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Making prevention a priority

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# **Executive Summary White Paper on Dental Caries Prevention and Management**

**A summary of the current  
evidence and the key issues  
in controlling this preventable  
disease**

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## Preamble

The Caries Prevention Partnership (CPP) 'White Paper on Dental Caries Prevention and Management' provides dentists, other oral health workers, and National Dental Associations (NDAs) with the knowledge and tools needed to deliver caries prevention and management in the best interest of the patient. It is the dental profession's ethical responsibility to use the best available evidence to achieve and maintain patient's oral health.

Despite recognition that extractive and restorative approaches to caries care are outmoded, costly, and fail to ensure the best health outcomes for patients, a preventive approach to caries remains to be adopted in many countries. A strong body of evidence exists on the effectiveness of fluorides, sealants, and other methods of sugar control and preventive care, and translation of this evidence into guidelines has armed the profession with the knowledge required to prioritize prevention and reserve restoration as a last resort.

The CPP White Paper addresses 13 key issues for advancing a patient-centred, evidence-based approach to caries care, and provides clear action points to drive this change.

## Section 1

### Aetiology and pathogenesis (what causes caries and what is the caries process?)

Dental caries is a complex multifactorial disease, involving interactions among the tooth structure, oral microbial biofilm, dietary carbohydrate, and salivary and genetic influences. These interactions determine whether the teeth are in a healthy state of dynamic equilibrium of demineralization and remineralization, or a diseased state of net mineral loss.

Demineralization starts with the formation of organic acids, mainly lactic acid, as a product of sugar metabolism. As acid builds up in the dental biofilm, the pH drops to the point where the mineral phase of tooth begins to dissolve. If the imbalance between mineral loss and mineral gain continues, demineralization progresses into the enamel resulting in the early clinical signs of the disease (white spots), and ultimately the more advanced signs of caries (cavitation).

Diet is an essential factor driving caries expression. Diets high in fermentable carbohydrates (mainly sugars) promote a low biofilm pH, resulting in progressive net mineral loss as described above. High sugar diets can also indirectly affect biofilm pH by favouring the growth of more acidogenic bacteria. Softer and liquid diets may lead to the atrophy of salivary glands, affecting the clearance pattern of cariogenic foods and beverages and resulting in a lower biofilm pH.

Fluoride alters the dose-response relationship between sugar consumption and caries experience by delaying when cavitation occurs. The interaction of fluoride with enamel crystallites effectively lowers the critical pH at which enamel will demineralize. Despite this, unacceptably high levels of caries persist even in countries with wide use of fluoride.

## Section 2

# Classification and epidemiology

### Classification

The 'iceberg' metaphor is often used to explain the different stages of caries severity and different diagnostic thresholds when classifying caries for public health, education and research purposes:

- The **D<sub>3</sub>** caries threshold records caries 'above the waterline', when large lesions with open cavities extending **into the dental pulp** together with more limited open cavities **into the dentine** are visible. Classification under this system should refer to either 'obvious decay' or 'no obvious decay', rather than 'caries free', as it does not record lesions in enamel.
- The **D<sub>1</sub>** threshold records the same lesions as the D<sub>3</sub> threshold, and additionally recognizes clinically detectable **cavities in enamel**, and clinically detectable **lesions in enamel with macroscopically intact surfaces** ('White-spot lesions'). This increases the lesions detected compared to the D<sub>3</sub> threshold.
- A further threshold including lesions the dentist would find using bitewing radiographs or other lesion detection aids again increases the number of lesions identified as caries.

