



Rethinking Prevention

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Abstract

The purpose of this paper was to present information that underscores: (1) the need for understanding the fundamental nature of dental caries; and (2) efforts to minimize its consequences in light of available scientific evidence, recent population trends, and persistent pressures to extend improvements in oral health to all children in the most cost-effective manner. The primary emphasis was placed on the importance of appreciating caries as a common, complex, chronic disease whose deleterious effects can be mitigated best with ongoing use of appropriate, risk-based protective measures. Additional attention was given to current and emerging challenges along with considerations for aligning oral health promotion and delivery system capacity with children's oral health care needs. (*Pediatr Dent* 2006;28:96-101)

KEYWORDS: DENTAL CARIES, PREVENTION, CHILDREN, DISPARITIES

Dental caries (tooth decay) is a prevalent, age-old affliction that has been researched extensively. The underlying nature of the disease, however, and the steps necessary to avert its deleterious consequences continue to be poorly understood by large segments of the public, health professionals, health officials, and policy makers. Misperceptions and confusion about the underlying causes of caries and the anti-caries effects—or lack thereof—of common “oral hygiene” practices such as flossing or “dry toothbrushing” (ie, brushing without fluoride toothpaste or other therapeutic agents) abound. Similarly, the impact of dietary practices and various systemic health conditions on caries (and vice versa) are underappreciated or poorly understood. Establishing a broad, evidence-based understanding of the nature of caries and the methods which have been shown to be effective in averting or minimizing its deleterious consequences is essential for promoting healthy behaviors and creating effective, efficient systems to deliver oral health services.

Numerous publications, including the Surgeon General's Report on Oral Health,¹ have highlighted declines in the overall levels of dental caries in US children over the past several decades. These overall declines and the concomitant improvements in children's oral health generally have been attributed to the application of multiple “preventive” measures. These include, but are limited to, increased exposure to and use of various types of fluoride, dental sealants, and efforts to educate the public about steps that individuals can take to enhance oral health.

Unfortunately, studies of the relative effects of particular anti-caries measures within the context of different constellations of prevailing caries-promoting or caries-inhibiting factors, or of changes in the impact of various measures over time, are generally lacking. The lack of such evidence has undoubtedly contributed to differences of opinion concerning the predominant factors responsible for reported caries reductions. Clinicians tend to emphasize the importance of regular periodic dental visits that include clinical preventive services, while public health advocates point to factors such as increased water fluoridation, community interventions, and use of fluoride toothpaste.

Differences in the way terms are used (or misused) also contribute to differences of opinion, confusion, and misunderstandings about the meaning of “prevention” when applied to dental caries. Examples of misuse include statements about preventive services (eg, dental sealants or fluoride applications) being “equivalent to immunizations,” implying that limited exposure to preventive dental services can convey long-standing protection via biologically sustained mechanisms. Misunderstandings stem from such misuses or common interpretation of the term “prevention” to mean completely stopping or averting something from happening—in this case, the caries process or its adverse consequences.²

The purpose of highlighting this state of affairs is not to challenge the observation that the collective oral health of children in the United States (and many other nations) has improved considerably over the past several decades. Nevertheless, it bears noting that, despite the overall trends, recent evidence indicates that significant disparities in childhood caries and oral health persist, and that caries levels in preschool-age children are no longer declining and have increased somewhat in low-income preschoolers.^{3,4}

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Rather, the purpose of this paper was to underscore the need for understanding dental caries and efforts to minimize its consequences in light of available scientific evidence, recent population trends, and persistent pressures to extend improvements in oral health to all children in the most cost-effective manner. Primary emphasis was placed on the importance of appreciating caries as a common, complex, chronic disease whose deleterious effects can be mitigated best with ongoing use of appropriate, risk-based protective measures. The paper concludes by identifying current and emerging challenges along with key strategies for achieving the ultimate goal of optimizing oral health for all children.

