Caries Risk Assessment and Prevention

Introduction of the disease, prevalence and global impact

Dental caries is the most common dental disease that requires restorative treatment. In 2010, the Global Burden of Disease Study reviewed the prevalence of 291 diseases from 1990 to 2010 and determined that untreated caries in adults was the most prevalent condition, impacting 2.4 billion people, or 35% of the world population.[1] Caries affects the entire spectrum of the general population, with 92% of adults between ages 20 and 64 having had dental caries in their permanent teeth.[2] Despite a general trend of decline in caries rates since the 1970s in the US, significant disparities in caries rates exist in different racial, socioeconomic, educational, and age groups.[2] Dental caries is considered one of the two most prevalent global oral health burdens.[3] Direct treatment costs due to dental diseases worldwide are estimated at $298 billion annually, representing an average of 4.6% of total global health expenditures.[4] In many low-income countries, if treatment were available, the costs of dental caries alone in children would exceed the total health care budget for children.[4] Dental caries is also one of the most prominent non-communicable diseases worldwide, following cardiovascular diseases, diabetes, cancer, and chronic obstructive pulmonary disease.[4,5] Prevention and caries risk assessment are clearly important and necessary. Caries risk for the elderly population is especially concerning because, many times, these patients need more dental restorations, or have multiple missing teeth, dexterity difficulties, or oral hygiene compliance issues. Recurrent caries around existing dental restorations can result in their premature failure and increased health care costs.

Pathogenesis and classification

The main cariogenic bacteria are *Mutans streptcococci* (*MS*) and *Lactobacilli* species.[6,9,10] Caries formation also requires host substrate, presence of biofilm, fermentable carbohydrates, and time.[9] For caries to be initiated, dental plaque usually has a high proportion of *MS* present. *MS* possess high adherence to the tooth surface, produces high levels of acid from sugars, and are acid tolerant.[6] *Lactobacilli* and Gram-positive bacteria are commonly isolated from the oral cavity and are highly acidogenic organisms as well, but they have low affinity to the tooth surface. Therefore, *Lactobacilli* and Gram-positive bacteria are more related to advancing rather than initiating caries.[6] Dental caries is the result of the metabolic activities of these bacteria growing within biofilm on tooth surfaces. The acid produced during the process causes demineralization, which increases porosity in the enamel and decreases translucency of the surface color.[7] As a result, white opaque lesions occasionally are observed. As the disease progresses, the porosity of the enamel causes staining from food and cavitation of the surface. Over time, the caries turns brown or black.[7] Many factors influence the speed and propensity of caries formation. These factors include tooth location, tooth anatomy, the presence of carbonated hydroxyapatite within enamel, saliva quantity and quality, biofilm formation, and host diet.[7] Based on

the location of the caries, they can be classified as (1) occlusal surface, (2) smooth surface, (3) interproximal, and (4) root surface caries.[8] However, the reliability and reproducibility of dental caries detection by clinical examination has been problematic, mostly due to the heterogeneity of the caries disease process and its numerous different clinical presentations. Many different detection systems make comparing studies and communication among clinicians difficult and confusing. The International Caries Detection and Assessment System (ICDAS) was developed to attempt addressing this issue. The system is based on restorative status of the tooth and severity of the caries.[8]

The age and prevalence of untreated caries is shifting from children to adults.[2] Caries incidence has three peaks at the ages of 6, 25, and 70 years old.[2] While young patients are susceptible to caries often due to diet, the older population is prone to dental caries as a result of microflora change due to reduced salivary flow rate, long-term medications, root surface exposure, prosthesis wearing, and an impaired immune system.

Caries diagnosis and risk assessment

It is important to make an appropriate diagnosis and risk assessment of caries in order to tailor treatments. More importantly, developing an assessment benchmark to evaluate risk level of each individual is also crucial when it comes to preventive care. Traditionally, the visual-tactile caries diagnosis is the most known method and is widely used by clinicians. The “stickiness” tactile sensation or resistance to withdrawal of a sharp dental explorer confirms the presence of dental caries. However, the research does not support that such practice increases sensitivity or specificity compared to visual examination alone of a dry tooth.[8] Probing can also irreversibly damage the tooth surface, causing a sound remineralizable subsurface lesion to become a cavitated lesion, which is much more prone to caries progression. Using a round-ended periodontal probe has been suggested, and using gentle strikes across the tooth surface has been recommended to be less invasive.[8] On the other hand, probing does render necessary information when it comes to root caries to detect the softness of the lesion.[8] Other ways to enhance visual diagnostic methods include using fiberoptic transillumination, tooth separation, and magnification. Another widely used caries detection method is dental radiography. A certain amount of mineral loss has to occur for the caries to be detected on the radiograph. The two-dimensional image is also affected by the thickness of the surrounding soft and hard tissues, the projection angles, receptor resolution, and examiner’s skills, making detection of minimally demineralized tooth surfaces difficult.[8] Currently, other novel caries detection methods are available. They are based on either certain types of light source, such as laser-fluorescence transillumination, or electronic current, such as electrical conductance measurement methods. Within the scope of research of this position statement, there seems to be no perfect caries diagnostic tool at this time. Clinicians should reserve these novel tools for adjunct caries detection, as false positive readings might drive overtreatment in some scenarios.[7]