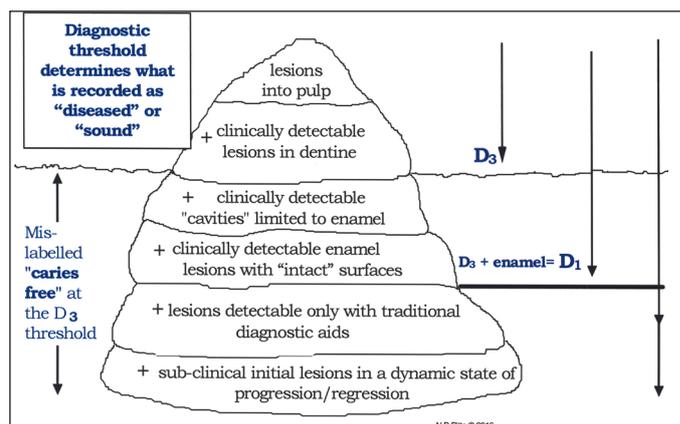
Several different caries classification systems exist, often focusing on one application or target audience. These systems differ in the stages of caries which they capture. The FDI Caries Matrix (an integration of several existing systems) and the International Caries Classification and Management System (ICCMS™) however both have three levels of classification that can be chosen according to purpose and preference:

1. 'No obvious decay' or 'obvious decay' at the cavitated caries into dentine D<sub>3</sub> threshold.
2. D<sub>1</sub> threshold including enamel caries with a limited number of caries severity stages.

3. Comprehensive staging of caries severity across the caries continuum using six stages.

These frameworks allow users to compare results in a valid manner with clarity of the detection threshold used, and collect data in a way that allows results to be expressed at different levels, according to need and choice.

Figure 1 - The Iceberg of Dental caries (1994>)



## Section 3

# Epidemiology

Untreated caries in permanent teeth was the most prevalent condition in the 2013 Global Burden of Disease Study, affecting 35% of all ages combined. In children, untreated caries was the 10th most prevalent condition. Despite the scale of the disease and societal burden, we do not currently enjoy accurate, up to date, data on caries at the global level, and often for the local level.

More reliable and meaningful data collection must be undertaken if we are to see if and where progress is being made in caries prevention and management. Efforts are being made worldwide to improve our understanding of caries epidemiology and improve and optimize methodologies for epidemiological field use. ICDAS and WHO Basic Methods criteria have been used in many countries which allow comparison of data, and the Caries Assessment Spectrum and Treatment (CAST) epidemiological index was developed in 2011 as a pragmatic index for epidemiological studies.

## Section 4

# Caries detection and assessment in a clinical context

Detection and assessment of caries in the clinical context is an essential component of care, but too often neglected. Responding to a need for common terminology for clinical caries assessment (and management), the International Consensus Workshop on Caries Clinical Trials (ICW-CCT) agreed on terminology that differentiates between **lesion detection, lesion assessment and caries diagnosis**:

### Detecting lesion extent

The discussion of detection thresholds and classification systems in Section 3 covers the essentials of detecting lesion extent. For visual caries examination, there is no evidence to support the use of sharp probes, and the best method is to inspect clean dry teeth with blunt probes. Other traditional methods used as caries detection aids include bitewing radiographs, transillumination and elective temporary tooth separation.

### Assessing lesion activity

Assessing lesion activity (i.e. whether a lesion is continuing to suffer net mineral loss, or it is arrested or undergoing remineralization) is a vital step in assessing the need for or success of any intervention. Although the evidence informing activity assessment is not yet as robust as for lesion detection, good systems exist that can be used judiciously while waiting for better tools. For primary teeth for example, the presence of mature dental plaque and tooth type are important factors for activity assessment.

### Monitoring lesion behaviour

Over time, monitoring lesion behaviour is becoming more important as the pattern and speed of caries progression changes in many patient groups, and the need for sound tooth structure preservation and minimally invasive dentistry practice is more appreciated.

Accurate assessments should be made and lesion specific records stored and reviewed at later visits to plan appropriate care and assess outcomes.

## Section 5

# Caries risk assessment

Risk assessment is an essential component in determining the appropriate level of caries care. It allows dental professionals to:

- Determine if additional diagnostic procedures are required.
- Identify patients who need additional caries control measures.
- Assess the effectiveness of interventions to prevent caries.
- Make treatment planning decisions and schedule the frequency of recall appointments.

The single best indicator of a patient developing future caries is previous caries experience. If there are clinical signs of active lesions, the patient should be considered as a risk for caries progression and primary and secondary preventive measures should be put in place.