Appreciating dental caries as a common, complex, chronic disease

Caries: a common disease

In spite of overall improvements in children's oral health, dental caries remains the most prevalent chronic disease of childhood, 5 times more prevalent than other common childhood diseases such as asthma (59% vs 11%).^{1,4} Numerous observations have been compiled and cited of late to underscore this point. Examples from recent national surveys⁴ include the following:

- 41% of US children 2 to 11 years old exhibit clinically detectable signs of caries in their primary teeth (55% of 2- to 11-year-olds living in poverty and 55% of 2- to 11-year-old Mexican American children, regardless of household income);
- Nearly 70% of US children in late adolescence (ages 16 to 19) exhibit clinically detectable signs of caries experience.

These statistics—as impressive as they are—serve as indicators of relatively late-stage consequences of the caries process (ie, cavities). Thus, they do not fully reflect the extent of the underlying disease (which can exist in subclinical states, not readily detectable with technologies commonly used in epidemiological surveys).

Caries: a complex disease

The following excerpt from a synopsis by a distinguished caries researcher⁵ concerning the current understanding of caries underscores the importance of considering the complex nature of this disease:

By appreciating that dental caries belongs to the group of common diseases considered as “complex” or “multifactorial” such as cancer, heart diseases, diabetes, and certain psychiatric illnesses, we have to realize that there is no simple causation pathway. It is not a simplistic problem such as “elimination of one type of microorganism,” or a matter of improving “tooth resistance.” Complex diseases cannot be ascribed to mutations in a single gene or to a single environmental factor. Rather they arise from the concerted action of many genes, environmental factors, and risk-conferring behaviors.

Statements such as this do not undermine the potential utility of considering caries as an infectious, transmissible disease. Rather they underscore the importance of recognizing that no single modality, such as fluoride or sealants, or alteration of the composition of bacteria in dental plaque should be expected to completely eliminate caries as a disease. Indeed, as Fejerskov notes, developing effective strategies for diagnosing and mitigating the effects of caries remains one of the greatest challenges facing researchers (and, one might add, clinicians).⁵ The caries-balance model developed by Featherstone is a useful adjunct for understanding the nature of the interactions among numerous protective factors and caries-risk factors.⁶ Other researchers have constructed interactive models that demonstrate the differential impact of various risk and protective factors within a dynamic, multifactorial framework.⁷ Caution should be used, however, in extrapolating the quantitative aspects of this model to populations beyond those on which the model is based.

Caries: a chronic disease

Epidemiological data clearly demonstrate that caries is a chronic disease. The proportion of the population with clinically demonstrable evidence of caries is significant, even in early childhood, and increases with age. These observations are consistent with the concept of ongoing, dynamic interactions among varying levels of multiple risk factors and protective factors (ie, the caries balance) throughout the course of individuals' life spans. Data from recent national surveys of children's oral health are illustrative. These surveys indicate that the proportion of children with clinical evidence of caries in their permanent teeth increases from approximately 20% for 6- to 11-year-olds to 50% for 12- to 15-year-olds and to nearly 70% for 16- to 19-year olds.⁴ The pattern of progression is similar for primary teeth, albeit within a younger age range.

Additional excerpts from the synopsis by Fejerskov⁵ again help underscore the significance of the chronic nature of caries when considering strategies for mitigating the adverse effects of caries over the course of a lifetime:

It is important to appreciate that the caries incidence rate in a group of individuals appears fairly constant throughout life if no special efforts to control lesion progression are made. These new paradigms help to explain the nature of lesion initiation and progression and, accordingly, why dental caries cannot truly be “prevented,” but rather “controlled” by a multitude of interventions. . . . At the individual patient level, we have successfully “controlled” the physiologic balance of the intraoral environment with topical fluorides, dietary monitoring, “plaque control,” etc, but the well-trained clinician knows that some patients require much more and “closer” monitoring than others to avoid new lesions. The consequence of the paradigms is to appreciate that the risk of developing new lesions is never 0.