For clinicians, the goal of caries diagnosis is to accurately and reliably determine whether the observed lesion is an area of actively progressing caries and to assess the severity of such progression. However, from a patient's perspective, what matters more is the disease prognosis and the available treatment alternatives. Patients will only benefit from a diagnostic test if the information gathered from such a test can be applied to alter subsequent treatment decisions, resulting in a better therapeutic outcome.[7] The paradigm shift in caries management from only repairing diseased teeth to focusing on prevention and lifestyle modification was triggered by the understanding that it is more important to tailor treatment based on a patient's risk level rather than treating everyone the same way.[7,9]

Currently, the most widely accepted and the most successful assessment tool is Caries Management by Risk Assessment (CAMBRA).[9-11] A questionnaire that evaluates the pathological and protective factors in the caries balance model allows clinicians to determine a patient's caries risk. Based on different risk levels, evidence-based treatment alternatives can be considered, and the one that best favors the positive balance of protective factors compared to pathologic factors can be chosen. These treatment options can be an array of behavioral, minimally invasive, chemical, dietary, and restorative techniques.[9]

Current treatment options and their limitations

The most common method of caries removal is with mechanical drilling using an air-driven turbine or an electric handpiece. Other methods include air abrasion, laser, and chemical solutions.

After surgically removing caries from a tooth, clinicians perform either a direct restoration, such as amalgam or composite resin, or an indirect restoration such as an inlay, onlay, or crown. While amalgam is suitable for non-esthetic areas (see ACP position statement on dental amalgam), composite resin based materials have gained popularity. There is concern that composite resin has inferior properties and may not be as durable for restoration of posterior teeth after caries removal. Research comparing long-term studies indicates that the main reasons for long-term failure of such restorations are often secondary caries, related to patients' caries risks, and fracture, related to the presence of a lining, as well as patient force factors, such as bruxism.[12] Recurrent caries is among the most common complications for indirect restorations.[13] In addition, the most common complication associated with a fixed dental prosthesis (FDP) is also recurrent caries. The mean recurrent caries rate diagnosed affecting an FDP abutment tooth is 18%.[13] These data all indicate that if there are not preventive measures put in place after caries removal, the chance of caries recurrence on any restoration in the same oral environment can be very high. In a high caries risk individual, it may be a better option to replace missing teeth with dental implants.

According to the CAMBRA protocol, each individual is designated a risk level and prescribed treatment with the goal of decreasing risk.[11] Frequent recall visits combined with dental radiographs, prophylaxis,

and oral hygiene instruction can be beneficial. Xylitol gum, fluoride varnish, high fluoride toothpaste (by prescription or over the counter), fluoride mouth rinse, chlorhexidine rinse, and other antimicrobial topical agents are effective adjuncts to reducing caries rate and arresting caries progression.[9-11] Water fluoridation is one of the most widely available and most effective ways to reduce caries in the general population (see ACP position statement on water fluoridation).[9] For patients at increased risks of caries due to systemic diseases, radiation, or medication, daily application of prescription fluoride gel with a custom tray is recommended.[7,13] Remineralization treatments can arrest white lesions and incipient caries. Sealants and fluoride-releasing restorative materials are also important in caries prevention.[7] Finally, patient behavioral and dietary modification play a key role in reducing caries risks.[9]

Some elderly patients require special considerations because of multiple co-morbidities and compliance issues. Systemic diseases, medication-induced dry mouth, a carbohydrate rich diet, decreased dexterity, and gingival recession render the elderly very susceptible to caries. Preventive measures should take priority, and operative interventions are used only if needed to improve the oral condition.[7] Removable dental prostheses (RDP) may complicate the oral environment and increase caries risks.[7] RDP should be prescribed only to improve esthetics and function. Many patients can function comfortably with a shortened dental arch.[7]

Innovative preventive and operative treatment options on the horizon

Newer approaches to reducing caries can be classified based on their mechanism of action. There are measures to help remineralize tooth surfaces, such as a miniature fluoride-releasing device attached to a tooth, application of amorphous calcium phosphate, ozone therapy to modify biofilm, probiotic substitution, non-acid producing bacteria replacement therapy, and laser treatment or medications to modify surface composition leading to an increased enamel resistance to demineralization.[8]

Conclusion

It is the position of the American College of Prosthodontists that caries risk assessment and prevention is an important part of patient management in order to improve oral health care outcomes.

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