

# Caries risk assessment

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Caries remains the most common chronic disease affecting both children and adults in the United States. High rates of primary and secondary caries in at-risk populations result in significant lifetime costs. Dental providers should be skilled in assessing an individual patient's risk for dental caries so that effective and minimally invasive preventive strategies can be employed to address the etiology of dental caries. Validated assessment strategies, such as the caries risk assessment model, allow dental providers to implement a systematic and evidence-based approach to astutely assess and record changes in the caries risk status of patients in an effort to prevent disease.

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**N**early 2 decades ago, dental caries was identified as a “silent epidemic.”<sup>1</sup> Although Americans have experienced a decline in caries prevalence due to widespread improvements in oral health, caries remains the most common chronic disease affecting both children and adults in the United States.<sup>2,3</sup> High rates of primary and secondary caries in at-risk populations result in significant lifetime costs of dental disease for both patients and payers. An analysis of dental insurance claims submitted in 2012 found that lifetime costs for a single carious molar can reach US\$6105.<sup>4</sup> Furthermore, all dental restorations have a finite longevity and require repair or replacement over time.<sup>5</sup>

This evidence suggests that a more intentional focus on disease prevention is needed to significantly benefit the oral health of individual patients and communities overall. Dental providers should be skilled in assessing an individual patient's risk for dental caries so that effective and minimally invasive preventive strategies can be employed to address the etiology of dental caries rather than continued use of traditional restorative treatment approaches.

## Etiology of dental caries

The understanding of disease etiology has increased in recent decades with the recognition that dental caries is a multifactorial disease process that is primarily driven by a diet high in fermentable carbohydrates, suboptimal oral hygiene, and elevated numbers of virulent, cariogenic bacteria.<sup>5-7</sup> A healthy mouth is characterized by a symbiotic relationship between cariogenic and noncariogenic bacteria that make up the oral biofilm (dental plaque). When this bacterial balance is disrupted, the resulting acidic environment induces a deleterious ecological shift.<sup>8</sup> This evolved “pathobiome” selects for cariogenic bacteria within the dental plaque (such as *Streptococcus mutans* and *Lactobacillus acidophilus*, which produce high levels of acid as a metabolic by-product) and further exacerbates the bacterial imbalance within the oral biofilm.<sup>8-10</sup> Frequent consumption of fermentable carbohydrates leads to increased acid production and lower salivary pH levels, resulting in dissolution of calcium and phosphate ions from enamel over time. If the local oral environment is not improved to promote remineralization at these affected sites, net mineral loss will progress into dentin and continue until a physical breakdown, or cavitation, of the enamel's crystal lattice structure occurs, requiring surgical intervention.<sup>11</sup>

Historically, management of caries was based on the perception that the disease process is progressive and would eventually destroy the tooth unless restorative treatment was completed.<sup>12</sup> Traditional restorative dentistry remains a predominant treatment approach for noncavitated and incipient carious lesions, despite mounting evidence demonstrating that caries removal and the placement of dental restorations do not alter the caries disease process.<sup>5,13</sup> In at least one randomized control clinical trial, the placement of dental restorations had no effect on

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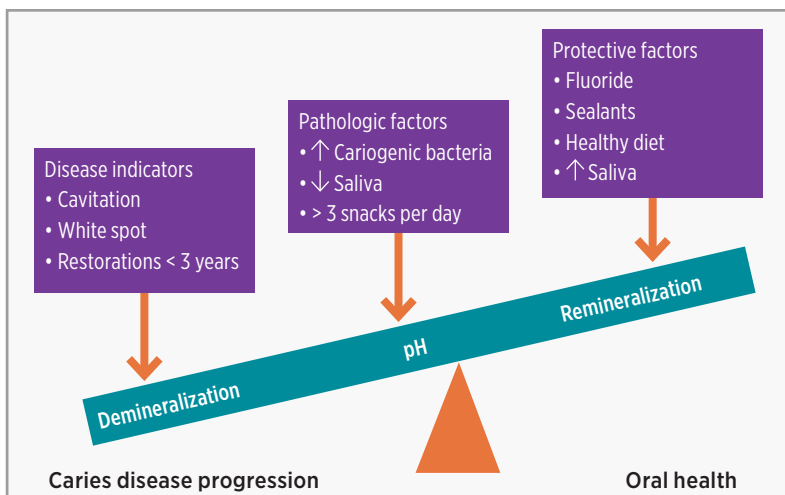
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**Figure.** The caries balance model depicts the balance among risk factors, protective factors, and caries disease indicators. (Adapted from Featherstone et al with permission from the California Dental Association.<sup>19</sup> ©October 2007.)

