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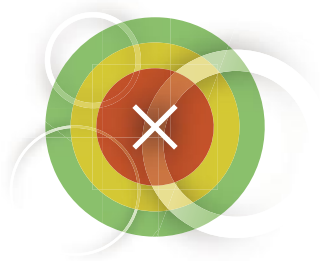

Clinical Protocols for Caries Management by Risk Assessment

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ABSTRACT This article seeks to provide a practical, everyday clinical guide for managing dental caries based upon risk group assessment. It is based upon the best evidence at this time and can be used in planning effective caries management for any patient. In addition to a comprehensive restorative treatment plan, each patient should have a comprehensive caries management treatment plan. Some sample treatment plans are included.

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Part 1: Caries Disease Management

YOU HAVE COMPLETED A CARIES RISK ASSESSMENT: NOW WHAT?

Performing a caries risk assessment as described in a previous article makes little sense if there is no difference in the way we plan treatment for individual patients. Indeed, if dental caries were pandemic, everyone has the disease, we would not need a risk assessment at all — every patient would be at high risk. One of the strongest predictors for future disease is a recent history of the disease. If every patient is at high risk, the management of every patient would be the same.

However, dental caries is not pandemic; many people simply do not have the disease, or at least detectable manifestations of it, and so we have to ask ourselves the questions: Should patients in different risk groups receive different treatment? And if so, what is the best way to manage patients at the different risk levels?

Recent research by Featherstone et al. clearly demonstrated that assigning risk assessment levels does make a difference in the effective management of patients for dental caries.[1] The use of antimicrobials, fluoride, sealants, the frequency of radiographs and periodic oral exams, as well as other risk factor management procedures will all be determined by the caries risk level of the patient and knowledge of the contributing risk factors for that patient. Subsequent to this research, protocols for the clinical management of caries by risk factor level, CAMBRA, have been determined and employed at a growing number of dental schools, including the five in California (see article by Young, Featherstone, and Roth). While complete consensus on these protocols continues to develop, there is strong agreement about treating patients for dental caries based on risk level.

This article seeks to provide a practical, everyday clinical guide for managing dental caries based upon risk group

assessment. It is based upon the best evidence at this time and can be used in planning effective caries management for any patient. We have also included some sample treatment plans to help practitioners visualize how CAMBRA may impact a patient's treatment. It is important to keep in mind research also shows that placing dental restorations does little or nothing to manage the caries disease process. In addition to a comprehensive restorative treatment plan, each patient should have a comprehensive caries management treatment plan.

CAMBRA TREATMENT RECOMMENDATIONS FOR PATIENTS AGE 6 AND OLDER

In this section, the authors present clinical guidelines for managing patients in each of the various caries risk assessment categories for age 6 through adult. Treatment for children age 5 and under is described in the article by Ramos-Gomez et al. in this issue. **TABLE 1** lists the four risk level groups (low, moderate, high, and extreme) and the recommendations for caries management procedures for each level. The authors first point out that a patient's caries risk level determines both diagnostic procedures and risk factor management procedures. The recommendations presented here were developed by consensus of the Western CAMBRA Coalition, a working group assembled from different aspects of the dental profession including unofficial representatives of education, research, industry, organized dentistry, governmental assistance agencies, the state licensing board, third-party payers, and private practice clinicians.

There are several things about this table of recommendations that should be noted. First, these recommendations are subject to clinical judgment based upon the caries risk assessment carried out by the individual dentist and are not intended to be the final word for any particular patient. Dentists should use this table as a guide in developing a comprehensive caries management program individually tailored for each patient's needs and wishes. Second, research in treatment modalities for managing caries is an ongoing process that most likely will result in modifications to these recommendations over the years. Third, these recommendations are based upon the available evidence at the time of writing and therefore constitute a basis for what counts as reasonable care for patients with dental caries. And finally, brand names of caries management products have not been used in **TABLE 1**. They are referred to by their generic composition. A full description and listing of available products is given in the paper by Spolsky et al. in this *Journal*. It is not our intention to endorse any one product or to exclude competitors.

PRACTICES THAT PRESCRIBE the same radiograph and periodic oral exam frequency for all patients are not exhibiting a reasonable protocol that will benefit the individual needs of their patients.

