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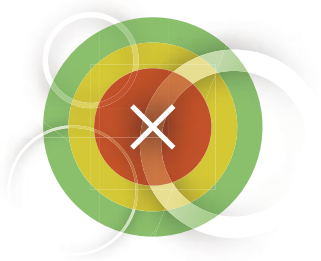

Caries Risk Assessment in Practice for Age 6 Through Adult

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ABSTRACT The aim of this article is to present a practical caries risk assessment procedure and form for patients who are age 6 through adult. The content of the form and the procedures have been validated by outcomes research after several years of experience using the factors and indicators that are included.

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Caries risk assessment is the first step in caries management by risk assessment, CAMBRA. The level of risk should be used to determine the need for therapeutic intervention and is an integral part of treatment planning. The management of caries following risk assessment for 6-year-olds through adult is described in this issue in detail in the paper by Jenson et al. A separate form and procedures for use for newborns to 5-year-olds is presented in the paper by Ramos-Gomez et al. in this issue.

A group of experts from across the United States convened at a consensus conference held in Sacramento, Calif., in April 2002. This group produced a caries risk assessment form and procedures based upon literature available up to that time. The results were published in 2003.[1] The consensus statement and supporting review articles are available on the net: www.cdafoundation.org/journal. This form, or some variation of it, has been in use in dental schools and private practices for as long as four years. Recent outcomes research based upon the use of the procedures in a large cohort of patients at the School of Dentistry at the University of California, San Francisco, was recently published, validating the form and procedures.[2] The results from this study are the basis for the current revisions to the caries risk assessment form and procedures presented here. The successful components of the previous version have been regrouped according to the outcomes results and are presented in **TABLE 1**. The form can be readily adapted for use in electronic record systems, as has been done at UCSF.

The background, rationale, and step-by-step procedures are described as follows.

Background

Successful and accurate caries risk assessments have been a dream for decades. Numerous research papers have been written on the topic, such as the reviews by Anderson et al. and Anusavice.[3,4] Several forms and procedures have been suggested, some of which are summarized in a recent review by Zero et al.[5] Individual contrib-

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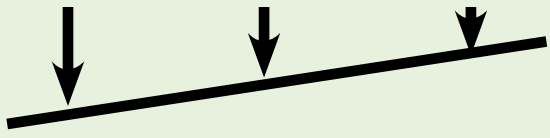
TABLE 1

