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Dentists and Preventive Oral Health Care

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1. Introduction

Millions of treatment decisions are making by dentists in every day all over the world. Dentists, therefore, have a unique opportunity for delivering updated knowledge on oral health promotion to the public and their decisions regarding disease control results in considerable variation in treatment practices.

Dental caries has been known as the key factor responsible for dental pain and tooth loss in populations all over the world throughout the history of mankind. In spite of preventable nature of dental caries, it is still a main burden of oral diseases in populations even in developed countries.

Practically, avoiding sugar use and applying perfect oral-self care is difficult to be reached on population-level (Marthaler 1990). Therefore, fluoride use is known to be the most important measure for caries prevention in the community level. Regarding the importance of local effect of fluoride, it was recommended to start fluoride use with the erupting first deciduous tooth. Multiple use of various fluoride products provide teeth with increased protection against caries (Zimmer et al. 2003).

Appropriate clinical caries management requires a comprehensive knowledge about caries detection, assessment and diagnosis. Clinicians should have a thorough understanding about the pathogenesis of caries and caries diagnostic level. They should also be able to interpret evidence derived from all sources. Restorative treatment only removes the carious tissues and does not, by itself, cure lesions. Once a restoration is placed, the tooth is subjected to a series of replacement restorations, tending to increase in size, complexity and cost (Pitts 2004).

2. Prevalence and burden of dental caries

Dental caries characterizes by localized dissolution of the hard tissues of tooth due to the production of acids from bacterial metabolism in dental plaque. It has been known as the major cause of dental pain and tooth loss in populations all over the world (Fejerskov and Kidd 2003) throughout the history of mankind and is still a major public health problem worldwide (Selwitz et al. 2007). In most industrialized countries, dental caries affects 60-90% of school-aged children (Petersen 2005a). Dental caries experience of 12-year-old children, based on WHO Global Oral Health Data Bank, is high in Americas (DMFT> 3.5) and in the

European Region (DMFT> 2.5) (Petersen 2003a). Looking at the DMFT data from countries show that there are several countries with fewer than three DMFT but high Sic Index [the Significant Caries (SiC) Index: mean DMFT of the one-third of the group having the highest DMFT in a population) (Bratthall 2000)] values illustrating the hidden caries burden for children (Nishi et al 2002). According to the U.S. Surgeon General's report (U.S. Public Health Service 2000), dental caries is the single most common chronic childhood disease in the United States. About 20% of US population in all age groups has been found to have untreated dental caries (National Center for Health Statistics, 2011). Two recent studies in UK revealed that more than one-third of 5- and 11-year-old children in Great Britain had evidence of caries experience in dentine (Pitts et al. 2006, 2007). In most developing countries, the level of dental caries is tending to rise due to excessive sugar consumption and inadequate exposure to fluoride (Petersen et al. 2005). In adults the situation is more worrisome as dental caries affects almost 100% of the population in the majority of countries (Petersen 2005b). Dental caries is not restricted to children and young adults. The elderly constitute a particular risk population especially regarding root caries (Petersen and Yamamoto 2005). It is worth mentioning, therefore, that dental caries has not been eradicated, but just controlled to a certain degree (Marthaler 2004, Petersen et al. 2005).

Dental caries, in its advanced stages, is associated with considerable pain, anxiety and impaired social functioning. Caries-related tooth loss causes eating disability, reduces self esteem and impair quality of life (Chen et al. 1997). In addition to its burden on individual, dental caries imposes a significant economical burden on communities. Tooth-related diseases have been considered as the forth most expensive to treat in industrialized countries (Petersen 2004). More than 51 million lost school hours per year has been recorded in the USA, due to dental-related illnesses which means approximately 3.1 days per year for 5-17-year-old children (National Center for Health Statistics 1996). There are calculations which show that the budget for restoring the permanent dentition of the child population of low-income nations with amalgam would exceed the available resources for the provision of an essential public health care package for the children of 15 to 29 low-income countries (Robert and Sheiham 2002).

3. Determinants of dental caries

Dental caries has been frequently acknowledged to be a multifactorial disease meaning that it has many causes (Baelum and Fejerscov 2003). Each single factor with a probable role in caries development presents a possible cause. Caries occurrence in different individuals, however, is not due to the operation of all of these possible causes. Different people may have different sets of causes for caries development, which are defined as sufficient causes. Each of these sets, in turn, may consist of many single causes (Rothman 1986). Caries will not develop until all the component causes of a sufficient cause have accumulated (Baelum and Fejerscov 2003).

Tooth (the host), microorganism (the agent) and diet (the environment) (Fejerscov 1997) are major necessary factors in the process of dental caries. By influencing these factors directly or through some intermediates, it is possible to change the route of caries process. From this perspective, it can be stated that dental caries, is a result of complex chains of events which can be proximal or distal. Proximal factors acts directly or almost directly in the causal chain of caries process, while distal factors act indirectly and via several intermediary causes (Petersen 2005a).

Determinants of dental caries can be seen from three different perspectives: tooth level, individual level, and population level. At each of these levels there are some factors which may influence the equilibrium between demineralisation and remineralisation constantly taking place at tooth surface. At tooth level, factors which affect pH fluctuations, such as thickness of microbial deposits, amount and composition of saliva, the diet, and the concentration of fluoride ion in oral fluids will determine the likelihood of mineral loss and rate at which caries occurs. At the individual level, oral health behaviour like frequency of removing dental plaque by tooth brushing or dental floss, frequency of sugar use and fluoride usage will influence factors mentioned in tooth level. At the population level accordingly factors such as socio-economic status, access to oral heath care, and level of education may have controlling effect on the factors in individual level (Baelum and Fejerscov 2003).

