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METHODS OF DENTAL CARIES PROGNOSIS

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МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ
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1-я КАФЕДРА ТЕРАПЕВТИЧЕСКОЙ СТОМАТОЛОГИИ

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МЕТОДЫ ПРОГНОЗИРОВАНИЯ КАРИЕСА ЗУБОВ

METHODS OF DENTAL CARIES PROGNOSIS

Учебно-методическое пособие

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Изложены современные методы прогнозирования кариеса зубов. Приведены различные модели прогнозирования, описана методика выполнения тестов.

Предназначено для студентов 3-го и 5-го курсов медицинского факультета иностранных учащихся, обучающихся на английском языке.

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Dental caries is the most prevalent disease worldwide. According to the global burden of oral disease report of 2005, the prevalence of dental caries among adults is nearly 100 % of the population in the majority of countries.

The negative impact of dental caries on the quality of life is significant both in the short and long term, with edentulism in senior patients reaching as high as 26–50 % in North America and 13–78 % in Europe. Furthermore, regarding the global burden of oral diseases of 2010, caries collectively with periodontal disease, edentulism, oral cancer and cleft lip/palate are responsible for 18,814,000 disability-adjusted life-years (number of lost years of healthy life), on an average corresponding to an increase by 45.6 % from 1990 to 2010. The negative influence of dental caries impacts far beyond overall health, affecting other important aspects of life such as social and employment opportunities.

TERMINOLOGY IN DENTAL CARIES PROGNOSIS

Dental caries of the permanent dentition is a multi-factorial disease resulting from the complex interplay of endogenous and environmental risk factors.

Not only clinical variables, but also socioeconomic and behavioral characteristics have been included in the studies on dental caries-related factors. The relevance of these studies is based on the fact that the knowledge of the main risk indicators and risk factors of the disease makes it possible to identify individuals who would benefit from preventive measures.

Let us discuss the terminology in dental caries prediction.

Medical prognosis (Greek “prognosis” — prediction) is a prediction of probability of a disease beginning or disease course and outcome, based on the knowledge of the patterns of pathological processes.

Prediction is the development of a prognosis of the person’s state according to the information collected up to the current moment.

Types of prognostic tasks:

– prediction of disease risk;

– prediction of disease course;

– prediction of disease outcome.

Levels of prognosis are as follows:

– community (social);

– group;

– individual.

At the community level specialists predict dental caries development in the world, continents, country, state or province, district, city etc.

The group level means allocation of people who due to of certain circumstances are most susceptible to a given disease, into groups. Such circumstances include certain age periods, physiological state of the body and some diseases, socio-economic status. The presence of certain diseases or

physiological conditions allows dentist to identify the following groups of people most succeptible to caries:

– persons with general diseases that primarily affect the function of salivation (for example, Sjogren's syndrome);

– people who regularly take medicines containing sugar, or drugs with a side effect of salivation;

– persons who have prescribed treatment which affects salivation (for example, radiotherapy in the maxillofacial region is often accompanied by xerostomia and "radiocaries");

– persons with mental disorders;

– persons with an impaired locomotor system, people with disabilities;

– persons with a significantly weakened immune system (e. g., HIV-infected);

– pregnant women;

– obese people due to frequent eating.

A separate group consists of people with a low socioeconomic status (for example, in industrialized countries they include emigrants from developing countries, refugees).

At the individual level we determine predisposition to caries of each individual.

A "risk" is probability that some harmful event (caries) will occur.

A "risk factor" is identified as a result of long-term studies of environmental, behavioral and biological factors, the presence of which increases the likelihood of disease, and its absence or elimination reduces the probability of disease. Risk factors are part of the causal chain leading to the disease.

A "risk indicator" is a likely or perceived risk factor, are often found in cross-sectional studies, but not yet confirmed by longitudinal studies.

A "risk predictor" is symptom (symptoms) associated with the progression of the disease, but not always a part of disease causal chain. The predictors are useful for identifying the risk, but not always suitable for the determination of the necessary preventive and therapeutic interventions.

A "prognostic factor" is an environmental, behavioral or biological factor, the presence of which directly influences the probabilities of a positive result of the disease treatment.

"Caries risk" is probability that an individual will develop carious lesions, reaching a given stage of the disease in progression during a specified period of time if the exposure status for risk factors remains stable during the period under consideration.

Earlier prediction models usually involve the association of one variable with caries development. More recently multiple factors have been included in modeling. This approach is sensible as caries is a multifactorial disease involving host, agent, and substrate factors. In 1988 a risk assessment

conference was held at the University of North Carolina. Among the conclusions of the dental caries working group were the following:

1. Clinical variables were stronger predictors than non-clinical variables.

2. Past caries experience was the most significant predictor; other important variables were socio-economic status, fluoride exposure, tooth morphology, and microbial agents.

3. Regression models were the preferred analysis using multiple factors and longitudinal data.

Caries Risk Factors can be divided into 2 groups:

I. Factors immediately involved in caries process, either as "attack" or "defense" mechanisms are as follows:

– dental plaque;

– the presence of various specific microorganisms in the plaque (including Str. mutans);

– the diet.

II. Factors related to the occurrence of caries, not actually participating in the development of the lesion:

– various socio-economic factors;

– past caries experience.

Such factors can be designated as indicators of caries risk, but do not participate actually in the "making" cavity.

CARIES RISK ASSESSMENT (CRA)

Why should CRA be used?

Categorizing patients by their risk of caries has been advocated as an initial step in determining appropriate preventive and treatment interventions. Identifying and determining risk should be a component in the clinical decision-making process because CRA and clinical examination provide an overview of exposures to potential caries risk/protective factors such as plaque, frequency of sugar intake, and exposure to fluoride while encouraging management strategies developed specifically for the patient.

CRA helps in identifying the main etiological agents that contribute to the disease and/or in determining the type of treatment and in making restorative treatment decisions including whether to intervene or not, preparing cavity designs and selecting dental materials.

CRA is useful to evaluate the degree of the patient's risk of developing caries to determine frequency of recall appointments or treatments.

CRA can improve the reliability of the prognosis of the planned treatment and assess the efficacy of the proposed management and preventive treatment plan at recall visits. CRA models currently involve a combination of risk

indicators and protective factors that interplay with a variety of social, cultural, and behavioral factors.

Risk Indicators:

1. Past caries experience: this has been the most consistent predictive factor observed in caries risk assessment studies. However, it is not particularly useful in young children, as determining caries risk before the manifestation of the disease is more important in this group. White spot lesions are considered good indicators to predict future caries development in young children.

2. Socioeconomic status (SES): most dental studies use low, middle or high socioeconomic advantage as a measure of SES. Research shows an inverse association between caries and SES levels indicating a higher caries experience in both primary and permanent teeth among children who are socioeconomically disadvantaged.

3. Sugar intake: the quantity of sugar consumption as well as the frequency of sugar intake contributes to dental caries. The relationship between sugar consumption and caries in developed countries has long been viewed as a positively linear one — the more the consumption and the higher the frequency, the greater the caries severity. Since the last decade, this linear relationship has been affected by fluoride exposure with most studies reporting a moderate or weak relationship between sugar consumption and caries. However, consumption of beverages with high sugar content such as soda pop or powdered beverage concentrates made with sugar was associated with progression of dental caries. Recently, WHO guideline on sugar intake for adults and children concluded that even a small reduction in risk of dental caries due to less consumption of sugar in childhood is of significance in later life.

4. Oral hygiene habits: the available evidence does not demonstrate a clear and consistent relationship between oral hygiene and dental caries prevalence. The reported association with tooth brushing frequency is more likely due to use of fluoridated toothpaste.

5. Bacteria: Streptococcus mutans and Lactobacilli, the main bacteria that are involved in the caries process, are constituents of the normal flora. Therefore caries is considered as a bacterial ecologic imbalance rather than as an exogenous infection. At a population (group) level, total bacterial count has been weakly associated with caries experience. At the individual level, bacterial count is a poor predictor of future caries. Streptococci mutans levels and the age of colonization with cariogenic flora are valuable in assessing caries risk, particularly in very young children.

6. Saliva: no variation in a single salivary component in a healthy population has been shown to be a significant predictive factor. Nevertheless decreased salivary function, as manifested by extreme xerostomia, is a consistent predictor of high caries risk. Despite the fact that normal salivary flow is an extremely important intrinsic host factor providing protection against caries, there is little information about the prevalence of low salivary flow in children.

METHODS TO DETERMINE CARIES RISK

By definition, caries risk assessment is to *predict future caries development* before the clinical onset of the disease. There are several caries risk assessment plans that are utilized: Caries Management by Risk Assessment (CAMBRA) and the American Dental Association's CRA Forms (Fig. 1), etc.