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:_____

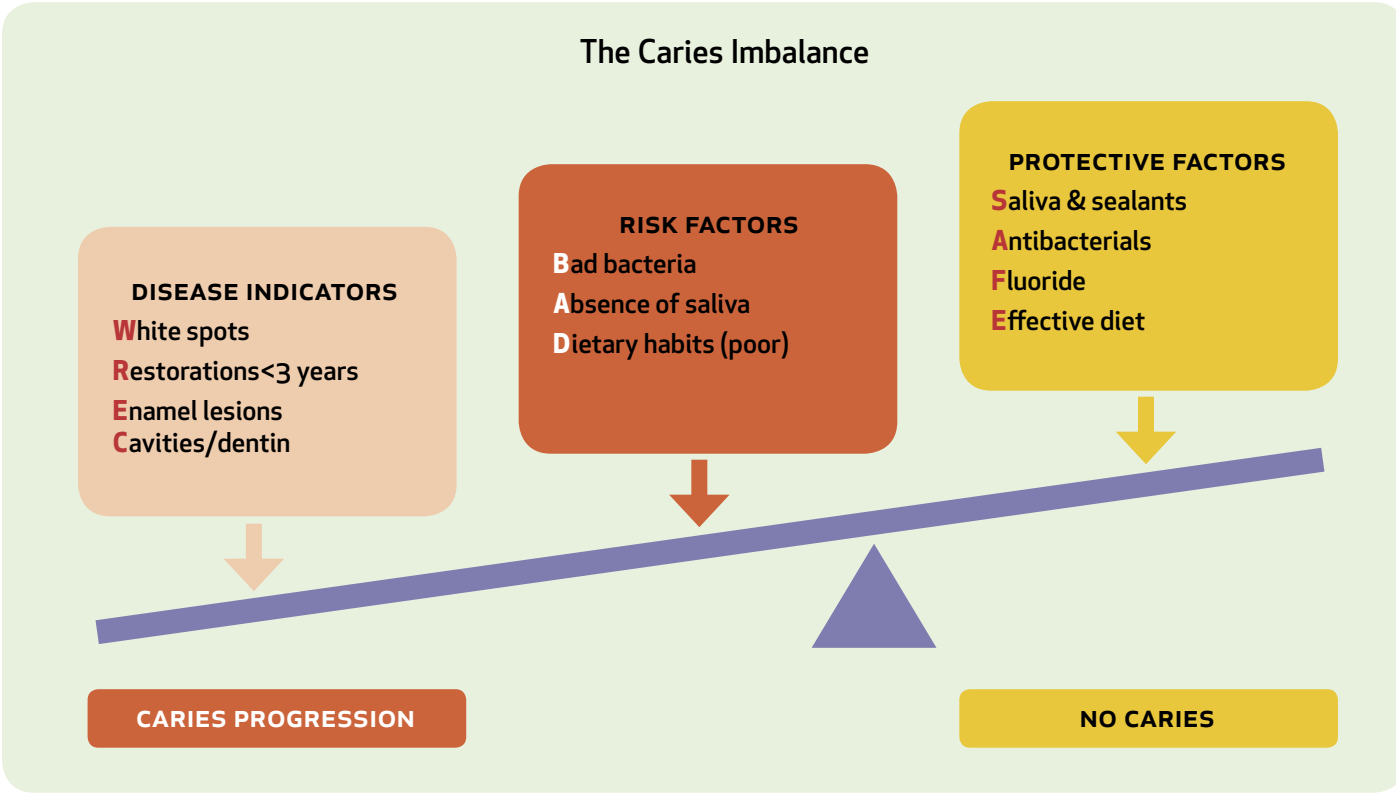


FIGURE 1. The caries "imbalance." The balance amongst disease indicators, risk factors and protective factors determines whether dental caries progresses, halts, or reverses. Refer to **TABLE 1** and the text for more detail on disease indicators. Cavities/dentin refers to frank cavities or lesions to the dentin by radiograph. Restorations < 3 years means restorations placed in the previous three years. This figure has been updated from previous versions of the "caries balance" with the very important addition of the disease indicators.[6] If these indicators are present they weigh heavily on the side of predicting caries progression unless therapeutic intervention is carried out. The leading letters that help to remember the imbalance (WREC; BAD; SAFE) have been added, as well as sealants as a protective factor. Dietary habits (poor) indicates frequent ingestion of fermentable carbohydrates (greater than three times daily between meals).

uting factors to caries risk have been identified over the last 30 years or so, and a review of these was published in two special issues of the *Journal of the California Dental Association*, February and March 2003 (www.cdafoundation.org/journal), together with the consensus statement referred to above.[6] Much of the information has been available for 10 to 20 years or more, but has not been put into everyday clinical practice, primarily because the information has not been gathered together in a simple form and procedure, and such combinations have not been validated until recently.[2] Utilization of risk assessment to determine therapeutic modalities was successful at a level of about 70 percent in an adult population. The authors anticipate that, with the updated form presented here, the success will be even higher as all of the contributing factors have been validated and ranked in order of the odds ratios found they were related to the formation of cavities.

Determining Caries Risk

Assigning a patient to a caries risk level is the first step in managing the disease process. A step-by-step guide how to do this is laid out later in this article. Before moving to the details some overall discussion and definition of terms are needed. This assessment occurs in two phases: the first is to determine specific disease indicators, risk factors, and protective factors each patient has. The second step is to determine the level of risk that the sum of these factors indicates.[7] Specific pathologic and protective factors for dental caries contribute to determining the balance between progression, arrestment, or reversal of the disease. For example, a young patient may have poor oral hygiene but no other caries risk factors. We would want to address the oral hygiene issue, but this, in and of itself, is not sufficient to put the patient in a high-risk category. We know that patients with high plaque levels frequently demonstrate no evidence of dental caries. On the other hand, a patient with a cavitated caries lesion is immediately put into the high-risk category because this is a well-documented predictor of future caries lesions.

