threshold, at which fluorosis seems to become aesthetically objectionable to the public, between one-fourth and one-half of the enamel surface of a tooth appears opaquely white in contrast to the normal glossy white appearance. Pendrys[38] estimated that nearly two-thirds of the cases of mild-to-moderate enamel fluorosis (as defined by the Fluorosis Risk Index), observed in several non-fluoridated Massachusetts and Connecticut communities, were attributable to the use of supplements with the pre-1994 dosage schedule. The other one-third of cases were attributed to the early use of fluoride toothpaste. Inappropriate use of supplements could explain as many as 13% of cases in fluoridated communities.

## Professional Fluoride Application

We identified no studies addressing the appropriateness of the use of topical fluoride agents by primary care clinicians (key question 4a) or the effectiveness of the primary care clinician in obtaining parental agreement for office visit application of topical fluoride (key question 4b). Fluoride varnish use by primary care clinicians is best characterized as being in the early stage of adoption, and no outcome evaluations have appeared.

Table 3 summarizes 6 clinical trials[39–44] of the effectiveness of fluoride varnish in preventing dental caries in primary teeth (key question 4c). Fluoride gel applications are not used for very young children because of problems with children swallowing the gel. The 6 trials tested 2 fluoride varnish products, 2.26% F (Duraphat®) and 0.1% F (Fluor Protector®) compared with negative (untreated) controls, all in general populations undifferentiated by caries risk. Three of the trials randomly assigned treatment to groups. Four trials, including all 3 RCTs, found statistically significant reductions in the number of tooth surfaces with cavitated lesions in the treatment groups. Percentage reductions ranged from 30% to 63.2% in these 4 studies; the actual reduction in affected surfaces ranged from 0.23 to 1.24 per year. Results related to the increments of noncavitated lesions (incipient lesions) were mixed, with large reductions in 1 trial, and nonsignificant increases in 2 experimental arms of another trial in which participants consumed special diets.

No studies have been published on the risk for enamel fluorosis from the use of fluoride varnish.[35] In a typical varnish application (0.3 to 0.5 millileters), the amount of fluoride varies from 0.3 milligrams to 11.3 milligrams.[45] Because only a small amount of varnish is applied, the total amount of active agent administered to the patient is markedly reduced compared with other topical fluoride application methods. The plasma fluoride peak after Duraphat® application is only about one-seventh of the peak after application of 1.23% acidulated phosphate fluoride (APF) gel.[47,48]

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| **Table 2. Abbreviated Evidence Table of Effects of Fluoride Supplements on Primary Teeth** | | | | | |
| **Study, year** | **Site and background F level** | **Age at baseline, (n)** | **Experimental intervention** | **Control intervention** | **Assignment method** |
| Hamberg, 1971[27] | Sweden, ~0.2 ppm | 2–3 wk (705) | 0.5 mg F&V drops | V drops | Not described |
| Hennon, 1972[28] | Indiana, <0.4 ppm, some with >exposure | 18–39 mo (815) | $E_1$: 1.0 mg F chews<br>$E_2$: 1.0 mg F&V chews | V chews | Unclear, "assigned according to sex and defs" |
| Margolis, 1967[29], 1975[30] | Michigan and New York, non-fluoridated | 1–4 mo (297)‡ | 0–3 y: 0.5 mg F&V drops<br>3 + y: 1.0 mg F&V chews | 0–3 y: V drops<br>3+ y: V chews | Not described |
| Hennon, 1977[31] | Indiana, 0.6–0.8 ppm | 1–14 mo (456) | 0–3 y: 0.5 mg F&V drops<br>3 + y:<br>$E_1$: 1.0 mg F&V chews<br>$E_2$: 0.5 mg F&V chews | 0–3 y: V drops<br>3+ y: V chews | "Systematic allocation after stratification by sex and age" |
| Hu, 1998[32] | China, <0.3 ppm | 2 y (324) | 2 y: 0.25 mg F drops<br>3 + y: 0.5 F drops | None | Children grouped by school, school assignment not described |
| Lin, 2000[33] | Taiwan, <0.1 ppm | 22–26‖ mo (140) | $E_1$: 0.25 mg F drops<br>$E_2$: 0.25 mg F chews | None | Random, method of randomization not described |

† No statistical testing reported

‡ Data from 2 parallel studies combined

§ 2 year increment (age 4–6 y only)

‖ Children with cleft lip/palate

*different from control at $P < 0.05$.

