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CAMBRA: Best Practices in Dental Caries Management

A Peer-Reviewed Publication
Written by Michelle Hurlbutt, RDH, MSDH

Abstract

The current approach to dental caries focuses on modifying and correcting factors to favor oral health. Caries management by risk assessment (CAMBRA) is an evidence-based approach to preventing or treating dental caries at the earliest stages. Caries protective factors are biologic or therapeutic measures that can be used to prevent or arrest the pathologic challenges posed by the caries risk factors. Best practices dictate that once the clinician has identified the patient's caries risk (low, moderate, high or extreme), a therapeutic and/or preventive plan should be implemented. Motivating patients to adhere to recommendations from their dental professionals is also an important aspect in achieving successful outcomes in caries management. Along with fluoride, new products are available to assist clinicians with noninvasive management strategies.

Learning Objectives

The overall goal of this course is to provide the reader with information on CAMBRA and dental caries management. On completion of this course the reader will be able to do the following:

1. Analyze the principles of caries management by risk assessment.
2. Recognize the value of performing a caries risk assessment on patients.
3. Describe and differentiate between clinical protocols used to manage dental caries.
4. Identify dental products available for patient interventions using CAMBRA principles.

Author Profile

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Abstract

The current approach to dental caries focuses on modifying and correcting factors to favor oral health. Caries management by risk assessment (CAMBRA) is an evidence-based approach to preventing or treating dental caries at the earliest stages. Caries protective factors are biologic or therapeutic measures that can be used to prevent or arrest the pathologic challenges posed by the caries risk factors. Best practices dictate that once the clinician has identified the patient's caries risk (low, moderate, high or extreme), a therapeutic and/or preventive plan should be implemented. Motivating patients to adhere to recommendations from their dental professionals is also an important aspect in achieving successful outcomes in caries management. Along with fluoride, new products are available to assist clinicians with noninvasive management strategies.

Introduction

Dental caries is the most common oral disease seen in dentistry despite advancements in science, and continues to be a worldwide health concern.[1] According to the National Health and Nutrition Examination Survey (1999-2004), dental caries continues to affect a large number of Americans in all age groups, with carious lesions in primary teeth increasing among children aged 2-5 years.[2] This survey revealed that 42% of children aged 2-11 have had carious lesions in their primary teeth and 21% of children aged 6-11 have had carious lesions in their permanent dentition. Approximately 59% of adolescents aged 12-19 have experienced dental caries, and by adulthood (aged 20-75+) well over 92% of those surveyed have experienced dental caries in their permanent dentition. This suggests that the population of individuals susceptible to carious lesions and dental caries continues to expand with increased age. The management of this disease continues to be a challenge and requires dental professionals to acknowledge that simply removing or restoring the carious lesion will not change the unhealthy plaque biofilm that contributes to this disease state.

Historically, dentistry has approached dental caries disease management through a surgical-restorative approach that can lead to several lifetime replacement procedures, resulting in an increased restoration size or more invasive procedures over time. It is estimated that 71% of all restorative treatments are performed on previously restored teeth, with recurrent carious lesions as a predominant cause.[3] This demonstrates that although the carious lesion was repaired, the dental caries disease was not fully treated, because the actual cause and risk factors were not adequately resolved. Current science has determined that the key to dental caries treatment and disease prevention lies with modifying and correcting the complex dental biofilm and transforming oral factors to favor health.[4-6] This can be accomplished through a best-practices approach that decreases caries risk factors, increases caries protective factors and is the basis for caries management by risk assessment (CAMBRA).

The CAMBRA philosophy was first introduced nearly a decade ago when an unofficial group called the Western CAMBRA Coalition was formed that included stakeholders from education, research, industry, governmental agencies and private practitioners based in the western region of the United States.[7] A consensus conference was held that same year, resulting in two entire issues of the Journal of the California Dental Association (February and March 2003) dedicated to the scientific literature on CAMBRA. Sharing of information among dental schools quickly led to all Western dental schools teaching the principles of CAMBRA. In 2007, another two issues of the Journal of the California Dental Association (October and November 2007) were devoted to the clinical implementation of CAMBRA, including clinical practice protocols. All four issues can be accessed by the public and downloaded, without charge, at www.cdafoundation.org/journal. As the CAMBRA philosophy grew in popularity, a Central CAMBRA Coalition and an Eastern CAMBRA Coalition were formed, and together with the Western CAMBRA Coalition they served as a catalyst to establish a Cariology Section within the American Dental Education Association (ADEA) and to have the core principles of CAMBRA adopted as official policy in dental education.

CAMBRA Principles

Caries management by risk assessment (CAMBRA) is an evidence-based approach to preventing or treating the cause of dental caries at the earliest stages rather than waiting for irreversible damage to the teeth. This philosophy requires an understanding that dental caries is an infectious bacterial biofilm disease that is expressed in a predominantly pathologic oral environment.[8] Science suggests this disease is the consequence of a shift in the homeostatic balance of the resident microflora due to a change in local environmental conditions (such as pH) that favor the growth of cariogenic pathogens.[9-10] Although acid-generating bacteria present in plaque biofilm are often considered the etiologic agents, dental caries is multifactorial since it is also influenced by lifestyle and host factors.[6] In the simplest of descriptions, dental caries disease is a result of these acid-producing bacteria feeding on fermentable carbohydrates and producing acid by-products that are capable of dissolving the carbonated hydroxyapatite mineral of the tooth surface, forming a carious lesion. The caries process is dependent upon the interaction of protective and pathologic factors in saliva and plaque biofilm as well as the balance between the cariogenic and noncariogenic microbial populations that reside in saliva.

Caries Risk Assessment

At the heart of the CAMBRA philosophy of care is the assessment of each patient for his or her unique individual disease indicators, risk factors and protective factors to determine current and future dental caries disease.[11,12] Caries risk assessment (CRA) is a critical component of dental caries management and should be considered a standard of care and included as part of the dental examination. It is essential in decision making to guide the clinician in the diagnosis, prognosis and treatment recommendations for the patient. Using a risk assessment provides for better cost-effectiveness and greater success in treatment compared with the more traditional approach of applying identical treatments to all patients, independent of their risk.[13] There are a variety of caries risk assessment forms available from professional associations and industry publications to assist clinicians in determining a patient's risk.

The American Dental Association developed two forms that determine low, moderate or high risk: one for patients 0-6 years old, and one for patients older than six years. These can be downloaded for free from the ADA website. The American Academy of Pediatric Dentistry has developed two forms that determine low, moderate or high risk: one for children 0-5 years old, and one for children older than five years. These forms can be downloaded from the AAPD website. Two CRA forms have been published in the Journal of the California Dental Association and determine low, moderate, high and extreme risk: one for patients aged 0-5 years, and one for patients age six through adulthood. These forms can be downloaded from the CDA Foundation website. The CDA forms are validated risk assessment instruments using a large cohort of patients and revealing statistically significant odds ratios relating to the future onset of cavitation.[14] While all of these forms differ in their risk factors, disease indicators and protective factors, they all agree that the strongest predictor of future dental caries disease is the dental caries experience, such as carious lesions or new restorations within the last three years. The AAPD and CDA forms require saliva testing to determine cariogenic bacteria levels. All available CRA forms "weigh" the disease indicators, risk factors and protective factors to some degree, evaluating the balance or imbalance that exists on a case-by-case basis for each patient (Table 1). Reassessment of the patient's risk for dental caries is considered best practices and should occur 3 to 12 months after the initial caries risk assessment, with the interval of time depending on the risk level of the patient.