Summary and implications

In summary, Fejerskov, Featherstone, and other experts in the field of cariology have eloquently specified that dental caries is a common, complex, chronic disease that results from an imbalance between multiple potential etiological (risk) factors and multiple protective factors over time. Ultimately, this disease process can cause loss of tooth structure through demineralization or frank cavitations (cavities).^{5,6}

Accordingly, declines in the incidence and severity of the clinical manifestations of dental caries in the pediatric population as a whole suggest a more favorable aggregate balance between protective factors and risk factors over time. These overall declines, however, mask significant disparities in caries levels among subgroups of children within the population. At a more fundamental level, individuals remain at varying levels of risk for caries development and progression over the course of their lifetimes. Accordingly, different protective factors—including those generally referred to as “preventive” measures—can have varying temporary effects on impeding the development or progression of caries at different points over the course of a person’s life (depending on the current balance of risk and other protective factors).

It is important to regard dental caries as a common, complex, chronic disease instead of focusing on cavities (the relatively late-stage consequence of this disease). Those who fail to understand the fundamental nature of caries and appreciate the distinction between caries and cavities are prone to declare that growing percentages of children are “caries free” (when the data indicate that they are “cavity free”). Many also infer that reductions in the incidence of cavities in children at various ages are the result of the elimination of underlying risk factors, rather than evidence of an enhanced balance between risk factors and protective factors at various points in time. These differences have significant practical implications for the design and implementation of strategies, policies, and systems for optimizing pediatric oral health that are beyond the scope of this paper, but are addressed in other publications.^{8,9}

Challenges to achieving optimal oral health for all children

Children raised in socially disadvantaged environments face the dual challenges of:

1. being at elevated risk for the development of dental caries (and other chronic diseases such as diabetes and obesity); and
2. having limited access to appropriate health care services.

Details of disparities in caries and access to oral health services have been documented in previous publications.^{3,10} The recent demographic trends highlighted next, however, provide an additional sense of the inherent challenge in extending optimal oral health to the emerging US pediatric population, especially those raised in disadvantaged households.

Increasing number of children in low-income/low socioeconomic status families

According to data published by the National Center for Children in Poverty^{11,12}:

- There were approximately 70 million children (birth to age 18) living in the United States in 2005.
- 38%—nearly 27 million children—live in low-income families (household income less than 200% of the FPL).
- 17%—nearly 11 million children—live in poor families (household income less than 100% of the FPL).
- The federal poverty level (FPL) in 2005 was \$19,350 for a family of 4; 200% of the FPL is \$38,700.
- The proportion of children living in low-income families has been on the increase since 2000.
- 50% of children in low-income families are headed by a single parent.
- Younger children are more likely to live in low-income families (43% for children under age 3 vs 33% for adolescents 13 to 17 years old).
- 26% of low-income children live with parents who have less than a high school education, and an additional 36% live with parents who have only a high school education.
- Children living in the South (10.7 million, or 43% of Southern children) and West (6.8 million, or 40% of Western children) are more likely to live in low-income families than children in the Northeast (4.0 million, 33%) or Midwest (5.2 million, 33%).

Increasing population diversity

America’s pediatric population is rapidly becoming more diverse. Moreover, many racial and ethnic minority children live in low-income households. Again, according to data provided by the National Center for Children in Poverty¹¹⁻¹³:

- 62% of Hispanic American children (8.2 million) and 60% of African American children (6.0 million) live in low-income families, compared to 28% of Asian American children (.8 million) and 26% of Caucasian children (10.9 million).
- 58% of children of immigrants and 65% of children of recent immigrants live in low-income households.
- 71% of children of low-income, recent immigrants live with married parents, compared to 42% of children of low-income, native-born parents.
- 45% of children of low-income, recent immigrants live with parents who do not hold a high school degree.
- 34% of children of low-income, recent immigrants are insured by Medicaid or the State Children’s Health Insurance Program (SCHIP), compared to 41% of children of low-income, native-born parents.
- Children of low-income, recent immigrants are unlikely to utilize public benefits, particularly in the South.
- 37% of children of recent immigrants live in the West, and 46% of children of recent immigrants who live in the West do not have a parent who holds a high school degree.