mean levels of cariogenic bacteria; approximately 70% of subjects returned within 2 years with new carious lesions.<sup>5,14</sup>

In the early 2000s, Featherstone and colleagues popularized a paradigm shift in caries management by asking dentists to embrace prevention, minimally invasive treatments, and reversal concepts in place of the traditional “drill and fill” surgical model, which has proven to be costly and ineffective in addressing dental caries.<sup>15-20</sup> This more conservative approach promotes optimal oral health through the utilization of preventive strategies that include identification of an individual’s risk for caries progression, early detection of noncavitated lesions, and the development of a patient-specific caries management protocol.<sup>21</sup>

A useful way to visualize the dynamic interaction between the previously mentioned preventive strategies and the development of dental caries is the iconic caries balance model (Figure).<sup>15,19</sup> This model, developed from decades of dental caries research, is a visual representation of the balance among pathologic (risk) factors, protective factors, and caries disease indicators; this balance determines whether dental caries will progress, stabilize, or reverse.<sup>16-18</sup>

In this model, caries disease indicators refer to clinical findings that reflect past or present caries activity and act as strong predictors of disease progression unless therapeutic interventions are initiated.<sup>16,18,22</sup> Examples of such disease indicators include clinical cavitations, white-spot lesions, and recent restorative history.<sup>15,16,18,19</sup> Common pathologic or risk factors that promote demineralization include high levels of cariogenic bacteria, frequent carbohydrate consumption, and salivary dysfunction. Examples of common protective factors include healthy salivary flow, fluoride exposure, sealants, a diet low in fermentable carbohydrates, and chemotherapeutic agents (eg, 0.12% chlorhexidine gluconate).<sup>18,19,23</sup>

## Caries risk assessment

### Objective

In a clinical setting, the dental provider (with the aid of auxiliary staff) is responsible for identifying patient-specific pathologic and protective factors by means of a detailed medical and dental

history. This information is then weighed with findings from a patient’s clinical examination to determine the directional swing of the caries balance toward caries disease progression or oral health.<sup>18</sup> This process of data collection is called a *caries risk assessment* (CRA) and culminates in the assignment of a risk level as low, moderate, or high, representing the likelihood of new caries development or lesion progression over a specific period of time in the individual patient.<sup>23</sup> CRA can provide a methodical, evidence-based approach for dentists to rapidly assess and continuously record the changing caries risk of their patients.

Implementation of a CRA in the dental office is most easily and reliably accomplished by using a CRA form.<sup>23,24</sup> Several organizations provide access to such forms, including the American Academy of Pediatric Dentistry (AAPD) and the American Dental Association (ADA).<sup>5,25</sup> Another CRA tool is caries management by risk assessment (CAMBRA), which is available from the California Dental Association.<sup>20,26,27</sup> The CAMBRA approach has been well validated through several studies involving larger patient populations.<sup>24,28-31</sup>

Although these forms vary, they all recognize previous caries experience as the strongest predictor of future caries. An expert panel with the Center for Evidence-Based Dentistry of the ADA compared different CRA tools and concluded that there is no existing tool that has both good sensitivity and good specificity for predicting caries progression.<sup>32</sup> However, 15 factors (risk factors, protective factors, and clinical disease indicators) were determined to be useful in predicting caries risk, and examples of such factors are presented in the Table.<sup>32</sup>

In a 2017 statement, the ADA Council on Scientific Affairs commented that “systematic methods of caries detection, classification, and risk assessment, as well as prevention/risk management strategies, can help to reduce patient risk of developing advanced disease and may even arrest the disease process.”<sup>25</sup> Thus, CRA is recognized as a valuable tool that can be used by dental providers to identify a patient’s risk status and develop preventive and therapeutic strategies.

