



Official  Event

SIDO CONSENSUS CONFERENCE

Italy for Oral Health in the World

# “Every Mouth Has Its *Tongue*”

Multiethnic Prevention Program

*EDITOR: G. Farronato*

**Friday, October 30, 2015**

Italian Pavilion Auditorium



**ITALIA**  
EXPO MILANO 2015





SIDO (Italian Society of Orthodontics) has developed a multiethnic project named *'Italy for Oral Health in the World - Every Mouth Has Its Tongue'*, part of the tight circle of those showcased at the Italian Pavilion during MILAN EXPO 2015.

In a multiethnic society populated by a multitude of lifestyles and eating habits, oral health has become an increasingly critical issue, having to harmonize different peoples and ethnic groups who do not regard oral health as a priority concern, especially during children's growth.

We consider this a formidable challenge never attempted before by any Italian Scientific Society. Our aim was to help understand, especially in times of crisis, how oral prevention, generally speaking, is a key factor not only for dental and oral health, but also for the well-being of the whole body, as recent clinical studies show.

The event that took place on 30 October 2015 marked the conclusion of several work groups dedicated to specific topics tackled by experts. Coordinated by a Leader, they presented the findings of their research at the Auditorium of the Italian Pavilion to an audience of lecturers, international professionals, delegates from public organizations and institutions, opinion leaders, communication professionals, and so forth. We have produced this publication to gather all the addresses delivered at the event.

I wish to thank all the authors who have contributed to the success of the event and Professors Ersilia Barbato, Federica Buglioni, Annamaria Cagetti, Enzo Grossi, Laura Stampini, and Laura Strohmenger, who superbly coordinated and chaired the event.

*Giampietro Farronato*  
SIDO President 2015



# SIDO CONSENSUS CONFERENCE

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# Between health rights and lifestyles, to better appreciate... Italian food

Francesca Manfrini - President of Accademia Italiana di Conservativa (AIC) 2013/15

## Feeding the planet, energy for life

This is the inspiring theme of Expo Milano 2015, also an opportunity for the CIC (Italian Committee for Coordination of scientific societies of dentistry), which has been invited to participate to the conference organized during the event, has developed its own contribution on the theme “Prevention, Care and Dental Wellness, Between Health Rights and Lifestyles”.

This issue can be particularly integrated with the second and the third line of the congressional guidelines, named “Abundance and Deprivation” and “The Future of Food”. The theme “Abundance and Deprivation” has set the ambitious goal to analyze and try to answer this serious problem by studying the planetary eating habits, facing - necessarily - fields such as education, prevention and lifestyles, almost reaching the social boundless and political field of international cooperation.

Even the theme “The Future of Food” can find many points of contact with our theme, where it aims to study what will be the food of tomorrow, what diets to follow and which new areas of research and new technologies aim to identify the so-called functional foods.

## Dental wellness and lifestyles

The “dental wellness” contribute very strongly to create the state of overall well-being for the human beings and involves not only the physical aspects; it is in fact both necessary to ensure masticatory efficiency and to help maintain a pleasant appearance the indispensable conditions to ensure a dignified private and social life. It has been demonstrated that health, beyond the absence of disease, is characterized by a state of complete physical, mental and environmental social wellness. The “dental wellness” can be affected by diseases of the hard tissue and the supporting tissue of teeth: by some estimates caries and periodontal diseases is affecting the 60/90% of the world population, causing lesions which can progressively lead to clinical conditions of varying severity.

Dental caries is still the most common chronic disease affecting children and adults, although its incidence is different in different regions. It affects especially children

in industrialized countries, where it is five times more common than asthma and seven times more common than seasonal allergy. 94% of the adult population has caries experience during its lifetime.

Periodontal disease is the main cause of tooth loss, resulting in serious functional and aesthetic impairment; it has a negative effect on the social life, compromising the smile and causing halitosis, with a major impact in the psychology sphere.

Recent epidemiological studies reveal that severe periodontitis affects more than 700 million people and is the sixth most common pathologic condition in the world. In Western countries it is a chronic inflammatory disorder with higher prevalence: more than 40% of the adult population suffers from periodontal disease.

It's very important to know these alarming and significant epidemiological data and it is imperative to cure these diseases before implementing corrective therapies, whether of restorative or surgical character.

A modern definition sees the carious pathology as an infectious and transmissible disease process, determined by the dynamic balance between pathological factors leading to demineralization and protective factors that determine the remineralization of dental hard tissues: it is on this balance that we have to put our operative efforts, in order to strengthen the protective factors.

A nutritional counseling program can be helpful to address the patient's eating habits:

- Consume sugar at meals and not between meals.
- Do not overlook the use of foods containing fluoride ion such as tea, seafood, raisins, grape juice and wine, the fluoridated salt, vegetables (lettuce, spinach, carrots), the legumes (beans), cereals, fruit (apples, nuts), drinking water from reservoirs rich in minerals, mineral water (depending on the origin and the labeled indications).
- Promote the use of other dietary factors with buffer properties, such as mature dairy products.
- Recommend the use of chewing gum without sugar and especially those enriched with xylitol, able to affect the oral ecosystem, decreasing the acidogenicity of

plaque. Even a glass of red wine can have therapeutic effects, thanks to the polyphenol content that disrupts the bacterial biofilms.

Hand in hand with nutrition counseling is the suggestion to counteract habits that favor the disease process: the continuous intake of antihypertensive drugs, anticholinergic, anti-Parkinson and psychotropic sedatives; smoking habits, alcohol abuse, caffeine, cannabinoids and opioids lead to decreased salivary flow, which, as is known, plays a protective role against the carious process.

Obviously the caries risk increases dramatically when, alongside “caries-favoring” dietary habits and inadequate lifestyles, poor plaque control because of incorrect oral hygiene habits.

Even periodontal disease, a chronic inflammatory disease that is caused by a polymicrobial infection, is closely linked to lifestyles and is affected in its course by local or systemic factors. The periodontitis acknowledges then a multi-factorial etiology in which bacterial plaque plays the leading role, supported by elements of genetic susceptibility and favored by alterations of the immune response, linked to systemic conditions and habits and inappropriate behavior of the affected patients. The scientific literature is unanimous in considering that a meticulous home and professional oral hygiene is one of the key factors for the prevention of periodontitis and for short and long term success of periodontal therapy, surgical and non-surgical.

In 1999 a position paper by the AAP showed that the use of tobacco is an important variable able to influence the progression of the various forms of periodontal disease. Tobacco use, with alcohol abuse, are also risk factors for the onset of oral cancer: tobacco underlies 80-90% of cases of oral cancer.

## Stress

Today life is hectic and stress accompanies much of our behaviors: it is important to learn to cope with stress caused by personal and psycho-social problems, because his chronicity can cause deep changes in the lifestyles of individuals, a basis for the spread of chronic diseases. Periodontal disease, like other chronic diseases, is linked to conditions that affect the resistance of the host against periodonto-pathogenic bacteria. Stress can generate parafunctions and determine attitudes, and, causing a dental and joints overload, can compromise the functionality and well-being of the stomatognathic system.

In recent years it has also been showed a relationship between periodontal disease and obesity: in obese subjects there is in fact a hyper-inflammatory systemic state, that increases the risk of periodontal disease and insulin resistance. Sometimes obesity leads to what is called metabolic syndrome, which includes pathological increase in body mass, dyslipidemia and is strongly associated with future development of diabetes, a very common disease in the presence of unhealthy lifestyles. Uncompensated diabetes is considered a risk factor for

the progression of periodontitis, because it favors the selection of periodonto-pathogenic bacteria, reduces the activity of polymorphonuclear cells and causes alterations of periodontal connective tissues, with deposition of metabolic products of glucose.

A proper diet, combined with physical exercise, can counteract obesity. The literature also suggests a possible association between periodontal disease and physical inactivity. Although the scientific evidence does not allow us to reach definitive conclusions regarding causal relations, it can be seen from several epidemiological studies that regular physical activity shows clear anti-inflammatory effects and that physically active individuals have a lower risk of periodontitis than sedentary people.

Recently - in addition to the obvious considerations about serious alterations and impairments caused by periodontal disease to oral health and oral well-being - it has been noted that periodontitis can cause negative effects on the entire body: in fact in some studies strong associations have been shown between periodontitis and certain systemic diseases, such as cardiovascular disease, diabetes, lung diseases and complications in pregnancy, all of them multifactorial diseases that share important risk factors related to unhealthy lifestyles.

A sure causality is still uncertain; however, we are strongly motivated to sensitize health professionals to suggest to the population the need for prevention and treatment of periodontitis.

In conclusion, the call “motivated” by the Dentist for an adequate lifestyle - dietary and not - as well as the prevention of oral diseases, would certainly lead patients more advantages in terms of wellness and overall health. This consideration may also be a good reason to sensitize health professionals to suggest to the people the need to prevent and treat periodontitis.

## Functional nutrition: the future of food?

As part of our search, the daily course of life must be inspired to hygienic / health behaviors that should become “habits” and role model for us and for others: “lifestyles”. To chase the goal of wellness, we witness daily to the promotion of new products that advertising offers us as “recipes for long life”. These products, whether industrial or homemade elixirs, sometimes pursue the illusion of curing a disease identified by certain symptoms, to soothe which the consumer is often conditioned to purchase.

The concept of functional nutrition is not new, it was introduced in Japan in the eighties, when health authorities studied diets specifically designed to improve the health and reduce the risk of disease, in order to increase the quality and life expectancy of a growing number of elderly people. In relation to this concept, foods characterized by additional effects are therefore defined as “functional”, that is, when the components naturally present have the power to interact in a more or less selective way with one or more functions of the organism, contributing to their



improvement and / or preservation. Research on the subject is very attentive, active and cautious. These groups of substances, depending on the intrinsic properties and / or additions in foods, can in fact contribute to the wellness of the organism with different modes of action: antioxidant, detoxifying, antitumor, antimicrobial and antiviral, anti-inflammatory, antihypertensive, hypocholesterolemic action and so on. But it is important to stress that it is necessary to scientifically prove, with studies and research, the beneficial effects of functional foods on health and prevention of diseases: in the European Union currently lacks specific legislation on this food category. Will the functionally oriented nutrition probably be the future of food?

### Prevention and health rights

Widespread is still the habit of treating the symptoms of diseases, without seeking the cause, neglecting prevention as a tool to avoid the onset of illness. The side of prevention is by far the least investigated in the history of medicine, in fact its “discovery” can be traced back to the after World War II of the last century. This finding may be attributed to the growing prosperity of the population, obtained with major achievements through historical, cultural and political paths. Then, the need of maintaining the acquired wellness was faced, and the first rule for this is preventing the occurrence of factors that may affect the wellness and then cause disease. Well, if on the one hand the search for disease prevention is up to us professionals belonging to the medico-scientific community, conversely all people can contribute to the maintenance of their own well-being, preventing the destabilizing factors, dealing with the so-called lifestyles and with the preservation of the environment in which they live, paying more attention to their habits, both individually and in groups, thus influencing the behaviors themselves. “Lifestyle” is, in hindsight, a phrase obviously concise and catchy, but which implies a complex web of methods and habits of life, starting from weaning, through the period of puberty and adolescence and beyond, following the way of wellness in the shadow of the three pillars that support this goal: the correct approach to food, the care of our body and the choice of the environment in which to live. Historical stages of the birth of the policy to protect the health starting with prevention, are marked by the identification of the concept of health as defined by WHO in 1948: “Health is a state of complete physical, mental and social well-being”.