**different from control at $P < 0.01$.

***different from control at $P < 0.005$.

****different from control at $P < 0.001$.

Chews = chewable tablets; defs = decayed, extracted, and filled primary tooth surfaces; dmfs = decayed, missing, and filled primary surfaces; dmft = decayed, missing, and filled primary teeth; F = fluoride; NNT = number needed to treat (to prevent 1 dmft/dmfs) (NNT not reported if reductions were not significant); ppm = parts per million; V = vitamin.

| | | | % Reduction | | NNT | |
|---|---|---|---|---|---|---|
| **Population description** | **Blinding** | **% Drop out** | **dmft** | **dmfs** | **dmft** | **dmfs** |
| Visitors to well-baby clinics | Parents and examiner | Not reported | 48† | | | |
| Infants in pediatric offices | Parents and examiner | 65 | 69**** 56**** | 65**** 62**** | 0.6 0.8 | 0.4 0.5 |
| Infants in pediatric offices | Parents and examiner | Not reported | 68***‡,§ | | 1.3 | |
| Infants in 8 towns with in-range F levels | Parents and examiner | 71 | 42* 32* | 47* 38* | 2.0 2.6 | 1.2 1.5 |
| Kindergarten students | Not reported | 26 | 54* | 51* | 1.4 | 0.9 |
| Patients at cleft‖ clinic | Examiners | 18 | 52** 72**** | 51 81*** | 0.9 0.7 | 0.3 |

Table caption (top of table): **Table 2. Abbreviated Evidence Table of Effects of Fluoride Supplements on Primary Teeth (cont)**

## Counseling for Caries Prevention Behaviors

We identified 140 articles on the effectiveness of physician counseling for adoption of caries preventive behaviors (key question 5a), reviewed 20 in detail, and included 1 in this review. That study[49] examined the effectiveness of primary care clinician on early parental counseling (infants aged 6 to 12 months) for 2 behaviors, bottle use and tooth brushing. A quasi-experimental design compared a brief oral health promotional message provided individually by nurses in mother and child health centers with negative controls. Before and after behavioral data were self-reported. The intervention was essentially ineffective with respect to bottle use and minimally effective with respect to tooth brushing.

We found no studies assessing the effectiveness of a primary care clinician-supplied counseling intervention in preventing dental caries (key question 5b). From the dental literature, we examined 4 published systematic reviews of the effectiveness of oral heath promotion and dental

| Table 3. Abbreviated Evidence Table of Effects of Fluoride Varnish on Primary Teeth | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Study, year** | **Country** | **Design** | **Age at baseline** | **Fluoride interventions** | **Other F exposure** |
| Holm, 1979[39] | Sweden | RCT, 2 y, alternate assignment | 3.0 | 2.2% F Duraphat® 2/y | 71% F dentifrice, 27% F tabs |
| Grodzka, 1982[40] | Poland | Comparison schools, 2 y, assignment unclear | 3.5 | 2.2% F Duraphat® 2/y | "low" F exposure, no professional F application |
| Frostell, 1991[41] | Sweden | RCT, 2 y | 4.0 | 2.2% F Duraphat® w/wo invert sugar 2/y | "most" use F dentifrice, "occasional" use of F supplements and mouth rinse |
| Twetman, 1996[42] | Sweden | Comm trial, 2 y, public clinics matched on SES | 4.5 | 0.1% F Fluor Protector® 2/y | 0.1 ppm F in water, 95% on F dentifrice, "a few" given F supplements |
| Petersson, 1998[43] | Sweden | Comm trial, 2 y, public clinics matched on specified criteria | 4.5 | 0.1% F Fluor Protector® 2/y | 10% with 1.2 ppm in water, 90% use F dentifrice |
| Autio-Gold, 2001[44] | United States | RCT, 0.75 y | 3–5 | 2.2% F Duraphat® | 0.8 ppm F in water |

† Differences not significant unless otherwise noted

*Different from control at $P$ <0.05

**Different from control at $P$ <0.01

Comm = community; defs = decayed, extracted, and filled primary tooth surfaces; dfs = decayed, filled primary tooth surfaces; $dmfs_1$ = decayed, missing, and filled primary tooth surfaces, incipient lesions excluded; $dmfs_2$ = decayed, missing, and filled primary tooth surfaces, incipient lesions included; F = fluoride; NNT = number needed to treat; ppm = parts per million; RCT = randomized controlled trial; SES = socioeconomic status; w/wo = with or without.

health education.[50–53] The interventions in those reviews were conducted by either dental personnel or public health education specialists in institutional settings, and mostly for patients older than the age range included in this review.

Table 4 summarizes the findings of these reviews for participant or parental knowledge level, oral hygiene behaviors, and caries prevention. Search strategies and inclusion criteria differed across the reviews, but the results were generally similar. Interventions aimed at increasing knowledge of oral health topics were effective in the short term,

but they needed reinforcement over time. However, improvement in knowledge of oral health topics was not related to changes in oral health behavior.