Caries Balance Concept

The Caries Balance/Imbalance model was created to represent the multifactorial nature of dental caries disease and to emphasize the balance between pathological and protective factors in the caries process.[11,12] If pathological factors outweigh protective factors, the caries disease process progresses. This is a dynamic and delicate balance, tipping either way several times a day. Progression or reversal of caries disease is determined by the imbalance/balance between disease indicators and risk factors on one side and the competing protective factors on the opposite.

Disease Indicators

Caries disease indicators are described as physical signs of the presence of current dental caries disease or past dental caries disease history and activity. These indicators do not speak to what initially caused the disease or how to treat the disease once it is present, but rather serve as strong predictors of dental caries continuing unless therapeutic intervention is implemented.[15] The Caries Imbalance model uses the acronym "WREC" (pronounced "wreck") to describe the following four disease indicators:

- White spots visible on smooth surfaces
- Restorations placed in the last three years as a result of caries activity
- Enamel approximal lesions (confined to enamel only) visible on dental radiographs
- Cavitation of carious lesions showing radiographic penetration into the dentin

Patient Examination

These findings are obtained from the patient interview and clinical examination. The CAMBRA philosophy advocates the detection of the carious lesion at the earliest possible stage so the process can be reversed or arrested before cavitation and subsequent restoration is needed. Thus, the accurate detection and diagnosis of noncavitated carious lesions are high priorities. The most commonly used method for detecting carious lesions is visual-tactile inspection. This type of examination is not without its limitations, as research has demonstrated a high ability of clinicians to correctly identify sound tooth surface sites but a low ability to correctly identify carious lesion sites, especially sites demonstrating early stages of caries activity.[16,17] This could lead to a higher rate of surgical treatment than what is really necessary. In addition, the technique of using a sharp dental explorer pushed into the pits and fissures of the tooth surface to check for "stickiness" is controversial, as the potential to cause an opening (cavitation) in the enamel surface is high, thus allowing for the penetration of pathologic bacteria. It has been suggested that a more appropriate use of the dental explorer is to use it to remove plaque from the examination area and to determine surface roughness of noncavitated lesions by gently moving the explorer across the tooth surface.[18] Bitewing radiographs are the current standard for examination of the

approximal surfaces, used because these surfaces cannot be accessed for assessment using direct visual or tactile methods. However, one of the important caveats in using radiographs for lesion detection is the fact that a radiograph will not give information about lesion activity. If a lesion is small and not progressing, depending on the situation, there may not be clinical value in restoring the lesion. Traditional radiographic images also tend to underestimate the actual lesion depth and cannot accurately identify early enamel carious lesions.[19] Some clinicians are starting to use temporary elastic tooth separation to visually confirm the status of the approximal lesion in question. In contrast to the usefulness of the bitewing radiograph on the approximal surface, it is not very helpful in detecting early occlusal lesions because of the superimposition of multiple enamel surfaces. It is important to remember that caries lesion detection is site specific requiring different methodologies.

Dental Caries Detection and Diagnostic Technology

In response to these restrictions in detection and diagnosis of dental caries disease, new technologies have been developed. Digital radiography has been shown to provide a slight but not statistically significant advantage in lesion detection compared with traditional film radiography.[20,21] Noninvasive, non-radiation, light-emitting technologies have been developed that are designed to serve as adjuncts to the traditional visual-tactile methods of detection. Some of these technologies include fiber-optic transillumination (FOTI and DIFOTI), electronic caries monitor, quantitative light-induced fluorescence, diode laser fluorescence, and LED light reflectance and refraction. While many of these technologies tout higher precision in carious lesion detection than traditional visual-tactile and radiographic means, it is important for clinicians to not rely solely on these modalities and to continue to use their clinical experience and judgment in their diagnosis.[22]

Despite advances, the reliable and reproducible detection of carious lesions by clinical examination continues to be a challenge for both clinicians and researchers. In response to the lack of a universally accepted carious lesion detection system, a group of cariologists and epidemiologists created the International Caries Detection Assessment System (ICDAS) in 2002 in Scotland.[23] This visual system was developed as a detection system for occlusal carious lesions, with a two-digit coding system: The first digit (0-9) identifies the tooth status, and the second digit (0-6) describes the severity of the carious lesion (Table 2). ICDAS has been shown to be a valid system for describing and measuring different degrees of severity of carious lesions as well as having a significant correlation between lesion depth and histological examination.[24-26] The examination protocol requires plaque to be removed from tooth surfaces prior to inspection, which can be accomplished using a toothbrush or a prophy cup/brush. Initially the tooth is assessed wet and then dried for approximately five seconds. To confirm visual detection, a ball-end probe rather than a sharp explorer may be used gently across the surface to confirm the loss of surface integrity.

Risk Factors

Caries risk factors are described as biological reasons that cause or promote current or future caries disease. Risk factors traditionally have been associated with the etiology of disease. Due to their pathologic nature, risk factors can also serve as an explanation of what could be corrected in order to improve the imbalance that exists when disease is present.[15] The CAMBRA philosophy identifies nine risk factors (Table 1) that are outcome measures of the risk for current or future caries disease, and each of these is supported with research.[12,14] The Caries Imbalance model uses the acronym "BAD" to describe three risk factors that are supported in the literature as causative for dental caries:

- Bad bacteria, meaning acidogenic, aciduric or cariogenic bacteria
- Absence of saliva, meaning hyposalivation or salivary hypofunction
- Destructive lifestyle habits that contribute to caries disease, such as frequent ingestion of fermentable carbohydrates, and poor oral hygiene (self care)

Bacteria

Not all oral bacteria are pathologic, but when large numbers of cariogenic bacteria reside in plaque biofilm and adhere to the tooth surface, ingested sugars from fermentable carbohydrates are converted to weak organic acids that will cause demineralization of the hydroxyapatite structure. Since dental caries disease is bacteria-driven and because carious lesions are late-stage symptoms of the disease, the evaluation of microbiological findings would assist clinicians in implementing early interventions to help prevent or arrest the disease. Contemporary studies have shown a distinct difference between the microflora of healthy, caries-free individuals compared to the microflora of those with dental caries.[27,28] Although mutans streptococci (MS) are part of the normal oral flora, under certain conditions they will become dominant, causing dental caries disease.[29] MS are of particular interest in the caries disease process because of their unique ability to produce both intra- and extracellular polysaccharides that help with acid production and survival during low-nutrition periods, as well as adherence to smooth surfaces.[30-32] The other bacteria species of interest in dental caries disease is lactobacilli (LB). LB

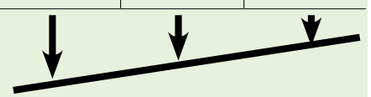
Table 1.