**Table.** Examples of factors predicting caries risk and related therapeutic interventions.

Risk factors	Caries disease indicators	Protective factors	Therapeutic interventions
<ul style="list-style-type: none"> <li>• Daily consumption of more than 3 sugary snacks or drinks between meals</li> <li>• Parents or siblings with cavitated lesion(s) in the last year (for children younger than 14 years)</li> <li>• Visible plaque on teeth</li> <li>• Orthodontic or prosthetic appliances</li> <li>• Recent caries experience since last assessment (or in the last 3 years)</li> <li>• Uncoalesced or unsealed pits and fissures</li> </ul>	<ul style="list-style-type: none"> <li>• Active initial or white-spot lesion(s)</li> <li>• Active moderate or advanced lesion(s)</li> </ul>	<ul style="list-style-type: none"> <li>• Brushing twice daily with a fluoridated toothpaste</li> <li>• Consuming fluoridated water or beverages made from fluoridated water</li> <li>• Regular professional fluoride applications</li> <li>• Use of over-the-counter fluoride mouthrinse (for patients older than 6 years)</li> </ul>	<ul style="list-style-type: none"> <li>• Increased frequency of radiographic assessment of active initial lesions</li> <li>• Chemotherapeutic agents (eg, 0.12% chlorhexidine gluconate mouthrinse and 0.5% fluoride toothpaste)</li> <li>• Pit and fissure sealants</li> </ul>

**Protocol**

To better understand the utilization of CRA in the dental setting, the dentist should know how to perform CRA to enhance patient education and guide evidence-based clinical decisions.

**History**

The first essential step is history taking in a predictable and standardized manner to determine relevant risk and protective factors for an individual. The dental provider or auxiliary staff member should gather relevant historical information: medical history, social history, previous dental care experiences, home oral hygiene practices, dietary habits, fluoride exposures (eg, frequency of using fluoridated toothpaste and fluoridated water consumption), and any personal or cultural habits impacting the patient’s oral health.<sup>23</sup> In the case of children, it is important to identify the degree of daily involvement of the adult caregiver for the purposes of determining the accuracy of the historical data gathered. This information can be recorded in a CRA form, ensuring that each patient is systematically assessed in the same way each time using the best available evidence.

**Examination and risk classification**

As the next step in establishing an individual patient’s caries risk status, the dental provider completes an oral examination to identify caries disease indicators (eg, clinically or radiographically visible caries into dentin, white spots on smooth surfaces, and restorations placed within the past 3 years). This component of the CRA is likely already being performed and recorded in a patient’s chart during regular recall visits. After accurately gathering all relevant information in the history and examination, the provider will be able to weigh the pathologic risk factors and caries disease indicators against the existing protective factors to classify a patient’s disease risk as low, moderate, or high.

**Management**

Once the patient’s risk status is assigned, the dental provider can decide the most appropriate evidence-based caries management

protocol to lower caries risk. These protocols consist of diagnostic, preventive, and therapeutic interventions, such as scheduling diagnostic radiographs at future recall visits, fluoride therapies, and placement of pit and fissure sealants. The frequency and utilization of such interventions are addressed in the latest guidelines provided by the AAPD and ADA.<sup>33-36</sup>