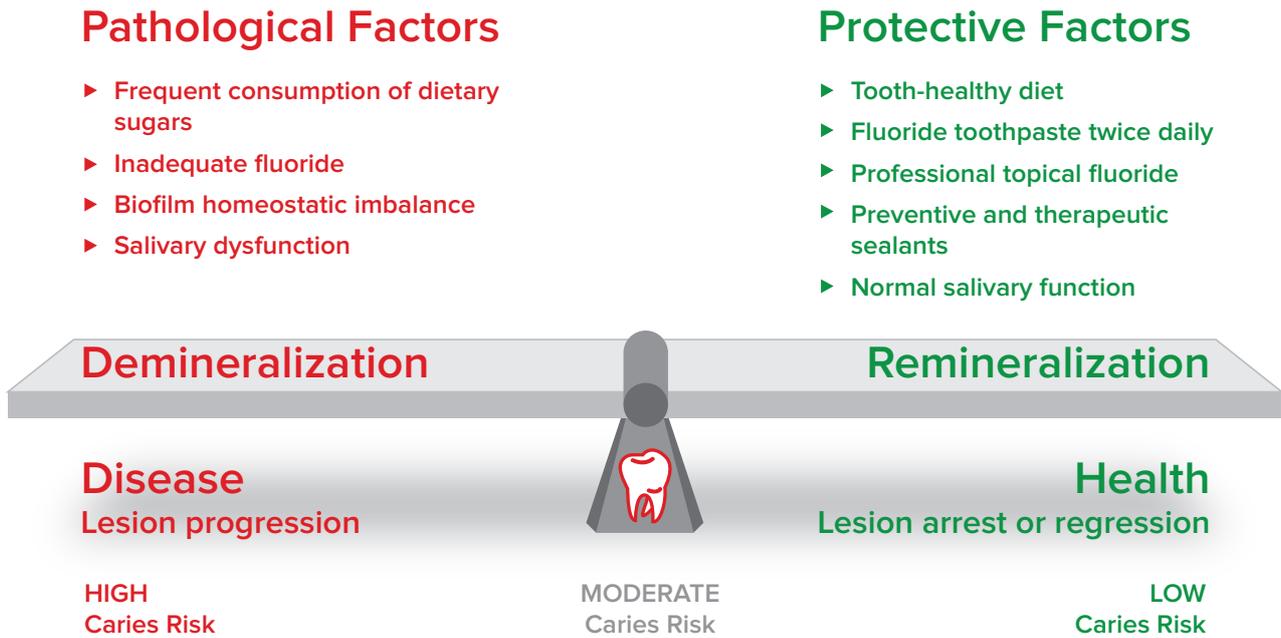
Several other factors may be helpful when used in combination with past caries experience. These include the extent of plaque coverage, high-sugar diets and reduced salivary flow. Specific teeth and tooth surfaces may be at increased risk of caries if they are erupting (particularly molars), crowded and therefore difficult to clean, covered by fixed or removable appliances, or if they have enamel defects, faulty restorations, or exposed root surfaces. On the other hand, fluoride exposure from all sources and dental sealants can reduce caries risk. Figure 2 illustrates how pathological and

protective factors can shift the balance in favour of health or disease.

Different caries risk assessment systems have been developed to help dentists assess patients' caries risk. Electronic tools are ideal as they easily document a patient's risk status and can track changes over time. Risk generally corresponds to a

patient's recent caries experience, though a patient may be classified as moderate or high risk in the absence of recent caries due to other factors such as newly onset hyposalivation. The risk assessment is then used to inform a treatment plan including risk-based recall frequency.

**Figure 2 - Effect of pathological and protective factors on caries risk status**



*Adapted from Pitts 1983 & Furtherstone 1999*

## Section 6 Primary Prevention

Primary prevention seeks to maintain health and prevent disease in patients who do not already have a disease. This section focuses on the role dentists can play in primary caries prevention, though public health, community and school based educational and interventional programmes. Figure 3 provides a ranking of primary preventive strategies based on the level of evidence that support them.