A considerable amount of studies over the past decades have shown the linkage between oral health and socio-behavioural factors (Locker 2000, Petersen 2005a, Antunes et al. 2006). Accordingly major oral diseases are primarily considered as behavioural diseases (Petersen 2005a). Dental caries has been found to be more prevalent among children of families in lower social class than those in higher social class (Gratrix and Holloway 1994, Watt and Sheiham 1999), in deprived than affluent families (Prendergast et al. 1997, Antunes et al. 2002, Willems et al. 2005) and also in children with low level of parent's education and family income (Petersen 1992). Miura et al. (1997), analyzing data on oral health and socioeconomic factors of 44 developing countries, found a statistically significant correlation between dental caries of 12-year-olds and socioeconomic factors such as population employed in the service sector, urban population, life expectancy, and school attendance rate. Different dental caries risk has been shown across cultures and ethnic groups even inside a same population (Sundby and Petersen 2003). Tooth loss as an outcome of oral diseases has been shown to have psychosocial causes (Burt et al. 1990). Negative health behaviour such as smoking and infrequent toothbrushing, low income and low level of education (Gilbert et al. 1993, Eklund and Burt 1994) and heavy drinking (Slade et al. 1997, Kressin et al. 2003, Klein et al. 2004, Kida et al. 2006) have been reported to associate with tooth loss. Therefore, to control oral diseases adopting healthy habits including oral self-care (Löe 2000, Axelsson et al. 2002) and regular dental check-ups (Ismail et al. 1994, Richards and Ameen, 2002) are essential. Furthermore, good oral health behaviour will contribute to general health promotion since oral diseases have common risk factors with some other chronic diseases (Sheiham and Watt 2000, Petersen 2003a).

Smoking, as one of the greatest threats to global health, has been considered as a major cause of many oral diseases and unfavourable oral conditions (Reibel 2003) contributing significantly to the global burden of oral disease (Petersen 2003b). The adverse effects of tobacco on oral health range from some harmless to life-threatening conditions such as staining and discoloration of teeth, mouth odor, bad taste and smell, negative effect on wound healing, periodontal disease, and success of dental implants, potentially malignant lesions and oral cancer, and possibly caries and candidosis (Reibel 2003). In a population study in Canada, it has been shown that current smokers are less likely to visit a dentist, more likely to report sensitivity in tooth, tooth ache in previous month, orofacial pain and social limitations due to teeth (Millar and Locker 2007). Strong association between smoking and periodontitis is well documented (Sheiham and Nicolau 2005). Bergström (2004) reported a 5-20-fold higher risk of destructive periodontal disease among smokers than non-smokers.

From the public health point of view, it is essential to consider the whole of the causal chain when assessing health risks. This consideration will also facilitate adopting appropriate policies and strategies for disease prevention. Regarding oral health, in addition to the efforts for modifying the risk behaviours in individual level such as oral hygiene practices, in a broader context, considering socio-environmental factors and the characteristics of available oral health services are needed for effective planning on disease prevention and treatment (Petersen 2005a). A detailed understanding of the factors influencing health – determinants of health– is crucial for effective delivery of health services. Achievement of sustainable improvements in the health of population depends on addressing the underlying causes of disease in a society (Daly et al. 2002, Watt 2007). Assessment of risks to health and focussing on them has a key role in preventing diseases (WHO 2002). Risk assessment in dental public health, however, has still a limited scope; the emphasis mostly being on behavioural risk factors rather than on socio-environmental factors in oral diseases (Petersen 2005a). Oral diseases have some risk factors shared with several chronic diseases, thus adopting a common risk factor approach, aimed at reducing risk factors of a large number of diseases, is suggested for the effective prevention of oral diseases through general health promotion (Sheiham and Watt 2000).

4. Dental caries management

For many years, almost from the beginning of 20th century, caries management has been dealt with tooth restoration as a cure for dental caries and at that time it was considered an improvement in the dental care compared to the previous treatment –tooth extraction (Selwits et al. 2007). New understanding about caries initiation and progression indicated that there are potentials for prevention of dental caries (Daly et al. 2002). Based on this understanding, in some regions like Scandinavia, a preventive approach has been adopted for control of dental caries since many years ago (Heidmann et al. 1987). It should be considered that dental caries is among a group of chronic diseases that are largely preventable by avoiding its risk factors and much more improvements are expected if public health programs established appropriately. (Fejerskov 2004, The Liverpool Declaration 2005).

4.1 Traditional restorative treatment

Traditionally, dental profession has focused on pain relief by restoring damaged teeth or tooth extraction (Kidd and Fejerskov 2003, Anusavice 2005). For many years dental caries in its early or late stages have been treated identically. Early surgical intervention and placement of restoration will, however, result into earlier introduction of teeth in the restoration life cycle (Elderton 1990), which makes the tooth survival time shorter (Anusavice 2005). Therefore, filling damaged tooth with a restoration should not be considered as real treatment since it does not aim at eliminating the fundamental cause of caries i.e. dental plaque (Elderton 1996). Disease control in dental caries concerns influencing biofilm formation and growth, or modifying the dissolution process of tooth enamel, or both (Kidd and Fejerskov 2003), which needs some adjustments in patient's dietary pattern, oral hygiene habits, and fluoride usage as appropriate (Elderton 1996).

Treatment strategies, dominated by restorative approaches, have been shown to be ineffective in diminishing the burden of oral diseases (Elderton 1993, Nadanovsky and Sheiham 1995, Sheiham 1997). In fact restorative treatment, *per se*, does not cure the dental

caries (Elderton 1996, Kidd and Fejerskov 2003, Ericson 2007). Unfortunately, operative intervention has been seen by many patients, dentists, and health decision-makers as the way to manage and control dental caries. But it is well understood that the placement of initial restoration in a tooth will increase the risk of future restorations in that tooth (Elderton 1996, Luan et al. 2000) each being more invasive than the previous one. In this stage the tooth has been entered into the repeat restoration cycle (Elderton 1990). It has been shown that 65% of restorative care of dentists were replacement of previous restorations with the secondary caries being as the most common reason for replacement. (Anusavice 1995, Forss and Widstrom 2004). Research on the longevity of restorations clearly shows that making the first restoration often leads to an irreversible cycle of subsequent restorations (Deligeorgi et al., 2001), which may finally result into tooth removal (Qvist et al. 1990, Mjör et al. 2000; 2005; Tyas 2005).