Prevention and therapeutic interventions target a patient’s risk factors and enhance protective factors to lower caries risk. Examples of preventive strategies include regular fluoride applications and pit and fissure sealants. A 2013 systematic review from the ADA favored the use of topical fluorides, which act to inhibit demineralization, enhance remineralization, and impede bacterial enzyme activity in high-risk patients.<sup>37</sup> These fluorides are available in different formulations, including 1.23% acidulated phosphate fluoride gel, 0.09% fluoride mouthrinse, 0.5% fluoride gel or paste (prescription strength), and 2.26% fluoride varnish. To reduce the risk of accidental ingestion, the last option is the only formulation recommended for children younger than 6 years of age.<sup>37,38</sup> The ADA guidelines recommend in-office applications of fluoride varnish every 6 months in moderate and high-risk patients and recognize the likelihood of additional preventive benefits for 3-month applications in high-risk patients.<sup>37,38</sup>

A systematic review concluded that sealants are effective in preventing and arresting pit and fissure caries in primary and permanent molars, especially in high-risk pediatric populations.<sup>13,33,39</sup> Furthermore, sealants have been shown to minimize progression of noncavitated carious lesions, thus preventing the need for more aggressive restorative treatments while enhancing the natural repair process through remineralization.<sup>40,41</sup> Despite strong evidence to support the preventive benefits of sealants, however, only about 30% of children aged 6-8 years have received this preventive intervention.<sup>2</sup>

Antibacterial agents such as xylitol and chlorhexidine gluconate can augment preventive therapies and lower patient risk; however, results are mixed.<sup>42</sup> Xylitol is a natural sweetener that, in addition to providing an alternative to sugar (sucrose), was thought to promote remineralization, increase saliva production,

and reduce sucrose metabolism via competitive inhibition.<sup>43,44</sup> Previously, patients were encouraged to use products containing xylitol to help prevent caries; however, results from a 2015 systematic review found insufficient high-quality evidence to support the use of xylitol for caries prevention.<sup>43</sup>

The evidence surrounding chlorhexidine gluconate as an anticaries agent is more promising. Historically, chlorhexidine gluconate has been used as an antiplaque rinse with antibacterial activity against *Streptococcus mutans*.<sup>45,46</sup> Chlorhexidine gluconate is available in a variety of preparations, including 0.04% toothpaste, 0.12% or 0.2% mouthrinse, 1% gel, 0.2% chewing gum and sprays, and thymol-containing varnishes with a range of strengths. One systematic review found little evidence to support the anticaries effects of chlorhexidine-containing gels and varnishes (sprays, toothpastes, chewing gums, and mouthrinses were not assessed due to limited available data).<sup>47</sup> However, a clinical trial using chlorhexidine gluconate 0.12% mouthrinse has shown encouraging results.<sup>14,30</sup> This trial found that the addition of chemotherapeutics (once-daily use of 0.12% chlorhexidine gluconate mouthrinse with twice-daily use of 0.5% fluoride toothpaste) as part of a caries management protocol significantly reduced the caries increment by 20%-38% in high-risk patients.<sup>30</sup> These results were replicated in a practice-based clinical trial, demonstrating that CAMBRA (and possibly other CRA tools) can be effectively implemented in dental offices.<sup>31</sup>

## Challenges to implementation

Despite the evidence supporting CRA and individualized caries prevention strategies as an effective means of caries management, numerous challenges prevent dental providers from adopting CRA-based practices. Data from a practice-based study showed that only 14% of dentists used a CRA form in their practice.<sup>48</sup> Possible reasons for poor utilization of a standardized CRA include time constraints, limited numbers of trained personnel, and inadequate pay structure or lack of reimbursement.

One obstacle to implementation of CRA in a private practice is a lack of patient transparency regarding known harmful habits. The CRA approach is dependent on accurate diagnosis, which is reliant on the provision of accurate information by patients and caregivers. One study evaluating the impact of lies on the doctor-patient relationship commented that “timely, astute, and compassionate care” is dependent on effective communication between patients and providers.<sup>49</sup> When this tendency is translated to CRA in dental practice, patients or their caregivers may give answers that are known to be favorable to avoid embarrassment and subsequent criticism, making it difficult for providers to identify factors and develop effective preventive strategies.<sup>49</sup> Palmieri & Stern suggest “preemptively explaining the tendency for patients to want to present themselves in the best possible light” as a method to maximize truthfulness.<sup>49</sup>