1. Diagnostic procedures

Caries is a chronic disease process that must be monitored over time to be effectively managed. The frequency of periodic oral examinations, radiographs, and bacterial tests are all determined by the caries risk level for a patient. For example, the national recommendations (www.kodak.com/go/dental) for radiographs for the recall patient depend upon a caries risk assessment. Recall patients who are at high risk for the disease are recommended to have posterior bitewing radiographs every six to 12 months, while patients in the low-risk category are recommended to have posterior bitewing radiographs no more frequently than every 24 to 36 months.

Of course, there may be other pathologies that require a higher frequency of radiographs, but as far as caries is concerned, one must know the caries risk level for a patient before prescribing radiographs. Similarly, patients in the high-risk group should be seen for clinical examination more frequently than the low- or moderate-risk groups. Practices that prescribe the same radiograph and periodic oral exam frequency for all patients are not exhibiting a reasonable protocol that will benefit the individual needs of their patients.

Patients who are at high risk for caries should have an initial base line bacterial test to determine the bacterial challenge of the organisms most closely related to the disease: mutans streptococci and lactobacilli.[2] The tests currently available on the market are described in the caries risk assessment article in this issue. Chemical antibacterial therapy to reduce the bacterial challenge and lower this risk factor must be monitored frequently to determine the effectiveness of the antimicrobial therapy and patient compliance.[3] The recommended frequency of such tests is displayed in **TABLE 1**.

Risk Factor Management Procedures

TABLE 1 lists risk factor management protocols that have some substantiated clinical success. It assumes patients in all risk groups will receive education in

TABLE 1

Caries Management by Risk Assessment Clinical Guidelines for Patients Age 6 and Older

Risk Level ### ***	Frequency of Radiographs	Frequency of Caries Recall Exams	Saliva Test (Saliva Flow & Bacterial Culture)	Antibacterials Chlorhexidine Xylitol ****	Fluoride	pH Control	Calcium Phosphate Topical Supplements	Sealants (Resin-based or Glass Ionomer)
Low risk	Bitewing radiographs every 24-36 months	Every 6-12 months to re-evaluate caries risk	May be done as a base line reference for new patients	Per saliva test if done	OTC fluoride-containing toothpaste twice daily, after breakfast and at bedtime. Optional: NaF varnish if excessive root exposure or sensitivity	Not required	Not required Optional: for excessive root exposure or sensitivity	Optional or as per ICDAS sealant protocol (TABLE 2)
Moderate risk	Bitewing radiographs every 18-24 months	Every 4-6 months to re-evaluate caries risk	May be done as a base line reference for new patients or if there is suspicion of high bacterial challenge and to assess efficacy and patient cooperation	Per saliva test if done Xylitol (6-10 grams/day) gum or candies. Two tabs of gum or two candies four times daily	OTC fluoride-containing toothpaste twice daily plus: 0.05% NaF rinse daily. Initially, 1-2 app of NaF varnish; 1 app at 4-6 month recall	Not required	Not required Optional: for excessive root exposure or sensitivity	As per ICDAS sealant protocol (TABLE 2)
High risk*	Bitewing radiographs every 6-18 months or until no cavitated lesions are evident	Every 3-4 months to re-evaluate caries risk and apply fluoride varnish	Saliva flow test and bacterial culture initially and at every caries recall appt. to assess efficacy and patient cooperation	Chlorhexidine gluconate 0.12% 10 ml rinse for one minute daily for one week each month. Xylitol (6-10 grams/day) gum or candies. Two tabs of gum or two candies four times daily	1.1% NaF toothpaste twice daily instead of regular fluoride toothpaste. Optional: 0.2% NaF rinse daily (1 bottle) then OTC 0.05% NaF rinse 2X daily. Initially, 1-3 app of NaF varnish; 1 app at 3-4 month recall	Not required	Optional: Apply calcium/ phosphate paste several times daily	As per ICDAS sealant protocol (TABLE 2)
Extreme risk** (High risk plus dry mouth or special needs)	Bitewing radiographs every 6 months or until no cavitated lesions are evident	Every 3 months to re-evaluate caries risk and apply fluoride varnish.	Saliva flow test and bacterial culture initially and at every caries recall appt. to assess efficacy and patient cooperation	Chlorhexidine 0.12% (preferably CHX in water base rinse) 10 ml rinse for one minute daily for one week each month. Xylitol (6-10 grams/day) gum or candies. Two tabs of gum or two candies four times daily	1.1% NaF toothpaste twice daily instead of regular fluoride toothpaste. OTC 0.05% NaF rinse when mouth feels dry, after snacking, breakfast, and lunch. Initially, 1-3 app. NaF varnish; 1 app at 3 month recall.	Acid-neutralizing rinses as needed if mouth feels dry, after snacking, bedtime and after breakfast. Baking soda gum as needed	Required Apply calcium/ phosphate paste twice daily	As per ICDAS sealant protocol (TABLE 2)

