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Caries Management by Risk Assessment: Consensus Statement, April 2002

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The following statement is the consensus of a meeting of a group of experts in dental caries, in particular the science and practice of caries prevention, risk assessment, and management, held at the California Dental Association, April 26-27, 2002. Twelve reviews were presented at the meeting, and the many references contained in those reviews form the basis for the following consensus document.[1-12] The reader is referred to these reviews for studies that support the following statements.

As a result of that meeting, this consensus summary statement is presented with practical risk assessment forms and instructions for use in caries management by risk assessment in clinical and community settings. Statements of special significance are in bold italics.

Basic Guiding Principles

The recommendations and guidelines produced by this conference are based on the best scientific information available at the time of the conference, April 2002. They are intended to be a work in progress subject to improvement and modification as new information becomes available. These recommendations and guidelines form the basis for practical caries intervention and prevention both by individuals and communities, and were crafted for use with children as well as with adults. By necessity, specific rules for special-needs groups are not addressed directly, and some modifications may be needed in those cases. Special-needs patients will be addressed at a separate conference, summarized by Glassman.[13]

The recommendations and guidelines that follow should be implemented as soon as possible for the improvement of oral health of children and adults in California.

The Need for Caries Risk Assessment, Caries Intervention, and Caries Management by Risk Assessment

Although dental decay significantly declined in the United States from the 1960s through the 1980s, it is still a major problem in adults and children. The dramatic reductions in levels of decay observed from 1960 to 1990 were undoubtedly related initially to the introduction of fluoride into the drinking water and subsequently to topical fluoride applications, especially through fluoridated dentifrice use and dental office topical fluoride.1,2 However, these tools are only successful up to a point, and we now must be thinking of more-aggressive ways to deal with dental caries as a bacterially based transmissible infection.1-3,12 To place this into perspective, a recently published survey on the dental health of California's children, from data that was accumulated in 1993 and 1994, reported that:

- 27 percent of preschool children have untreated decay;
- 55 percent of 6- through 8-year-olds have untreated decay;
- Up to 75 percent of minority high school students need dental care; and
- California's children on average have twice the national level of untreated tooth decay. Many millions of dollars are spent in California each year on the physical treatment of dental caries, rather than on prevention and intervention. Millions of hours are lost at school and work each year as a result of dental caries. There is a growing epidemic of early childhood caries in the United States, particularly in California.1,2,8

If we were dealing with any other disease in the human body, we would use measures to eradicate the cause of the disease, such as antibiotics for systemic infections, or introduce public health measures, such as immunization at the community level. We need to think of dental decay in this same fashion and treat the disease rather than just the results of the disease. There is enough information available to do this.

Overall Objectives of the Consensus Document

This document provides a summary of the components of successful caries risk assessment and the basis for minimally invasive caries management by risk assessment. The American Academy of Pediatric Dentistry is developing an outline instrument for caries risk assessment, but no one yet has truly addressed the infectious disease that is the basis of dental caries. The overall objective of this document is to provide the basis for a cross-disciplinary approach among medicine, dentistry, nursing, and other agencies that affect dental health to reduce or eradicate dental caries in children in every county, community, and culture in California by the year 2010.

The Caries Balance Concept as the Basis for Caries Risk Assessment and Management

Dental caries (dental decay) is a continual balance, or imbalance, between pathological factors and protective factors, as illustrated schematically in Figure 1.1

Pathological Factors

The pathological factors include:

A. The so-called cariogenic (acid-producing, caries-promoting) bacteria that produce acid by fermentation of carbohydrates. The two major groups of cariogenic bacteria involved are the mutans streptococci (S. mutans and S. sobrinus) and several of the lactobacillus species.1,6

B. The frequency of ingestion of fermentable carbohydrates, including sucrose, glucose, fructose, and cooked starch. Frequency of ingestion is the most important factor, rather than total quantity, since repeated ingestion leads to renewed acid production by the bacteria. In young children, the prolonged use of a bottle or a "sippy-cup" containing anything but water provides an almost continual acid challenge to the teeth as the oral bacteria are bathed in the carbohydrates. High-fructose corn syrup is the major sweetener in the United States.