Improving oral health behaviors, principally oral hygiene behaviors, could be accomplished by a variety of interventions, but personal one-on-one attention with active involvement was generally the most effective strategy. The effects of interventions designed to improve oral hygiene behaviors are seen only in short-term studies; the effects are lost over periods longer than 3 to 6 months without additional intervention. The evidence for effectiveness of oral

| | | | | % Reduction†, | |
|---|---|---|---|---|---|
| **Blinding** | **Attrition, %** | **Experimental** | **Control** | **index used** | **NNT** |
| Patients | 10 | 113 | 112 | 44**, defs | 1.2 |
| None | 20 | 100 | 148 | 5, $dmfs_1$ | |
| Examiners | Not reported | 26 (sucrose) | 37 | +31, $dmfs_2$ | |
| | | 18 (invert) | 33 | +50, $dmfs_2$ | |
| | | 113 (neither) | 93 | 30, $dmfs_2$ | |
| | | | | 37**, $dmfs_1$ | 1.5 |
| None | 2 | 374 | 442 | 30*, dfs | 4.3 |
| None | 19 | 1,916 | 2,245 | 6, dfs | NR |
| Patients | 22 | 83 | 59 | 63*, $dmfs_1$ | 0.8 |
| | | | | 67**, $dmfs_2$ | |

**Table 3. Abbreviated Evidence Table of Effects of Fluoride Varnish on Primary Teeth (cont)**

health education and promotion interventions on reducing dental caries is extremely limited; such interventions are associated almost entirely with adoption of the use of fluoride products. There is no conclusive evidence that interventions designed to improve oral hygiene result in caries reduction.

## Discussion

### Strength of the Evidence

The strength of the evidence addressing the first 2 key questions is poor. Two case studies found that single primary care clinicians identified caries lesions with an accuracy approaching that of dentists after 4 to 5 hours of training. The studies were consistent, but there are substantial questions about their external validity because each study involved only a single experimental subject. No evidence is available to document the accuracy with which primary care clinicians can identify children at elevated risk for dental caries. We identified only 1 study assessing the effectiveness of referral for dental care by the primary care clinician, reporting that referral by the primary care clinician is at best only partially effective. The virtual absence of evidence means that interventions relying on ability to detect dental caries and its risk indicators by primary care clinicians will necessarily not be evidence-based.

The strength of the evidence assessing the appropriateness of the prescription of supplemental fluoride by the primary care clinician is fair, principally because of its consistency. However, these studies are primarily self-reported, have relatively low response rates, were conducted chiefly in the 1980s (when dosing recommendations were different from what they are now), and addressed general behaviors

| Table 4. Summary of Systematic Reviews of the Effectiveness of Oral Health Promotion and Education | | | |
|---|---|---|---|
| **Review** | **Knowledge level** | **Oral hygiene behaviors** | **Caries prevention** |
| Brown, 1994[50] OHP and OHE, 57 studies | Most interventions are effective in increasing knowledge in the short term, little evidence for longer-term effects. (3 studies) | One-on-one instruction, repeated contact, and participant involvement lead to short-term improvement, but no longer-term effects. (13 studies) | Reduction in caries if target was use of fluoride-containing product. (3 studies) |
| Kay, 1996[51] OHE, 37 studies | Knowledge levels are consistently raised by interventions; more effective interventions tended to be more expensive. (14 studies) | Plaque removal programs are generally effective in short term, but no long-term benefits. (15 studies) | No evidence that dental health education interventions affect caries levels. (4 studies) |
| Sprod, 1996[52] OHP, 70 studies | Knowledge can be easily improved using many approaches, but may fade, may need reinforcement. Has limited effect on behavior change when used alone. (NR) | Behavior change is effected by active involvement, repetition, and continued support. Most effective methods address social, personal, environmental, and technical factors. (NR) | Very few studies, little evidence of long-term gain. (NR) |
| Kay, 1998[53] OHP, 164 studies | Knowledge levels are invariably altered by interventions, but alterations not related to changes in behavior or health. (NR) | Simple instruction alters behavior in short term, reducing plaque levels; no lasting effect. (20 RCTs) | Meta-analysis indicates 1.8 surface reduction associated with interventions increasing use of fluorides. (7 RCTs) |

NR = number of studies not reported; OHP = oral health promotion; OHE = oral health education; RCT = randomized controlled trials.

and knowledge more than specific patient-based decisions. Thus, most studies have problems of both internal and external validity. The results suggest that physicians' decisions may not always be made with full knowledge of a child's other fluoride exposures.