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The second phase of caries risk assessment is by no means a mathematical formula; it is better characterized as a judgment based on the likely balance between the indicators and factors identified in the risk assessment form (**TABLE 1**) and illustrated visually in **FIGURE 1**. The risk assessment form (**TABLE 1**) is comprised of a hierarchy of disease indicators, risk factors, and protective factors that are based on the best scientific evidence we have at this time. As mentioned previously, the risk assessment procedures published in 2003 have been assessed over more than three years and the outcomes led to the elimination of some items and to the validation of those included here, together with validation of the tool to assess caries risk.[1,2] The determination of high-risk status is fairly clear. The decision to place someone in the moderate-risk category is sometimes not clear and different practitioners may reasonably come to different conclusions. It is better to err on the conservative side and place a patient in the next higher category if there is doubt. As we get more clinical data the accuracy of these risk assessment forms will no doubt increase even further.

Rationale and Instructions for Age 6 Through Adult Caries Risk Assessment Form

The following section presents the rationale and instructions for the use of the form presented in **TABLE 1**: "Caries Risk Assessment Form — Children Age 6 and Over/Adults."

Caries Disease Indicators

Caries disease indicators are clinical observations that tell about the past caries history and activity. They are indicators or clinical signs that there is disease present or that there has been recent disease. These indicators say nothing about what caused the disease or how to treat it. They simply describe a clinical observation that indicates the presence of disease. These are not pathological factors nor are they causative in any way. They are simply physical observations (holes, white spots, radiolucencies). The outcomes assessment described previously and prior literature, highlight that these disease indicators are strong indicators of the disease continuing unless therapeutic intervention follows.

IT IS BETTER
to err on the conservative side and place a patient in the next higher category if there is doubt.

The four caries disease indictors outlined in **TABLE 1** are: (1) frank cavitations or lesions that radiographically show penetration into dentin; (2) approximal radiographic lesions confined to the enamel only; (3) visual white spots on smooth surfaces; and (4) any restorations placed in the last three years. These four categories are strong indicators for future caries activity and unless there is nonsurgical therapeutic intervention the likelihood of future cavities or the progression of existing lesions is very high.

A positive response to any one of these four indicators automatically places the patient at high risk unless therapeutic intervention is already in place and progress has been arrested. A patient with frank cavities has high levels of cariogenic bacteria, and placing restorations does not significantly lower the overall bacterial challenge in the mouth.[8]

Caries Risk Factors

Caries risk factors are biological factors that contribute to the level of risk for the patient of having new carious lesions in the future or having the existing lesions progress. The risk factors are the biological reasons or factors that have caused or contributed to the disease, or will contribute to its future manifestation on the tooth. These we can do something about.

There are nine risk factors recently identified in outcomes measures of caries risk assessment[2] listed in **TABLE 1**: 1) medium or high MS and LB counts; 2) visible heavy plaque on teeth; 3) frequent (> three times daily) snacking between meals; 4) deep pits and fissures; 5) recreational drug use; 6) inadequate saliva flow by observation or measurement; 7) saliva reducing factors (medications/radiation/systemic); 8) exposed roots; and 9) orthodontic appliances. If there are no positive caries disease indicators (see above), these nine factors in sum become the determinants of caries activity, unless they are offset by the protective factors listed below.