Caries Risk Assessment Form — Children Age 6 and Over/Adults

Patient Name: _____ Chart #: _____ Date: _____

Assessment Date: Is this (please circle) base line or recall

Disease Indicators (Any one "YES" signifies likely "High Risk" and to do a bacteria test)**	YES = CIRCLE	YES = CIRCLE	YES = CIRCLE
Visible cavities or radiographic penetration of the dentin	YES		
Radiographic approximal enamel lesions (not in dentin)	YES		
White spots on smooth surfaces	YES		
Restorations last 3 years	YES		
Risk Factors (Biological predisposing factors)		YES	
MS and LB both medium or high (by culture**)		YES	
Visible heavy plaque on teeth		YES	
Frequent snack (> 3x daily between meals)		YES	
Deep pits and fissures		YES	
Recreational drug use		YES	
Inadequate saliva flow by observation or measurement (**If measured, note the flow rate below)		YES	
Saliva reducing factors (medications/radiation/systemic)		YES	
Exposed roots		YES	
Orthodontic appliances		YES	
Protective Factors			
Lives/work/school fluoridated community			YES
Fluoride toothpaste at least once daily			YES
Fluoride toothpaste at least 2x daily			YES
Fluoride mouthrinse (0.05% NaF) daily			YES
5,000 ppm F fluoride toothpaste daily			YES
Fluoride varnish in last 6 months			YES
Office F topical in last 6 months			YES
Chlorhexidine prescribed/used one week each of last 6 months			YES
Xylitol gum/lozenges 4x daily last 6 months			YES
Calcium and phosphate paste during last 6 months			YES
Adequate saliva flow (> 1 ml/min stimulated)			YES
****Bacteria/Saliva Test Results: MS: LB: Flow Rate: ml/min. Date:**			



VISUALIZE CARIES BALANCE
(Use circled indicators/factors above)
(EXTREME RISK = HIGH RISK + SEVERE SALIVARY GLAND HYPOFUNCTION)
CARIES RISK ASSESSMENT (CIRCLE): EXTREME HIGH MODERATE LOW

Doctor signature/#: _____ Date: _____

From: Featherstone JD, Domejean-Orliaguet S, Jenson L, Wolff M, Young DA. Caries risk assessment in practice for age 6 through adult. J Calif Dent Assoc. 2007;35(10):703-713. Reprinted with permission from the California Dental Association.

Table 2. Description of ICDAS scores

Restoration and Sealant Codes	Carious Lesion Codes
0 = Not sealed or restored	0 = Sound tooth surface, no or slight change after prolonged air drying
1 = Sealant, partial	1 = First visual change in enamel seen after prolonged air drying
2 = Sealant, full	2 = Distinct visual changes in enamel
3 = Tooth-colored restoration	3 = Localize enamel breakdown, no dentin involvement
4 = Amalgam restoration	4 = Underlying dark shadow from dentin (not cavitated into dentin)
5 = Stainless steel crown	5 = Distinct cavity with visible dentin
6 = Porcelain, gold, PFM crown or veneer	6 = Extensive distinct cavity with visible dentin
7 = Lost or broken restoration	
8 = Temporary restoration	

constitute an acidogenic (acid-producing) and aciduric (thriving in acid) group of microorganisms associated with dental caries. LB prefer to live in low-pH niches that are difficult to clean and near plaque biofilm accumulation.[33] They are often found in the deep parts of the carious lesion and are now considered more involved in the progression of the already-established lesion.[34,35] LB are more resistant to bacteria-reducing substances than are MS. LB are somewhat fluoride-resistant, with fluoride not showing the same effect on its metabolism.[33] It should not be surprising that there is a significant correlation between carious lesions and the LB count in both adults and children.[36]

Bacterial Testing

Medium to high levels of MS and LB are considered caries risk factors (Table 1). Studies have found a correlation between MS levels in plaque biofilm and MS levels in saliva.[36,37] It has been shown that if saliva contains high bacterial counts, so does the plaque biofilm. High bacterial counts in saliva correlate to $>10^3$ colony-forming units (CFUs) of MS in plaque biofilm.[38] Chairside tests to help clinicians quantify MS and LB in saliva have been available for several decades, with current CAMBRA principles recommending culture-based methods of quantification.[12] Culture-based methods require the agar medium to be thoroughly coated with the patient's saliva and then incubated for 48-72 hours. Test results are then evaluated against manufacturer directions. Findings higher than 10^5 CFU of MS and/or LB indicate a high risk for future caries disease.[39,40]

Several culture-based methods are commercially available. The CRT® bacteria caries risk test is sensitive enough to provide information about a level of low, medium or high cariogenic bacterial challenge.[12] This test contains an agar carrier, with one side of the carrier containing blue Mitis Salivarius (MS) Agar with bacitracin, used to detect MS, while the other side contains MRS agar, used to evaluate LB. On completion of the process, the vial used is removed and opened, and the agar carrier is then evaluated using a chart. MS appear as small blue colonies with a diameter of <1mm on the blue agar, while LB appear as white colonies on the transparent green agar. Findings higher than 10^5 CFU of MS and/or LB indicate a high risk for future caries disease.[39,40] A modification of the procedure also allows for a determination of MS in the plaque biofilm and the LB count in plaque biofilm using a similar method.

While culture-based laboratory bacterial testing is often considered the gold standard, chairside saliva tests have been developed and are now available. There is now a monoclonal antibody test (similar to a pregnancy test) that uses a specific immunochromatography process that selectively detects the S. mutans species. The patient's saliva is placed into the test strip and within 15 minutes, the results will indicate the presence or absence of high counts of S. mutans (500,000 CFU/ml of saliva).[41] Another chairside test available to clinicians is a simple one-minute test that uses adenosine triphosphate (ATP) bioluminescence to identify oral bacterial load. Special swabs are used to swab the patient's mouth from canine to canine on the mandibular lingual region and then combined with special bioluminescence reagents. The swab is then placed in a handheld meter that measures the ATP reaction. High ATP values (>1,500-9,999) correlate to total bacteria and oral streptococci present and high caries risk.[42]

The newest plaque hypothesis purports that MS and LB can be present in the oral environment in numbers not high enough to cause disease. Disease will result only when there is a shift in the homeostatic balance of the resident microflora due to a change in local environmental conditions (such as pH) that favor the growth of pathogens.[9] Further, in the presence of low pH, the non-MS bacteria and the normally non-pathogenic bacteria can adapt to produce acid that then causes a shift to a more overall acidogenic plaque biofilm.[10] While there is no exact pH at which demineralization begins, the general range of 5.5 to 5.0 is considered critical for enamel mineral to dissolve, while for dentin and cementum a pH range of 6.7 to 6.2 is necessary. As demineralization progresses, so does the carious lesion. Both quantity and quality of saliva, therefore, are critical to the development and progression of dental caries disease.

Saliva

While bacteria play an important role in dental caries disease, the oral environment is regulated via the influence of the salivary glands. Except for during meal times and the occasional drink, saliva is the only fluid in the mouth. Consequently, the characteristics of saliva have a direct impact on the oral environment and on the growth and survival of cariogenic bacteria. Saliva contains electrolytes such as sodium, potassium, calcium, magnesium, bicarbonate and phosphate, as well as immunoglobulins, proteins, enzymes, mucins, urea and ammonia.[43] These components help modulate the bacterial attachment in plaque biofilm, the pH and buffering capacity of saliva, antibacterial properties, and tooth surface remineralization and demineralization. These components give saliva its overall quality and protective character and demonstrate its role as the most valuable oral fluid.[6]

Salivary gland hypofunction, or hyposalivation, is the condition of having reduced saliva production, and it differs from xerostomia, which has been referred to as oral dryness, including the patient's perception of oral dryness.[44] With hyposalivation, there is less saliva in contact with the tooth surface, reducing the number of calcium and phosphate ions that together with fluoride enhance remineralization. Without adequate saliva, there is longer oral clearance of sugary or acidic foods and less urea is available to help raise plaque biofilm pH.[45] Besides increased caries risk, salivary hypofunction leads to a plethora of other problems affecting the patient's quality of life, including dental erosion, ulceration of mucosal tissues, dysphagia (difficulty swallowing), dysgeusia (taste impairment), oral malodor, impaired use of removable prosthesis and candidiasis.[46] The best way to determine if hyposalivation is present is to measure salivary flow.