The strength of the evidence about the effectiveness of fluoride supplementation is fair, again chiefly because of its consistency. The available clinical trials are generally of fair-to-poor quality and typically used convenience samples without random assignment. The assignment method could

not be determined in 4 studies. None of the studies used an intent-to-treat analysis; in most studies, subjects were excluded from the analyses for nonadherence. Dropout rates, when noted, were high: up to two-thirds of the original samples were lost to follow-up, and measurement reliability generally was not assessed. External validity is also an issue, with 4 studies completed in the 1970s and the more recent trials performed in China and Taiwan; the latter trial was among children with cleft palates, whereby parental motivation may have been high because of societal norms and other

childcare requirements. The studies were consistent, indicating that among children who comply with the recommended schedules, dietary fluoride supplements are effective in preventing 30% to 80% of caries lesions in primary teeth, with numbers needed to treat (NNT) ranging from 0.6 to 2.6.

The strength of the evidence supporting the effectiveness of fluoride varnish in the prevention of dental caries in preschool-aged children is fair. No studies are available beginning at age 1 or 2 years (ie, the time that children at high risk for dental caries need to begin treatment), but results of available clinical trials were consistent. Six trials tested the caries-inhibiting effects of fluoride varnish when applied to primary teeth of children younger than 6 years of age (Table 3). The quality of these studies varies, but 3 used random assignment to treatment group, and sample loss to follow-up was generally small. Four studies, including all 3 RCTs, showed substantial caries-inhibiting effects. In 1 of the 2 studies with nonsignificant differences, Grodzka, et al,[40] used group assignment of children attending education centers and were unable to control adequately for potential group differences. In the other, Petersson, et al, studied Swedish clinic patients with low caries rates.[42] Here Fluor Protector® had no effect overall but did have statistically significant caries-inhibiting effects for children with high rates of decay on interproximal tooth surfaces, which presumably places these children in a high-risk category.

The strength of the evidence for the effectiveness of counseling provided by primary care clinicians for caries-preventive behaviors is poor. The single available study described an ineffective intervention. The systematic reviews of the literature about oral health promotion and dental health education suggest that knowledge improvement is easily achieved but that behavioral change is more difficult; they also suggest that caries reduction is likely only if the behavioral change involves use of fluoride.

## Research Agenda

The evidence base for recommendations to physicians concerning dental caries prevention in young children needs to be strengthened. A key

issue that underlies many of the possible preventive initiatives available to physicians and other primary care clinicians is whether they can accurately assess risk for dental caries. Elements of this issue include the predictive validity of current risk indicators and physicians' application of these indicators. Not all of the risk indicators currently advocated for use have been validated individually in prospective studies, and the relative strength of combinations of these indicators is entirely untested. Thus, echoing the recommendation of the recent NIH Consensus Development Conference on Diagnosis and Management of Dental Caries Throughout Life,[54] "more and higher-quality comprehensive longitudinal multifactor studies of implicated risk indicators are needed to obtain firm support for their associations with caries incidence to clarify the strengths of these associations in differing populations, and to reveal the extent to which the indicators provide independent, as opposed to redundant, information" (pp. 10–11). In addition, assessments of the accuracy of physicians' use of these risk indicators in identifying young children at elevated risk for dental caries are needed.

Several other issues also merit additional examination. One is the effectiveness of primary care clinician application of fluoride varnish for delaying the initial onset and reducing the incidence and increment of dental caries in young children. The existing studies constitute only fair evidence, represent efficacy studies, and were all performed by dental personnel. One or more effectiveness studies performed under field conditions by primary care clinicians would strengthen the evidence base for this incompletely evaluated approach to prevention. Studies on parental acceptance of this procedure are completely lacking.

The effectiveness and adverse outcomes of the current dosing schedule for supplemental fluoride could be better understood with additional studies. The recommended dose has been reduced twice in little more than a decade, and no studies of the effects of the most recently recommended regimen have been reported. Studies should examine preventive effectiveness, quantify risk for fluorosis by severity, and evaluate the public's perception of fluorosis outcomes.

Another issue for which further study is recommended is already the focus of increasing interest, and the results of ongoing studies might have substantial implications for counseling pregnant women and new mothers in the future. Efforts to block or delay the transmission of cariogenic bacteria from caregiver to child should be evaluated for both short- and long-term effectiveness. Even if the outcome of such efforts is simply to delay the appearance of lesions among the most susceptible, such delay would increase the likelihood of a child's exposure to other preventive interventions before the time when the development of a child's first lesion could be expected, which presumably could have an effect on reducing caries incidence.

Obviously, the effectiveness of counseling by the primary care clinician for behaviors to promote oral health and to prevent dental caries needs to be examined. Given the little that is known about the effectiveness of such counseling, attention should be devoted to developing approaches to increase current levels of effectiveness, rather than simply documenting these levels. It is evident that much of the arsenal of preventive interventions available to primary care clinicians depends on parental compliance with counseled behaviors, and methods to increase compliance need to be explored.

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