4.2 Preventive/non-operative caries treatment

Dental caries is the result of mineral loss in tooth tissues due to the bacterial metabolism of plaque biofilm accumulated on tooth surface. A range of factors determine the extent and rate of the mineral loss which include composition of bacterial biofilm, quality and quantity of saliva, the presence of carbohydrate, and the concentrations of minerals (especially fluoride) in oral fluids (Kidd and Fejerscov 2003). By influencing each element of the process, caries initiation and progression can be actively modified and the disease, therefore, be controlled (Baelum and Fejerscov 2003). The following measures may influence caries process: dental plaque removal, chemical modification of plaque, use of fluorides, modification of diet, influencing the composition and flow of saliva (Kidd and Fejerscov 2003).

5. Strategies for caries prevention

Dental caries is a multifactorial disease meaning that it has many risk factors. Since people are different in their risk to dental caries, setting strategies for caries prevention is worthwhile. Preventive strategies attempt to reduce the risk of disease by influencing its determinants (Daly et al. 2002). Strategies for preventing dental caries may be designed at different levels; at the individual level (for patients referring to dental practices) or at the population level (as an oral health care policy for the whole population or some particular subgroups of the population).

5.1 At the individual level

To succeed in caries control at the individual level, there are some aspects to be considered: assessment of the current caries activity and risk of future caries progression, using the information to classify patients in risk groups, selection of the appropriate treatment among the available preventive non-operative treatments, setting follow-up visits.

Caries risk assessment, as a major part of dental practice, will provide valuable information for dentist to focus on treatments according to each patient's need, to recognize particular risk factors for each individual, to define recall interval (since dental care would never complete with one course of treatment), and to inform patients about their relative risk for developing new lesions or progression of current lesions (so that patients get encouragement to keep on recall visits and become active in their preventive care) (Kidd and Fejerskov 2003).

Oral self-care practices have been proved to be effective preventive measures at individual level for maintaining good oral health (Bratthall et al., 1996; Downer 1996; Loe 2000; Axelsson et al., 2002). Moreover, due to common risk factors with general health, oral health behaviours such as oral hygiene practices, limiting sugar use, restricting smoking would help the improvement of general health as well (Sheiham and Watt 2000, Petersen 2003a, Sanders et al. 2005). Preventive measures at the individual level emphasize plaque control, use of fluoride, and diet modification. Selecting each of these measures depends on the particular conditions of each patient and there is no single pre-written caries preventive recommendation suitable for all patients (Kidd and Nyvad 2003).

Plaque control is the cornerstone of preventive caries treatment since carious lesion is the result of metabolic activity of dental plaque at tooth surface. Plaque control includes tooth brushing, interdental cleaning and professional tooth cleaning. For an effective plaque removal, teeth should be brushed at a regular basis at least once a day with fluoridated toothpaste. Twice-a-day tooth brushing, however, have shown to be more effective and, therefore, is more recommended (Adair 2006, Davies 2003). Interdental cleaning is needed especially when there are signs of active proximal lesions. There are different interdental cleaning aids as the form of floss, tape or brush which can be used according to each specific site in the mouth. In case of caries-active patients, it may be necessary to support the patient with additional plaque control in the form of professional tooth cleaning (Kidd and Nyvad 2003).

All individuals should use fluoride toothpaste, containing 1000-1500 ppm fluoride ion, as a basic caries-preventive measure (Kidd and Nyvad 2003, Twetman et al. 2003). Caries-active patients will need additional fluoride therapy in form of home use fluoride moth-wash (Marinho et al. 2003b) or professionally-applied fluoride containing products (American Dental Association Council on Scientific Affairs 2007) until the situation is under the control (Kidd and Nyvad 2003).

Diet change may not be necessary in caries-inactive patients. However, patients must be informed about the role of diet in the process of dental caries. For patients with multiple active lesions, diet analysis is always needed (Kidd and Nyvad 2003) and diet change might be unavoidable.

Recall intervals should be set according to existing caries situation of each individual. Therefore, it may vary widely during the course of treatment. Examining the condition of whole mouth regarding the caries status and quality and flow of saliva, and assessment of patient's compliance at recall visits are of major importance (Kidd and Nyvad 2003).

5.2 At the population level

Strategies employed for the control of dental caries at the population level fundamentally depends on risks, determinants, and distributions of caries in different populations (Sheiham and Fejerskov 2003). These strategies may aim at the whole population which is known as the whole-population approach, or target at certain sections of the population which is named the risk approach. Based on the subdivision of the population identified, the risk approach is known as the directed or targeted approach where a particular subgroup of population are the target group or the high-risk approach where individuals consists the target group (Daly et al. 2002). The goal, in the whole-population approach is to control the determinants of incidence of caries at the whole population while in the risk approach, identifying groups or individuals with high susceptibility to caries in order to protect them

is called for. The advantages and limitations of both high-risk and population strategies are summarized in the following table (Rose 1985):

	High-risk strategy	Population strategy
Advantages	Intervention appropriate to individual Subject motivation Dentist motivation Cost-effective use of resources Benefit: risk ratio favourable	Radical Large potential for population Behaviourally appropriate
Disadvantages	Difficulties and costs of screening Palliative and temporary; not radical Limited potential for both individual and population Behaviourally inappropriate	Small benefit to individual Poor motivation of subject Poor motivation of dentist Benefit: risk ratio worrisome

Table 1. Comparison of high-risk and population strategies

6. Caries-risk assessment

In any preventive program, determining person's risk to develop that kind of disease would help professionals better manage patients preventively. Incorporation of risk assessment, as an important part of clinical decision making, into routine dental practice has been increasingly emphasised in recent years (American Dental Association 1995, Brad Rindal et al. 2006). The information gathered from caries risk assessment will be helpful in directing preventive and curative efforts according to patients' need, identifying the particular risk factors for each patient, and transferring this information to patient in order to encourage him/her for keeping recall appointments (Kidd and Nyvad 2003). Providing preventive measures and recall visits according to each individual's need would ensure appropriate use of resources. Since patients with elevated caries risk require receiving especial preventive regimen to reduce elevated incidence and severity of caries while those with low caries risk needs no additional preventive interventions and should have extended recall intervals. (Brad Rindal et al. 2006). Caries risk assessment covers a variety of factors such as past caries experience, microbiological tests (salivary lactobacilli, mutans streptococci, and yeasts and salivary flow rate and buffer capacity), dietary habits, oral hygiene, and social factors (Hausen 2003).