Acknowledged this principle, the WHO has perfected it in 1986 by enacting the Ottawa Charter, which stresses the close relationship between the person (defined as an individual, family, social and cultural community) and the components of the environment in which he lives. On this basis rests the concept of “health promotion” as a path that allows the individuals to control their own health, with the aim of improving it.

The Ottawa Charter, ultimately, gives man the right to

the maintenance of his health, a right which is already protected by the Constitution of the Italian Republic in 1948 through the art. 32, which establishes health as a basic right.

Therefore health should be seen as an everyday resource of life and not just as an ultimate goal.

### Conclusion

Trying to make a final synthesis between this editorial and the purposes of the themes of EXPO 2015, it should be emphasized that a method of feeding properly, apt to prevent the onset of disease at a general and also peripheral level (mouth and teeth), it has decisive importance and should be subject to an improvement of our lifestyles and of a rebalancing of food resources worldwide. We can observe that, although there is food for everyone, its distribution is not equitable. If in the so-called industrialized hemisphere one can afford to select, calibrate and weigh what to eat, in a considerable part of the world men are unable to feed themselves: here the waste and the excessive use of food, there the lack of access to the resources.

While we do hope that the EXPO event can help finding the key to feeding the world, we like to recall what was written by Manuela M. Ravasio on “Sette”, editorial supplement of Corriere della Sera, reporting that the first indications of how to feed were born in Italy in 187 BC, when Marco Porzio Catone, in his “*De Re Rustica*”, showed how to select the meat and how to make wine. Sixteen centuries later, again in Italy, was born what may be called “*modern cuisine*”: Catherine de ‘Medici, going married to Henry II in 1533, brought him her team of chefs and meat experts, so exporting the Italian cuisine in France and in the courts of Europe.

It does not appear out of place, finally, to remember what the philosopher Ludwig Feuerbach argued, when he recalled that “*we are what we eat*”, with the inseparable connection between mind and body. To think better, we must eat better, food is a cornerstone of our health, our culture and our civilization.



# Oral cavity: an appealing source of mesenchymal stem cells

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## Abstract

Mesenchymal stem cells (MSCs) are non-hematopoietic cells of mesodermal origin identified in several adult tissues and organs. These cells, independently of their origin, are characterized by self-renewal ability and multipotent differentiation potential. Because of these properties MSCs were first investigated for their role in regenerative/reparative medicine. Further in vitro and in vivo studies demonstrated that MSCs have notable immunomodulatory effects on both innate and adaptive immunity, a fact that makes the cells also very attractive for allogeneic transplantations. In recent years, MSCs have also been widely investigated as vehicles for anti-cancer molecules, due to their ability to migrate towards tumours and inflammatory microenvironments. Even though bone marrow (BM) was the first and best-characterized source of MSCs, the highly invasive harvesting procedure and variability in cell recovery and differentiation potential, according to donor age, have encouraged investigation of alternative MSC sources. Of these, the oral cavity seems to be an attractive source because of its accessibility, the ease of MSC isolation and the rapid ex-vivo expansion. To date stem/progenitor cells have been isolated from teeth (five different types), gingiva, palatal connective and periodontal granulation tissues and from salivary glands. All of these share some properties with BM-MSCs (e.g. phenotypic markers, self-renewal and multi-differentiation potential) and differ in other respects (e.g. the proliferation rate and the more restricted differentiation potency). The aim of this article is to provide a summary overview of the different MSC-like populations derived from the oral cavity and their main biological properties.

## Introduction

Mesenchymal stem cells (MSCs) are non-hematopoietic cells of mesodermal origin identified in many adult tissues and organs. Among the main and most abundant study sources are those relating to bone marrow<sup>1</sup> and adipose tissues<sup>2</sup>, umbilical cord blood<sup>3</sup>, amniotic membrane from term placenta<sup>4</sup>, the pancreas<sup>5</sup> and deciduous teeth<sup>6</sup>. As the bone marrow (BM) is the first and best characterized source

of MSCs, the MSC-like populations derived from other tissues have been characterized according to the “minimal” criteria established for BM-MSCs<sup>7,8</sup>, that is: i) plastic adherence; ii) the capacity to form clonogenic colonies (self-renewal potential); iii) the ability to differentiate into multiple cell lineages when grown in specific culture media in vitro (osteogenic, chondrogenic and adipogenic lineages); iv) the expression of a panel of MSC markers (CD44, CD73, CD90 and CD105) and the lack of endothelial and hematopoietic markers (CD31, CD34 and CD45). Because of their self-renewal and multi-lineage abilities, MSCs were first investigated for application in regenerative or reparative medicine. Such application was based on the hypothesis that MSCs, after engrafting at the injured site, differentiated into resident cells and replaced damaged tissues<sup>9,10</sup>. Though this is probably the case, some authors have recently discredited it when they observed that only few engrafted MSCs are able to differentiate into the cells of the host organ and that the therapeutic

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effect (when observed) is mainly due to the soluble factors and/or microvesicles secreted by MSCs<sup>11</sup>. This has opened an interesting field of study aimed at verifying the biological activity of the MSC secretome. Many studies have shown that MSCs have anti-inflammatory and immunomodulatory properties by altering the behaviour of both adaptive and of innate immune cells<sup>12</sup>. MSCs have therefore been used in hematopoietic stem cell transplantation, both to promote the engraftment of donor cells and in the treatment of some clinical situations where there is acute graft-versus-host disease<sup>13,14</sup>. Over the last few years several studies<sup>15-18</sup> have described the ability of MSCs to migrate towards pathological sites, including to tumors. In a recent review, Cornelissen et al.<sup>19</sup> discussed the migration properties of MSCs that seem to follow the same rules as those for leukocyte migration (expression of integrins and adhesion molecules on MSC surface and the presence of chemotactic molecules). Although this behaviour is still very much a matter of debate (Ansboro et al.<sup>20</sup> state that after i.v. injection most of the MSCs are trapped in draining organs), several studies describing the possible use of MSCs as carriers for anti-cancer molecules (interleukins, interferons, oncolytic viruses, anti-angiogenic agents, pro-apoptotic proteins, growth factors antagonists and drugs) have been proposed<sup>21</sup>. The purpose of these investigations is to create new drug carriers for an targeted delivery, both improving the efficacy of therapy and limiting side effects. Many of these studies have been based on engineered MSCs: the genetic makeup of the cells is modified to arm them with anti-cancer molecules such as tumor necrosis factor (TNF)-related apoptosis-inducing ligand (TRAIL)<sup>22</sup>. Other authors<sup>23,24</sup> have exploited a physiological mechanism for the MSCs (with the uptake and release of drugs) to create a cellular drug carrier without genetic modifications. Although bone marrow is the best studied and best characterized MSC source it cannot be considered to be the “gold source” because of the invasive nature of the harvesting procedure and because of the decrease in recovery number, differentiation potential and maximum life span of MSCs obtained from this tissue, according to donor age<sup>25</sup>. This particular feature has led researchers to investigate alternative sources such as adipose tissue<sup>2</sup> or placenta<sup>4</sup>. In this panorama the tissues derived from the oral cavity should be considered a very promising source because of ease of isolation, accessibility and the rapid ex-vivo expansion of isolated MSCs with a stable stem-cell like phenotype<sup>26</sup>. By studying the oral cavity and annexes, MSCs have been isolated from various different tissues including postnatal dental pulp (DPSCs)<sup>27</sup>, exfoliated deciduous teeth (SHED)<sup>6</sup>, periodontal ligament (PDLSCs)<sup>28</sup>, apical papilla (SCAP)<sup>29</sup>, dental follicle (DFPCs)<sup>30</sup> and gingiva (GMSCs)<sup>31</sup>.

Stem cells are also isolated from palatal connective (pMSCs) and periodontal granulation tissues (gtMSCs)<sup>32</sup> and from the salivary glands<sup>33</sup>. Salivary gland stem cells in particular seem to have some of the characteristics of MSCs which

support their origin from a common endodermal tissue stem cell<sup>34</sup>. All of the above MSCs (listed in Table I) share some properties with BM-MSCs (e.g. phenotypic markers, self-renewal and multi-differentiation potential) and differ in other regards (such as the proliferation rate and more limited differentiation potency). This article will provide a summary overview of the different MSC-like populations derived from the oral cavity, their main biological properties and their potential clinical and pre-clinical applications.

## 1. MESENCHYMAL STEM CELLS FROM DENTAL TISSUES

### 1.1. MSCs FROM DENTAL PULP (DPSCs)

Dental pulp stem cells (DPSCs) were discovered for the first time by Gronthos et al.<sup>27</sup>. This source of adult MSCs is regarded as particularly promising because they can be obtained in large quantities without the need for invasive techniques. DPSCs can in fact be obtained from discarded teeth, especially wisdom teeth that have been extracted for orthodontic reasons. DPSCs meet all MSC characteristics of plastic-adherence, expression of some specific surface molecules (CD105, CD73, CD90 CD34, CD14, CD19 and HLA-DR), lack of expression of CD45 and the ability to differentiate into osteoblasts, adipocytes and chondroblasts in vitro<sup>27,35</sup>. DPSCs furthermore present a significantly higher frequency of colony-forming cells and a greater number of proliferating cells in cultures as compared with BM-MSCs<sup>27</sup>. Some authors have considered DPSCs to be superior in term of clinical enforceability with respect to BM-MSCs<sup>36</sup> and currently DPSCs are used in regenerative

Source	Acronym	References
Post-natal dental pulp	DPSCs	Gronthos et al., 2000
Apical papilla	SCAP	Sonoyama et al., 2008
Exfoliated deciduous teeth	SHED	Miura et al., 2003
Periodontal ligament	PDLSCs	Seo et al., 2004
Dental follicle	DFPCs	Morsczeck et al., 2005
Gingiva	GMSCs	Zhang et al., 2009
Palatal connective tissue	pMSCs	Pall et al., 2015
Periodontal granulation tissues	gtMSCs	
Salivary glands	SSCPs	Pringle et al., 2013

Table I: Main sources of mesenchymal stem cell in the oral cavity. Some of these share properties with BM-MSCs (e.g. phenotypic markers, self-renewal and multi-differentiation potential) but differ in other respects (e.g. their proliferation rate and more limited differentiation potency).

medicine and for tissue engineering<sup>37-39</sup>. Collart-Dutilleul and co-workers<sup>40</sup> suggested in a very recent review the importance of shifting preclinical results obtained with DPSCs to therapeutic applications in humans, considering these cells to be an advanced therapy medicinal product (ATMP). They propose the establishment of an allogenic biobank to produce and store, in accordance with good manufacturing practice (GMP) conditions, therapeutic batches of human leukocyte antigen (HLA)-typed DPSCs for clinical applications.