### Strategies to modify or eliminate aetiological factors

Toothbrushing with fluoride toothpaste at concentrations 1000 ppm F and higher and flossing are the main means of controlling plaque formation. Antimicrobial agents such as mouth rinses, gels and

varnishes have not been shown to reduce caries effectively, with the exception of chlorhexidine/ thymol varnish every three months to reduce root caries incidence in adults. Recently there has been a paradigm shift in dentistry from biofilm removal to promoting a healthy biofilm through dietary changes and prebiotics and probiotics, though sufficient evidence is lacking for prebiotics and probiotics.

There is limited evidence that one-on-one dietary interventions to reduce sugar intake in the dental setting are effective. Sugar consumption should still be assessed however, and patients advised to limit sugar consumption when necessary.

Chewing sugar-free gum for 10-20 minutes after meals has been recommended to stimulate saliva and reduce coronal caries.

Gustatory, masticatory and pharmaceutical salivary stimulation has also been recommended to

reduce caries incidence in patients with Sjörögen disease, although lack of evidence meant this recommendation was rated as weak.

**Figure 3 - Ranking of evidence supporting caries prevention strategies**

## Caries prevention strategies



## Strategies to increase resistance to caries

Community water fluoridation is the most cost-effective population level means of preventing caries.

Fluoride toothpaste is a proven effective measure, with its preventive effect increasing significantly with higher concentration. Table 1 provides recommendations for optimizing the effectiveness of fluoride toothpaste and minimizing safety concerns in young children.

Evidence shows that low fluoride toothpastes do not decrease the risk of dental fluorosis in children, but do increase the risk of caries.

Fluoride mouth rinses are additionally recommended for adults and children with high caries risk. The use of fluoride drops and tablets is controversial, and given the effectiveness and more general acceptability of toothpaste as a delivery method, should be carefully considered before recommendation.

Strong evidence supports the use of dental sealants for preventing the initiation and progression of caries in both clinical and school settings. Currently, resin-based sealants are considered the material of choice, while glass ionomer cement are preferred for partially erupted teeth or uncooperative patients where moisture control may be an issue. Concerns that a tooth with a partially lost sealant is at higher risk of caries than unsealed teeth appear to be unfounded. A moderate level of evidence supports professionally applied fluoride gels and varnishes for caries prevention. Based on limited evidence the home use of prescription strength fluoride gels and pastes are also recommended. There is also limited evidence to suggest that resin-based fissure sealants are superior to fluoride varnish applications for preventing occlusal caries in permanent molars. With regards to non-fluoride remineralization systems, there is no clinical evidence for their use in primary prevention.

**Table 1 - Recommendations for best practices based on available evidence for fluoride toothpaste use**

Action	Recommendation
<b>Brushing frequency</b>	▶ 2x/day (morning and before bed)
<b>Amount of fluoride toothpaste</b>	▶ >2yrs: thin smear, ½ a pea (0.05-0.1g) ▶ 2-6yrs: pea size (0.25g) ▶ <6yrs: full length of toothbrush (1-1.5g)
<b>Brushing time</b>	▶ minimum 2 minutes
<b>Post-brushing</b>	▶ spit, do not rinse with water
<b>Supervised brushing</b>	▶ up to the age of 8 years

## Section 7 Secondary Prevention

Accurate detection and assessment of early caries lesions along the caries continuum (Figure 4) is essential for secondary prevention. Dentists must remove the biofilm to visually detect the early stage of caries, with compressed air also required to detect the earliest stage of caries (ICDAS Code 1). The activity state of lesions should also be assessed, as arrested lesions do not require further intervention.

