REVIEW ARTICLE

CARIES RISK ASSESSMENT: AN OVERVIEW

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ABSTRACT

Currently, there have been many changes in understanding of the multifaceted nature of caries process and its management. Caries Management by Risk Assessment (CAMBRA) which is an evidence-based approach focuses on determining many factors causing the expression of disease and take corrective action. The clinicians can ascertain what behaviors are increasing a patient's risk for disease and disease progression by evaluating the current caries risk of a patient. With this modern CAMBRA protocol, a novel treatment plan can be designed to arrest dental caries thereby decreasing the chance of cavitation.. This review focuses on the repair of hard tooth tissues using noninvasive strategies.

Keywords: Caries management, Risk assessment, Lesion activity, Resin infiltrant.

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INTRODUCTION

Caries risk assessment is the determination of the likelihood of the incidence of caries (ie, the number of new cavitated or incipient lesions) during a certain time period.[1] It also involves the probability that there will be a change in the size or activity of the lesion in the mouth. When caries risk procedure is applied to populations it is termed as caries prediction.[2]

Caries activity tests estimate the actual state of disease activity (progression/regression). It is carried out in order to decide and monitor correct and efficient treatment of a patient.[3]

Caries Imbalance[4]

Disease indicators: White spots, Restorations >3 years, Enamel lesions and Cavities/ dentin.

Risk Factors: Bad bacteria, Absence of saliva and Dietary habits(poor).

Protective factors: Saliva & sealants, Antibacterial, Fluorides and Effective diet.

DISCUSSION

Concept of risk assessment

Term risk is often used to express the probability that a particular outcome will occur following a particular exposure usually implying a bad outcome. Estimations are made when the risk lies somewhere between 0 and 100%. In Dental Public Health, the concept of measuring and assessing risk which means confronting the varying susceptibilities to oral diseases has arrived more recently.5 The decline in caries experience at population levels that made it evident that not all children get caries, some do not get it, some get it only to a minor degree while others suffer badly from it. So the natural question of why do some get the disease and others do not has brought the concept of risk into caries prediction.[6]

OBJECTIVES[6]

- To improve the oral health in children, adolescents and adults.
- Introduce causal measures before irreversible lesions have become established.
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Uses of caries risk assessment[7]

- Evaluate the degree of patient's risk of developing caries to determine the intensity of treatment.
- Help identify main etiologic agents to determine the type of treatment.
- Determine if additional diagnostic procedures are required - salivary flow rate analysis, diet analysis.
- Improve the reliability of the prognosis of the planned treatments.
- Assess the efficacy of proposed management and preventive treatment plan at recall visits.

Caries Risk Assessment Tools

Caries Risk Assessment Tool (CAT): This tool was developed by the American Academy of Paediatric Dentistry (AAPD) in 2006. Depending on the age of children CAT incorporates three factors in assessing caries risk i.e. Biological factors, Protective factors and Clinical findings.[8]

Factors[9,10]

Biological

Patient with: Low socioeconomic status, >3 between meal sugar-containing snacks or beverages per day, Special health care needs, Recent immigrant.

Protective

Patient receives optimally-fluoridated drinking water, Brushes teeth daily with fluoridated toothpaste, Topical fluoride from health professional, Regular dental care.

Clinical Findings

Patient has >1 interproximal lesions, Active white spot lesions or enamel defects, Low salivary flow, Defective restorations, Wearing an intraoral appliance.

Caries risk assessment methods[1]

- Caries questionnaire in combination with clinical examination
- AAPD'S caries risk assessment form

- Cariogram model
- CARE-Caries Assesment and Risk Evaluation Test
- CAMBRA- Caries Management By Risk Assessment
- TLM-Traffic Light Matrix

Cariogram[11,12]

Cariogram is a new way in which toillustrate the interaction between caries related factors. This educational interactive program has been developed for better understanding of the multifactorial aspects of dental caries and to act as a guide in the attempts to estimate the caries risk. Original cariogram pie chart-3 colored sector:

• Red-bacteria

• Blue-sugar

• Light blue-host susceptibility

Later modified by including 2 more sectors:

• Yellow-circumstances

• Green-actual chances to avoid new cavities

Bacteria

• ü Type and amount of bacteria, bacterial adhesion, plaque formation rate, acid producing capacity and all factors which make plaque more or less cariogenic.

