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RESEARCH ARTICLE

Evidence-Based Dentistry Caries Risk Assessment and Disease Management

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Abstract

Dental caries is a multifactorial, dynamic disease process that results from a dysbiosis in the biofilm, driven by exposure to fermentable carbohydrates, which over time leads to demineralization of dental hard tissues. In spite of the significant reduction in caries prevalence in many parts of the world, dental caries remains a major public health problem affecting people of all ages. Furthermore, the disease is not equally distributed, with multiple population groups at increased risk. If allowed to progress, over time the disease will result in the development of detectable changes in the tooth structure, or caries lesions, which initially are noncavitated (i.e., macroscopically intact, sometimes referred to as "white spot" or "incipient" lesions), but that eventually might progress to cavitation. Modern caries management stresses a conservative and preventive evidencebased philosophy, with patient-centered risk-based disease management, early detection of caries lesions, and efforts to remineralize and/or arrest noncavitated lesions that aim to preserve tooth structure and maintain health. In support of this philosophy, numerous systems and guidelines have been developed. Furthermore, this caries management philosophy is the basis for current cardiology education frameworks worldwide.

Keywords: *Dentistry, Fluorides, Risk Assessment Disease, Risk Assessment Management.*

Introduction

Risk Assessment

Risk-based prevention and disease management have been recognized as the cornerstones of modern caries management [1]. The process of assigning a level of risk of caries involves determining the probability of incidence of caries during a certain time period. It also involves the probability that there will be a change in the severity and/or activity of caries lesions [2]. It is difficult to accurately identify at-risk patients, and the evidence on preventive measures for high-risk individuals is still scarce.

In fact, most studies on risk assessment have been conducted in children, and there is very little evidence from adults to help guide how to apply risk assessment models to older populations [3].However, most experts and organized dentistry organizations contend that when the well-being of the patient is considered, it is more important to carry out a risk assessment incorporating the best available evidence than just doing nothing due to lack of strong evidence.

As dental caries is unequally distributed in most populations around the world, including the United States, for most dentists it becomes imperative to be able to identify a patient's risk status to be able to develop the most cost-effective and clinically appropriate treatment strategy for that individual. Yet, a survey of clinical practices within a US Practice-Based Research Network suggests that a significant proportion of dentists had yet to adopt treatments based on assessment of caries risk.

Because of the multi-factorial nature of the caries process, and the fact that the disease is very dynamic, but not necessarily continuous (eg, lesions can progress and/or regress), risk assessment studies are complex, with a multitude of variables challenging the prediction at different times during life. Usually, demographic, social, behavioral, and biological variables, along with the clinical/radiographic examination and supplementary tests, are used to develop a caries risk profile or category (eg, low, moderate, or high caries risk) [4]. For a

clinician, the concepts of assessment of risk and prognosis are important parts of clinical decision-making. In fact, the dentist's overall subjective impression of the patient might have good predictive power for caries risk. Caries risk tools must be inexpensive and have a high level of accuracy to be cost effective, and they must be quick and require limited armamentarium to be acceptable. Existing data support the conclusion that caries risk can be assessed using only variables easily available from interviewing parents, for example, at periodic medical or dental examinations, without the need of additional clinical testing. In addition, "past caries experience" is one of the most powerful predictors of future caries development. However, for monitoring purposes, existing risk tools can be helpful as an objective record of risk included in the patient's chart.

A careful analysis including not only past caries experience but also all other risk (eg, presence of plaque, frequent consumption of carbohydrates, decrease in salivary flow rate) and protective factors (eg, exposure to fluorides) will allow the dental team and patient to understand the specific reasons for the caries disease and thus will allow for tailoring a personalized treatment plan and recall interval specifically designed to address the patient's needs [5].In general, in most risk forms, a low caries risk assessment is based on a combination of the following factors: no caries lesion development or progression for a recent period of time (eg, 3-5 years), low amount of plaque accumulation, low frequency of the patient's sugar intake, no presence of salivary problems, and adequate exposure to protective factors (eg, water fluoridation) [6].

In addition, the following factors, whether appearing singly or in combination, would yield a moderate to high risk assessment of caries: the development of new caries lesions, the presence of active lesions, and the placement of restorations due to active disease since the patient's last examination, together with a detrimental change in amount of plaque, incremental frequency of carbohydrate consumption, decrease in saliva flow, and decrease in exposure to caries protective factors [7].