### 1.2. MSCs from APICAL PAPILLA (SCAP)

Stem cells from apical papilla (SCAP) were isolated by Sonoyama and co-workers<sup>41</sup> from the root apical papilla of human teeth. SCAP are able to form adherent clonogenic cell clusters (CFU-F, colony forming unit), express several stem cell surface markers (STRO-1, ALP, CD24, CD29, CD73, CD90, CD105, CD106, CD146, CD166 and ALP) and are negative for hematopoietic markers (CD34, CD45, CD18, CD150). The expression of STRO-1 is a much discussed matter because other authors have isolated STRO-1 negative dental neural crest-derived progenitor cells (dNC-PCs) from the apical papilla<sup>42</sup>. The lack however of STRO-1 expression (probably due to differences in cell culture conditions and/or the cell isolation techniques), does not seem to modify the stemness properties of these cells. Furthermore, by comparing individual SCAP cell lines, some differences in the cell proliferation rate and differentiation potential among cell lines derived from the same donor were observed; this suggests that SCAP cell cultures contain different types of undifferentiated cells and that this heterogeneity is probably independent on the donor<sup>43</sup>. A very recent study from Bakopoulou et al<sup>44</sup> shows the angiogenic properties of SCAP. They investigated endothelial trans-differentiation, the secretion of pro- and anti-angiogenic factors and the paracrine effects of SCAP when exposed to environmental stress (conditions of serum deprivation, glucose deprivation and oxygen deprivation/hypoxia) to stimulate tissue damage. Under these conditions, SCAP cells express angiogenesis-related genes involved in vascular endothelial growth factor (VEGF)/VEGFR and angiopoietins/Tie pathways. SCAP moreover secrete pro-angiogenic factors (angiogenin, IGFBP-3, VEGF) and lower the amounts of anti-angiogenic factors (serpin-E1, TIMP-1, TSP-1).

### 1.3. MSCs from exfoliated deciduous teeth (SHED)

The presence of stem cells from human exfoliated deciduous teeth (SHED) was discovered by Miura et al.<sup>6</sup>. These cells can be expanded *ex vivo* and have a higher number of population doublings and proliferation potential respect to DPSCs derived from permanent teeth. SHED express the typical stem cell markers STRO-1 and CD146, and do not express the hematopoietic markers CD34 and CD45<sup>6,45</sup>. With respect to BM-MSCs, SHED differentiation potential is lower for osteogenesis, chondrogenesis and adipogenesis,

but a higher neurogenesis ability has been reported<sup>45</sup>. As SHED express early markers for neuroectodermal stem cells, many authors hypothesize that they originate from the cranial neural crest<sup>6,45</sup> and indicate that these cells have unique neurogenic properties that could be exploited for the treatment of degenerative diseases<sup>46</sup>. Very recent studies have demonstrated that SHED grown on the laminin-coated 3D alginate microcarriers produce exosomes that suppress 6-hydroxydopamine-induced apoptosis in dopaminergic neurons, concluding that exosomes derived from SHEDs could be considered a new potential therapeutic tool in the treatment of Parkinson's disease<sup>46</sup>. Intranasal administration of SHED conditioned medium (CM) in an Alzheimer's mouse model is able to improve cognitive function, suggesting that SHED CM may also provides a novel cell-free neuro-reparative therapy for Alzheimer's disease<sup>47</sup>.

### 1.4. Periodontal ligament MSCs (PDLSCs)

The function of Periodontal ligament (PDL) derived from dental follicle, is to provide a pool of cementum-forming cells in developing teeth. Seo et al.<sup>28</sup> isolated from human PDL, a population of stem cells (Periodontal ligament stem cells, PDLSCs) that are clonogenic, have a high proliferative potential *ex vivo* and express the stromal cells markers CD90, CD29, CD44, CD166, CD105, CD13<sup>48</sup> and are positive for STRO-1 and CD146<sup>28</sup>. PDLSCs have adipogenic potential, a capacity to form collagen fibers, express cementoblastic/osteoblastic markers but do not form dentin or bone. As reported by Wada et al.<sup>50</sup> the presence of interferon gamma (IFN- $\gamma$ ) produced by activated peripheral blood mononuclear cell (PBMNCs) up-regulates the expression of transforming growth factor beta 1 (TGF- $\beta$ 1), hepatocyte growth factor (HGF) and indoleamine 2, 3-dioxygenase (IDO) in PDLSCs, suggesting the immunosuppressive properties of these cells, valuable for modulating alloreactivity and tissue regeneration following transplantation into HLA-mismatched donors. As with many other MSCs, the PDLSCs can also be cryo-preserved without losing their stem cell characteristics so these cells provide a suitable approach for clinical applications<sup>49</sup>.

### 1.5. MSCs from Dental follicle precursor cells (DFPCs)

The dental follicle is a sac of mesenchymal origin containing the developing tooth. Wise et al.<sup>51</sup> were the first to describe the isolation of dental follicle cells, later defined as dental follicle precursor cells (DFPCs) or stem cells (DFSCs). The mesenchymal character of DFPCs has been demonstrated by several authors. Morsczeck et al.<sup>30</sup> described the isolation from human third molar teeth of cells with fibroblast-like morphology, able to differentiate into osteoblasts. Yao et al.,<sup>52</sup> described the abilities of DFPCs to differentiate into adipocytes and to express Neurofilament 200 if cultured in neuronal induction



medium. The chondrogenic differentiation potential was described by Park et al.<sup>53</sup>. Huang et al.<sup>54</sup> described the similarity of DFPCs with BM-MSCs being positive for STRO-1, CD44, CD73, CD105, and CD90 and negative for the hematopoietic marker CD45.

Because bone diseases and defects are recurrent in dental practice, Honda et al.<sup>55</sup> transplanted porcine DFPCs in immunodeficient rats with bone-defect and observed that DFPCs had a potential similar to BM-MSCs and PDLSCs for bone formation. Furthermore, the same authors observed that DFPCs can be considered as an alternative to PDLSCs in periodontal regeneration, because periodontium originates from dental follicle. Li et al.<sup>56</sup> investigated DFPCs as candidates for neural regeneration by transplanting DFPCs with an electrospun material into rats that underwent laminectomy. The authors observed that the nerve fibers could pass through the electrospun material and that the implanted cells survived and expressed the oligodendrogenic marker Olig2. Although these data seem to be promising, further studies are required because the results recorded in animal functional recovery were not statistically significant. Yao et al.<sup>52</sup> observed that DFPCs express, both in vitro and in vivo, the Breast Cancer Resistant Protein (BCRP), a membrane transporter belonging to the ATP-binding cassette (ABC) family. This protein was identified for the first time in the human breast cancer cell line MCF-7, but it is also expressed in normal tissues, such as placenta and blood-brain barrier, as well as in a subset of stem cells isolated from all of the main tissue of the body<sup>57</sup>. BCRP seems to play an important role in the detoxification mechanism of stem cells and contributes to the survival of DFPCs under hypoxic conditions<sup>58</sup>.

## 2. GINGIVA DERIVED STEM CELLS (GMSCs)

Gingival tissue, in addition to acting as a barrier against bacteria and chemical agents, presents particular features in the wound repairing process that are not present in any other organ or tissue<sup>59</sup>. Zhang et al.<sup>31</sup> was the first to isolate a population of MSCs within gingival tissues (GMSCs) that showed a stem cell nature. GMSCs present the typical properties of adult MSCs (plastic adherence, fibroblast-like morphology, colony-forming ability and multipotent differentiation), are positive for MSC markers (STRO-1, CD29, CD90, CD105, CD73, CD146, CD44) and are negative for the hematopoietic markers CD45 and CD34, for the endothelial cell markers CD144, CD31<sup>58,59</sup> and for HLA-DR<sup>59</sup>. GMSCs seem to have a reduced differentiative potential towards chondrogenic, adipogenic and osteogenic lineages compared to the well characterized BM-MSCs and adipose tissue MSCs<sup>8,60</sup>. Some authors, however, indicate gingiva as an ideal candidate source for cell-based therapies such as regenerative medicine and cancer therapy and also consider GMSCs superior to BM-MSCs for cell therapy in bone regenerative medicine<sup>61</sup>. The advantages of GMSCs are in fact manifold; for example, GMSCs can be easily isolated from human

gingival tissue, which is usually discarded as biological waste in the clinic. They also proliferate rapidly in vitro to meet the transplantation requirement for the cell quantities. GMSCs moreover display stable morphology, maintain normal karyotype and telomerase activity in long-term cultures, and are not tumorigenic<sup>61</sup>. Xu et al.<sup>59</sup> analyzed the homing mechanism of GMSCs labelled with green fluorescence protein (GFP) after systemic in vivo transplantation; they reported that GMSCs are able to home on the mandibular defects by promoting bone regeneration. Moshaverinia et al.<sup>62</sup> showed that GMSCs encapsulated in alginate microspheres in the presence of a suitable signaling molecule (TGF- $\beta$ 3) could induce patterns of gene expression aimed to regenerate tendon-like tissue. As expected, GMSCs, like other MSCs, also bring immunosuppressive and anti-inflammatory effects both in vitro and in vivo as demonstrated by the infusion of GMSCs that can ameliorate the severity of inflammation-related colonic tissue injuries in experimental colitis<sup>31</sup>. In our laboratory we isolated an MSC line from gingival tissue that expressed very high basal level of alkaline phosphatase activity (ALP), high pinocytotic activity and contained a high percentage (about 30%) of cells expressing the CD14 marker (unpublished data). The presence of CD14+ cells could reflect the macrophagic function of GMSCs in agreement with the specific function that GMSCs exert in active defence mechanisms and tissue regeneration during wound healing. Other studies are in progress to assess the ability of GMSCs to uptake and release drugs as previously demonstrated with other sources of MSCs (BM-MSCs, adipose tissue MSCs, dermal fibroblasts)<sup>23,62,63</sup>. This could increase the importance of this type of MSCs and also open up their potential use for cancer therapy.

## 3. SALIVARY GLAND STEM CELLS (SSCPs)

The existence of a stem cell population in salivary gland (SSCPs) has been suggested by Braam et al.<sup>67</sup> who observed the behaviour of salivary gland subjected to radiation therapy (RT) in cancer treatment. They found that salivary gland present a regenerative capacity correlated to the number of undamaged SSPCs after radiation. The isolation and expansion of SSPCs in vitro was obtained with salisphere based culture (primary spheres) via an enrichment culture, but also with monolayer culture. Stem cell-associated marker proteins are expressed by SSPCs in monolayer culture (CD44, CD49f, CD24/CD49f, CD90, CD104, and p75NGFR)<sup>68,69</sup> and also in salisphere cultures (CD117, CD24, CD29 and CD49f)<sup>33</sup>. Nanduri et al.<sup>70</sup> demonstrated the long-term in vitro maintenance and expansion of primary sphere-derived CD24hi/CD29hi cells which retain their ability to self-renew and remain fully functional on in vivo transplantation. Gorjup et al.<sup>34</sup> compared the SSPCs with the Pancreas stem cells (PSCs), showing that SSPCs and PSC have a similar capability of in vitro proliferation, a uniform phenotype related to mesenchymal stem cells, and an ability to differentiate into

adipogenic, chondrogenic and osteogenic lineages. For these reasons Gorjup et al.<sup>34</sup> assumed that both of them originate from a common endodermal tissue stem cell. The isolation and the replacement of SSPCs have been proposed to restore tissue homeostasis of the salivary gland into the patient with xerostomia, a hyposalivation-induced disease<sup>71</sup>.