Caries Protective Factors

These are biological or therapeutic factors or measures that can collectively offset the challenge presented by the previously mentioned caries risk factors. The more severe the risk factors, the higher must be the protective factors to keep the patient in balance or to reverse the caries process. As industry responds to the need for more and better products to treat dental caries, the current list in **TABLE 1** is sure to expand in the future. Currently, the protective factors listed in **FIGURE 1** are: 1) lives/work/

school located in a fluoridated community; 2) fluoride toothpaste at least once daily; 3) fluoride toothpaste at least two times daily; 4) fluoride mouthrinse (0.05 percent NaF) daily; 5) 5,000 ppm F fluoride toothpaste daily; 6) fluoride varnish in last six months; 7) office fluoride topical in last six months; 8) chlorhexidine prescribed/used daily for one week each of last six months; 9) xylitol gum/lozenges four times daily in the last six months; 10) calcium and phosphate supplement paste during last six months; and 11) adequate saliva flow (> 1 ml/min stimulated). Fluoride toothpaste frequency is included since studies have shown that brushing twice daily or more is significantly more effective than once a day or less.[9] Any or all of these protective factors can contribute to keep the patient "in balance" or even better to enhance remineralization, which is the natural repair process of the early carious lesion.

What to Do

1. Take the patient details, the patient history (including medications) and conduct the clinical examination. Then proceed with the caries risk assessment.

2. Circle or highlight each of the "YES" categories in the three columns on the form (**TABLE 1**). One can make special notations such as the number of carious lesions present, the severity or the lack of oral hygiene, the brand of fluorides used, the type of snacks eaten, or the names of medications/drugs causing dry mouth.

3. **If the answer is "yes" to any one of the four disease indicators in the first panel, then a bacterial culture should be taken using** the Caries Risk Test (CRT) marketed by Vivadent, (Amherst, N.Y.). (*–See below or equivalent test.)

4. Make an overall judgment as to whether the patient is at high-, moderate- or low-risk dependent on the balance between the disease indicators/risk factors and the protective factors using the caries balance concept (see bottom of **TABLE 1** and **FIGURE 1**). **NOTE:** Determining the caries risk for an individual requires evaluating the number and severity of the disease indicators/risk factors. An individual with caries lesions presently or in the recent past is at high risk for future caries by default. A patient with low bacterial levels would need to have several other risk factors present to be considered at moderate risk. Some clinical judgment is needed while also considering the protective factors in determining the risk.

FLUORIDE TOOTHPASTE frequency is included since studies have shown that brushing twice daily or more is significantly more effective than once a day or less.

5. **If a patient is high risk and has severe salivary gland hypofunction or special needs, then they are at "extreme risk" and require very intensive therapy.**

6. Complete the therapeutic recommendations section as described in the paper by Jenson et al. this issue, based on the assessed level of risk for future carious lesions and ongoing caries activity. Use the therapeutic recommendations as a starting point for the treatment plan. The products that can be used are described in detail in Jenson et al. and Spolsky et al. in this issue.

7. Provide the patient with therapeutic and home care recommendations in the form of a letter, based on clinical observations and the Caries Risk Assessment result.

8. Give the patient the sheet that explains how caries happens (**FIGURE 2**) and the letter with your recommendations. Sample letters are given. More details about these recommendations and procedures are laid out in Jenson et al. in this issue. Products that should be used are described in detail in Spolsky et al.

9. Copy the recommendations and the letter for the patient chart (or if you have electronic records the various form letters and recommendations can be generated to be printed out custom for each patient).

10. Inform the patient of the results of any tests. e.g., showing the patient the bacteria grown from their mouth (CRT test result*) can be a good motivator so have the culture tube or digital photograph of the test slide handy at the next visit (or schedule one for this purpose — the culture keeps satisfactorily for some weeks), or give/send them a picture (digital camera and e-mail).

11. After the patient has been following your recommendations for three to six months, have the patient back to reassess how well they are doing. Ask them if they are following your instructions, how often. If the bacterial levels were moderate or high initially, repeat the bacterial culture to see if bacterial levels have been reduced. Some clinicians report improved patient motivation when a second bacterial test is done initially immediately after the first month of antibacterial treatment. Documenting a "win in your column" early on is a valuable tool to encourage patients. Make changes in your recommendations or reinforce protocol if results are not as good as desired, or the patient is not compliant. Refer to Jenson et al. this issue for more detail on protocols and procedures.