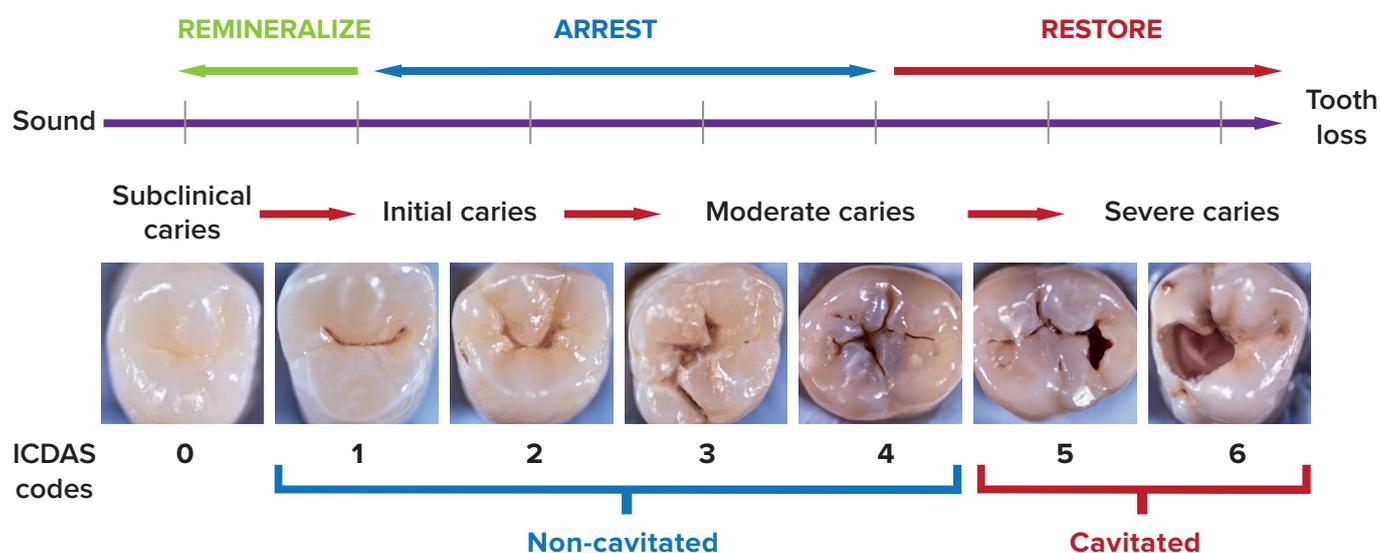
As long as the surface layer of the lesion is mostly intact, many of the same strategies involved in primary prevention are applicable for secondary prevention. Improved oral hygiene and diet can lead to the arrest and regression of caries, and oral health professionals can play an important role in educating patients about such behaviours. As with primary prevention, fluoride toothpastes and professionally applied gels and varnishes are effective in remineralizing non-cavitated caries lesions. Several systematic reviews have also concluded that sealing non-cavitated lesions in

permanent teeth is effective in reducing caries progression. Non-fluoride agents such as xylitol, chlorhexidine and CPP-ACP have not been shown to have a significant reduction in caries progression.

Resin infiltration of non-cavitated caries proximal lesions is a micro-invasive procedure that has been shown to be significantly more effective than non-invasive professional interventions or oral hygiene advice. Some concerns have, however, been raised regarding technique sensitivity for approximal sites and that the surface layer of enamel is removed as part of the procedure. With regards to minimally-invasive procedures, there is no evidence that these can lead to better long-term outcomes and re-restoration cycle improvement than more traditional restorative procedures.

Application of 5% NaF varnish every three months was recommended as the best secondary prevention choice for patients with root caries lesions. Daily use of 1.1% NaF paste or gel was considered the best alternative. Defective or carious margins of restorations and defective or lost fissure sealants should be sealed or repaired wherever possible.

Figure 4 - Caries diagnosis and management continuum



## Section 8 Preservation of tooth tissue

### Preservation of tooth tissue

The change of philosophies around caries management has been a slow and difficult process. The evidence on the need to move to ‘Minimal Intervention in the Management of Dental Caries’ has been available for decades. Research into the remineralization of non-cavitated lesions of enamel and dentine, minimal operative intervention of cavitated lesions using the Atraumatic Restorative Treatment (ART) technique, and the limited repair of defective restorations has shown how this can be implemented in different settings. However, there is still a wide variation in the progress of transition between countries.