## CONCLUSIONS

The oral cavity amounts to a very promising source for MSCs due to the fact that there are several oral tissues from which they can be isolated and because their isolation and accessibility are very easy. Furthermore, many oral tissues are made up of biological material that is generally discarded during or after medical practice. This makes this MSC source very appealing as there are little or no ethical controversy relating to their procurement. These cells may represent a very important tool for future personalized cell therapy (autologous) but also for creating bio-banks of MSCs for heterologous cytototherapy since this practice is compatible with the poor immunogenicity and immunosuppressive characters of MSCs.

## LIST OF ABBREVIATIONS

ABC: ATP-binding cassette  
 ALP: alkaline phosphatase activity  
 ATMP: advanced therapy medicinal products  
 BCRP: Breast Cancer Resistant Protein  
 BM: bone marrow  
 CFU: colony forming unit  
 CM: conditioned medium  
 DFPCs: dental follicle precursor cells  
 dNC-PCs: dental neural crest-derived progenitor cells  
 DPSCs: post-natal dental pulp stem cells  
 GFP: green fluorescent protein  
 GMP: good manufacturing practice  
 GMSCs: gingiva derived stem cells  
 gtMSCs: granulation tissue- derived MSCs  
 HGF: hepatocyte growth factor  
 HLA: human leukocyte antigen  
 HSCs: hematopoietic stem cells  
 IDO: indoleamine 2, 3-dioxygenase  
 IFN- $\gamma$ : interferon gamma  
 MSCs: mesenchymal stem cells  
 PBMNCs: peripheral blood mononuclear cell  
 PDLSCs: periodontal ligament stem cells  
 pMSCs: palatal-derived MSCs  
 PSCs: Pancreas stem cells  
 SCAP: stem cells from apical papilla  
 SG: salivary glands  
 SHED: exfoliated deciduous teeth stem cells  
 SSPCs: SG stem/progenitor cell population  
 TGF- $\beta$ 1: transforming growth factor beta 1  
 VEGF: vascular endothelial growth factor

## Competing interests

The Authors disclose that they have neither financial nor personal relationship with people or organizations that could influence their work.

## Authors' Contributions

VC and AB screened the scientific literature, collected the data for this study and draft this paper. AP conceived and critically designed this study. All of the remaining authors critically read the draft and gave their final approval.

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REVIEW

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# Timetable for oral prevention in childhood—a current opinion

Paddy Fleming<sup>1,2</sup> 

## Abstract

Dental caries in young children remains a public health problem particularly for children whose families are socioeconomically deprived. A child's first dental visit should be at approximately 12 months of age and this should facilitate the provision of anticipatory guidance concerning oral health and dental development to the child's parents/guardians. Compliance with dietary advice is of key importance and motivational interviewing shows promise in relation to parents adopting good oral health practices for their children. Twice daily toothbrushing using toothpaste that contains in the range of 1000–1500ppmF is a most important preventive measure. It is important to use a minimal amount of toothpaste, insure that it is not swallowed, have parental or adult supervision during toothbrushing and avoid rinsing with water following brushing with toothpaste. The professional application of topical fluoride varnish twice yearly is a proven caries preventative measure. The application of pit and fissure sealants to teeth with deep pits and fissures is recommended.

**Keywords:** Oral health; Children; Dental caries; Prevention; Toothbrushing; Toothpaste; Fluoride; Infant feeding; Early childhood caries

## Review

### Introduction

Health may be defined as a state of complete physical, mental and social wellbeing and not merely the absence of disease [1]. Oral health is an essential component of general health and influences a person's quality of life. Children should enjoy a high standard of health, including oral health, but as children, they are dependent on adults for this. The dental health profession has a responsibility to advocate for optimum oral health for all children. A major component of this advocacy should concern the prevention of oral disease—the most common chronic disease in children being dental caries—and appropriate management of dental caries that has not been prevented.

### The problem of dental caries in young children

Dental caries is the most common chronic disease of childhood and may affect a child's quality of life due to various factors including pain, infection, sleep loss, absence from school with compromised education, poor mastication,

compromised appearance, and inadequate nutrition, growth and development. In industrialised countries, dental caries remains a significant public health problem. For example, the recently published national epidemiological study on the oral health of children in England, Wales and Northern Ireland reported that 31 % of 5-year-olds had obvious decay experience [2]. The average number of teeth affected (dmft) in those 5 year olds with decay was 3.0. A third (34 %) of 12-year-olds and 46 % of 15-year-olds had dental caries or had treatment provided for caries of their permanent teeth. The mean dmft in 12-year-olds with dental caries experience was 2.5. There was a strong and consistent relationship between levels of deprivation and severity or extent of decay—thus, there was a considerable burden of disease in socioeconomically deprived children who had dental caries. Similar results have been reported from epidemiological studies in other countries. In addition, because it is not feasible to record bitewing radiographs in large epidemiological studies, the number of carious teeth is likely an underestimate in many children. For very young children, data from the National Health and Nutrition Examination Survey (NHANES) in the USA, which was collected from 2011 to

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2012, showed that 23 % of pre-school children had experienced dental caries [3].

Dental treatment of carious primary teeth in children is very costly with further dental treatment being subsequently required in many young children who have had comprehensive dental treatment provided [4]. Dental caries or its treatment in the primary dentition is a strong predictor for future development of dental caries in the primary, mixed and permanent dentitions. It is therefore recommended that parents and parents-to-be should be informed, encouraged and hopefully motivated to prevent the development of dental caries in their infants and young children.

### Expectant mothers

Dentists may be invited to present information concerning oral health to expectant mothers during prenatal classes. Paediatric dentists need to be aware that oral pregnancy-related changes are most frequent and most marked in the gingival tissues. Pre-existing gingivitis, due to hormonal changes in the gingival vasculature, may become more severe and manifest as 'pregnancy gingivitis' with dark red, swollen, gingivae that bleed easily. A relationship between poor maternal, periodontal health and pre-term delivery has been reported and continues to be investigated. An increase in salivary levels of mutans streptococci may occur, possibly associated with increased frequency of snacking because of metabolic demands of pregnancy. The paediatric dentist should promote good maternal oral health during pregnancy and after delivery, with an emphasis on a good diet and good oral hygiene practices [5].

Information concerning infant oral growth and development, including eruption of primary teeth, should be provided. Advice should also be given concerning infant feeding and its potential relationship with early childhood caries. Salivary mutans streptococci may be transmitted from mother to infant and young children, during feeding, so advice should be given to avoid sharing feeding utensils when feeding infants and young children [6].

The presence of a dental professional at prenatal classes is likely to increase awareness within the general population, amongst medical colleagues and amongst opinion makers and decision makers of the importance of oral and dental health as part of general health. When an expectant mother attends a general dentist for her own dental care, preventive advice concerning future infant and child oral health should be given by the dentist or by a member of the dental team to the expectant mother as well as providing her dental treatment.

### The first dental visit by a child's first birthday

It is recommended that a baby's first dental visit should be at approximately 12 months of age. A 'baby visit' is a happy occasion in a dental practice with all staff

naturally delighted to see a little infant attend for an oral examination.

The oral examination is best undertaken using the 'knee-to-knee' approach, with the infant lying supine, supported by the parent on her/his lap, and the infant's head lying on the dentist's lap. A good light source, such as the dental operatory light, is essential for examination of the oral soft tissues, alveolar ridges, palate and any erupted or erupting teeth. The teeth should be dried with gauze or with a cotton roll or cotton bud in order to visualise any developmental anomalies such as enamel opacities or hypoplasia and also to detect indicators of dental caries such as biofilm (plaque) deposits, gingivitis, demineralised enamel or cavitation of teeth.

Anticipatory guidance in relation to a child's oral health is a term used to anticipate the next stage of growth and development of an infant or child and give guidance to parents concerning what they may expect and what practices they might undertake to benefit their infant's or child's oral health. This visit is a wonderful opportunity for the dentist and team to provide such guidance to the mother and/or parents and also allows the opportunity to discuss prevention of early childhood caries [7].

### Toothbrushing

Parents should use an appropriately sized toothbrush to commence tooth brushing as soon as their infant's first tooth erupts. Toothpastes that contain fluoride in the range 1000 to 1500 ppmF are effective but because of the small size of an infant and very young child, it is important that the paste is not ingested as this could put the developing teeth, including the permanent anterior teeth, at risk of fluorosis. Therefore, only a smear of toothpaste, 0.1 ml volume, the size of an uncooked grain of rice, should be used, making sure that none is swallowed.

Once a child reaches 3 years of age, the amount of toothpaste may be increased to the size of a small pea, 0.25 ml volume, but again it is important that this is not swallowed and toothbrushing should continue to be supervised by an adult throughout childhood. Children should be encouraged to spit out excess paste but not to rinse with water following brushing with toothpaste [8, 9].

High dose fluoride toothpastes, containing 2800 ppmF, are available on prescription in the UK and are recommended for twice daily use in children aged 10 years and over who are assessed to be at high risk of developing caries [9].

It is recommended that toothbrushing should take place last thing at night before bedtime and on at least one other occasion during the day. The duration of toothbrushing should exceed 1 min on each occasion, and eating directly after brushing should be avoided [8].

The gingivae associated with primary teeth in healthy infants and young children should be clean and pink

coloured even if the teeth are not brushed. If biofilm (plaque) deposits and/or gingivitis are present in a healthy infant or young child, the clinician must suspect the presence of high numbers of mutans streptococci associated with frequent ingestion of sugary drinks, juices, diluted juices or sugary foods and classify the child as at high caries risk.

#### **Feeding practices in infants and young children**

An infant or young child should never sleep or nap with a feeding bottle or a feeding cup containing formula feed, fortified feed, milk or sweetened fluid as this habit will likely lead to severe early childhood caries. Some parents find that the use of a bottle containing only water is helpful in weaning their child from use of a feeding bottle. Sweetened fluids, juices or diluted juices should not be taken at any time from a bottle. Juice may be taken from a feeding cup as part of a meal but at all other times, including at most meals, water or milk should be the drink of choice.

Breastfeeding is encouraged as the ideal form of feeding for young infants. However, in some instances, older infants with erupted teeth and some very young children will breastfeed frequently on demand throughout the night—putting their erupted teeth at high risk of developing caries. In such circumstances, there should be a discussion with the child's mother explaining the link between prolonged breastfeeding during sleep, when there is little or no salivary flow, in an infant or young child with teeth, and early childhood caries. If feasible, breastfeeding in older infants with erupted teeth and in very young children should be limited to short periods of time when they are awake.

The frequent use of juices, diluted juices and other sweetened fluids is often associated with early childhood caries, and dental erosion may also occur. The infant's mother/parents should be advised to follow their doctor's or paediatrician's advice and introduce savoury rather than sweet foods to their developing young child's diet, plan a practical balanced diet, and use water and milk as the main drinks. In older children and in adults, the frequent consumption of sweet drinks and juices may be associated with the development of unhealthy weight gain, obesity, dental caries and erosion [10, 11].

Sweet foods including honey and dried fruit, confectionary bars and biscuits should be limited to special occasions only. Sweet drinks and juices, including diluted juices, have added sugars and their use should be restricted, with water or milk being the main drink during the day and with most meals. The current guideline of the World Health Organization, in relation to dietary intake of sugars in both adults and children, strongly recommends a reduction in the intake of free sugars to less than 10 % of total energy intake [12]. Free sugars include monosaccharides

and disaccharides added to foods and beverages by the manufacturer, cook or consumer, and sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates.