6.1 How to do caries-activity assessment?

Presence of active caries lesions (cavitated and/or non/cavitated) at the time of examination, is the strongest evidence for the prediction of future caries activity (Zero et al. 2001). There is no consensus on the definition of high caries activity; the following two criteria, however, might be indicative of high rate of caries progression in most populations: 1. Two or more lesion increment annually, and 2. Multiple active lesions in regions of mouth with high and rapid flow of saliva (lower incisors and buccal surfaces of upper molars) (Kidd and Nyvad 2003).

Stage of development of the dentition is another important issue when estimating caries activity status. Risk sites in different stages of dentition over life are as follows: in children, occlusal surfaces of erupting permanent molars; in adolescents, proximal surfaces especially

the distal surface of second premolars and the mesial surface of second molars; in adults and elderly, root surfaces which are difficult to be cleaned (Kidd and Nyvad 2003).

6.2 How to determine the risk factors?

A risk factor is defined as "an environmental, behavioural, or biologic factor confirmed by temporal sequence, usually in longitudinal studies, which if present, directly increases the probability of a disease occurring, and if absent or removed, reduces the probability. Risk factors are part of causal chain, or expose the host to the causal chain. Once disease occurs, removal of a risk factor may not result in a cure." (Beck 1998).

Caries risk factors are usually categorised as biological factors and social and demographic factors. Both of these risk factors can be detected by getting a medical and dental history. The following conditions that contribute to high caries activity should be considered in medical history: Dry mouth due to diseases like Sjögren's syndrome or radiotherapy in head and neck regions, using medications which interfere with salivary flow such as antidepressants or drugs which have sugar in their structure like some syrups or asthma inhalers. The following issues are informative in dental history: 1. A history of multiple restorations with frequent replacements is an important sign of high caries risk. 2. Questions about patient's oral hygiene activities like frequency and time of brushing and flossing, type of toothpaste, method of rinsing after brushing, use of mouthrinse. 3. Patient's diet: frequency of using sugary drinks or snacks. Sometimes asking patients to fill a diet sheet may provide further information than just a verbal enquiry.

Social and demographic risk factors are not involved directly in the process of dental caries (Kidd and Nyvad 2003). Instead, these risk factors such as income, education and social environment will influence dietary and oral health related behaviours (Kidd and Nyvad 2003).

6.3 How to categorise patients based on their caries-activity status?

After the information regarding caries activity gathered, patients will allocate to one of these categories: 1. Caries inactive or caries controlled: no active lesion or at maximum one presents, with no history of recent restoration. 2. Caries active but all relevant risk factors can potentially be changed: in this category, active lesions are present and patients experience two or more new/progressing/filled lesions in each year during past 2-3 years. These patients are able to control caries through changes in risk factors. 3. Caries active but some risk factors cannot be changed (for instance due to dry mouth or using some kind of medications) or risk factors cannot be identified: in this group active lesions are present and there is yearly increment of two or more new/progressing/filled lesions in the preceding 2-3 years. Patients in this category are always at high risk of caries but caries development can be controlled by maximum efforts to control risk factors (Kidd and Nyvad 2003).

Recommendations for controlling disease progression: 1. Caries inactive or caries controlled: these patients only need to keep on careful oral hygiene activities with the use of fluoride toothpaste. 2. Caries active but all relevant risk factors can potentially be changed: in this group, patients should improve their ability for mechanical plaque control. Supplementary fluoride mouthrinse or chair-side fluoride application might be necessary. Diet counselling is needed and diet change may be prescribed in case of presence of multiple active lesions. 3. Caries active but some risk factors cannot be changed or cannot be identified: caries control in this group is the most challenging. All related risk factors must be sought and preventive treatment must be designed individually (Kidd and Nyvad 2003).

High caries risk • ≤6-year-olds (any of the following situations) Any incipient or cavitated primary or secondary carious lesions during last three years Presence of multiple factors which may increase caries risk* Suboptimal fluoride exposure Xerostomia • >6-year-olds (any of the following situations) Three or more incipient or cavitated primary or secondary carious lesions in the last three years Presence of multiple factors which may increase caries risk* Suboptimal fluoride exposure Xerostomia
Moderate caries risk • ≤6-year-olds No incipient or cavitated primary or secondary carious lesions during last three years but presence of at least one factor which may increase caries risk* • >6-year-olds One or two incipient or cavitated primary or secondary carious lesions in the last three years No incipient or cavitated primary or secondary carious lesions during last three years but presence of at least one factor which may increase caries risk*
Low caries risk No incipient or cavitated primary or secondary carious lesions during last three years and no factors which may increase caries risk*
*Factors increasing the risk of caries development: • Clinical evidence: new lesions, developmental or acquired enamel defects, genetic abnormalities of teeth, presence of exposed root surfaces, premature extractions, anterior caries or restorations, multiple restorations, restoration overhangs and open margins, deep and caries-susceptible unsealed fissures, fixed orthodontic appliances, partial dentures • Dietary habits: frequent sugar intake, prolonged bottle or breast feeding, drug or alcohol abuse • Social history: social deprivation, high caries in siblings, low knowledge on dental disease, irregular dental attendance, ready availability of sugary snacks, low dental aspirations • Fluoride use: no fluoridation of drinking water, no use of fluoridated toothpaste, no use of fluoride supplements • Plaque control: infrequent and ineffective tooth cleaning, poor manual control • Saliva: low flow rate, low buffering, high counts of Stereptococus mutans and lactobacillus • Medical history: medically compromised, physical disability, medication-, radiation-, or disease-induced xerostomia, long cariogenic medications