* Patients with one (or more) cavitated lesion(s) are high-risk patients. ** Patients with one (or more) cavitated lesion(s) and severe hyposalivation are extreme-risk patients. *** All restorative work to be done with the minimally invasive philosophy in mind. Existing smooth surface lesions that do not penetrate the DEJ and are not cavitated should be treated chemically, not surgically. For extreme-risk patients, use holding care with glass ionomer materials until caries progression is controlled. Patients with appliances (RPDs, prosthodontics) require excellent oral hygiene together with intensive fluoride therapy e.g., high fluoride toothpaste and fluoride varnish every three months. Where indicated, antibacterial therapy to be done in conjunction with restorative work. ###For all risk levels: Patients must maintain good oral hygiene and a diet low in frequency of fermentable carbohydrates. **** Xylitol is not good for pets (especially dogs).

plaque removal and dietary counseling to control the amount and frequency of fermentable carbohydrate intake.

THE LOW-RISK PATIENT

Low-risk patients typically present with little history of carious lesions, extractions, or restorations.[4] Whatever combination of oral bacteria, oral hygiene habits, diet, fluoride use, or salivary content and flow they may have, it has protected them from the disease of caries thus far and could very likely continue to protect them from the disease in the future. However, there is no guarantee of this. If the protective or pathogenic factors in their mouth changes significantly, they will become susceptible to the disease. For example, addition of medications with severe hyposalivatory side effects could markedly alter the saliva flow of the patient and place them in the high- or extreme-risk category. Conversely, the absence of teeth and the presence of multiple restorations do not preclude someone from being at low risk. It is possible for someone who has had a history of uncontrolled caries, lost teeth, and multiple restorations to become a low-risk patient by effectively controlling their risk factors for the disease. The management strategy for the low-risk patient is to maintain the balance of protective factors they currently have and to make them aware that their risk for caries can change over time. Should there be a change in oral hygiene, bacterial levels, diet, salivary flow, or fluoride use, the dentist should address these following a caries risk assessment at each periodic oral exam.

Low-risk patients generally need less professional supervision for caries (they may well need frequent professional visits due to periodontal disease or other conditions) so the frequency of periodic oral exams is less and, following the *Guidelines for Prescribing Dental Radiographs* in 2004, (www.kodak.com/go/dental) the frequency of radiographic examination is less in these groups, with bitewing radiograph every 24 to 36 months.

THE MODERATE-RISK PATIENT

Moderate-risk patients, by definition have more risk factors than the low-risk patients. However, these patients typically do not show the signs of continuing dental caries that would put them into the high-risk group.[4] As mentioned before, risk level assignment is a judgment based upon the factors identified in the risk assessment procedure and getting consensus on moderate-risk patients is more difficult than with the high- and low-risk groups. A moderate-risk patient in general terms is one who has some risk factors identified and whose caries balance could likely be moved easily to high risk. In these patients additional fluoride therapy, for example, could be added to ensure that the balance is tipped toward arresting the progression of the disease.

IT IS ALSO POSSIBLE that someone who does not have a cavitated lesion, but has two or more high-risk factors, could be placed in the high-risk group.