Fluorides

Fluoride has been shown to reduce dental caries incidence consistently in both the primary and permanent dentitions, with the most current evidence strongly suggesting that most of fluoride's effect is topical, by affecting the demineralization exchanges between the tooth and the biofilm. Most clinical data for fluoride products and dental caries has focused on the investigation of fluoride's effect on caries lesion prevention. Well-conducted longitudinal clinical studies on use of fluoride products to arrest noncavitated or cavitated lesions are much more limited and varied [8]. Systematic reviews have shown that water fluoridation is effective in reducing caries in children and adults, 74.4% of the US population on public water systems had access to fluoridated water. In some instances in which fluoridated water is not available, prescription of fluoride supplements can be considered for young children.

The use of fluoride supplements has been associated with a reduction in caries incidence. The effect is clear in permanent teeth; but the evidence is not as compelling for primary teeth [9].Dentifrices with fluoride concentrations of 1000 ppm or above have been shown to reduce dental caries experience, with significant in vitro data to additionally show their potential for remineralization of noncavitated lesions, and for some formulations, for example, formulations with fluoride, calcium carbonate, and arginine, additional significant clinical data exist to demonstrate noncavitated lesion arrest. Their use during tooth brushing is probably the most common and effective oral hygiene practice around the world.

Due to fluoride's demonstrated efficacy and relative safety, dental and health organizations in the United States and around the world recommend the daily use of fluoridated dentifrices as soon as teeth erupt into the oral cavity. In young children, it is strongly recommended that the use of toothpaste is supervised by an adult. Recommended amounts also tend to be smaller than those used in adults to minimize the risk for development of dental fluorosis]10]. For higher-risk patients, use of additional fluoride products at home (eg, fluoride mouth rinses, high-concentration fluoride dentifrices) or professionally applied (eg, varnishes, gels), can provide additional benefits. For example, 5000 ppm fluoride dentifrices (1.1% NaF) are particularly

effective in root surface carious lesion prevention and arrest, but because there is a dose-response effect of fluoride dentifrices, these high-concentration dentifrices are also commonly considered for patients at higher risk of coronal lesions. Adding a fluoride rinse has been shown to be effective to reduce caries experience in at-risk patients. Professionally applied fluoride products, such as gels and varnishes, are frequently recommended for individuals at higher risk, and are effective for both caries prevention and arrest of noncavitated lesions in primary and permanent teeth. Silver fluoride products (eg, silver diamine fluoride) have also been shown to be effective at arresting cavitated lesions in coronal and root surfaces [10].

Dental Sealants

Sealants are considered one of the most effective evidence-based strategies available to prevent caries lesions on sound occlusal surfaces and to arrest occlusal noncavitated lesions. Yet, although they are recommended and frequently used in school based public health sealant programs, resulting in median caries reductions of 60%, they are unfortunately underutilized in clinical dental settings, even when systematic reviews, including those by the Cochrane Collaboration, support them as either effective or cost-effective to prevent or control caries lesions [11]. In fact, the preventive fraction to arrest noncavitated lesions of 71% is similar to reported values when sealants are used on sound surfaces. And even if clinicians were concerned with sealing in cariogenic bacteria, findings from a systematic review support that bacterial growth is significantly inhibited after sealing bacteria in caries lesions.

The most recent evidence-based clinical guidelines for sealant use by the ADA, developed based on a systematic review that focused on studies of sealant materials available in the US market at the time of the review, strongly recommended use of sealants to prevent caries lesions and arrest noncavitated lesions, and conditionally recommended use of sealants over fluoride varnish to prevent caries lesions [12]. Regarding which sealant material might be most effective, current systematic reviews by the Cochrane Collaboration and ADA conclude that it is unclear if glass ionomer (GI) sealants are similar to resin-based sealants for caries control. Yet, the ADA expert panel highlighted that it is important to take into account the likelihood of experiencing lack of retention (ie, resin-based materials have significantly higher retention rates over time than GI materials), and the difficulties in being able to obtain a dry field during isolation for sealant placement (ie, GI materials are more hydrophilic), when choosing the type of material to use, and the periodicity of retention checks over time [13]. Sealants have also been used effectively to arrest noncavitated lesions in interproximal surfaces, albeit this procedure is very technique sensitive, and it requires a second visit after tooth separation, as these lesions are normally initially clinically not accessible.

As an alternative, infiltration of noncavitated lesions (ie, if not visible by direct observation, assessed based on radiographic depth as radiographically into enamel or outer third of dentin) has been developed as a material and technique to be able to be used in a single dental appointment, and clinical studies and a recent systematic review by the Cochrane Collaboration support that infiltration is a very effective strategy to arrest these lesions in primary and permanent teeth [14]. Sealants have also been found to be effective over time at arresting lesion progression when used on more advanced lesions (ie, microcavitated lesions and/or radio graphically extending no more than half-way through the dentin), and repaired yearly. In a recent systematic review and meta-analysis, sealants and minimally invasive restorations led to less-invasive retreatments of more advanced lesions than just preventive care, yet sealants required more repairs over time [15].