Table 2. Caries risk criteria for evaluating patients' caries risk (modified from: American Dental Association Council on Scientific Affairs 2006, Preventing Dental Caries in Children at High Caries Risk, SIGN publications 2000)

7. Effectiveness of caries preventive measures

There is a large body of evidence supporting the effectiveness of preventive measures in caries management. We will look at these measures from three different perspectives:

7.1 Community-active measures

These are programs which run for the benefit of whole population. The best example is water fluoridation in which controlled amount of fluoride is added to the public water supply to prevent dental caries in the population using this water. There is substantial amount of evidence representing the effectiveness of water fluoridation in caries prevention (CDC 2001, NHMRC 2007). It has been known as one of the great achievements of public health in 20th century (CDC 2001) and may still be the most cost-effective public health measure to control dental caries in populations with high incidence and prevalence of dental caries (Ellwood and Fejerskov 2003, Pizzo et al. 2007). There are some arguments, however, that the continuation of water fluoridation may be unnecessary especially in industrialized countries (Pizzo et al. 2007) with regard to the following new evidences: 1. Anticaries effect of fluoride mostly exerts from its topical action rather than its pre-eruptive systemic absorption (Hellwig and Lennon 2004), 2. Experiences from some countries have shown that discontinuation of water fluoridation had no negative effect on caries prevalence of the population using that water (Seppa et al. 2000, Kunzel et al. 2000), 3. Substantial decline in caries prevalence has been reported in many European countries where never adopted water fluoridation (Marthaler 2004), and 4. Epidemiologic studies in recent decades have shown an increase in the prevalence of fluorosis in regions with water fluoridation (Cochran et al. 2004, Khan et al. 2005). Confining the consumers' option has also been mentioned as another objection towards water fluoridation (Jones et al. 2005).

Consequently research on alternatives to water fluoridation like salt and milk began in the second half of the 20th century (Petersen and Lennon, 2004). Salt fluoridation has been used as a caries preventive measure in several countries like France, Germany, Switzerland and some South American countries. Caries reduction due to using fluoridated salt has been reported from 14% in Germany (Marthaler 2005) to 84% in Jamaica (Gillespie and Baez 2005). Careful assessment of all fluoride sources available for the population, however, is needed when such program is planning to avoid excessive ingestion of fluoride and probable fluorosis. An increased risk of fluorosis has been reported in Mexico due to nationwide use of fluoridated salt (Vallejos-Sanchez et al. 2006). Switzerland is pioneer in using milk as a vehicle for fluoride since 1962. Milk fluoridation programs have used various channels such as distribution of milk, powdered milk or milk cereal in kindergartens and schools (Jones et al. 2005). Yeung et al. (2005), based on a recent systematic review concluded that sufficient evidence is lacking to show the effectiveness of milk fluoridation in caries reductions. According to the existing studies, the authors, however, suggested that milk fluoridation is beneficial to the permanent dentition of schoolchildren. Other vehicles of fluoride such as fluoridated sugar and beverages, fluoride-rich mineral water seems to be important in caries reduction at the individual rather than population level (Tseveenjav 2004).

7.2 Dental professional-active measures

In order to review the scientific evidence on professionally applied topical fluoride and develop clinical recommendations, the American Dental Association arranged an expert

panel. All publications regarding professionally applied topical fluoride—including gel, foam and varnish forms— were searched through October 2005. The experts were asked to identify any additional systematic reviews or other relevant published trials. After assessing the data from the individual studies which were summarized in the systematic reviews and from the identified clinical studies, the expert panel prepared a document which was resubmitted for more reviewing by other experts in the field of fluoride and caries. The expert panel prepared the clinical recommendations after consideration the comments received. A summary of these evidences and clinical recommendations which were approved by the ADA Council on Scientific Affairs, are presented here (ADA council on scientific affairs 2006):

- Fluoride gel is effective in preventing caries in school-aged children. The best caries reduction effect of fluoride gel is achieved with four minutes or more applications.
- Fluoride varnish is effective in caries prevention in primary and permanent dentition of children and adolescents when applied in six-monthly basis. It is effective in preventing caries of high-risk populations with two or more applications per year.
- Fluoride foam is effective in caries prevention in the primary dentition and newly erupted first molars with four-minute applications every six month.
- Moderate- or high-risk patients younger than 6 years should receive fluoride varnish applications at six-month intervals. The same rule is true for more than 6-year-old moderate- or high-risk patients except that in this age group fluoride gel is applicable as well.
- For patients with lower caries risk, fluoridated water and fluoride toothpaste may provide adequate caries prevention. Application of topical fluoride in this risk category, however, depends on professionals' judgment and patients' preference.

7.2.1 Pit and fissure sealants

Several clinical studies documented the effectiveness of pit and fissure sealant therapy in occlusal caries reduction in the permanent teeth of high-risk children and adolescents (Locker et al. 2003; Davies, 2003), although the quality of many of these studies assessed to be poor (Ahovuo-Saloranta et al. 2004). Various caries preventive effect has been reported for pit and fissure sealants. Rozier (2001), reviewing 24 studies from 1975 to 1990, reported a prevented fraction (the difference between the mean caries increment in the study and control groups divided by the mean increment in the control group [Adair 2006]) of 71% for fissure sealants. This figure was 33% in the review by Mejare et al. (2003) for sealing first permanent molar. Ahovuo-Saloranta et al. (2004) in a review for Cochrane Database of Systematic Reviews reported a range of caries reduction from 86% at 12 months to 57% at 48-54 months follow-up. Accordingly, the authors recommended sealant application in permanent molars for preventing caries in the occlusal surface with considering caries prevalence of both the individual and population. Moreover, cost-effectiveness of sealant therapy has been shown in longitudinal population-based studies (Virtanen et al. 2003) with long-lasting preventive effects (Wendt et al. 2001).