Caries Risk Assessment Form (Age >6)

Patient Name:				
Birth Date:			**Date:**	
Age:			**Initials:**	
		Low Risk	**Moderate Risk**	**High Risk**
Contributing Conditions		**Check or Circle the conditions that apply**		
I.	**Fluoride Exposure** (through drinking water, supplements, professional applications, toothpaste)	☐Yes	☐No	
II.	**Sugary Foods or Drinks** (including juice, carbonated or non-carbonated soft drinks, energy drinks, medicinal syrups)	Primarily at mealtimes ☐		Frequent or prolonged between meal exposures/day ☐
III.	**Caries Experience of Mother, Caregiver and/or other Siblings** (for patients ages 6-14)	No carious lesions in last 24 months ☐	Carious lesions in last 7-23 months ☐	Carious lesions in last 6 months ☐
IV.	**Dental Home:** established patient of record, receiving regular dental care in a dental office	☐Yes	☐No	
General Health Conditions		**Check or Circle the conditions that apply**		
I.	**Special Health Care Needs** (developmental, physical, medical or mental disabilities that prevent or limit performance of adequate oral health care by themselves or caregivers)	☐No	Yes (over age 14) ☐	Yes (ages 6-14) ☐
II.	**Chemo/Radiation Therapy**	☐No		☐Yes
III.	**Eating Disorders**	☐No	☐Yes	
IV.	**Medications that Reduce Salivary Flow**	☐No	☐Yes	
V.	**Drug/Alcohol Abuse**	☐No	☐Yes	
Clinical Conditions		**Check or Circle the conditions that apply**		
I.	**Cavitated or Non-Cavitated (incipient) Carious Lesions or Restorations** (visually or radiographically evident)	No new carious lesions or restorations in last 36 months ☐	1 or 2 new carious lesions or restorations in last 36 months ☐	3 or more carious lesions or restorations in last 36 months ☐
II.	**Teeth Missing Due to Caries in past 36 months**	☐No		☐Yes
III.	**Visible Plaque**	☐No	☐Yes	
IV.	**Unusual Tooth Morphology** that compromises oral hygiene	☐No	☐Yes	
V.	**Interproximal Restorations - 1 or more**	☐No	☐Yes	
VI.	**Exposed Root Surfaces** Present	☐No	☐Yes	
VII.	**Restorations with Overhangs** and/or **Open Margins; Open Contacts** with Food Impaction	☐No	☐Yes	
VIII.	**Dental/Orthodontic Appliances** (fixed or removable)	☐No	☐Yes	
IX.	**Severe Dry Mouth (Xerostomia)**	☐No		☐Yes

Overall assessment of dental caries risk: ☐ Low ☐ Moderate ☐ High

Patient Instructions:

Figure 1. The American Dental Association's CRA Form

CAMBRA system provides a more in-depth assessment tool as a key element of the overall approach and takes account of: Caries disease indicators: Socio-economic status, developmental problems, and presence of lesions or restorations placed within the previous 3 years. Caries risk factors: Visible accumulations of plaque and quantitative assessment of Streptococcus mutans and Lactobacilli, frequent snacking, saliva flow and salivary modifying factors, fissure anatomy, root surface exposure, and the presence of appliances. Caries protective factors include systemic and topical fluoride sources, adequate saliva flow, xylitol in the diet, use of calcium and phosphate paste or chlorhexidine. Clinical examination reveals presence of white spots, decalcifications, restorations, plaque deposits. The tool assigns patients to low, moderate, high, or extreme risk and offers two formats, one for patients aged 0–5 years, and one for 6 years onward. A key benefit of CAMBRA is that it forces both the dental professional and the patient (or their caregiver) to consider all the factors relevant to the patient's risk and disease state, shifting the focus away from the traditional restorative approach of cavitation and restoration toward the cause of the disease and the need to modify the causes wherever possible. It also allows for greater communication and understanding between all members of the dental team.

An assessment should be developed with each patient to determine their risk of dental caries.

Circle or check the boxes of the conditions that apply.

Low Risk = only conditions in "Low Risk" column present.

Moderate Risk = only conditions in "Low" and/or "Moderate Risk" columns present.

High Risk = one or more conditions in the "High Risk" column present.

The clinical judgment of the dentist may justify a change of the patient's risk level (increased or decreased) based on review of this form and other pertinent information. For example, missing teeth may not be regarded as high risk for a follow up patient; or other risk factors not listed may be present. The assessment cannot address every aspect of a patient's health, and should not be used as a replacement for the dentist's consultation and judgment. Additional or more focused assessment may be appropriate for patients with specific health concerns. As with other forms, this assessment may be only a starting point for evaluating the patient's health status.

The following oral risk factors are important:

– new carious lesions;

– previous carious lesions over the past three years;

– recurrent caries around restorations;

– deep pits and fissures;

– orthodontic treatment.

Home Care: Oral Hygiene and Fluoride Exposure:

– removing plaque;

– current understanding of plaque control and the patient's motivation;

– brushing with fluoridated toothpaste daily;

– drinking city-added or naturally occurring fluoridated water.

Dietary Analysis: carbohydrate intake, including frequency (sugary drinks such as soda, fruit juice, energy, and sports drink consumption).

Microbial and Salivary Factors:

– bacterial count;

– xerostomia;

– physiological conditions;

– prescription of drugs affecting saliva rate;

– salivary stones.

Family or Social Risk Factors:

– multiple carbohydrates intake in-between meals per day;

– fear of dentists;

– family caries history.

Immunity/Medical Risk Factors:

– chronic diseases;

– medically or physically challenged.

Each of these categories must be addressed at each dental examination to determine risk assessment, as a patient's oral condition may be different due to physiological changes or self-care practices. Two significant factors that indicate a patient is at high-risk include caries in the last three years and past restorative care, thereby indicating a higher bacterial count.

As you see, many risk factors are similar in different CRA systems.

In scientific literature data about odds ratio (OR) for some caries risk indicators are available. Having white spot lesions (OR = 5.25) was found to be a risk indicator of high caries level at baseline (HCLB). Schoolchildren with dental fluorosis (OR = 0.17) or those who brushed the teeth more than two times a day (OR = 0.37) presented less probability of HCLB. The predictors of high caries increment (HCI) were: dmfs > 0 (OR = 2.68) and mothers' educational level up to 8 years of schooling (OR = 2.87). Clinical and socioeconomic variables were found to be risk indicators and/or predictors of dental caries in schoolchildren. Another finding is that those with dental fluorosis were less prone to have a high caries level.

A current caries assessment should be performed at recall appointments.

If a patient is diagnosed as moderate- to high-risk of caries, you may follow the recommended treatment protocol by the American Dental Association or CAMBRA.

Although the current ADA evidence-based practice guidelines not recommend xylitol gum therapy, evidence is strong. The ADA considers xylitol

therapy as an “Expert Opinion”. In other words, the ADA believes that even though there is a lack of evidence about xylitol, they recommend it be chewed by their patients for 10–20 minutes after meals and snacks as it buffers saliva and stimulates saliva to assist with hyposalivation.

THE LCI INDEX AS A PROGNOSTIC FACTOR

Attention is drawn to the importance of comparing the DMFT index and age. The WHO offers evaluation criteria for the intensity of dental caries for 12-year-olds and 35–44-year-olds people.

Criteria for evaluation of caries intensity level by the WHO (1994) for 12-year-olds:

– 0–0.5 — very low;
– 0.5–1.5 — low;
– 1.51–3.0 — moderate;
– 3.01–6.5 — high;
– 6.5–10.0 — very high.

Criteria for evaluation of caries intensity level by the WHO (1980) for 35–44-year-olds:

– 0.2–1.5 — very low;
– 1.6–6.2 — low;
– 6.3–12.7 — moderate;
– 12.8–16.2 — high;
– > 16.3 — very high.

But there are other age groups! Therefore, in 1990, professor P. A. Leous developed the LCI (level of caries intensity) index, which makes it possible to determine the level of caries intensity at any age from 1 to 65 years (Table 1). To determine the individual LCI, the DMFT index of an individual is divided by his age:

– children under 8 years LCI = dmf / N;
– children and adolescents LCI = DMF / (N – 5);
– Adults LCI = DMF / N (N — the age of the patient in years).

Table 1

Criteria of LCI (P. A. Leous, 1990)

Digital values	Level of caries intensity
≤ 0.15	low
0.15–0.30	medium
0.31–0.60	high
≥ 0.61	very high

But risk factors for dental caries are not stable (preventive measures are changed, lifestyle depends on age). They can both improve, which will lead to a decrease in the growth of caries intensity, and worsen, which will lead to an increase in the growth of caries intensity. In both cases, the results will differ from the calculated DMFT. In order to eliminate these shortcomings in 1990, professor P.A. Leous proposed a method for the clinical prediction of dental caries (CPC).

CLINICAL PREDICTION OF DENTAL CARIES

Method of clinical prediction of caries enables dental specialists to make prognosis over a period of 1 to 5 years. Six cards for different ages have been developed (Table 2). The following clinical indices are used for caries prediction: OHI-S, DMFT, CPI (complex periodontal index), the level of caries intensity (LCI), dental care level (DCL)). Patients should answer next questions (Table 3).

Table 2

Cards for CPC

Card cipher	Recommended contingent
Cpc-1	Pregnant women
Cpc-2	Children aged 1–3 years
Cpc-3	Children aged 3–6 years
Cpc-4	Children and teens aged 7–14 years
Cpc-5	Teens and adults aged 15–34 years
Cpc-6	Adults aged 35–64 years

Table 3

Questions and appropriate corrections

Question	Answer	Correction
Do you brush your teeth?	No (OHI-S > 1.0) Yes (OHI-S < 1.0) Not regularly With fluoride toothpaste	+10 % –10 % +10 % –10 %
Do you eat sugar and sweets?	No Sometimes Once a day Several times a day	-10 % –10 % 0 +10 %
Do you think that sugar is bad for teeth?	Yes No I doubt it	–10 % +10 % +10 %
How often do you visit the dentist?	When I have a toothache Less than 1 time per year More than 2 times per year I do not visit the dentist	+10 % 0 –10 %

We should also take into account the trend of dental caries intensity in the region population:

increase +20 %, stabilization 0, decrease –10 %.

If we summarize the underlined numbers we will get:

$$40\ \% + 0\ \% + 100\ \% = 60\ \%.$$

For calculation of prognosed DMFT we should use the formula:

$$DMFT_p = DMFT_i + LCI_i * N_p * X\ \% / 100\ \%,$$

where $LCI_i = DMFT_i/Age$;
$LCI_p = DMFT_p/(Age + N_p)$;
LCI_i — initial (at the moment of prognosis);
LCI_p — prognosed (N_p years later);
$DMFT_i$ — initial (at the moment of prognosis);
$DMFT_p$ — prognosed (N_p years later);
N_p — number of years of prognosis (not more than 5);
X — correction in % (may be + or –) + 100 %.

After that we should calculate prognosed LCI_p:

$$LCI_p = DMFT_p / (Age + N_p),$$

where $DMFT_p$ — prognosed (N_p years later);
N_p — number years of prognosis (not more than 5)

After all calculations we can choose treatment tactic for the patient (Table 4).