A number of overarching and important themes were discussed by an expert group in 2012, to define a common approach to contemporary caries management. These clarifications should mark a pivotal line for judging when a surgical intervention would be necessary or not, and in the case of restorative care how to preserve the tooth tissue as best as possible.

Focus was put on aetiological factors, prevention, and non-operative initial stage treatment, with full alignment with the ICCMS™.

It is important when discussing the issue of preservation to consider the clinical management of lesions at both the enamel and the dentine levels, with the former being too often ignored. There has been some encouraging development in dental education moving towards a more patient-centred holistic view, starting in Europe and spreading to Latin America, Asia and most recently US Dental Schools.

Restorative dentistry can have damaging consequences on pulp health and increase risk of tooth fracture. We also need to consider the economic cost impact when looking for a technical solution to solve a biological problem related to a preventable disease. Another aspect to consider is the impact of a restorative approach on safety and the environment, particularly in the context of the

Minamata Convention on the use of Mercury and the associated phase down of dental amalgam which is required.

## Section 9 Caries management – a systematic approach

This section uses the ICDAS/ICCMS™ systems as a case study for a systematic approach to clinical caries management. The ICCMS™ system integrates the ICDAS caries classification system with prevention and risk assessment models, thereby giving a comprehensive system to describe and document the total caries experience at the population and individual level. The system is health outcomes focused, aiming to maintain health and preserve tooth structure, and has widely been identified as the most comprehensive of the available alternatives.

The ICCMS™ includes a ‘Wardrobe’, used for classification, which has four levels of caries status. This has proved the most straightforward way for many dentists to start using the system. Some do migrate to using the full six levels of the ICDAS classification however, and results at this more detailed level can always be translated into the corresponding Wardrobe or WHO Basic Methods level if needed for comparison purposes. Around the Wardrobe are the four ICDAS domains, which represent the different uses to which the System can be put; namely education, clinical practice, research and epidemiology. The ICCMS™ system can also be used in either paper or IT-based format, as long as the core scientific principles are respected.

In 2013, a group of academics, clinicians and experts met to develop a user guide to ICCMS™. The resulting guide, and a quick reference version, are available for free download from [www.icdas.org](http://www.icdas.org). Following a request from some potential users for an even shorter reference guide the ICCMS™ Group developed the 4D Caries Management Cycle, which communicates the essential steps of caries management (determine, detect and assess, decide, do). It is important to remember the many different

countries and settings that the System can be used in, and that the detail and sequence of steps may need to be adapted locally.

## **Section 10**

### **Remuneration for appropriate caries prevention and management**

One of the main obstacles for change has been the lack of reform in remuneration systems to cover caries prevention procedures, even though key stakeholders have called for change. Coupled with further education and training, a fairer pay scheme would go a long way to change the way we look at caries. Although some innovations in remuneration systems have been seen in Scandinavia, the UK, Germany, and the US, the traditional model still prevails in most countries of the world.

The traditional system is well-understood by dentists, patients and third-party payers, and is considered technically efficient and difficult to defraud due to the easy measurement of the number of cavities cut and amount of restorative material used. However, in such systems time spent by a dentist or his team on early-detection, activity assessment, preventive advice and non-operative care is either not reimbursed or insufficiently covered, thereby dis-incentivizing preventive care.

Existing and successful preventive-focused payment systems should reassure and encourage those who are reticent to change. Medical insurers with preventive plans in arenas such as cardiovascular health and diabetes are now looking more closely at dental plans, and the advent of evidence-based healthcare is driving different stakeholders to advocate for change.

Change remains a difficult thing to achieve, especially for well-established health systems or parties benefiting from the status quo. All stakeholders need to ensure that remuneration is

considered an important element in advancing a preventive approach to caries, and should prioritize preventive treatments where possible.

## **Section 11 Roles & opportunities of dental team and other health professionals**

The dental world includes a wide range of professionals with different training, skills and competencies, all of whom are identified under the same category of “dentistry personnel”. It is FDI’s vision to move towards multidisciplinary and collaborative team-based care, and shape a new model of healthcare delivery where the dentist supervises, provides training, and delegates, while remaining responsible for diagnosis and treatment planning and realization.