Parental education and compliance with preventive advice concerning feeding may prevent the development of early childhood caries, allow remineralisation of any demineralised lesions and arrest the progress of cavitated lesions that may subsequently be treated restoratively or surgically. Motivational interviewing (MI) is a relatively recently developed, goal-oriented, client-centred counselling style for eliciting behaviour change by helping clients to explore and resolve ambivalence. Compared with non-directive counselling, it is more focused and goal-directed. There have been encouraging results from numerous studies that have used parent-involved motivational interviewing to improve paediatric oral health behaviour, but more studies are required to see if MI may predictably reduce dental caries in young children [13].

#### **Frequency of dental visits for young children**

Annual review appointments may be arranged for those infants who are judged to be at low risk of developing caries, and reassessment of caries risk should be made at each review appointment. If an infant or young child is judged to be at high risk of developing caries, then review appointments at four to six monthly intervals should be arranged to provide professional preventive treatment, including the application of topical fluoride varnish on at least a six-monthly basis, and operative dental care as appropriate. Once a child has experienced dental caries, then frequent review appointments will be necessary.

When assessing caries risk in a child, the following factors should be considered: clinical evidence of previous disease, dietary habits, especially frequency of sugary food and drink consumption, social history especially socioeconomic status, use of fluoride, plaque control, saliva and medical history [9]. There are various programmes/tools available to assess caries risk, but provided multiple factors are taken into account, it does not appear that one system is significantly better than another in predicting future caries activity.

Health care workers other than dentists, such as public health nurses, paediatricians and nursery school teachers who have frequent early contacts with infants and very young children, may also undertake caries risk assessments and refer children judged to be at high risk of developing caries to dental practitioners or specialist paediatric dentists. Public health programmes for very young children with supervised nursery school tooth-brushing have resulted in a reduction in dental caries in the west of Scotland [14], and preventive measures, including twice yearly topical application of fluoride

varnish by paediatricians, have been valuable for children in primary care settings in the USA [15].

Regular review visits allow the dentist and team to provide ongoing appropriate anticipatory guidance and dental health education to the parent/s or carers of the young child. There are also likely positive psychological benefits for the child who attends for frequent non-invasive dental visits, in keeping with the latent inhibition hypothesis proposed by Davey [16]. Frequent non-threatening visits are thus likely to protect the young child from developing anxiety or fear following a potential future invasive dental procedure such as a dental extraction [17].

### Preventive dental procedures

Early diagnosis and intervention is necessary to prevent the development and rapid progression of dental caries in children. The professional application of topical fluoride varnish (22,600 ppmF) twice yearly in children has been shown to significantly reduce caries in primary and in permanent teeth, and the current SIGN guideline concerning dental interventions to prevent caries in children recommends this for all children in Scotland [9]. This recommendation may not be possible to implement for all children in other countries, but it should be implemented for children who are at high risk for dental caries.

In high-risk caries children, glass ionomer or resin pit and fissure sealants may be placed on the occlusal surfaces of primary molars that have deep fissure patterns—these sealants may be replaced at review visits if the sealants are no longer present and if the teeth are not carious.

Erupting or recently erupted permanent first molars that have deep pits and fissures are at risk of developing caries because of their anatomical configuration. Pit and fissure sealants, ideally resin sealants, should be used to prevent the development of carious lesions in such teeth in all children and should be placed as soon as possible following eruption of these teeth. In some children, it may not be feasible to achieve adequate moisture control for placement of resin sealants on recently erupted permanent first molars. In such cases, the placement of glass ionomer sealants, as an interim measure until the child is older, may be undertaken, and these sealants may be replaced if noted to be no longer present but without caries, at review visits [18, 19]. Resin sealants, when placed, also need to be evaluated at review visits and if no longer present will need to be replaced unless there is a carious cavity that requires restoration. The erupting permanent second molars in older children should be treated in a similar preventive manner.

The maxillary permanent incisors, particularly the lateral incisors, may have deep palatal pits. Periapical radiographs and sensibility tests should be recorded if dens invaginatus lesions are suspected. Fissure sealants using standard unfilled resin or using flowable composite should

be undertaken as soon as possible after eruption because the dental hard tissues at the bottom of the invagination may be very porous and close to the pulp. Further restorative and/or pulpal therapy may be undertaken later.

Examination of the interproximal surfaces of primary and permanent teeth that have closed contacts is best undertaken with bitewing radiographs. In very young children or in children who find it difficult to accept horizontal bitewing radiographs, the placement of the smallest size dental film (size 0) vertically with the child biting on a holder allows for more space as the teeth are not in occlusion and the film does not extend as far posteriorly as the traditional horizontally positioned films. The frequency of recording bitewing radiographs is determined by the caries risk—if this is high, then bitewing radiographs may need to be recorded as frequently as on a yearly basis while children with a low caries risk may have bitewings every 3–4 years as the dentition develops at 5, at 8–9 and at 12–14 years of age. The EAPD guidelines on dental radiography in children give very helpful guidance in relation to this [20].

Early diagnosis allows conservative tooth preparations for restoration of carious cavities with composite resin or glass ionomer tooth coloured materials. If aesthetics is not a concern, preformed metal crowns may be used with traditional tooth preparation and rubber dam isolation under local analgesia or the Hall technique may be used with larger sized crowns selected because there is no tooth preparation. Multi-surface or very extensive lesions in primary molars are best treated with preformed metal crowns because recurrent caries of teeth restored with these crowns do not occur and these restorations will last, without requiring further treatment, until the primary molars spontaneously exfoliate.

### Conclusions

Dental caries in young children remains a public health problem particularly for children whose families are socio-economically deprived. A child's first dental visit should be at approximately 12 months of age, and this should facilitate the provision of anticipatory guidance concerning oral health and dental development to the child's parents/guardians. Compliance with dietary advice is of key importance, and motivational interviewing shows promise in relation to parents adopting good oral health practices for their children.

Twice daily toothbrushing using toothpaste that contains fluoride in the range of 1000–1500 ppmF is a most important preventive measure. It is important to use a minimal amount of toothpaste, insure that it is not swallowed, have parental or adult supervision during toothbrushing and avoid rinsing with water following brushing with toothpaste. The professional application of topical fluoride varnish twice yearly is a proven caries preventative measure.

The application of pit and fissure sealants to teeth with deep pits and fissures is recommended. Glass ionomer may be used as a transitional sealant material if moisture control is not feasible in a young child or in a partially erupted tooth. A resin sealant may be applied at a subsequent visit when moisture control is possible.

#### Competing interests

The author declares that he has no competing interests.

Received: 7 August 2015 Accepted: 13 August 2015

Published online: 26 August 2015

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RESEARCH

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# Timetable for oral prevention in childhood—developing dentition and oral habits: a current opinion

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## Abstract

As most of the etiologic factors of malocclusion are of genetic origin and thus cannot be prevented, environmental causative factors have become the focus for correction. Early interception of oral habits may be an important step in order to prevent occlusal disturbances in children. The identification of an abnormal habit and the assessment of its potential immediate and long-term effects on the dentition and potentially on the craniofacial complex should be made at an early stage. This paper focuses on the most common oral habits influencing dentofacial growth in childhood and management of these habits in the developing dentition.

## Background

The correct development of a stable, functional, and aesthetically acceptable occlusion is an integral component of comprehensive oral health care for all paediatric dental patients. Early diagnosis and successful treatment of developing malocclusion is pivotal in the development of occlusal harmony and function and dentofacial aesthetics [1, 2]. Dentists have the responsibility to recognize, diagnose, and manage or refer abnormalities in the developing dentition [3–5]. As most of the etiologic factors of malocclusion are of genetic origin and thus cannot be prevented, environmental aetiological factors may be the focus of attention. In this context, the early interception of oral habits may be integral in preventing occlusal disturbances [6–9].

## Clinical oral examination

The first oral examination is recommended at the time of the eruption of the first tooth and no later than 12 months of age [10–15]. The initial oral examination is best undertaken using the “knee-to-knee” approach, with the infant lying supine, supported by the parent on her/his lap, and the infant’s head lying on the dentist’s lap. A good light source, such as the dental operatory light, is essential for examination of the oral soft tissues,

alveolar ridges, palate, and any erupted or erupting teeth. This visit represents an opportunity to discuss with the parents and caregivers the prevention of occlusal disturbances and about the importance to intercept oral habits. The developing dentition and occlusion should be monitored throughout eruption at regular clinical examinations [10–15].

## Oral habits

The habits of non-nutritive sucking, finger-sucking, tongue thrust swallow, and abnormal tongue position are the most common factors influencing dental development and potentially facial growth in childhood. The relationship between oral habits and unfavourable dental and facial development is associational rather than purely cause and effect [11, 14, 15]. Habits of sufficient frequency, duration, and intensity may be associated with dentoalveolar or skeletal deformations such as increased overjet, reduced overbite, posterior crossbite, or increased facial height. The duration of force is more important than its magnitude; the resting pressure from the lips, cheeks, and tongue has the greatest impact on tooth position, as these forces are maintained most of the time [11, 14, 16]. Non-nutritive sucking behaviours are considered normal in infants and young children. Prolonged non-nutritive sucking habits, however, have been associated with decreased maxillary arch width, increased overjet, decreased overbite, anterior open bite, and posterior crossbite [17]. According to Warren [18],

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there are significant differences in dental arch and occlusal relationships in pacifier users at 24 and 36 months compared with those that had stopped sucking by 12 months [15, 18]. Moreover, by age 2 to 5 years, a significant increase in overjet (>4 mm), open bite, and posterior crossbite in pacifier users was observed [17, 19].

### Principles of management

The frequency, duration, and intensity of the habit should be evaluated with identification of potentially harmful habits made as early as possible. Intervention to lead to habit cessation should be initiated if indicated [11, 17]. Both the Canadian Dental Association (CDA) and the American Dental Association (ADA) have similar guidelines on the appropriate use of pacifiers [17, 20]; more protracted use leads to a stronger association. The CDA recommends pacifiers over thumb sucking because it is easier for a parent to control the sucking habit. They advise against putting sugar, honey, or corn syrup on a soother because of the risk of caries induction and caution that a sucking habit should stop before the permanent teeth erupt. The ADA also advises parents who choose to use a pacifier to use a clean, unsweetened one. They state that although prolonged use can harm the teeth, it is easier to wean a child's sucking habit from a pacifier than from a thumb [17, 21]. Early dental visits allow anticipatory guidance to help children to stop sucking habits by age 36 months or younger.

According to Italian Ministerial Guidelines [22, 23], it is recommended to encourage breastfeeding, in order to promote more normal jaw development. In fact, proper labial and lingual posture, adequate nasal breathing, and correct transverse diameter of the palate are related to natural breastfeeding. Artificial feeding may promote malocclusion, when combined with non-nutritive sucking or with rhinitis; in fact, bottle-fed children can develop sucking habits more frequently than others. Non-nutritive sucking, together with allergic rhinitis, seems to be the most important factor for the development of a posterior crossbite in children under 5 years [22, 23]. It is also recommended to discourage non-nutritive sucking at 2 years of age, in order to definitively stop the habit by 3 years of age. Beyond 3 years, non-nutritive sucking is implicated in malocclusions, such as anterior open bite, posterior crossbite, and Class II molar relationship. It is also recommended to monitor patients with low posture of the tongue and mouth breathing, in order to prevent dental open bite and excessive mandibular growth. Tongue thrusting and an abnormal tongue position may be associated with anterior open bite, speech difficulties, and anterior protrusion of the upper incisors [22, 23].