Salivary flow rate is determined by measuring either resting saliva (RS) or stimulated saliva (SS) produced in a given period of time. The patient is advised to not eat or drink at least one hour prior to the test. RS is unstimulated saliva and is measured by having the patient seated comfortably in a quiet, private setting with his or her eyes open and head tilted slightly forward. Instruct the patient to let the saliva drool into a collection receptacle for four minutes. SS is a more practical way to measure salivary flow. An unflavored wax pellet is provided to the patient to chew for five minutes. All saliva produced during this time is collected and measured, which means the patient is chewing and spitting during the test time. Dividing the amount of saliva produced by the total time provides the flow rate. An RS salivary flow rate of less than 0.1 ml/min and a SS salivary flow rate of less than 0.7 ml/min are indicative of hyposalivation.

Determining saliva's overall quality, including flow rate, viscosity, RS and SS pH, and buffer capacity will also assist clinicians in decision making regarding preventive or therapeutic interventions as well as patient education related to saliva imbalance. There are easy-to-use chairside tests available to evaluate saliva quality. These tests measure resting flow rate and resting salivary pH, salivary consistency (viscosity), stimulated salivary flow rate and pH, and buffer capacity. Checking for saliva buffering capacity is critical to understand the ability of the saliva to minimize acid challenges. A high salivary buffering capacity may result in an elevated surface pH of the enamel crystal, resulting in favorable conditions for mineral uptake and remineralization.[47]

Diet

Diet affects the pH, quantity and quality (composition) of saliva. Sugar (sucrose) and other fermentable carbohydrates, after being broken down by salivary enzymes, provide a substrate for oral bacteria to thrive and, in turn, lower salivary and plaque biofilm pH.[48] It has long been understood that the development of a carious lesion is dependent upon this decrease in plaque pH, which occurs as a result of the metabolism of dietary carbohydrates by oral bacteria.[49] Fermentable carbohydrates are those that begin digestion in the oral cavity through breakdown by salivary enzymes and then may be fermented by oral microflora. Simple sugars such as sucrose, fructose and glucose are more cariogenic than are more complex carbohydrates.[6]

The physical properties of food and the frequency of eating influence the cariogenicity of the patient's diet. The texture, consistency and temperature of food can affect mastication and oral clearance from the mouth. Oral sugar clearance is the reduction in the concentration of sugar in saliva over time and has been shown to be a strong predictor of the prevalence of dental caries disease.[50] Likewise, the frequency of consumption, especially regular snacking or sipping of foods and beverages, can promote dental caries.

It is important for the clinician to realize that what patients eat is influenced by many factors, including socioeconomic status, culture, ethnicity, food cost, food availability, advertising and marketing.[51] Having knowledge about patients' dietary behaviors, especially those associated with caries risk, is important when developing interventions. At a minimum, clinicians should assess for diet-related risk factors such as the amount and frequency of sugar and fermentable carbohydrate intake, including acidic beverages or candies, and make recommendations for sugar substitutes and health-promoting snacks and meals.[52,53] Not only should the moderation of sugar be included in counseling patients and caregivers, but moderate salt and fat intake to achieve adequate growth and development should be advocated, and clinicians can suggest that patients follow the dietary guidelines outlined by the United States Department of Agriculture via the easy-to-navigate and free MyPyramid website. Recommendations for healthy snacks related to oral health will also aid patients in reducing their risk for dental caries disease.

Protective Factors

Caries protective factors are biologic or therapeutic measures that can be used to prevent or arrest the pathologic challenges posed by the caries risk factors. The higher the severity of the risk factors, the greater the intensity of protective factors must be in order to reverse the caries process.[15] These protective factors include a variety of products and interventions that will enhance remineralization and keep the balance between pathology and protection of the patient's oral health. Protective factors also include living in a community with fluoridated water; regularly using fluoridated toothpastes, low-fluoride oral rinses and xylitol; and receiving topical applications of fluoride, chlorhexidine and calcium phosphate agents (Table 1). The Caries Imbalance model uses the acronym "SAFE" to describe the following four protective factors:

- Saliva and sealants
- Antimicrobials or antibacterials (including xylitol)
- Fluoride and other products that enhance remineralization
- Effective lifestyle habits

Best practices dictate that once the clinician has identified the patient's caries risk (low, moderate, high or extreme), a therapeutic and/or preventive plan should be implemented. Clinical intervention protocols have been developed based on research, and individualized treatment options should be presented to the patient. Evidence-based clinical guidelines were developed in 2007, and with the pediatric protocols recently updated in 2010, to help clinicians plan and implement effective caries management for any patient[54,55] (Table 3).

Several of these protective agents are used off-label, meaning their use in caries management is not cleared for marketing by the Food and Drug Administration (FDA). While dental professionals are not regulated by the FDA, manufacturers are, and dissemination of off-label information about an FDA-regulated product is limited. If an individual dental professional decides to use a product off-label, he or she must first ascertain that the product is effective and safe for the intended use.

Saliva and Sealants

The protection that saliva provides to the oral cavity is often overshadowed by the emphasis on oral disease. An evaluation of the quantity and quality of saliva should be conducted on all patients at the initial exam and then periodically assessed for changes. At a minimum, during the clinical examination, the viscosity and flow should be evaluated. Saliva is 99% water and should look like water, not thick and stringy or frothy and bubbly.[43] A quick and simple test to confirm function and duct patency is to "milk" one of the major glands, such as the parotid or submandibular gland. Massage or squeeze the duct until saliva is expressed. If it takes longer than one minute to express saliva from the duct or the clinician is unable to express any saliva, this could indicate salivary hypofunction. At this time there is an opportunity to test the pH of the expressed saliva by using a simple piece of litmus paper. Healthy saliva pH should measure no lower than 6.6.[56] According to the CAMBRA clinical guidelines, saliva testing, including bacterial testing, is suggested at baseline for all new patients and if high levels of bacteria are suspected for patients who are at moderate risk for dental caries disease. High- and extreme-risk patients should have saliva testing conducted at every recare examination, provided they still have some functioning of the salivary glands.[54]

Compared to the total levels of calcium and phosphate in enamel, healthy saliva is supersaturated with these minerals. As the pH drops from bacterial acid challenges, the level of supersaturation of the calcium and phosphate also drops and the risk of demineralization increases. At the same time, the remineralization process redeposits calcium and phosphate ions back into the damaged tooth mineral to form new dental mineral that is stronger and more resistant to future acid challenges than the original tooth surface.[57]