The successful adoption of this approach will depend on, among other things, national regulations on licenses and level of supervision, remuneration schemes, the available workforce, the fostering of collaborative practice through education, and which kind of infrastructure is available. All of this will of course differ from country to country.

Several cases of successful implementation schemes already exist, which together reflect an evolving role for dentists. These cases show collaboration between dentists and hygienists, focusing on task reallocation and administration of care according to the needs of the patient rather than hierarchy. The delivery of interdisciplinary courses by dental schools to not only dentists, but also hygienists, and medical and nursing students, can further help advance team care. Similarly, greater inclusion of oral health in medical and nursing school curricula is needed.

In some countries, few dentists are available and access to oral care in remote areas is extremely difficult. In such areas task shifting becomes essential, and various projects where dentists train members of the wider health community, or even teachers and educators, have shown positive effects

on oral health behaviours. Integration into primary care is another example of how oral health can be improved through an inter-professional approach. In Brazil, oral health has been included into the Family Health strategy, resulting in a nearly 40% increase in access to oral healthcare over seven years.

## Section 12 Supporting change in caries management where it's needed

Dentists' willingness to change will be a key factor in achieving a new approach to caries management. In order to support them, a number of things need to happen. These include further education, new resources for life-long learning, Continuing Professional Development, new paper or software tools, and new incentives to change from both a professional and economic perspective. The Caries Prevention Partnership, which includes this White Paper, an Advocacy Toolkit and education webinars, is an example of how NDAs and dentists can implement change when supported with the right tools.

Just like healthcare, dentistry has resisted change in many areas, such as caries classification and secondary prevention. Caries care is seen as such a basic part of dentistry that it has been ignored in terms of innovation. There is a refractory attitude within dentists towards change which is either due to a lack of knowledge, a lack of proper resources or a lack of will.

Tools that would help support change include: high quality evidence-based guidelines; educational developments; adaption of existing resources; production of any needed new resources in electronic formats; implementation activities utilizing paper charts, checklists, IT systems to automate data collection and decision support; new or improved devices and preventive treatments that help preserve dental tissue; and better use of ICCMS™ tools such as the Quick Reference Guide, updated e-Learning software, tablet-based software and

other caries care information tools for patients, and tablet-based software for epidemiology.

The challenge will be to make all the pieces of the caries puzzle fit and work together, as considering them individually would not achieve the level of progress necessary. Nutrition, education, cariology, (dental) public health, clinical practitioners and those developing management systems like ICCMS™ are all “disciplines” within dentistry which need to be aligned, not only together but also with external stakeholders such as other health professionals, the public, patients and other stakeholders. Integration and support have to be scripted and adapted locally at practice, patient, system and country level, which may require different initiatives and partnerships.

## Section 13 Caries prevention and management: assessing outcome/progress

As mentioned previously, reliable data on caries outcomes is of great value to governments, insurers, health services and public health groups, patient groups and economists. Systematic data collection however is hindered by fragmented dental IT infrastructure in many countries, and a lack of consensus on what is required to guide software development by the private sector. The traditional mode of data collection, which records caries at the cavitated level and excludes initial lesions, also captures only data relevant to disease control, thereby excluding what is needed for more patient-centric and health maintenance focused approaches. The outcomes which should be covered when collecting data can be grouped into four elements:

1. **Health maintenance:** Outcomes may include patient capability to maintain oral health, number of truly sound teeth/tooth surfaces, number of restored teeth/surfaces maintained free from

new disease, prevention of inactive caries lesions progression, and cyclic risk-based care and review.

2. **Disease control:** Outcomes may include the number of initial caries lesions that remain unchanged or are reversed, effective management of lesions (through non-operative or tooth preserving operative care), control of lesion progression, and preservation of tooth structure.
3. **Patient-centered quality:** Outcomes may include patient satisfaction, attendance and care pattern being based on risk status, reduction or stabilization of risk status, and improvement of oral hygiene and dietary practices.