Table 4

Doctor's tactics

The level of dental caries intensity at the moment of prognosis (LCI_i)	**Predicted level of caries intensity (LCI_p)**	**Estimated tactics of doctor**
Low	low medium high	change nothing (a) eliminate risk factors (b) prescribe fluorides topically (c)
Medium	low medium high very high	a b + c b + c + prescribe fluorides systemically (d) b + c + d
High	medium high very high	a b + c b + c + d
Very high	medium high very high	a a b + c + d

PREDICTION OF DENTAL CARIES BASED ON IDENTIFYING CARIOGENIC MICROORGANISMS AND BUFFER CAPACITY OF SALIVA

Advantages:
– identification of Streptococci mutans and lactobacilli;
– high selectivity;
– reliable results.
Benefits for the practice team:
– comprehensive test to determine the caries risk status;
– the basis of targeted treatment;
– individualized recall intervals for the long-term maintenance of teeth.

The tests should be done at the beginning of a treatment session or during a separate visit and at least an hour after a meal, toothbrushing or smoking. It is important that the patient is relaxed and calm. The patient should not be sick or unfit. The tests should not be done in the middle of a treatment procedure for example after an injection with local anesthesia or after cavity preparation. The patient should not be on any antibiotics during the past one month.

If all the tests are performed at the same appointment, the following practical order is recommended:

1. Secretion rate measurement.
2. Saliva buffer capacity measurement.
3. Str. mutans test.
4. Lactobacillus test.

Estimation of the rate of "stimulated" saliva flow. Materials needed for the test: Paraffin and measuring cup or glass.

1. The patient should neither eat nor smoke for one hour prior to sampling.
2. The patient should be seated in an upright, relaxed position.
3. A patient is given a paraffin pellet to chew for 30 seconds, then is asked to spit out the accumulated saliva or swallow it.
4. The patient then continues to chew the paraffin pellet for 5 minutes, with the accumulated saliva collected continuously into a measuring glass. The time can be reduced if secretion rate is high or prolonged if the rate is low.
5. After 5 minutes, the amount of saliva is measured and the secretion rate is calculated. Example: 3.5 ml for 5 min = 0.7 ml/min. Normal saliva secretion is more than 1 ml/min.

Evaluation of the saliva buffer capacity. Dentobuff Strip is a quick and easy way to determine salivary buffering capacity. An indicator system incorporated in the test strip changes colour, clearly showing the buffer capacity of the saliva.

Method:

1. Place a Dentobuff test strip, test pad facing up, on an absorbent surface like a paper towel, without touching the test pad.

2. Use the enclosed pipette to apply a drop of stimulated saliva (see estimation of rate of saliva flow) to the test pad, enough to cover the entire pad.

3. After exactly 5-minute reaction time, compare the colour that has developed on the test pad with the Dentobuff Strip Colour Chart. When a drop of collected saliva is added to the test pad of the strip, the saliva starts to dissolve acids which have been dried into the test pad, which also contains pH sensitive dyes. This test system discriminates between low (yellow), medium (green) and high (blue) buffer capacity (Fig. 2).

Figure 2. Scale for evaluation of the saliva buffer capacity

Estimation of Str. mutans in saliva. Dentocult SM is used to estimate the Str. mutans count in saliva. The method is based on the use of a selective culture broth and the adherence of mutans streptococci to the test strip.

Method:

1. Take a bacitracin disc from the vial using forceps or a needle. Do not forget to close the cap tightly back.

2. Put the bacitracin disc into the culture broth vial and let it stand for at least 15 minutes.

3. Give the patient a paraffin pellet to chew for at least one minute. Chewing results in mutans bacteria moving from the tooth surfaces to the saliva.

4. Take one Str. mutans test from the container, touching only the square end. Insert 2/3 of the strip into the patient's mouth and rotate it on the surface of the tongue about 10 times. The strip should not be rubbed on the tongue, only wetted well.

5. Remove the strip mutans from the tongue, pulling it between closed lips in order to remove any excess of saliva.

6. Place the strip mutans in the culture medium. The cap should remain $^{1}/_{4}$ open. Hold the vial upright.

7. Fill in the data on the patient label and attach it to the vial.

8. Place the culture vial in an incubator at 35–37 °C (95–99 °F) and incubate for 2 days.

Compare the colony density with the densities of the model chart (Fig. 3).

0 1 2 3

Figure 3. Estimation of Streptococci mutans colony density in saliva

Estimation of lactobacilli in saliva. Dentocult LB is a dip-slide method for estimating the salivary lactobacillus count. It consists of a slide with a selective substrate for Lactobacillus.

Method:

1. Let the patient chew on the enclosed paraffin pellet for at least one minute (if saliva has not already been collected for secretion rate assessment).
2. Collect the stimulated saliva in the test tube.
3. Remove the nutrient medium from the culture vial without touching the agar surfaces.
4. Pour saliva from the test tube over both agar surfaces, making sure that they are totally wetted.
5. Allow the excess saliva to drip off, then screw the slide tightly back into the culture vial.
6. Write the patient's name and date of sampling on the enclosed label and stick it on the culture vial.
7. Place the culture vial in an upright position in an incubator for 4 days at 35 °C / 95 °F.

After incubation remove the nutrient agar slide from the culture vial. Compare the colony density on the agar surfaces with the densities of the model chart (Fig. 4).

10^3 10^4 10^5 10^6

Figure 4. Estimation of lactobacilli colony density in saliva

However, numerous studies have presented quite contradictory data on the reliability of single microbiological prognostic factors. Despite the inconsistency of the data, it was observed that the accuracy of prediction based on the determination of only cariogenic microorganisms is low — about 60 %. After all, we are talking about the etiologic factor. The explanations are as follows:

1. Tooth decay is a disease of a multifactorial nature.

2. Not only SM and LB, but also other microorganisms of plaque have cariogenic properties, i.e. can ferment carbohydrates with the formation of acid and at the same time be acid-fast. These properties are expressed to a lesser extent than SM and LB. However, their cariogenic capacity may be sufficient under certain conditions to reduce the resistance factors for the development of caries. This explains the occurrence of caries in the absence of SM colonies in the oral cavity of the patient.

3. This technique does not provide for the mathematical accuracy of calculating the intensity of dental caries. The essence is to identify people with a high risk of caries for the timely provision of preventive care and treatment.

4. Thus, if a young person aged 18–25 years has a combination of a very high LCI with a concentration of Streptococcus mutans greater than $1 \cdot 10^6$ cfu/ml, a low and medium buffer capacity of saliva, then the risk of a high increase in caries intensity is determined with an accuracy of 90 % (Fig. 5). Such a person, along with measures of mass prophylaxis of dental caries, requires a thorough dental examination, motivation and a set of individual therapeutic and prophylactic measures.

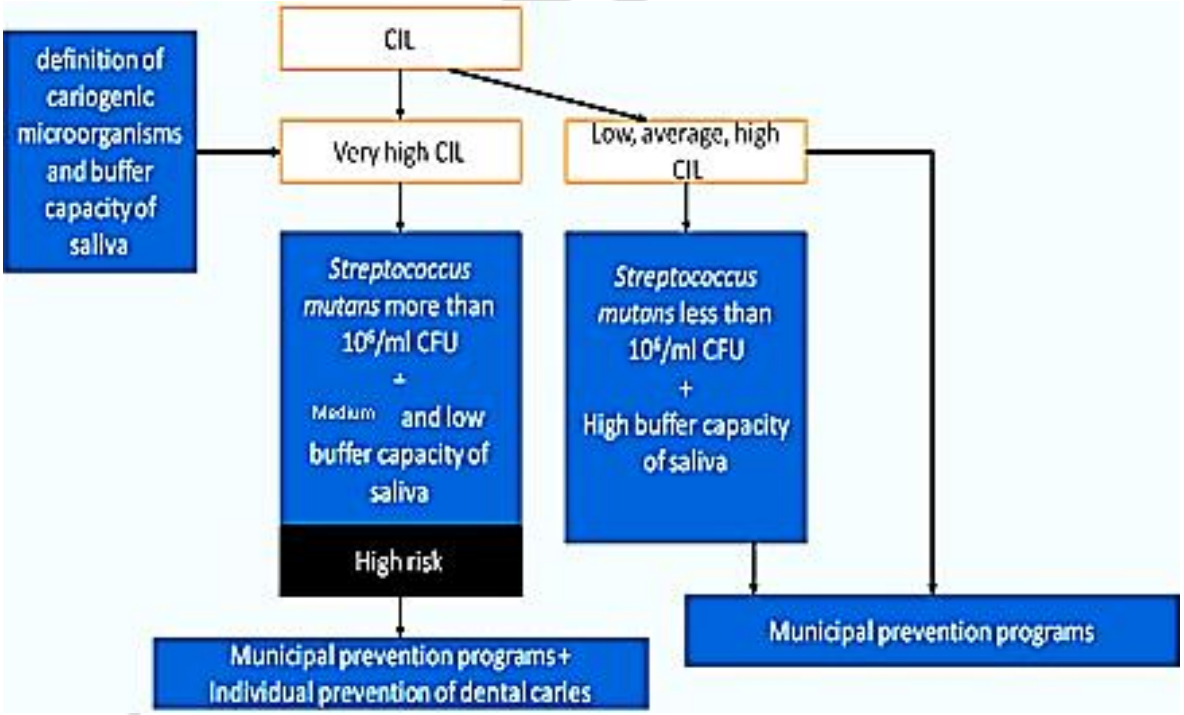


Figure 5. Caries prediction based on combination of evaluation of cariogenic microorganisms and buffer capacity of saliva

The modern version of Str. mutans test (GC) allows the dentist to get the result in 15 min without incubation (Fig. 6).