Another obstacle to the implementation of CRA in the private practice setting is the additional time required for this assessment during a dental visit. Recording an individual patient’s contributing factors and disease indicators in a nonjudgmental clinical environment and subsequently developing evidence-based interventions is time-consuming.<sup>50,51</sup> Despite the time

constraints posed by CRA, literature from the fields of primary care and nephrology suggest that investing in additional visit time to provide patient education improves care and cost outcomes.<sup>52,53</sup> Although patients can be provided with questionnaires to elicit answers about pathologic and protective factors to reduce chairside time, the accuracy of the information should be verified verbally by a dental provider or auxiliary staff member. Furthermore, verbal questioning has been shown to enhance interactive discussion, resulting in more effective patient education, which is central to adopting caries management strategies and lowering caries risk.<sup>54</sup>

A review of effective verbal strategies for patient education suggests that a team approach is key to helping patients understand their medical conditions.<sup>54</sup> This principle can be translated to the dental setting by having providers and auxiliaries play key roles in CRA implementation. Questions regarding patient contributing factors during the history-taking steps of CRA can be delegated to auxiliaries who are knowledgeable and adequately trained. In California, 89% of dental hygienists agreed that caries risk assessment was valuable for predicting future caries, but only 66% were familiar with CAMBRA, and only 40% worked in offices where CAMBRA was implemented.<sup>55</sup> With training, dental hygienists can be valuable team members who perform CRA and collaborate with dentists to create individualized caries management plans. Dental assistants can also play an adjunctive role by interviewing the patient and recording CRA factors.<sup>56</sup>

Medical studies show that screenings, interventions, and referrals performed by trained nonphysician providers (eg, social workers and nurse practitioners) resulted in improved patient education and care. Reasons cited for the success of non-physician care providers are fewer competing clinical priorities and greater time and motivation for counseling.<sup>57</sup> Employing a team approach uses the dentist’s time efficiently and provides the opportunity for multiple care team members to reinforce the same caries management message.<sup>24,56</sup>

Another barrier to implementing CRA is the lack of reimbursement. Higher rates of Medicaid reimbursement for oral examinations and prophylaxis correlated with greater use of preventive services.<sup>58</sup> In 2009, the ADA endorsed the use of CRA as a standard of care and added the codes D0601, D0602, and D0603 for documentation of low, moderate, and high risk, respectively. Instead of reimbursing CRA assessments, some insurance companies require patient risk status for justification of evaluations and procedures. In some states, chart documentation of an individual’s risk status is required for coverage of diagnostic and preventive services.<sup>59</sup> In other states, public insurers require proof of CRA documentation with each submission to ensure reimbursement.<sup>60</sup>

## Conclusion

Individualized patient care plans directed at prevention and patient education are becoming the gold standard within medicine and dentistry. Validated assessment strategies such as CRA allow dental providers to implement a systematic and evidence-based approach to astutely assess and record changes in the caries risk status of patients in an effort to prevent disease.



Although CRA utilization rates are low among general dentists, with continued development of supporting evidence and guidelines CRA will increasingly become the accepted standard of care. The consequences of this new standard would likely include changes to the current reimbursement models.

## Author information

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The Sleepy Tooth Group is a network of family practices throughout Delaware that offer all facets of General and Sedation Dentistry. Our offices are dentist owned to ensure the best care for our patients.



**Why Delaware?**  
Work-life balance matters and each of our locations offer a variety of lifestyle options so you can pick the place that's right for you! From the big city to small towns, and even beach-front living, Delaware has it all.



**Why Join Our Team?**  
The Sleepy Tooth Group is uniquely positioned to help you eliminate the challenges and headaches posed by owning your own practice. We take care of the back-end business aspects, like keeping your chairs full, allowing you to focus on your dentistry.

**The Sleepy Tooth Group**  
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