Sealants are universally recognized as an evidence-based method to boost the tooth's resistance to carious lesions in pits and fissures of teeth. As long as the pits and fissures remain filled with sealant material, carious lesions will not occur, so it is critical that clinicians include sealant retention evaluation at the patient's periodic examination.[58] Both unfilled and filled resin materials are available, and there are many sealant choices available in the marketplace. Fluoride-releasing sealants are gaining in popularity, with the premise that the low level of fluoride released from the sealant will assist with remineralization in the oral cavity and help prevent carious lesion formation at sealant margins.[59] Glass ionomer cements may also be used as a sealant, and it has been suggested that due to their fluoride-releasing and hydrophilic nature, they are especially suitable for partially erupted teeth when a dry working field cannot be obtained.[60] Because of their poor retention rate compared with that of resin-based sealants, glass ionomer sealants need to be closely monitored and their use be limited to a transitional sealant on tooth surfaces that cannot be adequately isolated to place a resin-based sealant.[59,60] CAMBRA clinical guidelines recommend that the placement of sealants be based on the risk of the patient, and resin-based sealants and glass ionomers are optional for patients at lower risk for caries. For moderate-, high- and extreme-risk caries patients, pit and fissure sealants are recommended, with the new pediatric guidelines published in 2010 emphasizing the use of fluoride-releasing sealants for deep pits and fissures.[54,55]

Antimicrobials

Antimicrobial agents destroy or suppress the growth or multiplication of microorganisms, including bacteria. CAMBRA clinical guidelines recommend the use of antimicrobials for patients over six years of age who are classified as being at high or extreme risk for caries, and for caregivers of noncompliant moderate through extreme risk children under the age of six.[54,55] Antimicrobials require repeated applications at various intervals, depending on the agent. Chlorhexidine gluconate rinse has been widely studied, and in addition to being FDA-approved to treat gingivitis, when used off-label as a 30-second rinse every day of the first week of every month, it is effective in reducing the levels of MS bacteria but is not as effective against LB.[61] In the United States, chlorhexidine gluconate rinse is available as a 0.12% rinse with or without alcohol. The use of 0.12% chlorhexidine gluconate rinse in caries management is not without controversy, and the long-term effects of bacteria suppression have been questioned.[62] Long-term use of chlorhexidine rinse can lead to discoloration of teeth, the

Table 3. Clinical guidelines

RISK CATEGORY	RECARE EXAM	RADIOGRAPHS	SALIVA TESTING	FLUORIDE	XYLITOL	ANTIMICROBIALS, i.e., Chlorhexidine	CALCIUM PHOSPHATE	SEALANTS (Resin-based & Glass Ionomers)	pH Neutralizing
LOW	6+: Every 6-12 months <6: Annual	6+: BWX every 24-36 months <6: BWX every 12-24 months	6+ & <6: Optional at baseline exam	6+ Home: OTC toothpaste 2x daily 6+ In-office: F varnish optional <6 Home: OTC toothpaste; no in-office fluoride	6+ & <6: Optional	6+: If required <6: No	6+ & <6: If required Optional for root sensitivity (adults)	6+: Optional on sound tooth surfaces <6: Optional on sound tooth surfaces	6+: If required <6: No
MODERATE	6+: Every 4-6 months <6: Every 3-6 months	6+: BWX every 18-24 months <6: BWX every 6-12 months	6+ & <6: Recommended at baseline and recare exams	6+ Home: OTC toothpaste 2x day + OTC 0.05% NaF rinse daily 6+ In-office: Initially 1-3 applications F varnish & at recare appt. <6 Home: OTC toothpaste 2x day <6 In-office: F varnish initial visit & recare Caregiver: OTC NaF rinse	6+: 6-10 grams/day <6: Xylitol wipes & substitute for sweet treats or when unable to brush Caregiver: 2 sticks of gum or 2 mints 4x day (in total 6-10 grams of xylitol per day)	6+: If required <6: Recommend for caregiver	6+: If required Optional for root sensitivity (adults) <6: Brush with smear (0-2 yrs) or pea size (3-6 yrs) 1x day, leave on at bedtime	6+: Optional on sound tooth surfaces <6: Fluoride-releasing sealants or glass ionomers on deep pits and fissures	6+: If required <6: No
HIGH 1 or more cavitated lesions is considered high risk	6+: Every 3-4 months <6: Every 1-3 months	6+: BWX every 6-18 months <6: Anterior PAX & BWX every 6-12 months	6+ & <6: Required at baseline and recare exams	6+ Home: 1.1% NaF toothpaste 2x day 6+ In office: Initially 1-3 applications F varnish & at recare appt. <6 Home: OTC toothpaste 2x day <6 In-office: F varnish initial visit & recare Caregiver: OTC NaF rinse	6+: 6-10 grams/day <6: Xylitol wipes & substitute for sweet treats or when unable to brush Caregiver: 2 sticks of gum or 2 mints 4x day	6+: 0.12% CHX gluconate 10 ml rinse for 1 minute/day for one week each month Antimicrobial therapy should be done in conjunction with restorative treatment as needed <6: Recommend for caregiver	6+: If required <6: Brush with smear (0-2yrs) or pea size (3-6 yrs) 1x day, leave on at bedtime	6+: Recommended <6: Fluoride-releasing sealants or glass ionomers on deep pits and fissures	6+: If required <6: No
EXTREME (High risk plus dry mouth or special needs) 1 or more cavitated lesions plus hyposalivation is considered extreme risk	6+: Every 3 months <6: Every 1-3 months	6+: BWX every 6 months <6: Anterior PAX & BWX every 6-12 months	6+ & <6: Required at baseline and recare exams	6+ Home: 1.1% NaF toothpaste 1-2x day & 0.05% NaF rinse when mouth feels dry & especially after eating or snacking 6+ In office: Initially 1-3 applications F varnish & at recare appt. <6 Home: OTC toothpaste 2x day <6 In office: F varnish initial visit & recare Caregiver: OTC NaF rinse	6+: 6-10 grams/day <6: Xylitol wipes & substitute for sweet treats or when unable to brush Caregiver: 2 sticks of gum or 2 mints 4x day	6+: 0.12% CHX gluconate 10 ml rinse for 1 minute/day for one week each month Antimicrobial therapy should be done in conjunction with restorative treatment <6: Recommend for caregiver	6+: Apply paste several times daily <6: Brush with smear (0-2yrs) or pea size (3-6 yrs) 1x day, leave on at bedtime	6+: Recommended <6: Fluoride-releasing sealants or glass ionomers on deep pits and fissures	6+: Acid neutralizing rinses/gum/mints if mouth feels dry, after breakfast, snacking, & at bedtime <6: No

Adapted from: Jenson L, Budenz AW, Featherstone JDB, Ramos-Gomez FJ, Spolsky VW, Young DA. Clinical protocols for caries management by risk assessment. J Calif Dent Assoc. 2007;35(10):714-723.