Diet

• Contents of fermentable carbohydrates and frequency of food consumption are included as well as possible antibacterial components in the food.

Susceptibility

• ü Remineralization of teeth, fluorides, saliva secretion and buffering capacity, salivary antibodies and salivary host components affecting demineralization and remineralization.

Care-caries assessment & evaluation test[13]

Many studies had shown the significance of genetics in caries development. Important in developed societies where a good dental coverage, adequate fluoride exposure and where gross malnutrition and oral health are rare. This plays a vital role in assessing child's overall caries risk status. Researchers at the division of diagnostic sciences of the university of southern California school of Dentistry developed a novel salivary test for Genetic CRA-CARE TEST.

CARE TEST- Only test that promote caries prevention at primary level. The widespread incorporation of CARE Test in clinical practice-future of dental care.

Caries Management by Risk Assessment (CAMBRA)[14]

The CAMBRA philosophy was first introduced nearly a decade ago when an unofficial group called the Western CAMBRA Coalition was formed that included stakeholders from education, research, industry, governmental agencies and private practitioners based in the western region of the United States. Evidence-based approach to preventing or treating the cause of dental caries at the earliest stages rather than waiting for irreversible damage to the teeth. Essentially based on the same factors as CAT to assess caries risk.

Traffic Light Matrix (TLM)[15]

TLM is based on 19 criteria in 5 different categories including saliva (6 criteria), plaque (3 criteria), diet (2 criteria), fluoride exposure (3 criteria) and modifying factors (5 criteria). Traffic light colours convey varying risk levels (red=high, yellow=moderate and green=low). The objective is to alert the clinician regarding the current risk status. This color code model keeps the visual interpretation simple and communicable to the patient as well.

Depending on predetermined criteria system scores Red, yellow & green light for each risk factors. Tests are carried for each risk factors independently and scores are generated.

The scores are compared with predetermined criteria. based on these criteria

Red for- high risk

yellow for- moderate risk

green for- low risk

Caries Risk Factors[1]

• Plaque

• Specific microbes and caries risk

- Diet
- Saliva
- Eating pattern
- Immune system
- Inherited risk susceptibility

Plaque[16,17,18]

It is important to estimate the number of surfaces affected, the amount of plaque accumulated, age of the plaque, whether its presence is associated with carious lesions in those same sites.

Risk areas for plaque accumulation

Mesiolingual and distolingual mandibular surfaces of molars, Mesiobuccal and distobuccal surfaces of maxillary and mandibular molars.

Plaque formation rate

On specific tooth surfaces thick plaque is present with a high percentage of acidogenic and aciduric bacteria - remains too long. Rationale for the development of Plaque formation rate index by Axelsson (1984,1989, 1991) based on the amount of plaque freely accumulated (de novo) 24hours. High plaque formation rate when associated with inadequate salivary secretion is considered to be at risk.

Nature of Plaque

A high intake of fermentable carbohydrates particularly sucrose will result in a sticky plaque rich in polysaccharides and an increased plaque formation rate. In the prevention plan for individuals with PFRI score of 4 or 5 and a frequent intake of sugar containing products should emphasize not only on frequent plaque control but also reduction in frequency of sugar intake.

Thickness and Age of the plaque

An increasing mass of plaque impedes penetration by saliva to protect the enamel. The critical fall in pH (below 5) occurs only in three day old plaque. In a tooth brushing population such plaque would be found if at all only on the approximal surfaces of molars and premolars and sub-gingivally.

pH of plaque

Pits and fissures favor plaque acidity compared to other tooth surfaces. The plaque on the maxillary incisors is less alkaline than mandibular plaque hence favoring the development of caries. Mandibular plaque pH has less pronounced pH response than maxillary plaque, the lowest values are recorded for anterior sites.

Plaque minerals

Calcium and Phosphates concentrations remain stable hence plaque concentrations can be considered as risk factors for caries. Fluoride concentrations is better considered as a risk indicator as relationship with caries has not been reported in longitudinal studies.