Moderate-risk patients generally require more frequent radiographic evaluation for caries disease activity than do low-risk patients, with bitewing radiographs approximately every 18 to 24 months, dependent upon the risk factors present and the practitioner's judgment. Risk factor interventions, such as diet counseling, oral hygiene instruction, and use of fluoride rinses, may require more aggressive implementation and more frequent monitoring. Use of sealants as a preventive measure may be more desirable to recommend in this risk category.[5]

THE HIGH-RISK PATIENT

Patients who currently have dental caries, most often determined by cavitated lesions, are high-risk patients.[4] The presence of observable carious lesions, for example, is a disease indicator, and is a very strong indicator that the disease, dental caries, will progress to produce more cavities, unless we intervene with chemical therapy to lower the bacterial challenge and increase remineralization (Featherstone et al., caries risk assessment, this issue). It is also possible that someone who does not have a cavitated lesion, but has two or more high-risk factors, could be placed in the high-risk group. These patients must be managed aggressively to eliminate or reduce the possibility of a new or recurrent caries lesion. Bacterial testing, antimicrobial treatments, 1.1 percent NaF toothpaste, 5 percent NaF fluoride varnish, and xylitol are standard regimens for all high-risk patients (details are given later and in **TABLE 1**).[3,6-9] The frequency of periodic oral exams is increased and radiographic evaluation with new bitewing radiographs may be desirable every six to 12 months.

THE EXTREME-RISK PATIENT

The extreme-risk patient is a high-risk patient with special needs or who has the additional burden of being severely hyposalivary. Patients in this risk group must be even more aggressively managed and seen more frequently than those in

the high-risk group. These patients lack both the buffering ability provided by saliva, and the calcium and phosphate needed to remineralize noncavitated lesions. Thus, additional therapies are indicated, including buffering rinses (e.g., baking soda and others, see Spolsky et al.) to replace the cleansing and buffering functions of normal saliva and calcium and phosphate pastes to replace the normal salivary components for remineralization of tooth structure following the acid production of food ingestion.[10,11]

A Word About Antimicrobials

As important as antimicrobial therapy is in combating the infectious pathogens that cause dental caries, the fact remains there is still no single modality that eliminates cariogenic bacteria with one treatment. Research and industry has yet to provide the products to rapidly and permanently modify the complex human biofilm to a healthy state. Current products always require repetition at intervals customized for each patient. Patients and clinicians should be warned that biofilm modification will not happen overnight and, in reality, may take several months or even years. Chlorhexidine, the most studied of caries antimicrobials, has been clearly shown to reduce levels of MS and to reduce the recurrence of caries lesions.[6] However, chlorhexidine has been shown to be less effective on lactobacilli in the mouth, which is another primary pathogen in dental caries.[2]

Although iodine has been reported in the literature to be effective in young children, when applied in the operating room environment, there is a lack of published research on its effectiveness in older children or adults and therefore has been excluded from the age 6 through adult protocol presented in **TABLE 1**.[2] With that said, the clinician must remember that efficacy of products are usually tested as the sole independent variable and not used with other products either concurrently or in succession. In practice, dentists commonly prescribe several modalities simultaneously and the efficacy of these combinations is poorly studied. It may well be that a combination of antimicrobials and other risk management products will lead to a beneficial change in the biofilm. In order to alter the caries imbalance that is present in high or extreme caries risk patients, aggressive antimicrobial therapy is needed as well as aggressive fluoride therapy.

TABLE 2

Sample Treatment Plan for a Low-risk Patient

Patient No. 1
Low caries risk: 24-year-old female, no history of decayed, missing, or filled teeth, no carious lesions present, adequate saliva flow, good oral hygiene, last dental visit more than three years ago, chief complaint of chipped anterior tooth.

Phase 0:

Comprehensive oral exam

4 bitewing radiographs

Phase I

Adult prophylaxis

Recommend OTC toothpaste with fluoride

Phase II

Tooth No. 9 incisal composite

Phase III

No Phase III (prosthetic) care indicated

Phase IV

Periodic oral exam in 12-24 months

Bitewing radiographs in 24-36 months

TABLE 3

Sample Treatment Plan for a Moderate-risk Patient

Patient No. 2
Moderate caries risk: 45-year-old male, history of several restorations and missing teeth, history of periodontal surgery, no new carious lesions, no lesions restored in the last three years, fair oral hygiene, uses salivary reducing medications, last dental visit six months ago with radiographs, chief complaint is broken lower molar.