Antimicrobials

Because dental caries results from a dysbiosis in the oral microbiome, restoring balance within that biofilm (through the use of antimicrobials, prebiotics, probiotics, and so forth) has been advocated [16]. Two of the most commonly investigated antimicrobial strategies for caries control and prevention have been chlorhexidine and polyols. Chlorhexidine is a broad-spectrum antimicrobial that has been used in dentistry for a very long time; however, current evidence suggests that chlorhexidine rinses have no beneficial effect in reducing dental caries and should not be routinely

recommended. On the other hand, available evidence on chlorhexidine/thymol varnishes applied professionally supports their use for the prevention and management of root caries lesions. Numerous studies have investigated the anticaries effects of polyols, particularly xylitol, delivered in a wide variety of vehicles, such as chewing gums, lozenges/ candies, toothpastes, and wipes [17]. Available evidence shows that xylitol is noncariogenic and has an antimicrobial effect that is dose and frequency dependent.

Furthermore, even when the evidence for numerous vehicles is insufficient, systematic reviews have consistently concluded that the regular use of xylitol or polyolcombinations in chewing gum and lozenges can be an effective adjunct in coronal and root caries prevention, but whether this is solely because of salivary stimulation or additionally because of the antimicrobial effects of the polyol, or whether it is substituting what otherwise would have been sugar ingestion, is less clear. Probiotics have been used in dentistry for caries control in both children and adults. Most of the published studies have used probiotics strains originally targeted to the gastrointestinal tract. Although the evidence is still limited and inconsistent, and most of the tested products are experimental and not available for commercial use yet, this may be a promising future approach to modulate biofilm dysbiosis [18].

Management of Cavitated Lesions

Cavitated caries lesions that limit regular dental plaque removal are likely to progress and generally require restorative treatment as part of the caries management for that patient. However, as stated previously, silver fluoride products (eg, silver diamine fluoride) have also been shown to be effective at arresting cavitated lesions in coronal and root surfaces. The main objective of restoring cavitated lesions, from a disease management perspective, is to stop the caries activity of the lesion and the restoration of a cleansable and functional tooth surface [19]. The introduction of adhesive materials with mechanical and physical properties has revolutionized the design of cavity preparations allowing for much more conservative restorative dentistry. Cavitated caries lesions should be restored using minimally invasive principles minimizing the removal of tissue, with the goal of preserving as much tooth structure as possible [20]. An International Caries Consensus Collaboration presented recommendations on terminology and on carious tissue removal and managing cavitated carious lesions. They recommended the level of hardness (soft, leathery, firm, and hard dentine) as the criterion for determining the clinical consequences of the disease and defined new strategies to carious tissue removal:

- Selective removal of carious tissue, including selective removal to soft dentine and selective removal to firm dentine;
- Stepwise removal, including initially selective removal to soft dentine, and at a second appointment 6 to 12 months later selective removal to firm dentine; and
- Nonselective removal to hard dentine, formerly known as complete caries removal (technique no longer recommended).

Furthermore, they suggested controlling the disease in cavitated carious lesions should be attempted using methods that are aimed at biofilm removal or control first. Only when cavitated carious lesions either are non cleansable or can no longer be sealed are restorative interventions indicated [21]. Carious tissue should be removed purely to create conditions for long-lasting restorations. Bacterially contaminated or demineralized tissues close to the pulp do not need to be removed. The evidence and, therefore, these recommendations support less-invasive carious lesion management, delaying entry to, and slowing down, the restorative cycle by preserving tooth tissue and retaining teeth long-term [22].

Summary

Patient-centered “personalized” prevention and management of dental caries should be based on restoring the balance in the oral environment, with the goal of preserving tooth structure, using best evidence available and taking into consideration the dentist’s expertise and individual needs of the patient. Although there is significant evidence supporting many of the individual components of this caries management philosophy, such as use of fluorides and sealants for caries prevention and management, there is scarcity of data in the literature to demonstrate the cost-effectiveness of this system approach when used in general dental practice, especially

among adult patients. Yet, available data suggest that a risk-based caries management system, in which risk is based on disease experience, and management uses evidence-based approaches, such as use of sealants and fluoride varnishes (with frequency tailored on risk), can be effective at decreasing restorative needs over time in adult populations in private practice settings.

Ethical Clearance

People identified as potential research participants because of their status as relatives or carers of patient's research participants by virtue of their professional role in the university and departments.

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