Specific microbes and caries risk[19,20,21]

Mutans streptococci and Lactobacilli have historically captured the greatest interest among researchers and clinicians. A high count in saliva more than 1 million colony forming units per ml of saliva indicates that most teeth are colonized by bacteria i.e. many tooth surfaces are subject to increased risk. The accuracy of salivary tests for Mutans streptococci in predicting future caries in the whole population is less than 50%. In populations with low caries prevalence, the caries predictive ability of microbiological tests is even lower. Tests for Lactobacilli are less sensitive for predicting caries than are those for MS.

Rationale for combining salivary ms tests and pfri for prediction of caries risk

Combination of salivary S mutans counts and plaque formation rate index (PFRI scores 1-5) is recommended for caries risk prediction, according to,

- No caries risk: Streptococcus mutans-negative individuals
- Low caries risk: Streptococcus mutans-positive individual with a PFRI score of 1or 2
- Moderate Caries risk: Streptococcus mutans-positive individual with a PFRI score of 3
- High caries risk: Individuals with high S mutans counts and a PFRI score of 4 or 5.

Lactobacilli

Lactobacilli are highly influenced by dietary carbohydrate content and intake frequency. Persistently high levels of lactobacilli after elimination of retentive sites like cavitated lesions indicate a diet rich in carbohydrates.

Other Bacteria

Many 'low pH non mutans Streptococci' which included S gordonii, S oralis, S mitis, S anguniosus out number the MS in plaque samples. Polymicrobial analysis have shown Actinomyces species predominate in active as well as arrested root surface lesions, suggesting a polymicrobial etiology for caries initiation in root surfaces.

Regular microbiological tests made by the dentists on an individual can be seen as monitors of change in the ecology of the oral cavity rather than caries indicators, indicating deviation from the norm for that individual. So any deviation from established colonal pattern of oral bacterial species would represent a change which if persisted could indicate a significant variation in the oral environment. Thus available bacterial tests should be used to determine cariogenic bacteria in the mouth and motivate behavioral changes, monitoring therapies like chlorhexidine therapy.

Diet[22]

Diet rich in fermentable carbohydrates (frequent sugar intake) is a very powerful external risk factor and prognostic risk factor for dental caries in populations with poor oral hygiene habits and associated lack of regular topical fluoride exposure from tooth pastes.

Eating Pattern[22]

Fall in plaque pH after consumption of sugary foods may be modified by the consumption of less fermentable foods before, concurrently or afterward e.g.: cheese.

Saliva[22]

Saliva plays an important role in the health of soft and hard tissues in the oral cavity.

Demineralization and Remineralization[23]

Main factors governing stability of enamel are the pH and concentration of Ca, PO34-, and F in solution which are all derived from saliva. The role of saliva in this process is highly dependent on accessibility, which is closely related to thickness of plaque. The ability of saliva to remineralize demineralized enamel crystals stems from its ability to supply bioavailable calcium and phosphate ions to the tooth. At physiological pH, unstimulated and stimulated parotid, submandibular and whole saliva are supersaturated with respect to most solid calcium phases.

Immune system and Caries risk[24]

Salivary immunoglobulin are mucosal antibodies that act as the first line of defense, and they include two major antibodies, namely, secretory IgA and IgG. Higher caries prevalance in preschool children with higher level of microbes such as mutans streptococci, C. albicans and Prevotellaspp., salivary protein including IgA, IgG immunoglobulins, histatin peptides, in saliva compared with caries free individuals.

Caries Risk Indicators[25]

Caries risk indicators broadly divided into: Pathological factors and Protective factors

Pathological factors are-

1- Past caries experience

2- Dietary habits

3- Socioeconomic status

4-Fluoride exposure

5-Medical factors

Past Caries Experience[25]

Most powerful single predictor for future caries incidence in children and young adults. It represent the sum result of all the etiologic and modifying risk factors to which individuals have been exposed. This is criticized because the aim should be to determine the high risk individuals before there are any signs of past caries experience.