Combined with the aforementioned data highlighting elevated levels of disease and risk in low-income children and children from racial and ethnic minority households, these observations underscore the magnitude of the challenge of providing optimal oral health for all US children. Moreover, they emphasize the importance of:

1. broad efforts to promote pediatric oral health starting at an early age;
2. delivery systems capable of providing robust access to appropriate services across diverse settings; and
3. sound public and professional policies to delineate the parameters of effective oral health care for children and judicious use of resources.

Aligning oral health promotion and delivery system capacity with children's oral health care needs

At a fundamental level, the keys to good pediatric oral health generally involve 3 basic elements:

1. sound nutrition and dietary practices;
2. regular "self-care" routines (daily brushing with fluoride toothpaste arguably being foremost); and
3. a regular, ongoing source of appropriate diagnostic, preventive, and treatment services (increasingly referred to as the "dental home").¹⁴⁻¹⁶

The first 2 elements require motivation and basic knowledge that can be acquired through encounters with the dental care delivery system as well as from numerous other sources. Unfortunately, many parents and caregivers do not receive sound information about how to care for their children's teeth until after caries has manifested, or are confused by conflicting recommendations (many of which are unfounded) from a variety of health care providers, family members, and acquaintances. The majority of diagnostic, preventive, and dental treatment services for children in the United States are provided in private practices. Many disadvantaged children who lack adequate access to basic dental care, however, obtain various types of services in a variety of alternative "safety net" settings.

Preventive services have been a major component of dental care delivery for US children for nearly 4 decades. Prior to that time, the primary focus of dentistry for children was on restoring cavities, which are the late-stage consequences of the caries process. The "prevention" era of pediatric dental practice began in earnest following development and testing of concentrated topical fluorides that could be applied at convenient intervals and efforts to promote greater use of fluoride toothpaste. Recommendations for semi-annual "check-ups" and fluoride applications became the norm with very little scientific rationale. These recommendations have been reinforced by practicing dentists and various media sources for over 40 years, and applied in a fairly uniform manner in clinical settings ("one-size-fits-all prevention").

Recognition of epidemiological trends in pediatric dental caries, however, whereby caries is no longer uniformly manifested in the population, has prompted the revision

of professional recommendations and the introduction of risk-based guidelines for preventive dental services.^{3,17,18}

A number of tools for assessing caries risk in children, including the American Academy of Pediatric Dentistry's caries-risk assessment tool (CAT), have been developed of late.¹⁸ These tools vary somewhat in content and format. Nearly all, however, are predicated on attempts to identify various categories of risk factors (eg, behavioral, biological, clinical, environmental, or sociological risks) that predispose children to the development of caries. Such tools can be useful adjuncts for educating children, parents, caregivers, and health professionals about caries risks as well as actual caries risk assessment in clinical or public health practice. Additional testing is necessary, however, to demonstrate the utility and reliability of various tools in different population groups and settings. The testing and further development of practical, reliable CATs is essential to the implementation of risk-based strategies that undoubtedly are the key to achieving effective programs for dealing with caries as a common, complex, chronic disease and efficient use of resources. Publications illustrating how caries risk assessment can be applied to children with varying levels of risk and presenting oral health status can be found in the literature.^{8,20,21}

Summary and conclusions

The inspiration for the title of this paper—"Rethinking Prevention"—came from a recent publication in the pediatrics literature by Schor entitled "Rethinking Well-Child Care."²¹ In it, the author noted that:

Well-child care is a core service of pediatrics, but it receives little emphasis in pediatric training, reluctant consideration by insurers, and rare attention from researchers. Although it encompasses a variety of health-promoting and disease-preventing services, the desired outcomes of well-child care and quality standards for its provision have not been specified. It is not surprising, then, that preventive care services, as they are being provided currently, are not meeting the needs of many families, especially families with the most vulnerable children.