CONTINUES ON 710

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AGE 6 THROUGH ADULT, CONTINUED FROM 707

How Tooth Decay Happens

Tooth decay is caused by certain types of bacteria (mutans streptococci and lactobacilli) that live in your mouth. When they attach themselves to the teeth and multiply in dental plaque, they can do damage. The bacteria feed on what you eat, especially sugars (including fruit sugars) and cooked starch (bread, potatoes, rice, pasta, etc.). Within just a few minutes after you eat, or drink, the bacteria begin producing acids as a by-product of their digesting your food. Those acids can penetrate into the hard substance of the tooth and dissolve some of the minerals (calcium and phosphate). If the acid attacks are infrequent and of short duration, your saliva can help to repair the damage by neutralizing the acids and supplying minerals and fluoride that can replace those lost from the tooth. However, if: 1) your mouth is dry; 2) you have many of these bacteria; or 3) you snack frequently; then the tooth mineral lost by attacks of acids is too great, and cannot be repaired. This is the start of tooth decay and leads to cavities.

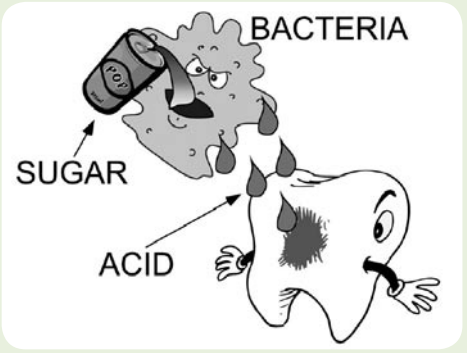

FIGURE 2. How tooth decay happens (to be given to each patient).

*Test procedures — Saliva Flow Rate and Caries Bacteria Testing

*1. *Saliva Flow Rate:* Have the patient chew a paraffin pellet (included with the CRT test — see below) for three to five minutes (timed) and spit all saliva generated into a measuring cup. At the end of the three to five minutes, measure the amount of saliva (in milliliters = ml) and divide that amount by time to determine the ml/minute of stimulated salivary flow. A flow rate of 1 ml/min and above is considered normal. A level of 0.7 ml/min is low and anything at 0.5 ml/min or less is dry, indicating severe salivary gland hypofunction. Investigation of the reason for the low flow rate is an important step in the patient treatment.

*2. *Bacterial testing:* An example (others are currently available) of a currently available chairside test for cariogenic bacterial challenge is the Caries Risk Test (CRT) marketed by Vivadent. It is sufficiently sensitive to provide a level of low, medium, or high cariogenic bacterial challenge. It can also be used as a motivational tool for patient adherence with an antibacterial regimen. Other bacterial test kits will likely be available in the near future. The following is the procedure for administering the currently available CRT test. Results are available after 72 hours (note: the manufacturer's instruction states 48 hours, but more reliable results are achieved if the incubation time is 72 hours). The kit comes with a two-sided selective media stick that assess mutans streptococci on the blue side and lactobacilli on the green side.

a) Remove the selective media stick from the culture tube. Peel off the plastic cover sheet from each side of the stick.

b) Pour (do not streak) the collected saliva over the media on each side until it is entirely wet.

c) Place one of the sodium bicarbonate tablets (included with the kit) in the bottom of the tube.

d) Replace the media stick in the culture tube, screw the lid on and label the tube with the patient's name, registration number, and date. Place the tube in the incubator at 37-degrees Celsius for 72 hours. Incubators suitable for a dental office are also sold by the company.

e) Collect the tube after 72 hours and compare the densities of bacterial colonies with the pictures provided in the kit indicating relative bacterial levels. The dark blue agar is selective for mutans streptococci and the light green agar is selective for lactobacilli. Record the level of bacterial challenge in the patient's chart, as low, medium or high. Some find it helpful for documentation to number the pictures 1 through 4.

Sample Patient Letters/ Recommendations for Control of Dental Decay (Age 6 and Over/Adult)

One of the following letters (**FIGURES 3–6**)including home care recommendations should go to each patient depending on the risk category and the overall treatment plan (refer to Jenson et al. this issue for treatment plan details).