Key-risk age group 1: Ages 1 to 2 years26

Kohler et al (1978,1982) showed that mothers with high salivary MS levels frequently transmit MS to their babies as soon as the first primary teeth erupt, leading to greater development of caries. It was also shown that the practice of giving infants sugar containing drinks in nursing bottles at night increases the development of caries Wendt and Birkhed, 1995

Key-risk age group 2: Ages 5 to 7 years[26].

In a study by Carvalho et al (1989), plaque reaccumulation was heavy on the occlusal surfaces of erupting maxillary and mandibular molars, particularly in the distal and central fossae.

Key-risk age group 3: Ages 11 to 14 years[26]

Normally, the second molars start to erupt at the age of 11 to 11.5 years in girls and at around

the age of 12 years in boys. Total eruption time is 16- 18 months. During this period, the approximal surfaces of the newly erupted posterior teeth are most caries susceptible.

Key-risk age groups in young adults[26]

Under certain circumstances, young adults (19 to 22 year olds) may also be regarded as a risk age group. Most have erupting or newly erupted third molars without full chewing function and with highly caries-susceptible fissures.

Other risk groups[26]

• Persons who work in occupations where frequent food sampling is required

• Persons who are obese

• Persons who abuse recreational drugs

• Persons who have systemic diseases and are taking regular medication

• Women who are pregnant

Uses of Caries Risk Assessment[20]

• Evaluate the degree of patient's risk of developing caries to determine the intensity of treatment.

• Help to identify main etiologic agents to determine the type of treatment.

• Help in determining whether additional diagnostic procedures are required: salivary flow rate analysis, diet analysis.

• Improve the reliability of the prognosis of the planned treatments

• Assess the efficacy of proposed management and preventive treatment plan at recall visits.

TESTS IN CRA[27]

• Bacterial challenge: determination of Mutans streptococcus as an indicator of relative risk.

• Diet: determination of lactobacilli as an indicator of sugar content in diet.

• Remineralization potential: salivary flow rate and buffer capacity as an indicator of potential biologic repair.

• Host susceptibility: caries experience as an indicator of past activity.

Microbial tests for mutans streptococci detection[28,29]

Several methods are available to measure the levels of mutans streptococci in saliva and plaque and on individual tooth surfaces.

- Laboratory Method
- Chair side Method
- Survey Method
- Selective Method
- Adherence Method

Saliva is collected from the individual to be sampled. Then, mixed with proper transport medium. After incubation using a selective medium, mutans colonies on the plates are counted and the results are expressed as no. of colony forming per units per ml saliva. A common type of selective agar plate for mutans streptococci is the mitis salivarious bacitracin agar, MSB agar. For screening surveys using agar plates, a simplified method has been described in which wooden spatulas are contaminated by saliva and then directly pressed against selective agar plates. After incubation the no. of colonies on a predetermined area of the agar is calculated.

Strip Mutans method for Mutans Streptococci Counts[30]

Dentocult-SM developed by Jensen and Brathall (1989). Useful for both chair side as well as for dental research. This method utilizes the ability of MS to grow on a hard surface in a selective mitis salivarius broth containing 20% sucrose. Has a specially rounded plastic strip for sampling which is slightly roughened on one side to promote bacterial adhesion. These strips can be stored for years in plastic foils for future comparisons. The density of the colonies is evaluated against a chart provided by the manufacturer and scored 0-3, where the scores 2 and 3 correspond to approximately 1x105 CFU and >1x 106 CFU/ml saliva.

Modification- Strip mutans technique[30]

The sampling of the selected sites is carried out either with a wooden tooth pick or a small saline wetted brush and transferred straight across the strip on an elevated pad so that four sites can be sampled on each strip. It is useful for monitoring the outcome of a site specific antibacterial treatment.

Survey Method[31]

Plates can be placed into plastic bags

containing expired air, which are then sealed and incubated at 37° C. Counts of more than 100 CFU by this method are proportional to greater than 108 CFU of S. mutans per ml of saliva by conventional methods.

Selective Method[31]

Plaque samples are collected from gingival third of buccal tooth surface. Toothpicks are inserted into approximal spaces and Place into Ringer's solution. Contaminated sides are then pressed into the approximal spaces for Incubation at 37°C for 72 hours. Sites with or without mutans streptococci can be identified.