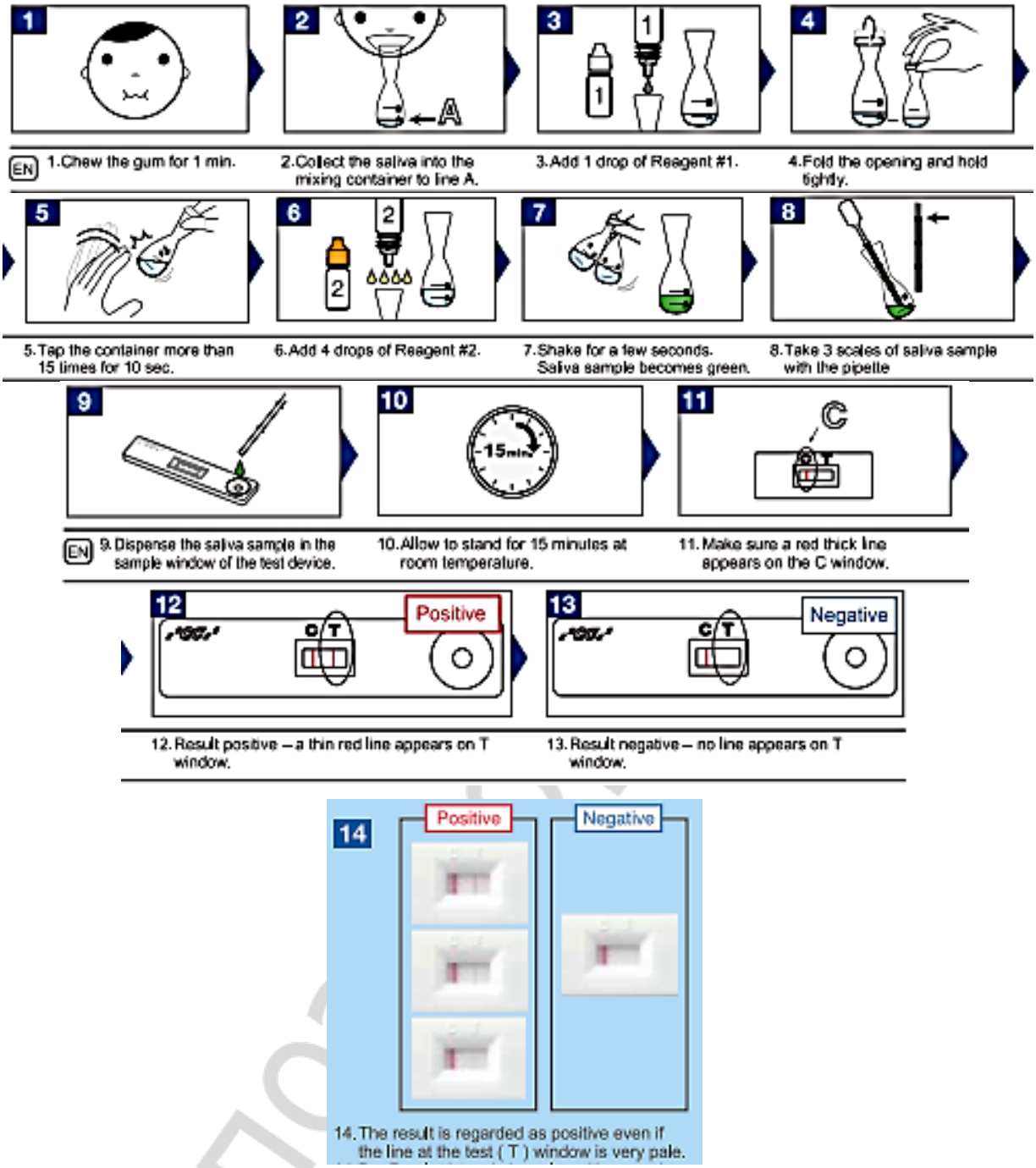


Figure 6. Saliva Check Mutans guide

Indications:

– New patients, particularly children and the elderly.

– Patients with lower natural oral protection because of low salivary flow.

– Patients with an acidic diet, low oral pH or high frequency of fermentable carbohydrates.

– Patients undergoing periodontal treatment due to higher risk of root surface caries.

– Patients before extensive restorative treatment to avoid recurrence of cavities.

– Expectant parents or young child carers, to prevent transmission.

Advantages:

– Results are available in 15 min only, without any special equipment.

– Using 2 monoclonal antibodies detect only Streptococcus mutans and no other bacteria species.

– The results enhance the motivation of patients with low salivary flow or low oral pH, with an acidic diet or high frequency of carbohydrate.

Modern version of saliva tests Saliva Check Buffer kit is divided into 5 different steps, the first 3 steps involve unstimulated saliva while the last 2 steps involve the stimulated saliva (Fig. 7). As the functions and characteristics of these two forms of saliva are different, by evaluating both, the test results will become very useful diagnostic and powerful communication tools to the patients.

Figure 7. Saliva Check Buffer kit

Step 1 and 2 — flow rate, viscosity and consistency of unstimulated saliva provide information how the patient's lifestyle may consequently affect oral health (Fig. 8, 9).

Step 3 — pH of resting saliva to determine whether acid levels may be dangerously high, possibly causing erosion or caries (Fig. 10).

Step 4 — measure quantity of stimulated saliva that can be produced to identify any major salivary gland diseases (Fig. 11).

Step 5 — buffering capacity of stimulated saliva shows the effectiveness of saliva in neutralizing acids (Fig. 12).

Indication:

Saliva-Check Buffer is very useful to identify contributing factors like stress, smoking, disease, salivary gland pathology, chronical renal failure, drug abuse, menopausal hormone imbalance and medicine side effect. The results can be explained to the patient as part of the discussion about prevention and treatment.

Figure 8. Hydration assessment

Figure 9. Viscosity assessment

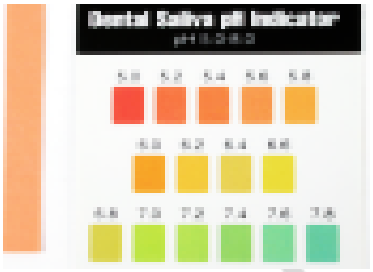


Figure 10. Saliva pH indicator

Figure 11. Saliva flow assessment

Figure 12. Test for buffering capacity of saliva assessment

Step 1. Resting flow rate. Visually assess the labial secretion of lower lip. Evert the lower lip, gently blot the labis mucosa with a small piece of gauze and observe the mucosa under good light. Droplets of saliva will form at the orifices of the minor glands. If the time required for this to occur is more than 60 seconds, the resting flow rate is below normal. Interpretation is shown in the Fig. 13.

Step 2. Salivary consistency. Visually assess the resting salivary consistency in the oral cavity (Fig. 14).

Low	Greater than 60 seconds
Normal	Between 30-60 seconds
High	Less than 30 seconds

Figure 13. Interpretation of the resting flow rate of saliva

Strongly increased viscosity	Sticky frothy saliva
Increased viscosity	Frothy bubbly saliva
Normal viscosity	Watery clear saliva

Figure 14. Interpretation of resting salivary consistency in the oral cavity

Step 3 — testing pH of Resting Saliva. Instruct the patient to expectorate any pooled saliva into the collection cup. Take a pH strip, place this into the sample of resting saliva for 10 seconds and then check the color of the strip. Highly acidic saliva will be in the red section, pH 5.0–5.8. Moderately acidic

saliva will be found in the yellow section, pH 6.0–6.6. Healthy saliva will be in the green section, pH 6.8–7.8 (Fig. 15).

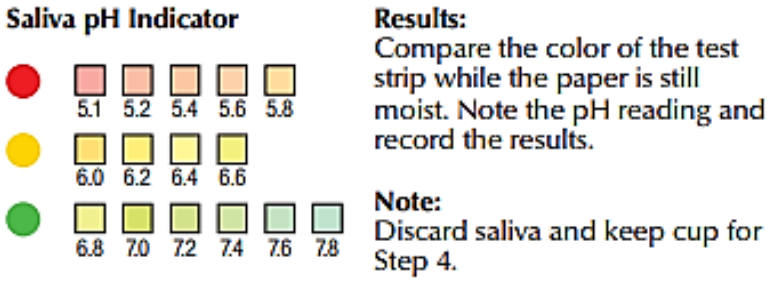


Figure 15. Saliva pH indicator

Step 4 — testing quantity — stimulated saliva. Ask the patient to chew the supplied piece of wax. After 30 seconds ask the patient to expectorate (spit) into the collection cup. They should then continue chewing the wax for a further 5 minutes, expectorating every 15–20 seconds in the cup provided. It is preferable that you leave the patient alone in the room while he/she collect the saliva. Measure the volume of the liquid in the cup excluding froth and record the result (Fig. 16). Note: Keep saliva for the next step.

Step 5 — testing buffering — stimulated saliva. Open the buffer test foil pack. Use the pipette to draw up some saliva from the cup. Dispense 1 drop from the cup onto each of the 3 test pads. Turn the test strip on its side to drain excess saliva onto a tissue. After 2 minutes compare the color of each pad with the table below, total the 3 scores and record the results (Fig. 17).