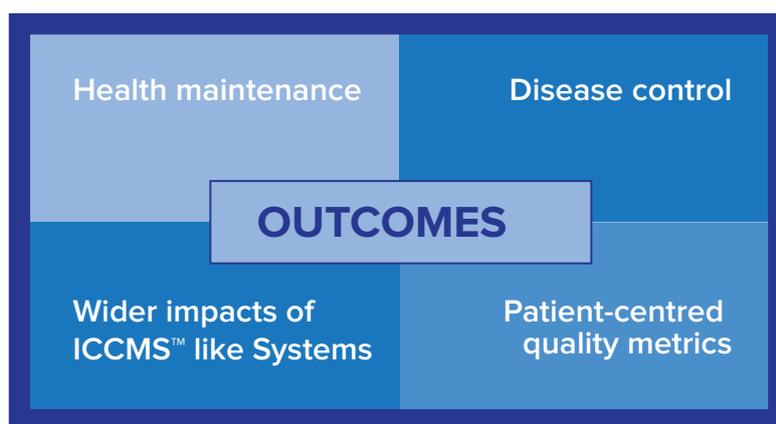
4. **Wider implications:** Outcomes may include changes in care philosophy (in dental practices, dental schools, insurance systems, health systems and national policies), new research, the linking of oral health to general health goals, appropriate reimbursement systems, and improved value for caries care.

The refinement and development of these four elements in ways that are appropriate to local, national and global contexts, and the associated development of IT support to capture such information, should be a priority.

### Call for action

Going forward it is important that: 1) the four types of caries outcome measures outlined continue to be developed and refined in ways that are appropriate locally, nationally and globally; and 2) that the IT support required to capture this information as efficiently as possible is developed locally, nationally and globally in parallel.

**Figure 5 - Four key aspects of caries prevention and management outcomes (example from ICCMS™)**



## Section 14

### A call for action

In order to meet the challenges outlined in this Paper, FDI calls on NDAs and all stakeholders to consider the following:

#### Prevention

- Primary prevention needs to target different audiences, including patients (promotion of oral health literacy, oral hygiene, diet), dentists (use of fluorides, sealants and dietary advice) and policymakers (policies on fluoride, availability of sugary foods and drinks etc.).
- Secondary prevention to stop lesions progressing to a point where surgical intervention is required and to preserve tooth tissue should be a priority in dental care for all age groups.
- All prevention strategies should be integrated across disciplines, with dental practitioners, other health professionals, individuals and policymakers working together to achieve the re-integration of oral health into general health.

#### Clinical practice

- Dentists need to be well supported with what is required to move to an up-to-date, comprehensive, evidence-based, risk-informed, tooth preserving, preventive caries management, working with a wider range of internal and external partners.
- The development of devices, software and techniques that support lesion detection, activity assessment, risk assessment and overall minimally invasive clinical care is urgently needed.

#### Education

- Training and education in cariology need to be re-launched at both undergraduate and continued education levels with up-to-date and evidence-based data.

#### Integration

- All disciplines (nutrition, education, behavior change etc.) need to be pieced together and aligned to make oral health an integrated part of general health.
- Caries prevention and control strategies need to be put in context with the implementation of the UNEP Minamata Convention (phase-down of amalgam, phase up of prevention)

#### Financing

- All stakeholders in national or local contract specification and negotiations, which include caries care need to ensure that remuneration incentivizes preventive treatments, supports operative treatment when needed, and that the patient's best interest is always the main concern.
- Health Systems need to avoid investing in potentially unnecessary costly infrastructure.

#### Evaluation and data

- The quality of data needs to be improved to obtain valid and comparable information, and disease detection thresholds placed so that prevention success and needs can be assessed and monitored.
- The four types of caries outcome measures need to be developed and refined, and IT support needs to be developed in order to capture the information.

**For access to the full text and references, please visit:** <http://www.fdiworlddental.org/resources/white-papers/white-paper-on-dental-caries-prevention-and-management>

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