Research on the relationship between malocclusion and mouth breathing suggests that impaired nasal respiration may contribute to the development of increased

facial height, anterior open bite, increased overjet, and narrow palate, although it is not the sole or even the major cause of these conditions [11, 24]. Mouth breathing children often present with skeletal II discrepancies, with transverse maxillary constriction, increased anterior facial height, and obtuse mandibular-maxillary planes angle. These findings may relate to the inferior tongue posture and hypotonia of facial muscles associated with mouth breathing [11, 24–26].

Management of an oral habit is indicated whenever the habit is associated with unfavourable dentofacial development or adverse effects on overall wellbeing or where there is a reasonable indication that the oral habit will result in unfavourable sequelae in the developing permanent dentition. Any treatment must be appropriate for the child's development, comprehension, and ability to co-operate.

Habit treatment modalities include patient/parent counselling, behaviour modification techniques, myofunctional therapy, appliance therapy, or referral to other providers including, but not limited to, orthodontists, psychologists, myofunctional therapists, or otolaryngologists. Use of an appliance to manage oral habits is indicated only when the child wants to stop the habit and would benefit from a reminder [11]. Patients and their parents or caregivers should be informed regarding consequences of an oral habit. Parents may play a negative role in the correction of an oral habit as nagging or punishment may result in an increase in habit behaviours; change in the home environment may be necessary before a habit can be overcome.

### Competing interests

The authors declare that they have no competing interests.

### Authors' contributions

AM conceived the study and revised the manuscript. EB drafted the manuscript. FA helped to draft the manuscript. GC revised the manuscript. AP revised the manuscript for intellectual content. All authors read and approved the final manuscript.

### Disclosure statement

All authors disclose any financial and personal relationship with other people or organizations that could influence their work.

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Received: 24 September 2015 Accepted: 9 October 2015

Published online: 02 November 2015

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REVIEW

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# The role of rapid maxillary expansion in the promotion of oral and general health

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## Abstract

Rapid maxillary expansion (RME) is an effective orthopedic procedure that can be used to address problems concerned with the growth of the midface. This procedure also may produce positive side effects on the general health of the patient. The aim of the present consensus paper was to identify and evaluate studies on the changes in airway dimensions and muscular function produced by RME in growing patients. A total of 331 references were retrieved from a database search (PubMed). The widening of the nasal cavity base after midpalatal suture opening in growing patients allows the reduction in nasal airway resistance with an improvement of the respiratory pattern. The effects of RME on the upper airway, however, have been described as limited and local, and these effects become diminished farther down the airway, possibly as a result of soft-tissue adaptation. Moreover, limited information is available about the long-term stability of the airway changes produced by RME. Several studies have shown that maxillary constriction may play a role in the etiology of more severe breathing disorders such as obstructive sleep apnea (OSA) in growing subjects. Early orthodontic treatment with RME is able to reduce the symptoms of OSA and improve polysomnographic variables. Finally, early orthopedic treatment with RME also is beneficial to avoid the development of facial skeletal asymmetry resulting from functional crossbites that otherwise may lead to functional and structural disorders of the stomatognathic system later in life.

**Keywords:** Dentofacial orthopedics; Rapid maxillary expansion; Oral health; General health; OSAS; Breathing disorders; Muscle activity

## Review

### Introduction

Dentofacial orthopedic treatment, in particular rapid maxillary expansion (RME), is indicated for a wide variety of clinical conditions routinely faced by the orthodontist [1]. Frequently observed morphological problems involve an underdevelopment of the midface, which can be manifested by a constricted high-arched palate and poor transverse and/or sagittal maxillary growth [2].

Maxillary constriction can be associated with several problems that include occlusal disharmony and esthetics as well as such functional difficulties as narrowing of the pharyngeal airway, increased nasal resistance,

and alterations in tongue posture, resulting in retro-glossal airway narrowing and mouth breathing [3–5].

RME is an effective orthopedic procedure that has been used routinely in growing patients for over half a century. The goal of RME is to open the midpalatal suture, providing appropriate and stable maxillary width increase [6, 7]. Because of various positive side effects on the patient's general health, the number of indications for RME has grown dramatically over the years.

Although this therapy is carried out to correct dental and skeletal maxillary transverse discrepancies, some investigators have shown that treatment outcomes also could involve increasing nasopharyngeal airway dimensions, leading to improved nasal breathing [8–10]. Constricted airways are thought to play a potential role in the pathophysiology of obstructive sleep apnea (OSA), a common health problem that if left untreated may have a deleterious impact on neurocognitive and behavioral

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outcomes, physical development, and cardiovascular health [11].

Traditionally, studies on the changes in upper airway dimensions have consisted of analyzing the RME post-treatment effects with two-dimensional (2D) cephalometric radiographs. Recently, the reduction in radiation dose obtained with cone beam computed tomography (CBCT) and low-dose multislice computed tomography (CT) has allowed the development of software capable of computing nasal airway volume [12].

Airway changes induced by RME treatment have been studied by means of functional examinations such as rhinomanometry (a standard diagnostic tool used to evaluate the respiratory function of the nose objectively) and acoustic rhinometry (a new technique that evaluates nasal obstruction by analyzing the reflections of a sound pulse introduced via the nostrils). These diagnostic procedures indicate a significant decrease in nasal airway resistance with consequent improvement in nasal breathing [13–15].

Polysomnography (PSG), commonly referred to as a “sleep study,” is considered the gold standard for diagnosing conditions such as obstructive sleep apnea. This diagnostic regimen provides various quantitative parameters to evaluate respiratory function such as oxygen saturation and Apnea–Hypopnea Index (AHI) [16].

Other diagnostic tools also have been introduced in orthodontics, such as electromyography (EMG), which is used to analyze the activity of the masticatory and facial muscles. EMG, a simple method of detecting and registering electric activity of muscle fibers, has been shown to have good reproducibility [17, 18].

The aim of our consensus paper was to identify and qualify the evidence of reports evaluating changes in

airway dimensions and muscular function in patients treated with RME during the growth period. Studies using radiography, CBCT, magnetic resonance imaging (MRI), PSG, EMG, and ultrasound (US) were considered for this purpose. The focused questions were the following: What are the effects of RME therapy on airways, nasal cavity, and breathing function? Are these changes stable in the long term? Do children undergoing RME therapy to correct a transverse discrepancy have any long-term benefit in muscular activity?

**Search methodology**

In order to identify relevant studies about the impact of RME on a child’s general health, a computerized database search was conducted using the Medline database (Medline/PubMed). The search covered the period up to March 2015. The terms used in the search were “rapid palatal or maxillary expansion” in combination with “general health,” “oral health,” “breathing,” “OSAS,” “facial musculature,” “muscle activity,” and “chewing” (Table 1). A total of 331 references were retrieved from the database search. Among them, 44 duplicate references were found.

For the full articles to be selected from the abstracts, they had to satisfy the following inclusion criteria: human-controlled clinical trial; growing subjects; and the use of radiography, CT, CBCT, MRI, PSG, EMG, or US to measure changes in airways, breathing, and musculature functions. The exclusion criteria were surgical expansion or other simultaneous treatment during the active expansion phase as well as systemically compromised subjects or cleft subjects.

The initial selection excluded all titles and abstracts not related to the topic or that involved any exclusion

**Table 1** Search strategy

Search	Query	Items found
#14	(rapid palatal expansion) AND chewing	7
#13	(rapid maxillary expansion) AND chewing	8
#12	(rapid palatal expansion) AND muscle activity	3
#11	(rapid maxillary expansion) AND muscle activity	4
#10	(rapid palatal expansion) AND facial musculature	1
#9	(rapid maxillary expansion) AND facial musculature	1
#8	(rapid palatal expansion) AND OSAS	9
#7	(rapid maxillary expansion) AND OSAS	14
#6	(rapid palatal expansion) AND breathing	88
#5	(rapid maxillary expansion) AND breathing	105
#4	(rapid palatal expansion) AND oral health	27
#3	(rapid maxillary expansion) AND oral health	29
#2	(rapid palatal expansion) AND general health	4
#1	(rapid maxillary expansion) AND general health	4

criteria. Theses, author opinion, annals, and case reports also were excluded. If the abstract contained insufficient information for a decision concerning inclusion or exclusion, the full article was obtained and reviewed before a final decision was made. Titles with no abstract available that suggested a relationship to the objectives of this review were selected to screen the full text. The reference lists of the retrieved articles also were hand searched for additional relevant publications that could have been missed in the databases.

### Airways and breathing function

Maxillary transverse deficiency is a common skeletal problem in the craniofacial region, and it is often found in children with abnormal breathing [19, 20].

According to the functional matrix theory of Moss [21, 22], only nasal breathing allows proper growth of the dentofacial complex. This theory is based on the principle that normal nasal respiratory activity influences the development of craniofacial structures, favoring their harmonious growth by adequately interacting with mastication and swallowing. Lione et al. [23] reported that prolonged mouth breathing in growing subjects influenced the development of a different palatal morphology, with a narrower and higher palatal vault compared to subjects with a nose-breathing pattern.

In recent years, there has been a growing interest in the use of three-dimensional methods of investigation such as CT and CBCT scans to evaluate the transverse effects of RME in prepubertal subjects. Podesser et al. [24], Ballanti et al. [25], Garrett et al. [26], and Palaisa et al. [27] found a mean value of expansion of the nasal cavity of 1.5 mm following RME. These findings demonstrated that the dimensional increase of the nasal cavity on the transverse plane was not limited to the anterior region, but it extended to the posterior region as well [24–27]. A systematic review by Baratieri and co-workers [7] on the skeletal effects after RME found that when the midpalatal suture is opened in growing patients, the widening of the nasal cavity is stable over the long term.

It is well accepted that the lateral displacement of the nasal cavity also is associated with an enlargement (opening) of the upper airway. Tecco et al. [28] observed that the RME group with a mean age of 8 years had a significant increase in nasopharyngeal airway dimension (5.3 mm) compared with a matched control group (1.2 mm). This airway improvement occurred 6 months after RME and remained stable at a 12-month follow-up examination. The clinical significance of these findings is that RME causes decreased nasal airway resistance, which results in a reduction of head elevation and suggesting improvement in nasal breathing [28]. In growing patients with maxillary constriction treated with RME, Ribeiro et al. [29], Smith et al. [30], Chang et al. [31],

Zeng and Gao [32], and Hakan and Palomo [33] observed dimensional changes of the upper airway as assessed by means of CBCT. An increased cross-sectional area immediately posterior to the hard palate was found. The effect of RME on the upper airway was limited and local; it diminished farther down the airway, possibly as a result of soft-tissue adaptation [29–33].

The examination of the upper airway plays an important role in the evaluation of the growth and general health of subjects with breathing disorders. Because of the great complexity of airway anatomy and function, several measurement methods have been proposed. These methods can complement each other in the assessment of changes in breathing function after RME [2, 34].

De Felippe et al. [19], by means of 3D morphometric analysis and of acoustic rhinometry evaluation under basal conditions, found an increase in the minimal cross-sectional area of the nasal cavity, concomitant with a 34 % reduction in nasal airway resistance immediately after RME. These authors also observed stability of the results in a long-term follow-up (60 months after RME), with values comparable to those of subjects with normal nasal breathing conditions [19].