Ramos-Gomez F, Crystal YO, Ng MW, Crall JJ, Featherstone JDB. Pediatric dental care: prevention and mangaement protocols based on caries risk assessment. J Calif Dent Assoc. 2010;38(10):746-761.

mucous membrane, the tongue and composite restorations; it can also lead to taste disturbances. These undesirable side effects can be avoided by using a chlorhexidine-containing varnish. Chlorhexidine varnish, approved for desensitization in the United States, has also been shown to be effective against cariogenic bacteria, especially the highly susceptible S. mutans. It has been concluded that the most persistent reductions of MS have been achieved by chlorhexidine varnishes. Chlorhexidine gels are the next most efficacious, followed by oral rinses for patients at moderate to extreme risk.[63] It has been shown that a 1% chlorhexidine diacetate and 1% thymol varnish (Cervitec® Plus, Ivoclar Vivadent), when applied and dried, contains approximately 10% chlorhexidine and 10% thymol and has been found in a systematic review to have a higher efficacy than other chlorhexidine varnishes.[63] The side effects seen with chlorhexidine rinses are not seen with chlorhexidine varnishes, and the application of the varnish is easy and moisture-tolerant. It has also been shown to reduce the incidence of root carious lesions in a geriatric population.[64,65] The application of chlorhexidine varnish every three to four months may be a more viable option than the use of chlorhexidine rinses, especially for caregivers of children.

Xylitol

CAMBRA clinical guidelines recommend the use of xylitol to control the cariogenic bacteria S. mutans for patients over six years of age who are classified as being at moderate to extreme risk for caries.[54] For children under six, xylitol wipes and xylitol products to replace sugary treats are recommended for children and all others who are classified as being at moderate to extreme risk, including caregivers.[55]

Xylitol has been well-studied, and it is generally accepted that this naturally occurring sugar alcohol reduces the amount of MS and the quantity of plaque biofilm when habitually consumed.[66,67] Studies have also demonstrated that habitual consumption of xylitol by caregivers of young children has halted or slowed the transmission and colonization of MS.[68] Xylitol is dose-dependent, and the minimum amount needed to provide a beneficial effect on the plaque biofilm has been shown to be 5-6 grams/day, divided into three to four doses, for no shorter than 5-10 minutes per exposure.[67] Currently, it is suggested that no more than 6 to 10 grams/day be ingested as the effects of xylitol plateau between 6.44 g and 10.32 g xylitol/day.[69] The 2007 clinical guidelines for patients over 6 years of age recommend no more than 6-10 grams/day of xylitol.[54] Clinicians need to know the amount of xylitol present in the products being recommended, as it varies considerably. Simply telling a patient or caregiver to use xylitol gum or mints three to four times a day may not deliver the minimum amount shown to be effective.

Fluoride

The use of fluoride has been the cornerstone of prevention, and fluoridated toothpaste remains the most common and cost-effective form of dental caries control. A Cochrane Review on fluoride confirmed the benefits of daily toothbrushing with fluoridated toothpaste as a means to decrease dental caries, and for preventing caries in children and adolescents, toothpastes of at least 1,000 ppm fluoride should be used.[70] For very young children, when brushing with concentrations greater than 1,000 ppm fluoride, a risk-benefit decision needs to be discussed with caregivers regarding the development of mild fluorosis. While research emphasizes the positive use of fluoridated toothpaste, other topical fluoride modalities such as mouth rinses, gels and varnishes have also been studied and their effectiveness has been confirmed.[71] The American Dental Association Council on Scientific Affairs developed evidence-based clinical guidelines for professional topical application of fluorides that have endorsed the use of in-office fluoride gels and fluoride varnishes.[72] As with chlorhexidine varnish, the use of fluoride varnish for caries management is considered off-label, as it is cleared for marketing by the FDA for the treatment of dentin hypersensitivity associated with the exposure of root surfaces. The use of 5,000 ppm prescription fluoride toothpaste and home-use fluoride rinses has also been recommended.

Fluoride varnish is a concentrated topical fluoride designed to stay in close contact with the tooth surface for hours, enhancing fluoride uptake during the early stages of demineralization. Because of the large amount of fluoride that can be deposited in the demineralized enamel, varnishes are effective when used on early white spot lesions. The caries preventive efficacy of fluoride varnish is well-studied, and has been found in a systematic review to be more effective than traditional topical fluoride gels.[70] Its ease of use and relative safety make it suitable for prevention in community-based dental programs. Most fluoride varnishes in the United States are 5% sodium fluoride (22,600 ppm fluoride ions), and several products offer single-unit-dose application, keeping the delivery cost-effective. Recently, manufacturers have added amorphous calcium phosphate or tricalcium phosphate to enhance remineralization and fluoride uptake (Enamel Pro® varnish, Premier Dental; Vanish™ with TCP, 3M ESPE). Another effective fluoride varnish contains 0.9% difluorosilane in a polyurethane base with ethyl acetate and isoamylpropionate solvents (Fluor Protector, Ivoclar Vivadent) and is equivalent to 0.1%, or 1,000 ppm in solution. As the solvents evaporate, the concentration of the fluoride at the tooth surface will rise, resulting in effective fluoride binding and uptake.[73] In addition, the viscosity of this varnish allows it to flow easily on the tooth surface. The ADA's clinical guidelines suggest that applications of fluoride varnish two to four times per year are effective in reducing carious lesions in children and adolescents who are at high risk for caries, and the CAMBRA clinical guidelines recommend a frequency of application of fluoride varnish as indicated by the patient's caries risk[54,55,72] (Table 3).

Effective Lifestyle Habits

While the use of fluoride has decreased the need for strict dietary control of sucrose, dental caries disease does not occur in the absence of dietary fermentable carbohydrates. Reducing the amount and frequency of sugar consumption, including the "hidden sugars" in many processed foods, continues to be important for patients at high risk for caries.[74]

Consuming foods or snacks that do not promote carious lesion formation or progression would be ideal for patients at risk for dental caries. Hard cheese has been shown to coat teeth with a lipid layer, protecting surfaces from acid attack.[74] Emerging science suggests increasing arginine-rich proteins in the diet, as it has been shown that consumption of these foods can rapidly increase plaque pH.[75-77] Arginine-rich proteins include a variety of nuts (peanuts, almonds, walnuts, cashews, pistachios), seeds (sunflower, pumpkin, squash), kidney beans, soybeans, watermelon and tuna. Ammonia production from arginine and urea metabolism has been identified as the mechanism by which oral bacteria are protected against acid killing, and it maintains a relatively neutral environmental pH that may suppress the emergence of a more cariogenic microflora.

Dental products that can assist in neutralizing acid and encourage an on-acidic environment include sodium bicarbonate products that can be found in commercially available toothpastes and rinses. The use of baking soda rinses has been suggested to neutralize an acidic oral environment. Chewing gum, especially high-dose xylitol gum, can raise plaque pH and reduce MS at the same time.[78] Calcium phosphate products have also been shown to raise plaque pH in addition to delivering bioavailable calcium and phosphate to the tooth surface to enhance remineralization.[79] A variety of calcium phosphate technologies are currently available, including amorphous calcium phosphate (ACP), casein phosphopeptide-amorphous calcium phosphate (CPP-ACP), calcium sodium phosphosilicate and tricalcium phosphate (TCP). The use of most calcium phosphate products is considered off-label because most of these products are accepted by the FDA as tooth-polishing or desensitizing ingredients only rather than as agents of remineralization. Sugar-free chewing gum with CPP-ACP has been shown to increase remineralization by approximately 20% compared with plain, sugar-free gum.[80] Calcium phosphate therapy supports fluoride therapy and is not designed to replace the use of fluoride. For patients who have salivary hypofunction, including low or no flow, low pH, and poor buffering capacity, the use of these agents may be beneficial. CAMBRA clinical guidelines (>6 years old) suggest the use of calcium phosphate for patients with excessive root exposure or sensitivity and is recommended for use several times daily for patients classified as being at extreme risk.[54] For pediatric patients (0-6 years old), CAMBRA clinical guidelines suggest alternating brushing between toothpaste and calcium phosphate, leaving the latter on at bedtime for patients classified as noncompliant and at moderate to extreme risk[55] (Table 3).