7.2.2 Anti-microbial agents

There are few antimicrobial agents with documented cariostatic effect. This is primarily due to the organization of plaque microorganisms in the form of biofilm. Biofilm, an aggregate of microorganisms in a complex matrix of biopolymers, acts as a barrier which keeps microorganisms out of the reach of antimicrobials and immune response of the host (Scheie 2003). The most comprehensively studied antimicrobial agent is chlorhexidine (Scheie 2003).

Chlorhexidine gel, has been reported to have a caries-preventive effect of 47% (Davies 2003), and is effective in prevention of caries in high-risk children (Rozier 2001). The evidence for the anti-caries effect of the chlorhexidine-containing varnishes has been found to be incomplete in a recent review (Twetman 2004). A wide range of other antimicrobial agents like Cetylpyridinium chloride, Hexetidine, Triclosan, Metal ions, Xylitol, and etc has been studied for their anti-caries effect. Due to the probable deteriorating effect of antimicrobial agents on the ecological balance of the oral flora, the use of these agents, however, should be restricted to situations which conventional prophylactic methods are likely to be ineffective such as handicapped individuals, hyposalivation, intraoral fixation or splinting, orthodontic treatments, prosthetic restorations or implants, and so on (Scheie 2003).

7.3 Individual-active measures

7.3.1 Fluoridated toothpaste

The caries-inhibiting effect of fluoridated toothpaste for permanent dentition is backed up with an established and strong evidence; for primary teeth, the evidence is incomplete (Marinho et al. 2003b; Twetman et al. 2003). Nevertheless no logical reason exists to presume that it is less effective in primary teeth (Adair 2006). In a study with a placebo, the use of fluoridated toothpaste has resulted to a 24.9% prevented fraction in young permanent dentition (Twetman et al. 2003). Higher baseline levels of patients' caries, higher fluoride concentration, higher frequency of use, and supervised brushing have been found to increase the preventive effect of fluoridated toothpaste (Marinho et al. 2003b).

7.3.2 Fluoride supplements

Fluoride dietary supplements have been estimated to have an effectiveness of 20% to 30% for caries reduction. They have primarily been developed for the sake of populations with no access to water-borne fluoride (Adair 2006). They are not, however, considered as a public health preventive measure due to the paradigm shift in the understanding about fluoride's mode of effect from systemic to topical (Fejerskov 2004, Hellwig and Lennon 2004), exposure to other sources of fluoride, and the potential risk of fluorosis in permanent dentition (Adair 2006, Davies 2003), thus their usage are limited in high-risk children (Davies 2003).

7.3.3 Fluoride mouthrinses

Fluoride mouthrinses are available at two forms: 0.2% concentration for weekly and 0.05% concentration for daily use (Adair 2006). Their supervised regular use, with a prevented fraction of 26%, is associated with a clear reduction in caries increment in the permanent dentition of children (Marinho et al. 2003a).

7.3.4 Self-applied fluoride gels

The use of self-applied fluoride gels has been shown to result into 32% caries reduction in fluoride-deficient communities and 7% to 35% in optimally fluoridated areas. There is no systematic review on the effectiveness of purely self-applied gels (Adair 2006).

7.3.5 Self-applied chlorhexidine gels and rinses

A meta-analysis of clinical studies has demonstrated an overall caries- reduction effect of 46% for the chlorhexidine treatment irrespective of application method, frequency, caries risk, caries diagnosis, tooth surface, or fluoride regimen (Van Rijkom 1996).

7.3.6 Slow-release fluoride devices

Such devices would be beneficial to prevent dental caries in high-risk children (Featherstone 2006). In a clinical trial 70% reduction in caries has been reported for high risk children who wore a fluoride-releasing glass device in their mouths comparing to control group (Toumba and Curzon 2005). Evidence for caries-inhibiting effect of slow-release fluoride devices was, however, regarded as weak and unreliable in a recent Chochrane systematic review (Bonner et al. 2006).

7.3.7 Restriction of sugar consumption

There is no doubt that sugars have a fundamental role in the initiation and development of dental caries (Moynihan 2005, Burt and Pai 2001). Although this role seems to be weakened with the nowadays widespread fluoride exposure (Burt and Pai, 2001), there is still a direct relationship between sugar intake and caries in presence of adequate fluoride (Moynihan 2005). Therefore, restriction of sugar consumption remains an essential, if not the most important, aspect of caries prevention (Burt and Pai, 2001). Recommendations in this regard emphasize reducing the frequency and amount of sugar consumption and also limiting sugar use to mealtimes (Moynihan and Petersen 2004, Tseveenjav 2004). The frequency of sugar intake should not exceed than four times per day and the total amount of sugar consumption should be less than 15 kg/year/person (Sheiham 1983).

7.3.8 Non-cariogenic sweeteners

A number of observational studies and clinical trials have shown the caries-protective effect of xylitol, and to a lesser extent sorbitol (Honkala et al. 2006, Burt 2006, Anderson 2003, Hayes 2001). For the first time, comprehensive Finnish "Turku Sugar Study" (Scheinin et al. 1976) revealed an 85% decline in dental caries by total dietary substitution of sucrose with xylitol over a 2-year period. Xylitol also has been shown to reduce the vertical transmission of Streptococcus Mutans from mothers to children (Söderling et al. 2000). Consequently, promotion of the use of xylitol-sweetened gum has been proposed as a caries-preventive measure in public health (Burt 2006, Honkala et al. 1996, Virtanen et al. 1996, Isokangas et al. 1989). Its use may be limited, however, due to high cost and low versatility (Tseveenjav 2004).