Enoki et al. [35] evaluated the effects of RME on the nasal cavity in 29 children and compared computed rhinomanometric values before, immediately after, and 90 days after RME. Their results showed no significant difference for the minimal cross-sectional airway at the level of the nasal valve. Nevertheless, despite the absence of minimal cross-sectional airway changes, the computed rhinomanometry found a progressive decrease in the inspiration and expiration resistances, reaching statistical difference from before RME to 90 days after RME. These findings indicate that the benefits of RME might be a modest functional improvement based on bony expansion rather than a mucosal dimensional change [35].

Iwasaki et al. [36] used CBCT and computational fluid dynamics to estimate the effects of RME on nasal airflow function (pressure and velocity) in 22 subjects with a mean age of 9.10 years without morphologic obstruction. In 18 patients undergoing expansion, the pressure and velocity of nasal ventilation after RME resulted significantly lower than before treatment indicating an improvement in nasal breathing [36].

Fastuca et al. [37, 38] evaluated changes in airway volumes and respiratory performance in 15 patients with a mean age of 7.5 years undergoing RME to determine whether any correlations exist between the morphological and respiratory functional modifications. On CBCT, the airway regions were segmented and the volumes were computed to detect variations after the removal of the maxillary expander 12 months later. The multiple logistic regressions showed that the more a subject presented with a reduced nasal volume in the

middle and lower compartments, the more he or she would benefit from RME in terms of improved oxygen saturation.

The Apnea–Hypopnea Index (AHI) can be used to indicate the severity of sleep apnea. Evaluating AHI as a secondary outcome, Fastuca et al. [38] found an improvement in the index with a reduction in apneic events of 4.2 per hour. Not only the upper and nasal airways but also the middle and lower airway compartments underwent significant volume increases. Such increases were greater for the nasal cavity and slightly lower for the middle and lower compartments [38].

### **Obstructive sleep apnea**

Several studies have shown that maxillary constriction may play a role in the etiology of more severe breathing disorders such as obstructive sleep apnea (OSA) in growing subjects [3, 11]. OSA is a condition characterized by the episodic cessation of breathing during sleep. An examination of the causes of apnea has produced several classifications for this condition. Apnea secondary to sleep-induced obstruction of the upper airway and combined with simultaneous respiratory efforts is the most common type; it has been classified as obstructive sleep apnea syndrome (OSAS).

OSAS results in oxygen desaturation and arousal from sleep, thus bringing several signs and symptoms related to oxygen desaturation and sleep fragmentation [39]. Impaired sleep quality leads to excessive daytime sleepiness, deterioration of memory and judgment, altered personality, and reduced concentration. Growth hormone is produced during slow-wave sleep, and its secretion may be interrupted by fragmented sleep. The increase in effort for breathing to overcome obstruction and its consequent calorie demand are a further mechanism by which OSA impacts growth. Moreover, the reduced blood oxygen saturation may give rise to hypertension, cardiac arrhythmia, nocturnal angina, and myocardial ischemia [40].

Under physiological conditions, the nose accounts for 50 % of respiratory resistance. Nasal obstruction related to both anatomical–structural and functional causes is an important risk factor for OSAS. Reducing nasal resistance, therefore, is one of the main objectives of therapy with RME. By widening the palate, RME increases the volume of the nasal and buccal cavities, thus helping to reduce nasal resistance [41, 42].

Several investigators have analyzed growing patients from 6 to 13 years of age with oral breathing, snoring, and nighttime apnea history treated with RME. These studies have demonstrated that at the end of orthopedic treatment, RME was effective in children affected by OSAS without any other obvious obstruction of the

upper respiratory airways. RME therapy widened the nasal fossae and released the septum, thus restoring normal nasal airflow with the disappearance of obstructive sleep disordered breathing [43–45].

Marino et al. [46] evaluated the effects of RME in a group of 15 OSAS preschool children after a mean period of 1.5 years. These investigators found that at the end of the overall observation period, approximately half of the patients demonstrated an improvement of the Respiratory Disturbance Index (RDI). The RDI reflects the average number of apneas plus hypopneas observed per hour of sleep; it usually is obtained by identifying and manually counting each respiratory disturbance with subsequent division of the sum by the number of hours slept [47].

The use of RME to enhance respiratory function was more effective in OSAS children with bimaxillary retrusion. Maxillary retrusion has been suggested to constrict the upper airway including the nasal cavity and velopharynx and affect airway size or ventilation [46].

Over a 36-month follow-up period, Villa et al. [48] observed subjects between 4 and 11 years old with clinical signs of malocclusion (all presented with a high, narrow palate associated with deep bite, retrusive bite, or cross-bite). The subjects also had signs and symptoms of OSA, including habitual snoring, apneas, and restless sleep witnessed by parents. They were characterized by an obstructive apnea/hypopnea index  $>1$  proven by laboratory polysomnography; the parents of these children had refused adenotonsillectomy as a treatment alternative. Early orthodontic treatment with an RME in these children resulted in reduced symptoms of OSAS and improved polysomnographic variables. In 10 of the 14 patients who completed treatment (71 %), the symptoms of OSAS regressed, and in 79 % of treated patients, the AHI decreased significantly. In all patients, the oral breathing disappeared after orthopedic therapy because of the enlarged space available for the adenoids and tonsils [48].

Pirelli et al. [49] evaluated the long-term efficacy of RME in 23 individuals followed up for 12 years from an initial sample of 31 children. At baseline the subjects presented with a mean age of 8.7 years, OSA diagnosis, maxillary contraction, and absence of enlarged adenotonsils [49].

Guilleminault et al. [45] conducted a clinical trial of 31 children with a mean age of 6.5 years who had been diagnosed with OSAS based on clinical signs and symptoms and who had undergone a sleep study. They were randomized into two groups: group 1 received adenotonsillectomy followed by orthodontics, while group 2 received orthodontics followed by surgery. The authors reported that there was no significant difference between the group beginning with orthodontic treatment and the one beginning with surgical treatment after the first

intervention. Most children, however, needed both treatments to have complete resolution of their symptoms and normalization of PSG [45].

### Muscle activity

It is well accepted that occlusal factors may influence and cause functional disturbances of the masticatory system [50]. In particular, maxillary constriction and functional unilateral posterior crossbite have been shown to be associated with temporomandibular disorders and altered muscle function. The diagnosis of “functional crossbite” is based on the presence of a mandibular shift from centric relation to an asymmetric intercuspal position. Patients with functional crossbites have symmetric mandibles that merely are positioned laterally [51].

Several investigators have demonstrated through tomographic evaluation asymmetric condylar position in centric occlusion in children with unilateral posterior crossbite, due to an anterior and inferior position of the condyle within the glenoid fossa on the non-crossbite side compared with that of the crossbite side [52–54]. During the growth period, continuous condylar displacement in the glenoid fossa induces differential growth of the condyles and of the mandibular ramus, leading to skeletal asymmetry [54].

The functional mandibular shift also is related with postural adjustments. EMG studies have shown that the activity of the temporal and masseter muscles in functional crossbite patients is disturbed [55]. The position of the mandible at rest is held by the viscoelastic properties of muscles and tendons that counterbalance the force of gravity. At rest, EMG activity should be minimal or completely absent [56].

De Rossi et al. [5] found that children with crossbite have EMG activity for all the masticatory muscles in rest position. This observation is due most likely to an increase in basal tonus in the stomatognathic system [5]. Children with functional crossbite have greater resting activity of the anterior temporalis muscle on the non-crossbite side and of the posterior temporalis muscle on the crossbite side when compared with healthy subjects [57].

The asymmetrical mandibular position induces different development of the elevator muscles on each side of the jaws leading to a thinner masseter muscle on the crossbite side, which already can be seen in the early mixed dentition [58]. Egermak-Eriksson [59] observed that individuals with crossbite more often chew unilaterally than those that had no crossbite. Ingervall and Thilander [60] found in children aged 8–12 years an abnormal chewing pattern (i.e., reverse sequencing), which was interpreted as an adaptation to avoid cuspal interferences. Chewing cycles are

similar to the pattern of patients with temporomandibular dysfunctions and different from the pattern of the subjects with normal bites. After the elimination of crossbites, cycles generally become more regular and symmetrical, comparable to those of patients with normal occlusion [60].

Thus, crossbite is a morphological malocclusion that seems to predispose to functional disturbances, which might be taken as indicating treatment as early as possible [58]. RME is considered the treatment of choice for functional crossbite because it eliminates the lateral functional mandibular shift, preventing the development of skeletal asymmetry and of muscle function disturbances [56, 59].

### Conclusions

RME is an effective orthopedic procedure used to treat structural and functional problems in the midface. Such treatment has been shown to have positive side effects on the general health of the patient. The widening of the nasal cavity base, found after midpalatal suture opening in growing patients, allows for the reduction in nasal airway resistance and improvement in the respiratory pattern. The significant improvement of the volume of the upper airway that remains stable in the long term suggests a fundamental role of dentofacial orthopedics in the treatment of not only maxillary constriction but also of constrictions of the nasopharyngeal spaces associated with oral breathing, snoring, and obstructive sleep apnea syndrome during childhood. The effects of RME on the upper airway, however, have been described as limited and local, and they diminished farther down the airway, possibly as a result of soft-tissue adaptation. Moreover, very limited information is available about the long-term stability of the airway changes produced by RME. Several studies have shown that RME can be beneficial in the treatment of maxillary constriction associated with more severe breathing disorders such as obstructive sleep apnea (OSA) in growing subjects.

Early orthopedic treatment with RME also is beneficial in avoiding the development of facial skeletal asymmetry that may lead to both functional and structural imbalances in growing patients. If left uncorrected, such a functional shift may lead to the development of temporomandibular disorders and other related conditions later in life.

### Competing interests

The authors declare that they have no competing interests.

### Authors' contributions

DMJAJr, DA: revised the manuscript critically for intellectual content. LR: acquisition of data, drafted the manuscript. FL: conception and design, drafted the manuscript. CLH, AF: acquisition of data, revised the manuscript critically for intellectual content. CP: conception and design, final approval of the version to be published. All authors read and approved the final manuscript.

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Received: 2 August 2015 Accepted: 20 September 2015

Published online: 07 October 2015

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# Revalidation and lifelong learning: a challenge for Europe and the goal of a better life

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## Abstract

Health education is the first and most effective form of prevention and, if properly implemented for all levels of the population, it can make a difference in terms of public health and in terms of lowering health care costs.

This proposal is to ensure the training and updating of every health care professional through CPD with a view to encouraging preventive health through healthier lifestyles for every individual.

Expo 2015 could be a stepping-stone for raising awareness of the importance of communication in influencing lifestyles. The theme of the exhibition is “feeding the planet”, which provides a basis for insights and the linkage of a topic close to everyone’s heart, that of food, and those of health and prevention.