For those patients with high or extreme risk, a power toothbrush may be beneficial. While most research concerning power toothbrushes focuses on the ability of the brush to remove plaque biofilm, recent research has shown that power toothbrushes may be helpful in the delivery and retention of fluoride. Recent research has shown that one sonic toothbrush enhances fluoride effects on the plaque biofilm, causing increased fluoride delivery and retention at the tooth surface.[81] In addition, for patients at extreme risk (demonstrating hyposalivation, or reduced salivary flow), the sonic power toothbrush has been shown to increase salivary flow and decrease the numbers of incipient and frank root caries, as compared to a manual toothbrush.[82,83]

Patient adherence to the recommendations made by the dental professional is critical to successful implementation of these caries protective factors. It is well-understood among dental professionals that adherence and motivation are issues for many patients, and lack of adherence or noncompliance affects outcomes across all dental disciplines. The ability of the clinician to motivate the patient to make positive behavior change is crucial. One technique gaining popularity among patient-centered clinicians is motivational interviewing. The main focus of motivational interviewing is to help the patient overcome ambivalence to behavior change. This is achieved through focusing on what the patient feels, wants and thinks, and involves the patient speaking and the clinician listening. The strategies involved in motivational interviewing are more persuasive and supportive than coercive and argumentative and are designed to tap into the patient's intrinsic motivation rather than being imposed extrinsically.[84] Motivational interviewing with parents of pediatric patients has been shown to be more effective in reducing the number of carious lesions and has more of a protective effect compared to traditional educational counseling methods.[85,86]

Conclusion

Multiple factors, such as the interaction of bacteria, diet and host response, influence dental caries initiation, progression and treatment. Time has proven that this disease cannot be controlled by restoration alone. Assessment of the caries risk of the individual patient is a critical component in determining an appropriate and successful management strategy. CAMBRA supports clinicians in making decisions based on research, clinical expertise, and the patient's preferences and needs. Motivating patients to adhere to recommendations from their dental professional is also an important aspect in achieving successful outcomes in caries management. Along with fluoride, new products are available to assist clinicians with noninvasive management strategies. While research exists for these newer preventive intervention and clinical guidelines, more in vivo clinical trials are needed to establish their true clinical relevance. This does not mean that clinicians should not consider these products, strategies and guidelines but rather that they should carefully weigh the benefits and risks of recommending these

products for their patients. Best practices are an evolving approach to exceptional patient care, and CAMBRA offers clinicians the ability to apply the most relevant, research-based and helpful interventions to real-life practice.

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Michelle Hurlbutt is an Assistant Professor in the Department of Dental Hygiene, Loma Linda University School of Dentistry where she teaches pharmacology and nutrition courses. She is also the Director of Loma Linda University's online BSDH degree completion program, where she teaches research and cariology courses. Michelle is the 2010-2011 co-chair of the Western CAMBRA Coalition.

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Questions

1. According to the National Health and Nutrition Examination Survey (1999-2004), _____ of children aged 2-11 have had carious lesions in their primary teeth.
   a. 22%
   b. 32%
   c. 42%
   d. 52%
2. The predominant cause for all restorative treatments performed on previously restored teeth is _____.
   a. cuspal fracture
   b. recurrent caries
   c. endodontic therapy
   d. none of the above
3. Approximately _____ of adolescents aged 12-19 have experienced dental caries, and by adulthood well over _____ of those surveyed have experienced dental caries in their permanent dentition.
   a. 39%; 62%
   b. 59%; 82%
   c. 59%; 92%
   d. 49%; 92%
4. CAMBRA is an acronym for _____.
   a. caries mitigation by risk assessment
   b. caries management by risk assessment
   c. caries management by reducing affectors
   d. none of the above
5. The caries process is dependent upon the _____.
   a. interaction of protective and pathologic factors in plaque biofilm
   b. interaction of protective and pathologic factors in saliva
   c. the balance between the cariogenic and noncariogenic microbial populations that reside in saliva
   d. all of the above
6. Caries risk assessment (CRA) _____.
   a. is a critical component of dental caries management
   b. should be included as part of the dental examination
   c. should be considered a standard of care
   d. all of the above
7. Caries risk assessment forms can be downloaded from the _____ website.
   a. American Dental Association
   b. American Academy of Pediatric Dentistry
   c. California Dental Association Foundation
   d. all of the above
8. Caries disease indicators _____ .
   a. are physical signs of the presence of current or past dental caries disease and activity
   b. speak to what initially caused the disease and how to treat it
   c. serve as strong predictors of dental caries continuing unless therapeutic intervention is implemented
   d. a and c
9. With respect to the use of radiographs, the Caries Imbalance model considers _____.
   a. enamel approximal lesions (confined to enamel only) visible on dental radiographs
   b. occlusal caries visible on radiographs
   c. cavitation of carious lesions showing radiographic penetration into the dentin
   d. a and c
10. The CAMBRA philosophy advocates the detection of the carious lesion at the earliest possible stage so the process can be _____.
    a. reversed before cavitation
    b. arrested before cavitation
    c. contained with a restoration
    d. a and b
11. The dental explorer can be appropriately used _____.
    a. to remove plaque from the examination area
    b. by gently moving it across the tooth surface
    c. to determine surface roughness of noncavitated lesions
    d. all of the above
12. A traditional radiograph _____.
    a. will not give information about lesion activity
    b. will tend to underestimate the actual lesion depth
    c. cannot accurately identify early enamel carious lesions
    d. all of the above
13. New technologies developed for the detection of caries have included _____.
    a. digital radiography
    b. light-induced and diode laser fluorescence
    c. fiber-optic transillumination
    d. all of the above
14. The reliable and reproducible detection of carious lesions by clinical examination continues to be a challenge for _____.
    a. clinicians
    b. researchers
    c. no-one
    d. a and b
15. The International Caries Detection Assessment System was developed as a detection system _____.
    a. for occlusal carious lesions
    b. with a two-digit coding system
    c. that has been shown to have a significant correlation between lesion depth and histological examination
    d. all of the above

Questions

16. The Caries Imbalance model uses the acronym "BAD" to describe _____.
    a. bad bacteria
    b. absence of saliva
    c. destructive dietary habits
    d. all of the above

17. Contemporary studies have shown _____ difference between the microflora of healthy, caries-free individuals compared to the microflora of those with dental caries.
    a. no
    b. a minimal
    c. a distinct
    d. none of the above

18. Mutans streptococci _____.
    a. are part of the normal oral flora
    b. under certain conditions become dominant
    c. cause dental caries disease
    d. all of the above

19. Mutans streptococci have the unique ability to produce both intra- and extracellular polysaccharides that help with _____.
    a. acid production
    b. bacterial survival during low-nutrition periods
    c. adherence to smooth surfaces
    d. all of the above

20. Lactobacilli _____.
    a. prefer to live in low-pH niches
    b. are often found in the deep parts of the carious lesion
    c. are now considered more involved in the progression of the already-established lesion
    d. all of the above

21. Current CAMBRA principles recommend _____ methods of quantification.
    a. acid-based
    b. culture-based
    c. polysaccharide-based
    d. all of the above