Phase 0

Periodic oral exam

Phase I

Periodontal maintenance

Oral hygiene instructions

Recommend OTC toothpaste (1,000 or 1,100 ppm fluoride) with fluoride

Recommend OTC fluoride rinse (0.05 percent sodium fluoride) daily in addition to toothpaste

Recommend xylitol candies or gum daily

Phase II

Tooth No. 19 porcelain bonded to metal crown

Phase III

Partial denture reline to laboratory

Phase IV

Periodic oral exam in 12 months

Bitewing radiographs in 12 months

Periodontal maintenance every three months

A Word About Recommended Procedures and Optional Procedures

TABLE 1 contains recommendations based on the available science. Often, patients, and sometimes their health care professionals as well, want to feel they are doing all they can to promote oral health. When there is a lack of definitive scientific research demonstrating that such a treatment modality has clear benefits for a particular risk category (not all these studies have been done based on risk category), the decision to use additional or other preventive measures should be carefully considered and the risks and costs weighed against the benefits of those measures.

Antimicrobials, sealants, and high-strength fluoride could have some associated risks and costs that accompany any potential benefit. If the cost and any risks of a treatment modality are ac-

ceptable to the informed patient, then a treatment could be considered to be optional for patients who wish them.

Sample treatment plans are given in **TABLES 2-5** for each of the low-, moderate-, high-, and extreme-risk situations.

Part II: Caries Lesion Management

The decision to manage an existing carious lesion by chemotherapeutic means (e.g., fluoride, antimicrobial, xylitol) or by surgical means (excision and restoration) may at times be influenced by the site or location, the depth or extent of lesion, and the activity status of the lesion (active or arrested). Although surgical repair of cavitated caries lesions may not alter the disease risk level of a patient, it does remove niches that harbor caries-causing bacteria and, of course, restores the function of the tooth.

SITE-SPECIFIC MANAGEMENT OF LESIONS AND PREVENTION

Evidence-based intervention strategies are chosen to bring the patient back into a healthy state. However, the CAMBRA treatment model does not stop at managing caries risk (prevention); it also includes early detection and minimally invasive strategies that treat carious lesions differently depending on site (occlusal, approximal, or root); extent of the lesion (cavitated or not); and caries activity.[12,13] Although the chemistry of the caries process is the same at all sites, the differences in morphology, mineral content, and ability to detect early lesions lead to very different management strategies.[14]

1. Occlusal Pit and Fissure Lesions (Hardest to Detect)

Occlusal caries lesions are responsible for the majority of the restorations in children.[15] A number of studies have concluded that the use of a dental explorer is not adequate for detecting early occlusal caries and because of false negatives, may lead to a significant number of lesions being undetected (the so-called "hidden occlusal lesions").[16-20] Because of the large amount of surrounding sound enamel on the facial and lingual of the tooth, radiography cannot detect occlusal lesions until they are well advanced.[21] Caries detecting dye applied to fissures does not improve

TABLE 4

Sample Treatment Plan for a High-risk Patient

Patient No. 3
High caries risk: 26-year-old male, history of restorations for carious lesions 18 months ago, no missing teeth, carious lesion to the dentin on tooth No. 4, poor oral hygiene, white spot lesion buccal No. 19, no symptoms, privately insured.

Phase 0

Comprehensive oral exam

Caries bacterial test (insurance code: D-0405)

Diet analysis

Bitewing radiographs

Phase I

Adult prophylaxis

Oral hygiene instruction

Prescribe high concentration 1.1 percent sodium fluoride (NaF) toothpaste used twice daily in place of OTC fluoride toothpaste

Prescribe chlorhexidine gluconate (0.12 percent) rinse to be used once daily at night for one week each month. Repeat monthly. Use separated by one hour from high concentration fluoride toothpaste.