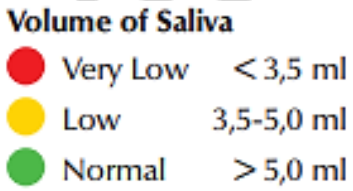


Figure 16. Interpretation of saliva secretion quantity

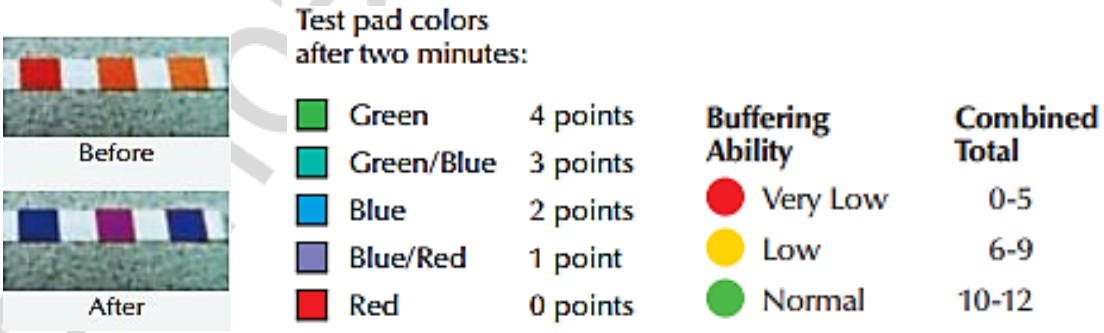


Figure 17. Interpretation of stimulated saliva buffer capacity

Results of all tests should be summarized (Fig. 18).

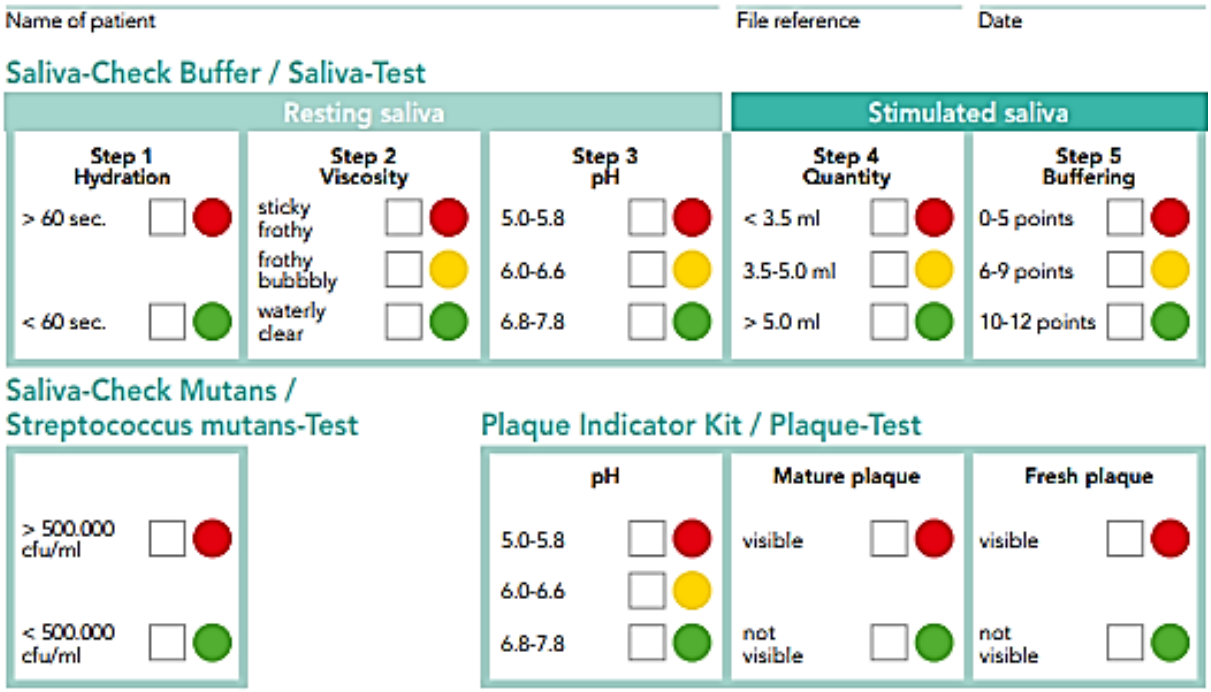


Figure 18. Results of saliva tests

GC also produces “GC Dental Plaque Disclosing Gel” (Fig. 19).

Figure 19. GC Dental Plaque Disclosing Gel

Advantages:

– The patient’s risk of caries is identified within 5 minutes.

– Provides a total picture of sites where plaque accumulation exists.

– GC Tri Plaque ID Gel is a chairside motivation test that helps educate patients on plaque that remains on the teeth after brushing. This product allows them to easily visualize those areas where they should concentrate and improve their brushing and flossing routine. It is an innovative, plaque disclosing gel that identifies new, mature and acid producing biofilms in three colors (red/pink, dark blue/purple, and light blue) (Fig. 20).

Figure 20. Different colors of plaque depend on its maturity

USING "CARIOGRAM" IN CARIES PREDICTION

This program was developed by professor D. Bratthal (Sweden, Malmo University, 1997). The "Cariogram", a pie circle-diagram, is divided into five sectors. "Cariogram" is a graphical picture illustrating in an interactive way the individual's/patient's risk for developing new caries in the future, simultaneously expressing to what extent different etiological factors of caries affect the caries risk for that particular patient.

This program cannot replace the personal and professional judgement of caries risk made by the examiner. However, it may give valuable hints and may even serve as a basis for discussions with the patient regarding various risk factors and preventive strategies. In other words, it does not take over the judgement or the responsibilities of the examiner, but may serve as a valuable tool in the clinical decision-making.

The need for predicting the caries risk accurately is obvious, as targeted preventive actions can be directed to those having a high caries risk, before cavities could develop. Naturally, if the main etiological factors could be identified, suitable treatment for that particular individual could be carried out with good results.

"Cariogram" never specifies a particular number of cavities that will or will not occur in the future. It rather illustrates a possible over-all risk scenario, based on what can be expected depending on our interpretation of available information.

The Cariogram helps to:

– illustrate the interaction of caries related factors;
– illustrate the chance of avoiding caries;
– express caries risk graphically;
– recommend targeted preventive actions;
– can be used in the clinic;
– can be used as an educational programme.

Which factors are to be considered in the estimation of caries risk?

These factors can be divided into two groups:

– Factors immediately involved in the caries process, either as "attack" or "defence" mechanisms, at the site of the development of the lesion.

– Factors related to the occurrence of caries, without actually participating in the development of the lesion.

The "Cariogram" is basically built on the first group of risk factors. This does not mean that the second group is ignored as these factors indirectly contribute to changes in the factors in the first group. For example, poor socio-economic factors can negatively affect both oral hygiene and the diet of an individual. Factors, which the tooth surface is directly exposed to and which contribute to the development of the caries lesion, are dependent on "dose", "frequency" and "duration". Each factor therefore has to be considered from these points of view. For example, a large amount of plaque (high dose) indicates a high risk only if it is present often (high frequency) and for a longer period of time (long duration).

The factors included in the "Cariogram" have been given different "weights". This means that the key factors, which support the development of caries, or resist caries, have a stronger impact than the less important factors when the program calculates the "Chance to avoid new cavities". The factors are also weighed in relation to each other. Thus, different factors have different "weights" in different situations and the number of combinations of factors is enormous. The given weights are based on thorough search of the literature and evaluation of results in a large number of scientific publications. In addition, clinical experience gained from decades of use of saliva tests has been incorporated. However, it should be understood that there are no actual scientific studies available that have evaluated all the factors at the same time, for different age groups and for different areas. Caries risk evaluations cannot be made with mathematical exactness. For example, it is impossible to say with 100 per cent certainty that "this patient will definitely develop five cavities during the coming year". On the other hand, it is possible to say that "based on available information it seems very likely that this patient will develop several cavities during the coming year — with this combination of caries related factors, cavities usually develop". The "Cariogram" concept is an attempt to illustrate how a large set of data can be evaluated – based on both science and art!

Caries risk evaluation can be compared to the weather forecast. To produce an accurate weather report one needs information on several factors such as direction of the wind, wind velocity, temperature, humidity of the atmosphere etc. The meteorologist, when such data are collected and put together, may forecast that, as for a certain area, there was an 80 % risk for strong winds. For the listener this means that the risk for strong wind was high but not absolutely certain. Maybe the wind will be less strong in some parts of the district.

If the “Cariogram” shows for example that there was an 80 % chance to avoid caries, taking into account all the factors, it means an overall 80 % chance in avoiding new caries in the future. The caries activity will be low provided the patient does not change his/her behaviour and biological factors which the judgement was based on. The “Cariogram” gives the picture for the “whole patient”, but locally it may be different, for example nearby an overhanging filling, crown edge or around crowded teeth. Often, it is too time-consuming to make a caries risk evaluation for every tooth site.

The program, in a normal case, never shows 0 % or 100 % chance to avoid caries (should the figures appear, it is because of decimal rounding up). It is needless to say, the caries risk assessment is complex and one has to be cautious when interpreting it.

The green sector shows an estimation of the “Actual chance to avoid new cavities”. The green sector is “what is left” when the other factors have taken their share (Fig. 21)!