22. With culture-based bacterial testing, _____.
    a. the agar medium must be thoroughly coated with the patient's saliva
    b. the agar medium must be incubated for 48-72 hours
    c. findings higher than 10^5 CFU of MS and/or LB indicate a high risk for future caries disease
    d. all of the above

23. With respect to chairside bacterial testing, _____ is available.
    a. a monoclonal antibody test that uses immunochromatography
    b. a simple one-minute test that uses ATP bioluminescence
    c. a modified radiographic test
    d. a and b

24. In the presence of _____, the normally nonpathogenic bacteria can adapt to produce acid that then causes a shift to a more overall acidogenic plaque biofilm.
    a. high pH
    b. neutral pH
    c. low pH
    d. all of the above

25. Enamel demineralization is generally considered to begin at a pH range of _____.
    a. 6.0-5.5
    b. 5.5-5.0
    c. 5.0-4.5
    d. none of the above

26. The Food and Drug Administration (FDA) regulates _____.
    a. dental professionals
    b. manufacturers
    c. patients
    d. all of the above

27. Dentin and cementum demineralization is generally considered to begin at a pH range of _____.
    a. 6.7-6.2
    b. 6.2-5.7
    c. 5.7-5.2
    d. none of the above

28. The oral environment is controlled exclusively by the _____.
    a. oral mucosa
    b. lifestyle factors
    c. salivary glands
    d. all of the above

29. Saliva contains _____.
    a. electrolytes
    b. immunoglobulins
    c. enzymes
    d. all of the above

30. Saliva _____.
    a. helps modulate the bacterial attachment in plaque biofilm and has antibacterial properties
    b. offers buffering capacity
    c. helps modulate tooth surface remineralization and demineralization
    d. all of the above

31. Salivary gland hypofunction _____.
    a. is the condition of having reduced saliva production
    b. does not refer to the patient's perception of dryness
    c. reduces the number of calcium and phosphate ions available
    d. all of the above

32. The best way to determine if hyposalivation is present is to measure _____.
    a. the acidity of the oral environment
    b. the bacterial count
    c. salivary flow
    d. all of the above

33. Salivary flow rate is determined by measuring _____ in a given period of time.
    a. resting saliva
    b. stimulated saliva
    c. a or b
    d. a and b

34. Having knowledge about patients' dietary behaviors is important when developing _____.
    a. restorations
    b. interventions
    c. family support groups
    d. all of the above

35. The caries preventive efficacy of fluoride varnish is well-studied, and has been found in a systematic review to be more effective than _____.
    a. traditional topical fluoride gels
    b. essential oils
    c. artificial sweeteners in general
    d. all of the above

36. In addition to effective dietary habits, the caries imbalance model describes _____ as protective factors.
    a. saliva and sealants
    b. antimicrobials or antibacterials
    c. fluoride and other products that enhance remineralization
    d. all of the above

37. Fluoride varnish is available containing _____.
    a. amorphous calcium phosphate
    b. tricalcium phosphate
    c. bicalcium phosphate
    d. a and b

38. _____ can assist in raising the pH.
    a. Chewing gum
    b. Baking soda rinses
    c. Calcium phosphate products
    d. all of the above

39. _____ has/have been found to be protective.
    a. Cheese
    b. Arginine-rich proteins
    c. Reducing the amount and frequency of sugar consumption
    d. all of the above

40. The remineralization process redeposits calcium and phosphate ions back into the damaged tooth mineral to form new dental mineral that is _____ the original tooth surface.
    a. stronger than
    b. more resistant to future acid challenges than
    c. the same as
    d. a and b

41. It has been suggested that _____ are especially suitable for partially erupted teeth when a dry working field cannot be obtained.
    a. fluoride-releasing resin-based sealants
    b. glass ionomer cements
    c. composite resins
    d. all of the above

42. CAMBRA clinical guidelines recommend that _____.
    a. the placement of sealants be based on the risk of the patient
    b. resin-based sealants are optional for patients at lower risk for caries
    c. glass ionomers are optional for patients at lower risk for caries
    d. all of the above

43. CAMBRA clinical guidelines recommend the use of antimicrobials for _____.
    a. patients over six years of age who are classified as being at high or extreme risk for caries
    b. all patients
    c. caregivers of noncompliant moderate through extreme risk children under the age of six
    d. a and c

44. Chlorhexidine varnish _____.
    a. has been shown to be effective against cariogenic bacteria
    b. is moisture-tolerant and easy to apply
    c. does not have the side effects seen with chlorhexidine rinse
    d. all of the above

45. Chlorhexidine varnish has been shown to reduce the incidence of _____ in a geriatric population.
    a. root carious lesions
    b. endodontic infiltration
    c. enamel sensitivity
    d. all of the above

46. Habitual consumption of xylitol has been found to _____.
    a. halt or slow the transmission of MS
    b. halt or slow the colonization of MS
    c. reduce the quantity of plaque biofilm
    d. all of the above

47. The minimum amount of xylitol needed to provide a beneficial effect on the plaque biofilm has been shown to be _____, divided into three to four doses, for no shorter than 5-10 minutes per exposure.
    a. 3-5 grams/day
    b. 5-6 grams/day
    c. 7-8 grams/day
    d. 8-10 grams/day

48. Fluoride varnish is available as_____.
    a. sodium fluoride varnish
    b. difluorosilane varnish
    c. hexasilane varnish
    d. a and b

49. Calcium phosphate therapy _____.
    a. supports fluoride therapy
    b. is designed to replace the use of fluoride
    c. is not designed to replace the use of fluoride
    d. a and c

50. Motivating patients to adhere to recommendations from their dental professional is _____.
    a. an important aspect in achieving successful outcomes
    b. less relevant than interventions
    c. always successful
    d. all of the above

ANSWER SHEET

CAMBRA: Best Practices in Dental Caries Management

Name: Title: Specialty:

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Requirements for successful completion of the course and to obtain dental continuing education credits: 1) Read the entire course. 2) Complete all information above. 3) Complete answer sheets in either pen or pencil. 4) Mark only one answer for each question. 5) A score of 70% on this test will earn you 3 CE credits. 6) Complete the Course Evaluation below. 7) Make check payable to PennWell Corp. **For Questions Call 216.398.7822**

Educational Objectives

1. Analyze the principles and science of caries management by risk assessment.
2. Recognize the value of performing a caries risk assessment on patients.
3. Describe and differentiate between clinical protocols used to manage dental caries.
4. Identify dental products available for patient interventions using CAMBRA principles.

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Please evaluate this course by responding to the following statements, using a scale of Excellent=5 to Poor=0.

2. To what extent were the course objectives accomplished overall?	5	4	3	2 1 0
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4. How would you rate the objectives and educational methods?	5	4	3	2 1 0
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9. Please rate the usefulness of the supplemental webliography.	5	4	3	2 1 0
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_____
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14. How long did it take you to complete this course?
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3.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	28.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
4.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	29.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	30.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	31.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	32.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	33.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	34.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	35.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	36.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	37.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
13.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	38.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
14.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	39.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
15.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	40.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
16.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	41.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
17.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	42.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
18.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	43.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
19.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	44.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	45.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
21.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	46.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
22.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	47.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
23.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	48.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
24.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	49.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
25.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	50.	Ⓐ	Ⓑ	Ⓒ	Ⓓ

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