7.4 Effectiveness of fluoride in caries prevention in adults

Most of the studies on the effectiveness of fluoride in preventing caries have been conducted among children (National Institutes of Health Consensus Development Conference Statement, 2001). In a systematic review on studies published on the effectiveness of the fluoride in preventing caries in adults, Griffin et al. (2007) found that any fluoride application, self- or professional or water fluoridation averted 0.29 coronal carious and 0.22 root carious surfaces in a year. They found a prevented fraction of 27% for water fluoridation in adults. The authors concluded that fluoride is effective in caries prevention among adults in all ages.

7.5 Effectiveness of non-operative caries management on community level

Practicality and cost-effectiveness of caries preventive measures in managing dental caries on community level have been largely studied. Ekstrand et al. (2000) offered a caries-preventive program including education of the child, parents and teachers on caries disease, training in toothbrushing, and professional plaque removal, applications of sodium fluoride (2%) and sealant applications based on individual needs to a group of children in a district

of Moscow. After 2.5 years the children in study groups had improved their oral health status significantly compared to the children in the control group and the program found to be highly effective in controlling dental caries in the permanent dentition.

Ekstrand and Christiansen (2005) in their study assessed the effectiveness and performance of a non-operative caries treatment program (NOCTP) used since 1987 in the municipality of Nexö in Denmark. Mechanical plaque control was the central focus of the method and the eruption period of molar teeth as a risk factor has been considered. The effectiveness and performance of the NOCTP were both considered high, as very low DMF-S and high percentages of DMF-S = 0 had been achieved by 1999, and 18-year-olds in Nexö had significantly less caries compared to other municipalities. The cost/child/year significantly reduced in the years with the NOCTP compared to that before 1988.

In another study (Axelsson 2006), a needs-related caries preventive program was introduced for all 0-19-year-olds in the county of Varmland, Sweden, in 1979. The goals were set as: not having proximal restorations, occlusal amalgam restorations, and proximal loss of periodontal attachment. Furthermore, motivation and encouragement of individuals to assume responsibility for their own oral health was considered as another goal to be reached. The effect of the program evaluated once every year on almost all 3-19-year-olds from 1979. Most of the individualized preventive program was carried out by dental hygienists or dental assistants at clinics in the elementary schools. During the 20-year period the percentage of 3-year-olds with DMF=0 increased from 51% to 97%. In 1999 as many as 86% of the 12-year-olds diagnosed as being DMF=0. Caries incidence was reduced more than 90% in all age groups. More than 90% did not develop any new caries lesions in 1999. As a consequence, caries prevalence was dramatically reduced. In 12- and 19-year-olds, the mean number of Decayed and Filled Surfaces (DFS) per individual was reduced from 6 to 0.3 and from 23 to 2 respectively. In 19-year-olds the mean number of proximal DFS was <1 and only half of them had to be filled. The mean number of occlusal DFS was less than one.

The above mentioned examples clearly show that preventive programs for the control of dental caries will be successful, if planned and performed based on proper understanding of populations' need and available resources.

Further improvements in oral health and reducing the inequalities in oral health of populations are dependent upon the implementation of public health strategies that give attention to the underlying determinants of oral diseases (Petersen 2003a, Watt 2005, 2007). Despite documented effectiveness of various preventive measures, clinical prevention of oral diseases and health education alone will not result into sustainable improvements in oral health (Watt 2005). Therefore, public health strategies based upon the common risk approach are now suggested for achieving significant oral health gains in both developed and developing countries (Watt 2005). Accordingly, establishment of a comprehensive oral health care system for the control of oral diseases has been set by WHO as a goal to be achieved by the year 2020 (Hobdell et al. 2003).

7.6 Dentists' preventive orientation

7.6.1 Dentists' oral self-care

Due to their professional knowledge of the prevention of oral diseases, dentists hold a key position in providing a positive model of oral self-care for their patients. This highlights the necessity for implementing optimal oral self-care for the dentists themselves. Limited information is, however, available regarding dentists' oral health behavior. In the USA, 73%

of male dentists selected from the basic Health Professionals Follow-Up Study group reported brushing their teeth at least twice daily, and 56%, flossing at least once daily (Merchant et al. 2002). In Mongolia, 81% of dentists reported brushing their teeth twice daily, 62%, using fluoride toothpaste regularly, 52%, eating sugary snacks less than daily, and 75% visiting a dentist for dental check-up (Tseveenjav et al. 2004). Generally, smoking seems to be rare among dentists and it has been reported that they have the lowest smoking rates (from 1% to 23% during years 1979-2005) among all health professionals (Smith and Leggat 2006). Dentists from Jordan (Burgan 2003) and Italy (Lodi et al. 1997) have been found to be exceptions since about one-third of dentists reported to be smokers. In view of the fact that dentists are at the forefront of oral care, it is important that the rate of smoking among dentists even be reduced further.

7.6.2 Dentists' preventive practice

Dentists' clinical decisions influence the oral health (Petersson and Bratthall 1996) and overall health (Dyer and Robinson 2006) of the population. Therefore, dentists are increasingly being expected to apply preventive measures in their routine practice (Pitts 2004). They, however, seem to have underestimated preventive measures and the risk-based approach in their practice (Kawamura et al. 1998, Brennan et al. 1998, Helminen et al. 1999, Varsio et al. 1999).