Adherence Method[31]

Unstimulated saliva is inoculated in MSB Broth. Inoculated tubes are set at 60° angle and incubated aerobically at 37°C for 24 hrs. After growth has been observed,the supernatant medium is removed.

Microbial tests for Lactobacilli count

Laboratory Method[32]

Saliva is obtained by chewing a piece of paraffin. Shaken with glass beads to break up aggregates of bacteria. Saliva is then mixed with a buffer solution and 1 ml of the dilutions 10-2 and 10-3. 10ml is poured into the Petri dish. Plates are incubated at 37°c for 4 days. Lactobacilli appear as whitish dots.

Salivary Flow Rate[33]

Can be done by paraffin wax or citric acid 3%. Saliva derived is divided by collection time i.e. 5 minutes or ml/minute. Adults have rates of 1-1.5 ml/ minute, values below 0.7ml/minute are low an indicate risk for caries.

In children the values depend on age and cooperation. Preschoolers have secretion rates of 0.5ml for stimulated and 0.3ml/min for unstimulated saliva. An unstimulated rate of 0.1ml/min is considered a risk value.

Buffering Capacity[34]

Dentobuff method (Ericsson and Brathall, 1989)

Dentobuff strip is used. This method reflects the bicarbonate system and identifies saliva with low (yellow), intermediate (green) and normal (blue) buffer capacity. Test should be read exactly after 5 minutes otherwise, color changes with time and will give misleading results. The yellow color indicates pH of 4 or less, meaning the saliva was unable to raise the pH and should be considered as a risk value.

Viscosity of Saliva[34]

Measurement of oral mucosal friction by aid of rheologic device has been developed and may be important for elderly patients on xerogenic drugs.

Salivary Clearance Rate[35]

Clearance of food and microorganisms is disturbed by either extensive growth of bacteria as a consequence of poor oral hygiene, excessive dietary intake of fermentable carbohydrates or systemic diseases or hyposalivation. In caries susceptible individuals usually a combination of these factors are responsible. Clearance rate is dependent on SSR and volume of saliva before and after swallowing. Thus a high SSR will result in rapid clearance and low SSR in a slow clearance. Caries risk increases enormously with low SSR.

Caries Activity Tests

Synder Test[36]

Saliva is collected before breakfast by chewing paraffin wax. A tube of Snyder glucose agar is melted and then cooled to 50°C. Saliva specimen is shaken vigorously for 3 minutes. 0.2ml of saliva is pipetted into the tube of agar and immediately mixed by rotating the tube. Agar is allowed to solidify in the tube and is incubated at 37°C. Color change of the indicator is observed after 24, 48 and 72 hours of incubation by comparison with an uninoculated tube against a white background.

Alban Test[36]

60grams of Synder test agar is placed in 1 liter of water. Suspension is brought to boil over a low flame. After suspension has melted the agar is distributed using about 5 ml per tube. Tubes should be autoclaved for 15 minutes; allowed to cool in refrigerator. 2 tubes are taken from the refrigerator and patient is asked to expectorate a small amount of saliva directly into the tubes. Tubes are labeled and incubated at 98.6°F for 4 days. Tubes are observed daily for color change.

Swab test[36]

Advantage is no collection of swab is required. It is valuable in evaluating caries activity in very young children. Principle is same as Synder test. The oral flora is sampled by swabbing the buccal surface of teeth with cotton.

Reductase Test[36]

This test measures the activity of reductase enzyme present in salivary bacteria. The sample is mixed with fixed amount of diazo-resorcinol. The changes in color after 15 minute is taken as a measure of caries activity.

CONCLUSION

Across age and circumstance indicators of past caries experience are the strongest predictors. Bacterial levels are included in the most accurate prediction models. The success of a caries risk assessment model, one or more social, behavioral, microbiologic, environmental or clinical variables should be included due to the multifactorial assessment of carious etiology. The multifactorial etiology of dental caries makes it likely that even the most sophisticated risk models will be of limited value in predicting future caries development very accurately.

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