Fluoride varnish of all teeth

Phase II

Tooth No. 4 DO amalgam

Sealants for all posterior teeth

Phase III

No Phase III treatment indicated

Phase IV

Periodic oral exam every six months

Caries bacterial test every six months to check for compliance and efficacy of the chlorhexidine rinse

Review compliance with chlorhexidine gluconate rinse and 1.1 percent NaF toothpaste and oral hygiene

Adult prophylaxis

Fluoride varnish of all teeth

TABLE 5

Sample Treatment Plan for an Extreme-risk Patient

Patient No. 4
Extreme caries risk: 52-year-old female, extensive restorative history, missing teeth, generalized attachment loss, new carious lesions Nos. 4, 8, 9,10, 18, and 31, taking medications resulting in salivary gland hypofunction, last dental visit two years ago.

Phase 0

Comprehensive oral exam

Full-mouth series of radiographs

Caries bacterial test

Medical consult on medications

Diet analysis

Phase I

4 quadrants of scaling and root planing

One-month re-evaluation

Oral hygiene instruction

Prescribe 1.1 percent NaF toothpaste used twice daily in place of OTC toothpaste (same as for high-risk patient, above)

Prescribe chlorhexidine rinse used once daily at night for one week each month. Use separated by one hour from high concentration F toothpaste (same as for high-risk patient above)

Prescribe baking soda rinses four to six times daily

Fluoride varnish of all teeth

Calcium/phosphate paste applied several times daily (trays can be helpful)

Phase II

Tooth No. 8 mesial composite

Tooth No. 9 mesial composite

Tooth No. 10 distal composite

Tooth No. 4 mod amalgam

Tooth No. 18 full veneer gold crown

Phase III

Hold on prosthetics until caries and periodontal processes are stabilized

Re-evaluate caries and periodontal status at four to six weeks from initial therapy/ Phase I

Phase IV

Periodic oral exam every three months

Caries bacterial test at each caries recall exam

Fluoride varnish at each caries recall exam

Bitewing radiographs every six months

Periodontal maintenance every three months

the visual detection of dentinal caries and should not be used for that purpose.[22] Fissure widening has been shown to improve sensitivity from 17 percent to 70 percent, but it still is difficult to determine whether the lesions extended into dentin.[22] The use of a DIAGNOdent caries detector (KaVo America Corp, Lake Zurich, Ill.) may aid in the decision making process of an early occlusal lesion, but is by no means absolute.[23-26]

Until recently, there was no universal way for clinicians to categorize the visual characteristics of the occlusal surface of teeth. The International Caries Detection and Assessment System, ICDAS, was developed by international committee to facilitate caries epidemiology, research, and appropriate clinical management.[27] The system was designed to provide a terminology to describe what is seen visually rather than dictate treatment protocol.[27] However, given the correlation of visual findings to histologic findings, the system can reasonably be used to guide treatment decisions in managing occlusal lesions. **TABLE 6** shows the ICDAS definitions, histologic findings, and visual interpretation of the definitions. The recommended protocol is footnoted at the bottom of the **TABLE 6**.

In summary, pits and fissures identified as codes 0-2 = do not require sealants. Sealants are considered optional if no tooth structure is removed to complete the procedure. (DIAGNOdent readings may be helpful in classifying lesions using the ICDAS codes.[23-26]) Pits and fissures classified as codes 2-3 with DIAGNOdent readings in the 20-30 range should have a minimally invasive "caries biopsy" (conservative fissure widening) to determine whether a sealant and, quite possibly, a restoration is to be placed.[25] Pits and fissures classified as codes 4-6 require minimally invasive restoration. The definition of a "sealant" and "restoration" are defined by the CDT-7 codes and summarized as follows: Sealant means it is still confined in enamel; it is not the dental material (e.g., resin versus glass ionomer). It is considered a restoration if any part of the preparation is in dentin; if the preparation "extends to" a second surface (whether or not the second surface is in dentin), then if is considered a two-surface restoration.

Note: In performing minimally invasive dentistry, especially when surgical procedures are involved, it is critical to have proper documentation. In this case, ICDAS codes, DIAGNOdent readings (if done), and preop, intraop, and postop clinical photographs is highly recommended. We have the professional obligation to eliminate the unethical misuse of MID (overtreatment) for financial gain.

UNTIL RECENTLY, there was no universal way for clinicians to categorize the visual characteristics of the occlusal surface of teeth.