C. Salivary dysfunction caused by factors such as medications, radiation therapy for cancer of the head and neck, some systemic diseases, or genetically induced conditions that result in reduction of salivary function. In young children, medications such as anti-asthma therapy may cause hyposalivation, which is a major risk factor. Pediatricians, parents, caregivers, and health care professionals must be aware of the importance of medication-induced saliva flow reduction as a risk factor.

Protective Factors

The protective factors include:

A. Almost all of the components of saliva, including buffers that neutralize the acids;

B. Saliva flow for clearance purposes;

C. Fluoride from topical (to the surface of the teeth) sources to provide inhibition of demineralization and enhancement of remineralization;

D. Antibacterial agents in saliva and/or from extrinsic sources or products;

E. Salivary proteins and lipids that form pellicle and protect the tooth surface; and

F. Calcium and phosphate derived either from the saliva or from the dietary sources, such as cheese.

At any one time, the direction of the caries balance can be tipped toward caries progression and demineralization of the tooth mineral or toward repair of the tooth mineral by remineralization as a result of one or more protective factors. The eventual outcome of either progression, reversal, or status quo determines whether an individual tooth surface becomes cavitated. This concept forms the basis for risk assessment and for caries management based upon risk assessment.

Bacterial Challenge

The bacteria that cause caries (cariogenic bacteria) are primarily from two groups, the mutans streptococci and the lactobacilli species. The two species in the mutans streptococci group that appear in humans are Streptococcus mutans and S. sobrinus. These acid-producing bacteria are necessary for the progression of dental caries. The cariogenic bacteria are transmitted from one individual to another and in particular from mother or caregiver to child in the early stages of childhood.6 Child-to-child and adult-to-adult transmission also occurs. Early transmission and growth of these pathogenic bacteria lead to more decay later, as compared to children who are colonized later.6 Placing restorative materials (fillings) in cavitated caries (holes in the teeth) or in early caries that are drilled out by the dentist restores the function of the tooth but does not significantly reduce the infection in the remainder of the mouth.

Sampling Bacteria in the Mouth

Levels of these cariogenic bacteria in the mouth can be assessed by selective media culturing either in a microbiological laboratory or in the dental office (see below). In the future, monoclonal antibody technology is expected to be available routinely for rapid in-office assessments of cariogenic bacterial levels. Saliva that is stimulated by chewing can be used as a sampling method to collect bacteria from the teeth and around the mouth and quantify them as colony forming units, except in very young children (about 3 years or younger). Levels of mutans streptococci of 105 cfu/ml and lactobacilli levels of 103 cfu/ml and above in stimulated saliva are considered high risk. The combination of the two groups of bacteria is particularly damaging.1

Combating the Bacterial Challenge

Antibacterials that are naturally in saliva -- such as lysozyme, lactoferrin and immunoglobulins -- help to keep the caries bacterial pathogens under control. However, manufactured antibacterials must be used in the case of high-caries-risk (caries-active) individuals, individuals with existing decay, and individuals with high levels of these pathogens in the mouth. In the United States, 0.12 percent chlorhexidine gluconate is available as a mouth rinse and is effective against the mutans streptococci, but not as effective against the lactobacilli.5 Iodine may also prove to be a useful alternative to chlorhexidine, as described in detail below.8 Future antibacterials that are more effective and easier to use will be of considerable added benefit.

A Paradigm Shift Is Needed

In summary, a paradigm shift that underlines the necessity of treating the bacteria as an essential component of dental caries management, rather than simply drilling and filling cavities, is the fundamental basis for the protocols laid out below.