Dear (Patient X),

Congratulations, you have been assessed at low risk for future dental decay. We want to help you stay that way. You will find that you will be able to maintain your current level of oral health if you do the following:

- Brush twice daily with an over-the-counter fluoride-containing toothpaste.
- Review with us your dietary and oral hygiene habits and receive oral hygiene instructions. If good, continue with your existing dietary and oral hygiene habits unless there is a change in status, such as new medications.
- Get a thorough professional cleaning as needed for your periodontal health. We will be happy to provide these cleanings for you.
- Return for a caries recall exam (when requested) in six to 12 months to re-evaluate your current caries risk.
- Have new bitewing radiographs (X-rays) taken about every 24 to 36 months to check for cavities.
- Consider using xylitol gum/candies and over-the-counter fluoride rinse (0.05 percent sodium fluoride) instead of regular gum/candy or mouthwash.
- Get fluoride varnish after teeth cleanings, base line bacterial test, sealants if your dentist recommends it. You may or may not need this. It depends on your oral conditions.
- Other recommendations:

FIGURE 3. Low caries risk.

Dear (Patient Y),

You have been assessed to be at moderate risk for new dental decay in the near future because you have (fill in the blank). We want you to move into a safer situation to avoid new decay in the future. Here are some ways to accomplish this goal:

- Review your dietary and oral hygiene habits with us and receive oral hygiene instructions.
- Brush twice daily with an over-the-counter fluoride-containing toothpaste, following the oral hygiene instruction procedures you have been given.
- Purchase an over-the-counter fluoride rinse (0.05 percent sodium fluoride, e.g. Fluorigard or ACT) and rinse with 10 ml (one cap full) once or twice daily after you have used your fluoride toothpaste. Continue daily until your next dental exam.
- Get a thorough professional cleaning from us as needed for your periodontal health.
- Chew or suck xylitol-containing gum or candies four times daily.
- Return when requested for a caries recall exam in four to six months to re-evaluate your progress and current caries risk.
- Get new bitewing radiographs (X-rays) about every 18-24 months to check for cavities.
- Get a fluoride varnish treatment every four to six months at your caries recall exams.
- You may also need a base line bacterial test and sealants (depending on your situation and condition).
- Other recommendations:

FIGURE 4. Moderate caries risk.

Dear (Patient Z),

Our assessment reveals you are at a high risk of having new dental decay in the near future because you have (fill in the blank). We want to help you to move to a safer situation to avoid new decay if at all possible. We strongly recommend the following:

- Complete a caries bacterial test with us today (as a base line before antibacterial therapy). We will have the results of this test in three days.
- Complete a saliva flow measurement to check for dry mouth. This is a very simple test that we will do today as part of the bacterial assessment.
- Review with us your dietary and oral hygiene habits and receive instructions on both. The most important thing is to reduce the number of between-meal sweet snacks that contain carbohydrates, especially sugar. Substitution by snacks rich in protein, such as cheese, will also help as well as the xylitol gum or candies described below.
- Brush twice daily with a high fluoride toothpaste, either Control RX or Prevident Plus toothpaste (5,000 parts per million fluoride). We will provide some for you today. This is to be used twice daily in place of your regular toothpaste.
- Rinse for one minute, once a day with a special antibacterial mouthrinse we will provide for you today. It is called Peridex or Periogard and has an active ingredient called chlorhexidine gluconate at 0.12 percent. You should use this once daily just before bed at night (10 ml for one minute), but only for one week each month. You must use this at least one hour after brushing with the 5,000 ppm fluoride toothpaste.
- Have the necessary restorative work done, such as fillings or crowns, as needed, in a minimally invasive fashion.
- Suck or chew xylitol candies or gum four times daily. You can obtain supplies from us today or we can help you buy these elsewhere.
- Get sealants applied to all of the biting surfaces of your back teeth to keep them from being reinfected with the bacteria that cause dental decay. We will be happy to do this for you.
- Return when requested for a caries recall exam in three to four months to re-evaluate your progress and current caries risk.
- Participate in another caries bacterial test at your caries recall exam or earlier to compare results with your first visit. This will allow us to check whether the chlorhexidine is working satisfactorily.
- Allow us to review your use of chlorhexidine and Control RX/Prevident and oral hygiene at that visit.
- Get a thorough professional cleaning as needed for your periodontal health.
- Get new bitewing radiographs (X-rays) about every six to 18 months to check for cavities.
- Get a fluoride varnish treatment for all of your teeth every three to four months at your caries recall exams.
- Other recommendations:

FIGURE 5. High caries risk.