Preventive care of the occlusal surface is problematic. Resin-based materials do not bond as well to aprismatic enamel (common on newly erupted teeth), nor do they allow for continued mineralization of a newly erupted tooth, and resin sealants may fail when isolation is not ideal. In order to get a good resin bond to enamel, pits and fissures should be deepened and widened; however, this is contradictory to a minimally invasive approach. Glass ionomer sealants that bond chemically rather than micromechanically might be an alternative choice. Some studies show resin-based sealants have good retention, while other studies found 25 percent to 50 percent decay underneath previously placed sealants.[28-29] Recently, new conventional glass ionomers have been proposed as a chemical treatment for caries, mainly for its ability to chemically bond to enamel (prismatic or aprismatic) and dentin, as well as its internal caries preventive effects at the tooth-glass ionomer interface.[30,31]

Glass ionomer, since it is a chemical acid-base reaction, does not have the problem of the contraction gap formation common when resin is polymerized. It, by nature of its fluoride release, is caries protective.[32] One study showed better penetration and retention of the unprepared fissures using a glass ionomer sealant in the presence of saliva.[33] In addition, some have speculated that placing resin on a newly erupted tooth could inhibit future mineral maturation, and perhaps glass ionomer may prove advantageous for continued permeation of certain molecules and minerals into the tooth.[30,34]

In summary, as of yet, there is no perfect way to detect the early occlusal lesion. ICDAS occlusal codes and protocol could help clinicians make the decision to treat a pit or fissure with chemotherapeutic agents, sealants, or restorations. Glass ionomer could be a possible treatment alternative to resin-based sealants, especially in immature enamel, when no fissure preparation is performed, or when proper isolation is not achievable.[33] Aggressive prevention and early minimal intervention is indicated for those at higher risk.

2. Approximal Lesions (Smooth Surface Lesions)

If the surface of a smooth surface lesion is not cavitated, then chemical repair is the recommended treatment.

TABLE 6

Occlusal Protocol***

ICDAS code	0	1	2	3	4	5	6
							
Definitions	Sound tooth surface; no caries change after air drying (5 sec); or hypoplasia, wear, erosion, and other noncaries phenomena	First visual change in enamel; seen only after air drying, or colored change "thin" limited to the confines of the pit and fissure area	Distinct visual change in enamel; seen when wet, white or colored, "wider" than the fissure/fossa	Localized enamel breakdown with no visible dentin or underlying shadow; discontinuity of surface enamel, widening of fissure	Underlying dark shadow from dentin, with or without localized enamel breakdown	Distinct cavity with visible dentin; frank cavitation involving less than half of a tooth surface	Extensive distinct cavity with dentin; cavity is deep and wide involving more than half of the tooth
Histologic depth		Lesion depth in P/F was 90% in the outer enamel with only 10% into dentin	Lesion depth in P/F was 50% inner enamel and 50% into the outer 1/3 dentin)	Lesion depth in P/F with 77% in dentin	Lesion depth in P/F with 88% into dentin	Lesion depth in P/F with 100% in dentin	Lesion depth in P/F 100% reaching inner 1/3 dentin
Sealant/restoration Recommendation for low risk	Sealant optional DIAGNOdent may be helpful	Sealant optional DIAGNOdent may be helpful	Sealant optional or caries biopsy if DIAGNOdent is 20-30	Sealant or minimally invasive restoration needed	Minimally invasive restoration	Minimally invasive restoration	Minimally invasive restoration
Sealant/restoration Recommendation for moderate risk	Sealant optional DIAGNOdent may be helpful	Sealant recommended DIAGNOdent may be helpful	Sealant recommended or caries biopsy if DIAGNOdent is 20-30	Sealant or minimally invasive restoration needed	Minimally invasive restoration	Minimally invasive restoration	Minimally invasive restoration
Sealant/restoration Recommendation for high risk *	Sealant recommended DIAGNOdent may be helpful	Sealant recommended DIAGNOdent may be helpful	Sealant recommended or caries biopsy if DIAGNOdent is 20-30	Sealant or minimally invasive restoration needed	Minimally invasive restoration	Minimally invasive restoration	Minimally invasive restoration
Sealant/restoration Recommendation for extreme risk **	Sealant recommended DIAGNOdent may be helpful	Sealant recommended DIAGNOdent may be helpful	Sealant recommended or caries biopsy if DIAGNOdent is 20-30	Sealant or minimally invasive restoration needed	Minimally invasive restoration	Minimally invasive restoration	Minimally invasive restoration

* Patients with one (or more) cavitated lesion(s) are high-risk patients. ** Patients with one (or more) cavitated lesion(s) and xerostomia are extreme-risk patients.