Caries Risk Assessment Diagnostics

Diagnostics for Caregivers and Nondental Health Care Personnel

For young children, a caregiver or health practitioner simply lifting the lip to look for white spot lesions, stained fissures in the biting (occlusal) surfaces of the teeth, or gross cavities (holes) in the teeth is an excellent start. The first line of defense for young children can be the parent or caregiver.8,12 They can easily do this examination to ensure that caries is not starting or progressing. Nondental health care professionals can also readily use these techniques.

A questionnaire that addresses maternal dental history, number of people in the household, family dynamics, socioeconomic status, and frequency of ingestion of fermentable carbohydrates will also help.

For a quantitative measure of bacterial challenge, bacterial assessments and saliva flow testing must be used, as described below. Nondental health care professionals can administer these tests.

All of the above procedures can readily be carried out in a community setting by health professionals or their assistants.

Diagnostics for Dental Professions

Diagnostics for dental professionals include the same list as above for caregivers and nondental health care personnel.3,8,12 The dental professional will add tactile and visual inspection using instruments, such as the explorer. The disadvantage of the explorer is that it is difficult to differentiate between anatomical defects and incipient caries in the occlusal (biting) surfaces. X-rays (dental radiographs) are appropriate for interproximal lesions (on the abutting surfaces of the teeth) and advanced occlusal caries that are well into the dentin. In the case of an interproximal lesion, if the radiograph indicates that the lesion has not penetrated past the dentinoenamel junction, and the surface integrity has been maintained, then it can be reversed, or at least arrested, by remineralization and fluoride therapy. If caries levels are low, then remineralization may be enough to halt the decay. In the case of caries-active individuals (active cavities and/or high bacterial levels), antibacterial therapy will be needed in conjunction with the fluoride therapy.1

New optical imaging devices are becoming available that can assess hidden lesions, especially in occlusal surfaces. The Diagnodent device (KaVo, Ill.) is approved and marketed in the United States for this purpose. Quantitative light fluorescence and optical coherence tomography are experimental methods that are likely to become available to clinicians in a few years.

Antibacterial Therapeutics

Therapeutics that can be used by caregivers and other nonhealth care personnel include:

A. Xylitol, which is relatively new to the United States. It is a sweetener that looks and tastes like sucrose but is not fermented by cariogenic bacteria. Xylitol also inhibits attachment and transmission of the bacteria and can be delivered through chewing gum or lozenges as an effective anticaries therapeutic measure. Xylitol gum chewed by mothers during the first two years of their children's lives led to much lower levels of caries in the children later.11

B. Sodium bicarbonate (baking soda), which has antibacterial properties and neutralizes acids produced by bacterial metabolism. It can be delivered via toothpaste or in a solution in hyposalivatory cases.

C. Chlorhexidine gluconate, which is a broad-spectrum antibacterial that works by opening up the cell membrane of the bacteria. It is administered in the United States via prescription. In the United States, only 0.12 percent chlorhexidine gluconate is available as a mouthrinse, and it is effective against the mutans streptococci. Chlorhexidine is used as a mouthrinse, 10 ml once daily for a two- week period every two to three months.5 Recent data indicates that one week every month is similarly effective. In high-bacterial-challenge individuals, this therapy will need to be continued for approximately one year and monitored by bacterial assessment (see below). One of the problems with this compound is that it must be administered by the individual or home caregiver, it affects taste, and compliance is often poor.7

D. Iodine is an effective antibacterial. As described above, chlorhexidine is effective against mutans streptococci in the mouth but not lactobacilli. A potentially useful antibacterial is povidone iodine (sold as 10 percent povidone iodine, which is equivalent to 1 percent available iodine). It has been shown to reduce the incidence of early childhood caries in high-risk children when applied once every two months but has not been thoroughly proven.8 This therapy has the advantage that it can be applied in a dental office or by a health care provider simply by swabbing the teeth and is effective in reducing levels of lactobacilli as well as mutans streptococci.