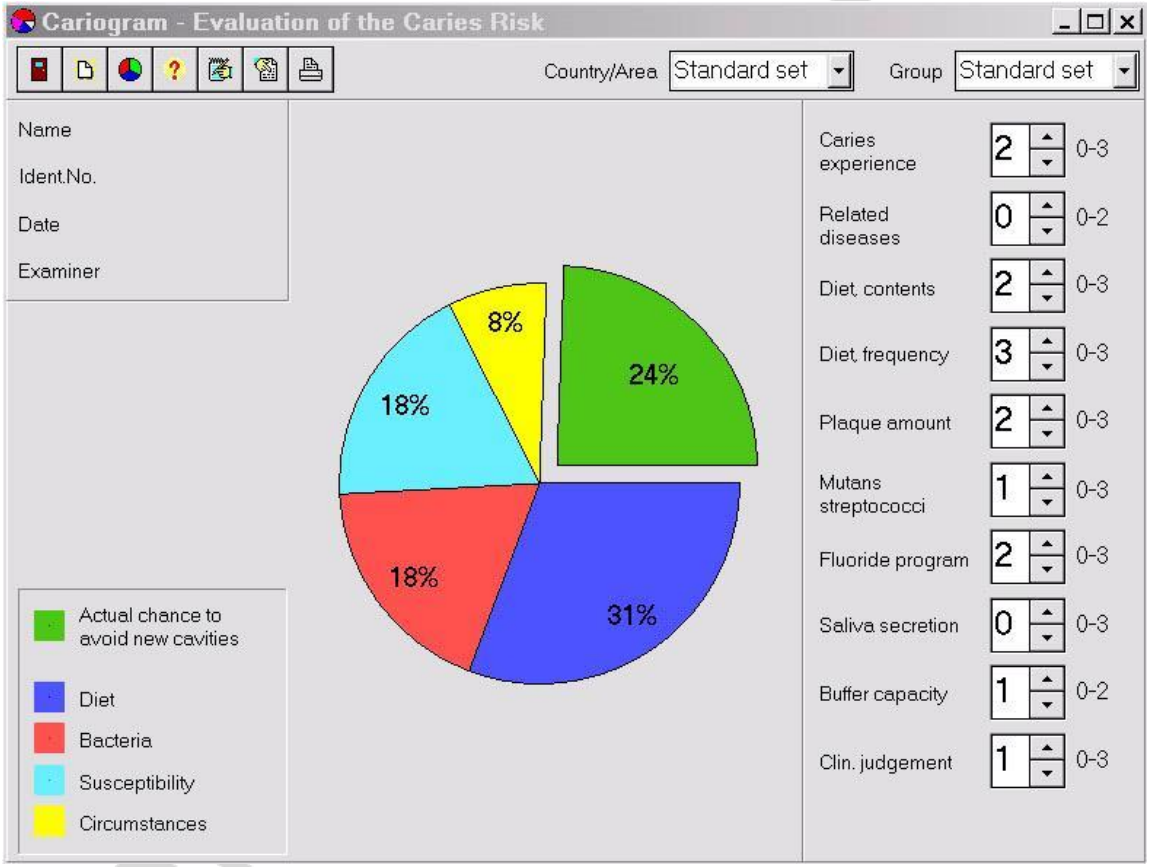


Figure 21. “Cariogram”

The dark blue sector “Diet” is based on a combination of diet contents and diet frequency.

The red sector “Bacteria” is based on a combination of the amount of plaque and Streptococci mutans.

The pale blue sector “Susceptibility” is based on a combination of fluoride program, saliva secretion and saliva buffer capacity.

The yellow sector “Circumstances” is based on a combination of past caries experience and related diseases.

The significance of each factor is evaluated in points from “0” to “2”, or “0” to “3”.

“0” is a favorable indicator.

“1” to “3” — are unfavorable indicators.

!!! The bigger the green sector, the better dental health the patient has (Fig. 22).

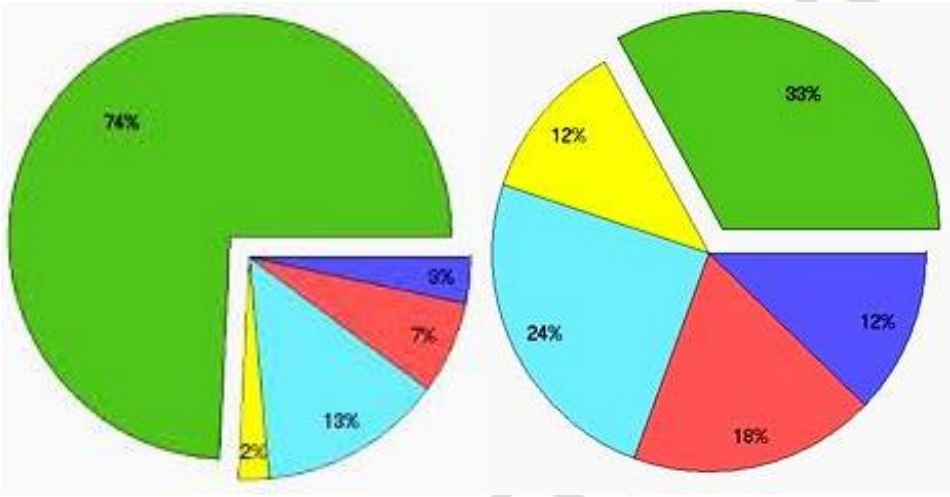


Figure 22. Different sizes of the green sector:
a — low risk of new caries cavities; *b* — high risk of new caries cavities

A small green sector means a low chance of avoiding caries = high caries risk!!! For the other sectors, the smaller the sector, the better from a dental health point of view.

The level of caries risk depends on the size of the green sector:

– 0–20 % — very high;

– 21–40 % — high;

– 41–60 % — meduim/moderate;

– 60 % and more — low.

How to use the “Cariogram”.

Settings for “Country/Area”

The impact of different caries-related factors may differ between different countries/areas depending on several background information. The “Standard set” is most suitable for an industrialised country without water fluoridation. The examiner may want the “Cariogram” to continuously express somewhat higher or lower “Chances to avoid cavities” than the standard set and can choose for Country/Area “Low risk” or “High risk” accordingly (Fig. 23). Thus,

the “Chance to avoid cavities” becomes bigger or smaller respectively, but the relationship between the factors Diet/Bacteria/Susceptibility/Circumstances is not affected.

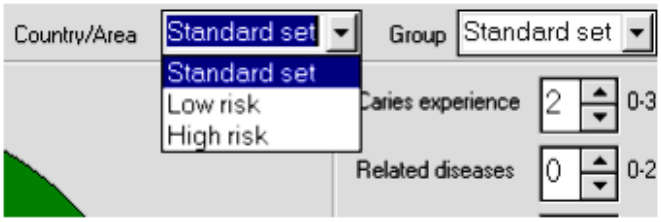


Figure 23. Settings for “Country/Area”

Settings for “Group”

A patient may belong to a “group” with higher or lower caries risk compared to the general population in the area. Example: Elderly patients with exposed root surfaces have higher risk and the setting “High risk” is appropriate. If you use the Cariogram to investigate a special group or a population, pre-set “Group” to Standard set, Low risk or High risk according to the group you have in mind (Fig. 24).

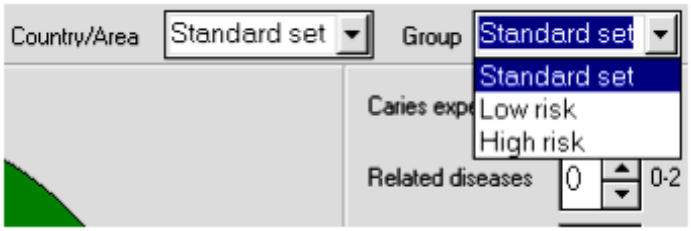


Figure 24. Settings for “Group”

Giving scores for the different factors.

To build a “Cariogram”, scores for the caries-related factors are entered in the boxes on the right side of the screen. Hints appear when the cursor points at the text or the scores. Move the cursor to the respective ranges “0”–“3” or “0”–“2” and choose your score (“0”, “1”, “2”, or “3”) most suitable for your patient (Fig. 25, Table 5).

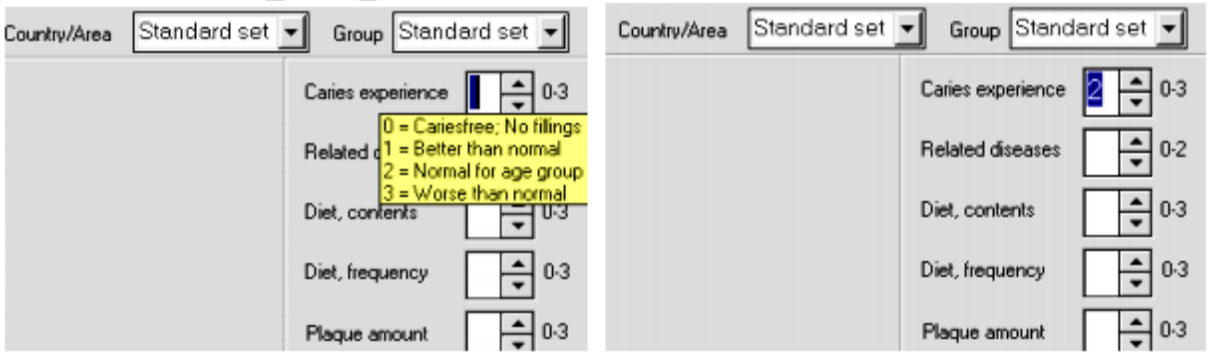


Figure 25. Giving scores for the caries related factors

Table 5

"Cariogram": explanation for the scores to be entered

Score	Explanation
Caries experience (caries prevalence)	
0 = Caries-free and no fillings	Completely caries-free, no previous fillings, no cavities or M-missing teeth due to caries
1 = Better than normal	Better than normal — better status than normal, for that age group in that area
2 = Normal for age group	Normal status for that age group
3 = Worse than normal	Worse status than normal for age group, or several new caries-lesions the last year
Related general diseases	
0 = No diseases	There are no signs of general diseases of importance related to dental caries. The patient is "healthy"
1 = Disease/conditions, mild degree	A general disease, which can indirectly influence the caries process, or other conditions which can contribute to higher caries risk, e. g. poor eye-sight, inability to move
2 = Severe degree, long-lasting disease	Patient could be bed-ridden or may need continous medication for example affecting the saliva secretion
Diet, contents	
0 = Very low fermentable carbohydrate	Very low fermentable carbohydrate, extremely "good" diet from the caries development perspective. Sugars or other caries inducing carbohydrates at a very low level. Lowest lactobacillus class needed to support a zero
1 = Low fermentable carbohydrate intake, "noncariogenic" diet	Low fermentable carbohydrate, "noncariogenic" diet, appropriate diet from a caries perspective. Sugars or other caries inducing carbohydrates at a low level
2 = Moderate fermentable carbohydrate content	Moderate fermentable carbohydrate content. Diet with a relatively high content of sugars or other caries inducing carbohydrates
3 = High fermentable carbohydrate intake, inappropriate diet	Inappropriate diet from a caries perspective. High intake of sugar or other caries inducing carbohydrates
Diet, frequency	
0 = Maximum three meals per day (including snacks)	Very low diet intake frequency, a maximum of three times per 24 hour as a mean under a longer time period
1 = Maximum five meals per day	Low diet intake frequency, a maximum of five times per 24 hours on average
2 = Maximum seven meals per day	High diet intake frequency, a maximum of seven times per 24 hours on average
3 = More than seven meals per day	Very high diet intake frequency, a mean of more than seven times per 24 hours on average
Plaque, amount	
0 = Extremely good oral hygiene, Plaque Index, PI < 0.4	No plaque, all teeth surfaces are very clean. Very "oral hygiene conscious" patient, uses both tooth brush and interdental cleaning