*** All sealants and restorations to be done with a minimally invasive philosophy in mind. Sealants are defined as confined to enamel. Restoration is defined as in dentin. A two-surface restoration is defined as a preparation that has one part of the preparation in dentin and the preparation extends to a second surface (note: the second surface does not have to be in dentin). A sealant can be either resin-based or glass ionomer. Resin-based sealants should have the most conservatively prepared fissures for proper bonding. Glass ionomer should be considered where the enamel is immature, or where fissure preparation is not desired, or where rubber dam isolation is not possible. Patients should be given a choice in material selection.

Early approximal lesions are ideal to remineralize simply because topical fluoride works well on smooth surfaces and there is a reliable way to monitor its progress (bitewing radiographs). In 1992, Pitts and Rimmer correlated radiographic depth to cavitation. In this study, none of the samples were cavitated that presented with a radiolucency in the outer half of enamel. If the radiolucency appeared in the inner half of enamel on the radiograph, then the percent cavitation was about 10 percent. This increased to 41 percent if the radiolucency extended to the outer half of dentin, and 100 percent cavitation if the radiolucency extended to the inner half of the dentine.[35] Other studies correlating radiographic depth to histology are not as helpful since it does not determine the presence of cavitation. Thus, many resort to surgical repair only if the radiograph shows a clear enamel cone with a dentinal penetration and use chemical remineralization strategies to repair lesions showing lesser radiographic penetration.

The exception to this guideline is the case of vertical marginal ridge fracture where bacteria could be penetrating dentin showing a dentinal radiolucency without radiographic radiolucency in enamel.[36] In this case, restoration is indicated after clinically confirming the vertical marginal ridge fracture. Those showing slight vertical fracture of the marginal ridge without radiographic dentinal radiolucency may not require restoration. It is also reassuring to note the conservative approach is especially applicable to the approximal lesion because most early lesions, even if chemical repair was attempted and failed, could be easily observed on a subsequent radiograph and restored without making the preparation design much bigger, if at all.

3. Root Lesions (Hardest to Restore)

Cementum and dentin is much more porous than enamel, being about 50 percent by volume mineral and about 50 percent by volume diffusion space (water, protein, and lipids). Bonding composite materials to dentin and cementum is a clinical challenge if for nothing more than its location, often subgingival, difficult to isolate (keep dry), and difficult to light cure (deep box forms). In this case, chemical seal is perhaps more important than retentive bond strength.[30] Glass ionomer restorative materials are, reasonably, the material of choice on dentin and cementum because of their chemically fused seal (rather than micromechanical bond), less shrinkage, fluoride release, biocompatibility, and perhaps the nicest feature, the need for a moist surface to interact with.[31,32] Composite can also be layered on top of glass ionomer products using the correct techniques and materials.[37] This so-called "sandwich" technique allows the stress of the resin polymerization process to be dissipated in the setting glass ionomer (glass ionomer takes days to set and has been shown to increase in strength for two to three years).[38]

Conclusions

Caries risk assessment is the basis for subsequent treatment planning to manage the disease of caries. Caries risk assessment should be routinely built into comprehensive oral examinations and periodic oral examinations. Patient treatment plans should reflect both caries management strategies as well as restorative plans for the destruction created by the disease. Caries management strategies may include chemical therapy to reduce bacterial challenge as well as fluoride and other therapies to enhance remineralization of lesions that are not cavitated. If surgical treatment is needed for cavitated lesions, the principles of minimally invasive dentistry should apply. The guidelines presented in this article are based in the best available scientific literature and are intended to be a helpful guide for dental practitioners managing dental caries. ■■■■

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