Due to dentists' knowledge on adverse effects of smoking and their frequent contacts to a wide range of population, their involvement in smoking cessation has been considered as a modern and necessary tool in preventive practice (Warnakulasuriya 2002, Petersen 2003b). Dental professional's advices can effectively motivate smokers to quit smoking (Dolan et al. 1997, Smith et al. 1998, Johnson 2004) even with a brief intervention (Fiore et al. 2000, Warnakulasuriya 2002, Gordon et al. 2005). The great potential benefits of dentists' involvement in smoke cessation for the public health will be more evident when considering that dentists examine a significant number of smokers in each year (Tomar 2001). Dental providers have many opportunities to reduce the prevalence of smoking since dental treatment often necessitates multiple visits that provide a mechanism for initiation, reinforcement, and support of tobacco cessation activities. On the other hand, dental patients (especially those with dental insurance) receive care on a regular basis (Albert et al. 2005). Approximately 50% of smokers have been estimated to visit a dentist annually (Tomar et al. 1996, Tomar 2001), which gives the dental professional the opportunity to associate cessation advice with readily visible changes in oral status. Therefore, the dental office may be ideally suited to help patients quit smoking. Dentists, accordingly, seem to recognize smoking cessation as an important part of their duties and are becoming more concerned in this area of preventive practice (Johnson et al. 2006), although limitations have been reported in dentists' involvement in smoke cessation due to barriers such as lack of training and time constraint (Hu et al. 2006), perceived lack of relevance of smoking cessation to dentistry, patients' not acceptance, and lack of remuneration (Watt et al. 2004).

7.6.3 Dentists' restorative treatment threshold

One of the most important aspects of dentists' practice is their decision as when to treat a caries lesion restoratively. Dentists' restorative threshold can be defined as the point at which they would begin drilling a carious lesion for placement of a restoration. In spite of the progress in understanding the caries process, there is still uncertainty among members of the dental community on clear definition of dental caries (Ismail 2004). During most of

the 20th century, dental caries was detected and managed as if the caries process is equal to 'cavities' and accordingly the practice of dentistry has traditionally focused on developing 'drill and fill' interventions (Ismail 2004). Nevertheless, detecting the early or non-cavitated caries level and preventing these lesions from progressing to the cavitated stage (or being restored) could have a significant impact on the oral health status around the world and certainly also on the costs of treatment (Mjör et al. 2000, Ismail 2004). Making the first restoration leads to an irreversible cycle of subsequent restorations (Elderton 1990, Mjör and Toffentti 2000, Deligeorgi et al. 2001) which may finally result in tooth removal (Mjör et al. 2000). It has been recognized that caries lesions progress at slower rates than previously believed (Pitts 1983, Shwartz et al. 1984, Mejár et al. 1999, Lith et al. 2002) and that caries can be arrested and the affected dental structure remineralized (Elderton and Osman 1991, Verdonschot et al. 1999) so a large proportion of the "iceberg of dental caries" (Pitts and Longbottom 1995) is subject to preventive care (Pitts 2004b). Therefore, dentist's restorative decision making should take into account current knowledge on progression and arresting of caries lesions (Anusavice 1995).

7.6.4 Barriers against providing preventive dental care

The introduction of preventive approach into real practices, however, seems to be challenging since it has not been applied in situations with scientifically approved effectiveness (Horowitz 1995). Furthermore, dentistry as a profession has been recognized to be a technically oriented discipline, dental practice generally follows market principles (Fejerskov and Kidd 2003), and dentists seem to prefer restorative approach (Elderton 1993, Helminen and Vehkalahti 2003). To apply preventive measures in dental care some numerous barriers must be tackled which are categorized as practice-, dentist-, and patient-related barriers (Cohen 1987, Horowitz 1995, Freeman 1999a, 1999b, 1999c).

7.6.5 Dentists' knowledge of and attitudes towards preventive dental care

The major challenges for the future of peoples' oral health will be to translate knowledge and experiences of disease prevention into action programs (Petersen 2003a). Understanding of dental caries initiation and progression has been improved in recent years, which necessitates development of new treatment strategies (Ismail et al. 2001, Featherstone 2004, Fejerskov 2004). Dental professionals are expected to update their practices according to the evidence-based knowledge which emphasize continuous changes in dentists' education (McGlone et al. 2001, Widström 2004). In this process, the central elements to be improved are dentists' preventive knowledge and attitude which acts as a framework for their practice (Brown et al. 2002) and are factors affecting their patients' oral health-related behaviour (Eijkman and de With 1980). Previous studies on dentists' knowledge of and attitudes towards preventive dental care are controversial. Dentists, generally, seem to be knowledgeable in preventive matters (Gonzalez et al. 1988) and have positive attitudes towards prevention (Allard 2000, Kujan et al. 2006); deficiencies in their knowledge, however, have been revealed (Eijkman and de With 1980, Lewis and Main 1996, Moon et al. 1998).

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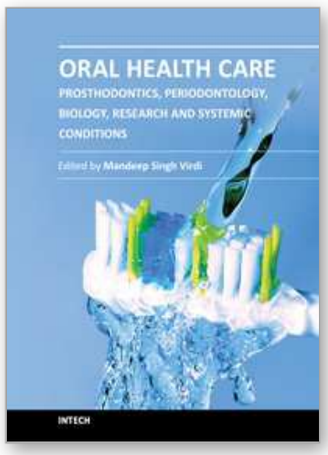

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Geriatric dentistry, or gerodontics, is the branch of dental care dealing with older adults involving the diagnosis, prevention, and treatment of problems associated with normal aging and age-related diseases as part of an interdisciplinary team with other healthcare professionals. Prosthodontics is the dental specialty pertaining to the diagnosis, treatment planning, rehabilitation, and maintenance of the oral function, comfort, appearance, and health of patients with clinical conditions associated with missing or deficient teeth and/or oral and maxillofacial tissues using biocompatible materials. Periodontology, or Periodontics, is the specialty of oral healthcare that concerns supporting structures of teeth, diseases, and conditions that affect them. The supporting tissues are known as the periodontium, which includes the gingiva (gums), alveolar bone, cementum, and the periodontal ligament. Oral biology deals with the microbiota and their interaction within the oral region. Research in oral health and systemic conditions concerns the effect of various systemic conditions on the oral cavity and conversely helps to diagnose various systemic conditions.

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