To be continued

Score	Explanation
1 = Good oral hygiene, PI = 0.4–1.0	A film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may be seen in situ only after application of disclosing solution or by using the probe on the tooth surface
2 = Less than good oral hygiene, PI = 1.1–2.0	Moderate accumulation of soft deposits, which can be seen with the naked eye
3 = Poor oral hygiene, PI > 2.0	Abundance of soft matter within the gingival pocket and/or on the tooth and gingival margin. The patient is not interested in cleaning the teeth or has difficulties in cleaning. He/she feels like cleaning his/her teeth thoroughly, professionally and immediately!
Str. mutans	
0 = Str. mutans class 0	Very low or zero amount of Str. mutans in saliva. Only about 5 % of the tooth surface are colonised by the bacteria
1 = Str. mutans class 1	Low levels of Str. mutans in saliva. About 20 % of the tooth surfaces are colonised by the bacteria
2 = Str. mutans class 2	High amount of Str. mutans in saliva. About 60 % of the tooth surfaces are colonised by the bacteria
3= Str. mutans class 3	Very high amounts of Str. mutans in the saliva. More than 80 % of the tooth surfaces are colonised by the bacteria
Fluoride programme	
0 = Receives “maximum” fluoride programme	Fluoride toothpaste plus constant use of additional measures – tablets or rinsings and varnishes. A “maximum” fluoride program
1 = Additional F measures, infrequently	Fluoride toothpaste plus some additional measures — tablets or rinsings and varnishes infrequently
2 = Fluoride toothpaste only	Fluoride toothpaste only, no supplements
3 = Avoiding fluorides, no fluoride	Avoiding fluorides, not using fluoride toothpastes or other fluoride measures
Saliva secretion, amount. Values below for adults	
0 = Normal saliva secretion	Normal saliva secretion, more than 1.1 ml stimulated saliva per minute
1 = Low, 0.9–1.1 ml stimulated saliva/min	Low, from 0.9 to less than 1.1 ml stimulated saliva per minute
2 = Low, 0.5–0.9 ml saliva/min	Low, from 0.5 to less than 0.9 ml stimulated saliva per minute
3= Very low, Xerostomia, < 0.5 ml saliva/min	Very low saliva secretion, dry mouth, less than 0.5 ml saliva per minute; problem judged to be long-standing
Saliva buffer capacity	
0 = Adequate, Dentobuff blue	Normal or good buffer capacity, Saliva end — pH ≥ 6.0
1 = Reduced, Dentobuff green	Less than good buffer capacity, Saliva end — pH 4.5–5.5
2= Low, Dentobuff yellow	Low buffer capacity, Saliva end — pH ≤ 4

To be continued

Rest of Table 5

Score	Explanation
Clinical judgement, opinion of the dental examiner, "Clinical feeling"	
0 = More positive than what the "Cariogram" shows based on the scores entered	The total impression of the caries situation, including social factors, gives a positive view, more positive than what the "Cariogram" seems to indicate. The examiner would like to make the green sector bigger, i. e. improve the "Chance to avoid caries" for the patient
1= Normal setting!	Risk according to the other values entered. The total impression of the caries situation, including social factors, gives a view, in line with what the tests and the other factors seem to indicate and points to the same caries risk as in the "Cariogram". The examiner does not have any reason to change the program's inbuilt evaluation
2= Worse than what the "Cariogram" shows based on the scores entered	The total impression of the caries situation, including social factors, points in the direction of increased caries risk. Less than good compared to what the tests and the other factors seem to indicate. The examiner would like to make the green sector smaller, which is to reduce the "Chance to avoid caries"
3 = Very high caries risk, examiner is convinced that caries will develop, irrespective of what the "Cariogram" shows based on the scores entered	The total impression of the caries situation, including social factors, is very bad. The examiner is very sure that caries will occur in the coming year and would want the green sector to be minimal, irrespective of the "Cariogram" results. The examiner overrules the program's inbuilt estimation

A good support for diet counselling is the use of saliva tests, like the lactobacillus test. A high lactobacillus count may indicate high carbohydrate consumption. Note that retention areas, open cavities or bad fillings can contribute to a high lactobacillus count. One way of measuring lactobacilli is using the "Dentocult® LB" method.

The frequency of fermentable carbohydrates intake is one of the key factors in the estimation of caries risk. Even a small snack — a biscuit or a sweet — contributes to acid production. However, a snack of only sugar-free ("tooth-safe") products, or water, should not be taken into consideration. There are several methods available according to which a patient can be evaluated. For example: intake frequency questionnaire, the interview method (24-h recall) where you search for a typical dietary pattern in an ordinary day's intake and the dietary record method (usually three days record) where the patient writes down the amount and type of diet for three ordinary days including a weekend day (of course avoiding birthdays and Christmas days!).

Estimation of the saliva flow rate (amount of saliva) can be done in the clinic using simple methods. The patient's subjective symptoms of a dry mouth, lack of saliva, and saliva volumes are not always correct, and an objective test method is recommended.

If a reduced flow is recorded, one can normally expect that not only the amount but also the quality of the saliva is changed for the worse. Medication, radiation therapy to the head and neck that affect the salivary glands, salivary stones, anorexia nervosa, autoimmune diseases and diabetes mellitus are examples of causes of the low secretion rate. Try to judge if the low secretion rate is of a temporary cause or if it is long-lasting. Choose values from the table above so that they represent the saliva secretion rate over a long period of time.

In measuring saliva flow rate, one can either choose "unstimulated" or "stimulated" saliva secretion. They are often but not always co-related. If one is uncertain, both types of saliva should be measured.

Note: "Clinical judgement" is automatically pre-set to score 1. That value will let the other factors express the "chance to avoid new cavities" according to the program. If you have a reason to believe that the "Chances" are better or worse, change to lower or higher values respectively. Note: If one wishes to change the "clinical feeling" (not agree to the normal setting) it should be done last. In other words, let the "Cariogram" build-up from the other factors and then include the score for judgement. Naturally, if there is a valid reason pointing to disagree (better or worse) with the "Cariogram" result, scoring accurately for the clinical judgement is very relevant. Reasons that could affect the clinical feeling and motivate for other score than "1" could be the examiners opinion of the patient's interest for preventive actions, her/his capacity to understand the given advice, the examiner's opinion of the rightness of, for example, the diet situation, judgement of the clinical examination or if the test results actually reflect the condition over a long period of time. The score "0" could be taken into consideration if other preventive actions have been installed which are not expressed in the factors of the program. The score "3" has the greatest input (weight) of all the factors of the program, it means that you actually do not need the "Cariogram", because you overrule the judgement of the program. At the same time, the possibility to use the score "3" shows that the examiner has the final responsibility of the total judgement. The score "0" does not have the corresponding great positive input (weight) because it is not reasonable to believe that the caries risk could be non-existent if several bad factors are present.

In order to see a "Cariogram" develop in the screen, the examiner must give a score for the different factors, shown in the right hand side of the screen. The examiner has to gather information accurately by talking with and by examining the patient. In certain components of the sectors, like saliva and bacteria, further standard diagnostic test results are needed to give the correct score to build the "Cariogram" in the screen. The examiner should have all the relevant information when using this program so as to get an accurate "Cariogram" reflecting the particular patient's caries profile.

There are 10 caries-related factors and it is therefore possible to enter 10 scores in this program, but the “Cariogram” would already appear when only 7 scores have been entered. The score for the “Clinical Feeling” will automatically come up as “1”, which is the standard. This means that the program estimates the caries risk on the basis of the other entered values. Only if the operator finds special reasons to abandon the program’s point of view, another score should be entered here. Any unfilled box thus makes the program less specific. To obtain reliable and accurate results it is therefore best to enter as many scores as possible instead of depending on pre-set values in the program.

Preliminary interpretation and proposed measures.

A set of suggestions for targeted actions in the form of proposed measures can be found if you click on the icon “Preliminary interpretation” in the upper left corner (Fig. 26). It should be understood that these are some suggestions only and do not give a full picture of all possibilities. The responsible examiner must decide if suggested actions, or other actions, are to be carried out or not. Note that the order of the points is not related to their order of importance.