By and large, these statements apply to the current situation regarding the "prevention" of pediatric dental caries as well.

As noted throughout this article, failure to appreciate the nature of dental caries as a common, complex, chronic disease and the importance of differences in caries risk across individuals and over time has led to predominantly "one-size-fits-all" approaches for those who can access services on a regular basis and "something must be better than nothing, even if it's only once and a while" approaches for those who do not have access to a regular source of care. In light of the current understanding of the nature of dental caries, such approaches arguably are:

1. not rational;
2. based on weak or outdated evidence;
3. not representative of efficient use of resources; and
4. inconsistent with the goal of achieving optimal oral health for all children.

Overcoming the shortcomings of the present situation and implementing systematic reforms that apply current and emerging knowledge in new ways—while preserving current system strengths—is a formidable, yet achievable challenge. The observations and broad strategies in Table 1 are offered as a guide to those who seek to achieve these changes.

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Table 1. Observations and broad strategies to guide system improvements.

Observations:

The predominant oral health concern for children is dental caries (tooth decay).

Although the consequences of dental caries (ie, cavities) may take months or years to manifest, all children (and adults) are at varying levels of risk for caries throughout life.

The underlying causes of dental caries are present at a very early age and must be mitigated by a variety of protective factors—some of which occur naturally (eg, saliva) and some of which depend on daily behaviors or obtaining clinical services.

Low-income and minority children generally, though not always, are at higher risk.

For many moderate- or high-risk children, pediatric oral health care providers simply are not intervening early enough to create a more effective environment or balance between caries risk factors and protective factors.

Early detection and targeted interventions for dental caries lead to the best possible outcomes.

Pediatric oral health care providers need to do a better job of identifying high-risk children earlier and managing their caries risk over time.

In theory, pediatric oral health care providers know how to minimize the impact of dental caries (healthy diet, regular personal care activities—eg, daily brushing with fluoride toothpaste—and periodic professional oral health care). Too often, however, pediatric oral health care providers assume that poor families have “the basics” in terms of knowledge, skills, attitudes, and material resources to practice sound caries “prevention.”

Broad strategies:

Reduce the burden of disease through the efficient integration of:

- health promotion;
- preventive services;
- disease management;
- treatment services.

Expand access to ongoing diagnostic, preventive, and treatment services through “dental homes.”

Apply risk assessment and targeted interventions.

Align financing and reimbursement with evidence-based practice guidelines.

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Abstract of the Scientific Literature



Marginal Microleakage and Placement Technique for Composite Resins

As dental practices lean toward an amalgam-free environment, many problems—including postoperative sensitivity and recurrent caries due to microleakage—have become apparent. The ability of a composite restoration to minimize the extent of microleakage at the tooth/restoration interface is important in predicting clinical success. The purpose of this study was to evaluate microleakage of Class II cavities restored with 2 different types of composite resin: 1 a hybrid and 1 packable, differing in technique of restoration and margin placement.

In each of 100 bovine teeth, Class II cavity preparations were made on both the mesial and distal surfaces, with random choice determining placement of gingival margins (either on the dentin or enamel). This total of 200 preparations was divided into 8 equal groups, with restorations being placed in either bulk or incremental insertions and on dentin or enamel margins with 25 restorations in each category. After thermocycling and subjection to a methylene blue solution, the amount of dye penetration at the restoration margin was evaluated.

The results showed all groups having considerable evidence of microleakage. Within the same type of resin, however, the method of placement did not alter the levels of microleakage. For restorations below the cemento-enamel junction, or large in size, the incremental technique is preferred; for small cavity preparations, bulk placement is preferred. The hybrid composite performed significantly better than the packable resin, but the focus of this study was to compare 2 different placement techniques.

Comments: This paper states that microleakage at the proximal margin is, to date, an unavoidable occurrence. The results were clinically useful in determining what placement technique to use. Further (and future) studies could compare brands or types of resin-based composites to determine which is best suited for individual situations or patient types (eg, posterior vs anterior, pediatric vs adult). **GM**

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