E. New antibacterial compounds or antibacterial approaches are in development and are expected to be available soon.

Tools for Inhibition of Demineralization and Enhancement of Remineralization -- Fluoride Delivery Forms

The various delivery methods that provide fluoride to the surfaces of the teeth inhibit demineralization, enhance remineralization, and can also inhibit bacterial activity.1 Sources of fluoride for this purpose are those that can provide fluoride to the mouth (topical) and include drinking water; dentifrices (toothpastes and gels); over-the-counter fluoride rinses (0.05 percent sodium fluoride, such as Fluorigard or ACT); and professionally applied office topical varnishes, foams, gels, acidulated phosphate fluoride, and stannous fluoride. Prescription high-concentration fluoride gels and toothpaste (5,000 ppm fluoride, such as Prevident) are valuable for high-risk subjects for home use, especially in adults for root caries or high-caries-risk patients. High-concentration fluorides should be used with great care in children as they are readily ingested and increase the risk of fluorosis. They should not be used for children younger than 6. As with all therapeutics that are self-administered, compliance is a major problem. Patients must be persuaded as to the need to use these products. Persuasion that parental supervision is critical is a key part of successful therapy for children.

Biomaterials for Minimally Invasive Dentistry and Inhibition of Caries Progression

Biomaterials are now available for restoration of cavities with a minimum removal of sound tissue. This conservative approach protects as much as possible of the tooth's integrity so as to retain tooth function in the later years. Preventive resin restorations or small amalgam restorations are used for early lesions in occlusal surfaces. Restorations restore tooth function but do not fix the bacterial nature of the disease. Sealants are available for use to prevent caries in occlusal surfaces.4 Fluoride-containing restorative materials, including glass ionomer products, help prevent further decay at the site of placement.9,10

Interfering With Vertical Transmission of Cariogenic Bacteria -- Mother to Child

Delaying or preventing primary infection by mutans streptococci reduces the risk for future dental caries. Strategies aimed at reducing the risk of vertical (mother-to-child) transmission of cariogenic bacteria translate into improved oral health outcomes for children. All children are at risk for early colonization in the first two to three years of life. On this basis, it is recommended that pregnant women should have a dental exam and caries risk assessment during the second or third trimester of pregnancy. This exam should include radiographs only if lead shield precautions are utilized to protect the developing fetus. Prospective mothers who are found to be caries-active, either because they have frank cavities or through the risk assessment tools detailed below, should receive aggressive dental care shortly after delivery of their child. Therapy should eliminate all active caries lesions, provide dietary counseling and use topical antimicrobial agents (e.g., chlorhexidine rinses, self-applied fluoride gels) as described in the protocols below to reduce the cariogenic bacterial levels in the mother's mouth. Further, daily use of xylitol-containing chewing gum or mints by mothers during the first two years of the child's life has been shown to reduce the transmission of bacteria from mother to child and to markedly reduce the caries levels later in the child's life. This approach will reduce the maternal salivary levels and/or significantly alter the genotype/phenotype of cariogenic bacteria, thereby reducing the risk of early vertical transmission. Education of mothers about the transmissibility of caries-causing bacteria, how dental decay occurs, and how it can be prevented should be included both pre- and postnatally.

Caries Risk Assessment Protocol in Simple Steps

Caries risk assessment forms are provided as templates for use or modification. The one-page forms are designed for use with two age groups. The first is for babies and infants from 0 to 5 years of age. The second is for people age 6 years and older, including adults. Special-needs patients will require additional considerations.13 Following each of the forms is a one-page summary of instructions, which is designed to be printed on the back of the form. In practice, this allows for a one sheet, two-sided form. This is followed by a patient check sheet for recommendations for home caries intervention. The back of this form should display the one-page simplified description of the dental decay process aimed at the patient, parent, or caregiver.

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Caries risk assessment forms (PDF format)