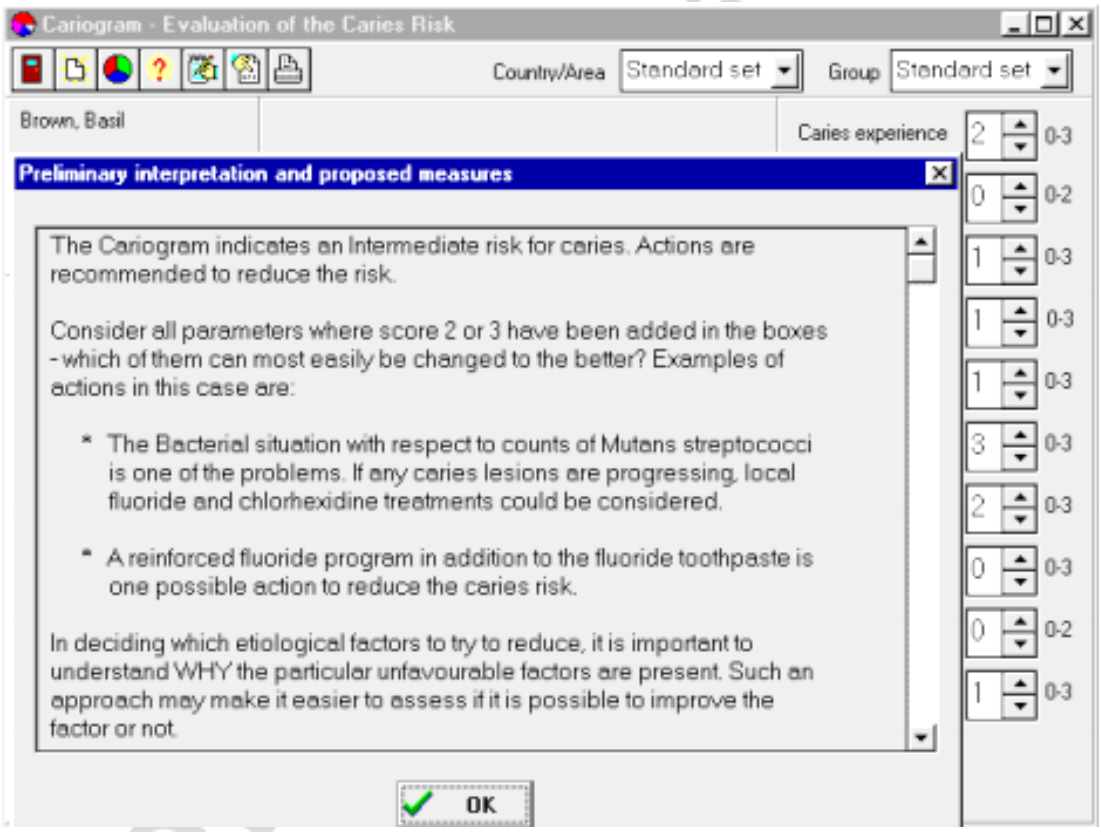


Figure 26. Preliminary interpretation and proposed measures

The “Cariogram” also helps us to illustrate and explain the situation to the patient. For “high risk” patients discuss which of the factors the patient is willing to change and what measures the dental team could consider. Try to use the “Cariogram” as an inspiration for the patient to make his/her own efforts.

Demonstrate to the patient how the caries risk can be reduced, that is to make the green sector bigger, by just changing scores (to the right) for the different factors.

Different methods of caries prognosis have their advantages and disadvantages (Table 6).

Table 6

Advantages and disadvantages of different methods of caries prognosis

Prognostication Method	Advantages	Disadvantages
The method of clinical prediction of dental caries (CPC, P. A. Leous, 1990)	Simple, cheap, accurate enough	Not demonstrative for the patient
Risk Model "Cariogram" (D. Bratthall, 1997)	Simple enough, absolutely accurate, graphic (demonstrative)	Time-consuming. The cost depends on the cost of the express tests for saliva, you need a computer
Caries prediction method on the basis of estimation of cariogenic microorganisms and buffer capacity of saliva (P. A. Leous, Y. Modrinskaya, 2002)	Simple enough, absolutely accurate, graphic (demonstrative)	The cost depends on the cost of express tests for saliva
Modification of "Cariogram" program (P. A. Leous, S. Tikhonova, 2003)	Simple, graphic (demonstrative)	Time-consuming. The doctor need a computer

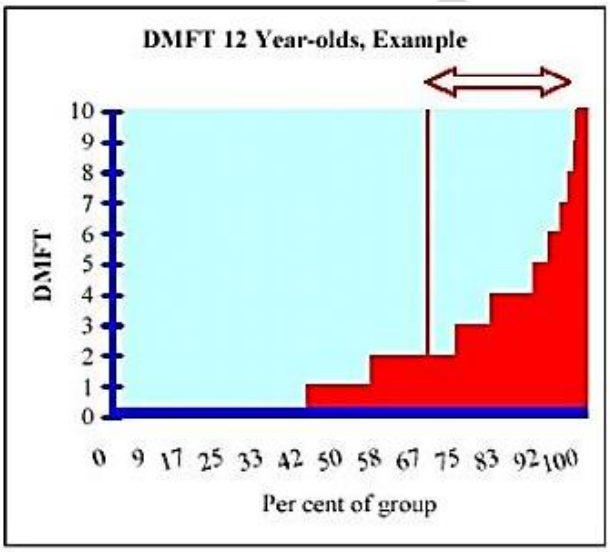
A recent systematic review appraised the evidence for the prediction of caries using four caries risk-assessment systems (Cariogram, CAMBRA, American Dental Association and American Academy of Pediatric Dentistry), focusing on prospective cohort studies or randomized controlled trials. The authors concluded that the evidence on the validity for existing systems was limited and that there was a necessity to develop valid and reliable methods for caries risk assessment. Furthermore, caries risk assessment systems such as "Cariogram" (including 9 factors) and CAMBRA (including 25 factors) performed at a level that did not assure that including a large number of factors was more beneficial than including only a few.

Powell reviewed 33 articles and stated that since individual prediction models had been developed for different purposes, it was difficult to select the best prediction model. The main result of this review was that the multifactorial prediction model was useful. The most commonly used method in the selected models was logistic regression, followed by linear discriminate analysis. Classification and regression tree analysis (CART) and Poisson regression analysis were used only in one paper each. Modern researches also use artificial neural networks and data mining to assess different risk factors.

In spite of caries decline observed in the last decades, high disease levels have still been identified in a minority of individuals, the so-called high-caries risk individuals. The early identification of these subjects allows health authorities to plan specific measures for caries prevention and to increase

the efficiency of preventive programs. For this purpose "Significant index of Caries" developed by D. Bratthall and co-authors (2000) was proposed. SiC is based on epidemiological studies. The next step in the tactics of a dentist is to identify and eliminate the risk factors for carious disease among a group of people with increased susceptibility.

The SiC index is calculated as follows: the age group under study is distributed according to the individual DMFT values in the ascending order (from minimum to maximum). Then, one-third of those who have the highest DMFT values are singled out as a separate subgroup. In this subgroup, the average value of the DMFT of the teeth is calculated, which is the highest caries intensity (Fig. 27, 28).



Int Dent J 2000, 50: 378-384.

Figure 27. Significant Index of Caries

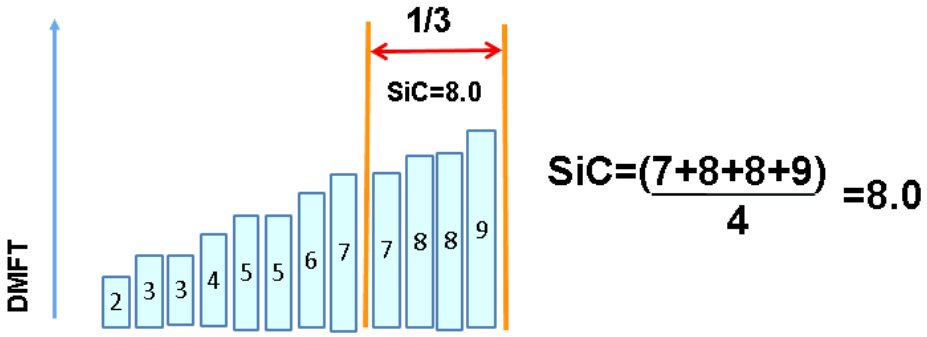


Figure 28. Calculation of SiC for group of 12 people

There are three basic prerequisites for a successful application of the high-risk strategy in controlling dental caries. First, the occurrence of caries in the target population must be low enough to justify the effort and expense of

identifying individuals who are believed to develop an unacceptably high number of cavities. Second, one must have accurate, acceptable and feasible measures for identifying the subjects with an unacceptably high risk. Third, the preventive efforts that are aimed at bringing down the elevated risk of these subjects should be based on measures that are effective and feasible.

After assessment of caries risk level, we can choose tactics for treatment and prevention.

In case of a low level of caries risk factor:

– Control the oral hygiene.
– Recommend system and local fluoridation.
– Provide patient with guidelines on diet and nutrition habits.
– Undertake no active treatment.
– If necessary, do teeth restorations.
– Carry out caries monitoring once a year.

In case of a medium level of caries risk factor:

– Control the oral hygiene, use daily home dyes for control of dental plaque.
– Provide patient with guidelines on diet and nutrition habits.
– Recommend system and local fluoridation.
– Perform professional oral hygiene twice a year.
– Do micro-restorations.
– Carry out caries monitoring twice a year.

In case of a high level of caries risk factor:

– Control oral hygiene every season.
– Recommend the patient home use of toothpastes with high fluoride content.
– Recommend professional and home applications of fluoride-containing drugs.
– Insert delayed teeth restorations (GIC).
– Carry out caries monitoring three or four times a year.

GC offer the doctor's tactics according to saliva tests results (Fig. 29).

RESULT	RISK	IN-OFFICE TREATMENT	AT-HOME TREATMENT
GREEN	LOW		MI Paste or MI Paste Plus after brushing and flossing
YELLOW	MODERATE	MI Varnish 2x/year	MI Paste or MI Paste Plus 2x/day after brushing and flossing
RED	HIGH	MI Varnish 3x/year	MI Paste or MI Paste Plus 4x/day and at bedtime
Xerostomia patients	*HIGH*	*MI Varnish 4x/year*	*MI Paste or MI Paste Plus every 3-4 hours and at bedtime*

RESULT	RISK	DISPENSE	RECALL	RE-TEST SALIVA
GREEN	LOW	as needed	6 months	6 months
YELLOW	MODERATE	as needed	4 months	4 months
RED	HIGH	as needed	3 months	3 months
Xerostomia patients	*HIGH*	*as needed*	*3 months*	*3 months*

Figure 29. Doctor's tactics according to saliva tests results

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METHODS OF DENTAL CARIES PROGNOSIS

Учебно-методическое пособие

На английском языке

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