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TO REQUEST A PRINTED COPY OF THIS ARTICLE, PLEASE CONTACT John D.B. Featherstone, MSc, PhD, University of California, San Francisco, Department of Preventive and Restorative Dental Sciences, 707 Parnassus Ave., Box 0758, San Francisco, Calif., 94143.

Dear (Patient Z),

Our assessment indicates that you are at extreme risk of new dental decay in the near future because you have (fill in the blank) and you have severe "dry mouth" due to (fill in the blank). We want you to move to a safer situation to avoid new decay if at all possible. Please do the following right away:

- Complete a caries bacterial test with us today (as a base line before antibacterial therapy). We will know the results of this test in three days.
- Complete a saliva flow measurement to confirm your extreme dry mouth. This is a very simple test that we will complete today as part of the bacterial assessment.
- Review your dietary and oral hygiene habits with us and receive instructions about how to improve them both. The most important thing is to reduce the number of between-meal sweet snacks that contain carbohydrates, especially sugar. Substitution by snacks rich in protein, such as cheese, will also help as well as the xylitol gum or candies recommended below.
- Brush twice daily with a new strong toothpaste, either Control RX or Prevident Plus toothpaste (5,000 parts per million fluoride). We will provide you with some today. This is to be used twice daily in place of your regular toothpaste.
- Rinse for one minute, once a day with a special antibacterial mouthrinse that we will provide you with today. It is called Peridex or Periogard and has an active ingredient called chlorhexidine gluconate at 0.12 percent. You will use this once daily just before going to bed at night (10 ml for one minute), but only for one week each month. You must use this at least one hour after brushing with the 5,000 ppm fluoride toothpaste.
- Get a fluoride varnish treatment for all of your teeth every three months at your caries recall exams.
- Receive the necessary restorative work such as fillings and crowns, as needed, in a minimally invasive fashion.
- Suck or chew xylitol candies or gum four times daily. You can obtain supplies from us today or we can help you buy these elsewhere.
- Use a special paste that contains calcium and phosphate (e.g., MI paste). Apply it several times daily to your teeth. We will teach you how to do this properly.
- Obtain a thorough professional cleaning during your current visit.
- Get a sealant treatment on all of the biting surfaces of your back teeth to keep them from being reinfected with the bacteria that cause dental decay.
- Use a baking soda rinse (or similar neutralizing product) four to six times daily during the day. You can make this yourself by shaking up two teaspoons of baking soda in an eight-ounce bottle of water.
- Please return when called for a re-evaluation in about one month.
- Please return when requested for a caries recall exam in three months.
- Get new bitewing radiographs (X-rays) about every six months until no cavitated lesions are evident.
- Come in for another caries bacterial test at the three-month visit or sooner to compare results with your first visit to check whether the chlorhexidine is working satisfactorily.
- Receive a review of your use of chlorhexidine and Control RX/Prevident and oral hygiene at that visit.
- Come in for a thorough professional cleaning as needed for your periodontal health.
- Get another fluoride varnish treatment of all teeth again at three-month caries recall visit and another set of bitewing X-rays at six months.

We will provide you with a timetable to help you to remember all of these procedures.

Although this sounds like a lot of things to do and to remember, this intensive therapy is necessary to stop the rapid destruction of your teeth. It can really work, and if you are willing to put in the time and effort, you can clear up your mouth, gums, and teeth and avoid costly restorative dental work in the future. Please help us to help you.

Practitioner signature _____ Date_____

Patient signature _____ Date_____

FIGURE 6. Extreme caries risk (high risk plus severe salivary gland hypofunction).