## Introduction

For many years, Italy and all EU member states have been seeking common policies in the development and management of continuing education. Much progress has already been made and, especially in recent years, the key points have been outlined for the governing the Health professionals’ training<sup>1</sup>. Up to now postgraduate education has been entrusted to continuing education through which professionals can be kept constantly up-to-date throughout

their careers, while improving their knowledge in their own fields<sup>2</sup>. In every field of health there is a trend towards the emergence of hyper-specialised professionals who, thanks to continuous training, often achieve real excellence in their specific areas. This improvement in skills on the one hand may result in a loss of an overall view on the other. Continuing education is increasingly oriented towards improving specific skills and there is a risks that in the long run this could translate into an unwitting loss of broad brush stroke health promotion which could help prevention of systemic diseases in general<sup>3</sup>. There is an increasingly felt need to act at all levels of society to influence lifestyles and raise awareness towards of preventive health and health maintenance. A society can be seen as advanced and in a position to progress to the extent it is able to prevent rather than treat or cure. Such a situation can be achieved only if health care professional as a whole are trained in accordance with this as a policy direction. To implement prevention each and every must be trained or brought up to date on what it means to have a healthy lifestyle<sup>5</sup>.

Career health care professionals, whatever the particular field may be, are pushed to specialise in ways such that their very competence may cause them to lose sight of general care.

What emerged from the last ConsEuro Congress held in London in 2015 was the need to sensitise training management leaders to a more global view.

The current situation needs the concept of CPD

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(Continuous Professional Development) to develop an ethical content as professional is continuously updated. The professionals should always improve their skills with their patients at the heart of the matter so that the care provided is continuously improving and customised to individual needs<sup>6</sup>.

This must be seen as fundamental starting point and not as a point of arrival. Much work remains to be done in this respect.

## Review

The need to improve continuous training and Life Long Learning stems from a desire to promote health in a broader context and to ensure health care is effective at all levels. While it is useful for all professionals to train and refresh their training in their specific fields of excellence, they must also become health promoters in a wider sense during their careers in health care<sup>7</sup>.

This does not of course mean having to cease the pursuit of excellence, but it does mean that CPDs should be set up in ways health care professionals are able to promote health and good or healthier lifestyles<sup>8</sup>.

It has been seen that calls for healthier lifestyles from non-recognised or intangible sources is not effective in preventing or promoting certain behaviours. It is much more likely that an individual will follow advice and heed warnings from a person close to him or her that is recognised as influential and competent in this area. Such people are all those health care professionals who have a direct relationship with them and are able to influence behaviour and lifestyles and so induce patients to prevent before treatment becomes necessary<sup>9,10</sup>. As health care professionals have the potential to be a point of reference for the patient, and hence have the power to influence lifestyles, they must be continuously trained in this aspect. As a result the CPDs must most certainly provide the channels to ensure things more in this direction<sup>12</sup>.

## The new prevention

The concept of prevention is currently expanding to embrace broader connotations. It has ceased in recent years to relate only to action designed to prevent the onset of specific disease. Prevention has now acquired a global sense, with the aim of change lifestyles and thus the general onset of diseases<sup>12,13</sup>. Focus has shifted in terms of teaching good behaviours with regard to nutrition and daily activities. The implication is that lifestyle, from the early years of the individual's life, should be as healthy as possible so that diseases related to lifestyles and habits can be prevented. It is probably more effective to teach young people about the consequences of cigarette smoking on their general health than to try to persuade adults to stop smoking with warnings and shock tactics<sup>14</sup>. Health education is the first and most effective form of prevention and, if properly implemented throughout every level of the population it can make a difference in terms of public health and also of lowering the costs of care that are borne

by that same population. It is essential to continue to proceed further with this trend. The markets, in all their forms, illustrate the trend, including the use of smartphone applications that tell us what and how to eat and how to live a healthier life, apps that enable us to adjust calorie intake to our physical activity and workouts and apps that give instruction for and motivate daily exercise when time is limited. All this can be very effective and help effect changes for improved lifestyles of each individual who, with no particular effort, can start to engage in healthier behaviour for good preventive health<sup>15,16</sup>.

## Teaching for prevention - who and how

To change lifestyles and raise awareness of the need to do so it is fundamental that health care professionals teach this effectively. It is thus first essential to educate the health care professionals, each in his or her own field, in particular skills for the purpose. Skills development starts with initial training and follows on with continuing education, which should provide invaluable input for the health professional's whole working life<sup>17</sup>. The European Parliament has already stated its intent to this effect with Directive 2013/25/EU of May 2013, itself an amendment of EU Directive 2005/36 on the recognition of professional qualifications, and EU Regulation 1024/2012 on administrative cooperation through the Internal Market Information System, set January 18, 2016 as the deadline for all member states to show they are implementing CPD measures and improving the skills of their health care professionals. The CPD is set forth clearly as the process by which each health care professional should demonstrate the validation and implementation of their professional knowledge to provide good levels of care and service to patients. The title of Master is just a starting point for continuous building, through CPD, of a constantly up to date set of skills. The objectives of CPD are clear and fixed for the provision of professional accountability such that professional skills never fall below a certain standard and for the promotion of continuous improvement of the quality of care. CPD is regulated by the competent authorities designated by the governments of EU member states. CPD is both well established and essential, it is the basis for the upgrading of technical and professional education and the building of the career of the health professional (Long Life Learner). With its Directive 2013/25/EU of May 2013 the EU took first steps in raising awareness among EU member states to establish CPD courses for this training. Changes to the content of the CPDs would however be necessary with the inclusion of specific educational requirements aimed at producing health care professionals as proponents of a healthier lifestyle. This would only be possible by introducing the current proposals on Long Life Teaching skills in global health, prevention and professional standards and technologically-based communication skills<sup>18</sup>.

The EU Health Programme (2008-2013), in a contract for services with the Executive Agency of Health and

Consumers (EAHC) has at the request of the European Commission, produced a very detailed review in which the association for each specific association identified the educational requirements for vertical professions and the current state of the requirements for these health care professionals. The review shows the importance of CPD and Long Life Learning (LLL) as integral part of the health professions: “CPD and LLL help to ensure that professional practice is up-to-date, contributes to improving patient outcomes and increases public confidence in the professions, where the national interpretations of CPD offer rich scope for differing approaches and present opportunities for the identification of recommendations and best practices in the EU”. The obligations of health care professionals in terms of CPD are clear. The survey clearly defines the notion of Continuous Education in every field of each health field and particularly the Formal CPDs, Informal CPDs, Mandatory CPDs, Voluntary CPDs, revalidation and re-registration: which clarification provides a common language and common goals for Long Life Learning<sup>19</sup>.

Since it is possible to imagine evolution of the concept of CPD it can be seen that specific training can be given to all health care professionals in ways that make them the primary proponents of a Healthier Life Style. For this to happen the CPD training of must be of the highest quality/focus training on the promotion of health benefits. The result would be a reduction in costs for the management of public health, which should be spend less on treatment and more on encouraging individuals to adopt healthier lifestyles. Health care professionals need to be the primary representatives of such a movement and be properly trained and updated to fulfil this role.

It may need to establish obligations to fulfil these requirements in Europe, as the Directive 2013/25/EU of May 2013 has begun to do, calling on member states to demonstrate an adjustment in the field of continuing education. It will need to work in this direction to form figures that are now competitive in this area and to set up a training system able to certify and re-certify professionals in the quality of their knowledge and in general health promotion. The previously cited European Directive is just the first step on Life-Long Teaching (LLT) classification and a training programme has to be put into effect that will positively affect the entire population through the work of properly trained and updated professionals.

There is already a system of training and verification processes in place that are used by the member states of the EU to certify LLL, but the European Union believes that adherence of all countries to comparable quality standards is necessary, while it would be at the same time useful for all the CPDs to include training in the field of public health.

### Our proposal

It is clear that the trend in Europe with regard to LLL is to promote continuous training and the revalidation

of diplomas so that professionals are genuinely continuously updated and academic qualifications are constantly recertified. The result is a bolstering of health care professionals’ skills with a positive impact on the population at large. We believe that much can be done to facilitate and further improve this developing process<sup>20,21</sup>. An examination of LLT and LLL, it is clear that it is essential to establish a communication channel through all the information needed in education and training can be shared. This is also true for the transmission of fundamental concepts of health and prevention to patients who are have not had much personal experience of medical or health care. For health care professionals to be able to have a positive impact in promoting the health of the population, we believe it is appropriate that their LLL process is based not only on substantial content but also on the manner of communication and promotion of a healthier lifestyle. We believe therefore that CPD should also provide the means for conveying concepts learned during the continuous training so that these can be most effectively employed. Good communication is relevant to the ability to learn and to the following of advice<sup>22</sup>; horizontal persuasion rather than imposition of sterile concepts has proven more effective in changing the habits of individuals. This is in our view the focal point for this work and insist that to date health care professionals need to include bring communication skills into the lists of skills<sup>23,24</sup>. Good communication will help the professional interface with the public and bring the message of healthy living to the community while stressing its importance and generally raising awareness of the relationship between poor lifestyle and the onset of disease. This has to form the basis of effective prevention.

We would like to focus on health care professionals role in influencing and changing behaviours, particular for example as regards dietary habits. Before actual onset of bad nutrition relation illness, people should be educated to eating correctly as the basis for a healthy life. Each health professional has available knowledge that must be conveyed to patients, which can only be done by means of effective communication, which can be taught.

Expo 2015 should be a stepping-stone for conveying the importance of effective communication for influencing lifestyles. The theme of the exhibition is “feeding the planet” which provides opportunities for insight and to link the topic of food, which is dear to everyone’s heart, to the concepts of health and prevention.

This is a real opportunity for communication is since the topic is of universal interest in the community.

### Conclusions

In the light of the literature review and the strides in education in Europe in the last five years, we can say that there have been significant efforts made towards improvements. Acknowledgement in Europe of the need for continuing education in general care, while accepting

the trend towards hyper-specialisation and excellence, has been important and is very much needed for community health and prevention. The learning processes through which health care professionals acquire knowledge in general care need to be determined by EU member states and then validated.

The European Union, with the Directive 2013/25/EU of May 2013, required that each member state has to declare by 18 January 2016 that it has put in place measures to establish CPDs and continuing education procedures.

The scientific and professional associations have established precise classifications for revalidation and recertification and set forth their CPD requirements.

There are the bases for the establishment of an LLT, including general health care for each of the health professions in Europe. Health and prevention should be taught rather than imposed. Such awareness of healthier lifestyles is the best form of prevention as it induces people to put into effect healthier behaviours which not only prevents disease onset but also makes for the general well-being of the individual.

To raise health awareness, the professionals should be trained. They must not only have the knowledge but must also be communicate it to their patients in ways that will persuade them to engage in appropriate behaviour<sup>25</sup>.

We feel that the field of nutrition is where the ambitious process should start. Healthy behaviour for individual health should be encouraged by nutritional education<sup>26</sup>.

These ideas are very much of the moment and such media opportunities such as Expo 2015 should be taken and firmly grasped.

### Competing interests

The Authors disclose that they have neither financial nor personal relationship with people or organizations that could influence their work.

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# Answer to a still open question: Temporomandibular disorders and posture

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## Abstract

Even though research over the last two or three decades has confirmed the biopsychosocial nature of temporomandibular disorders (TMDs), their complex etiology and their generally benign prognosis, many dental practitioners still hold with the misconception that TMDs are monocausal. As a result they often continue to manage TMDs with occlusal therapies and even treat postural problems by occlusal means, assuming that there is a causal relationship between so-called “malocclusion” and problems of body posture and vice versa. This consensus paper briefly reviews the complex mechanisms regulating body posture, summarizes the most relevant literature on body posture and occlusion/TMDs and reviews the basic diagnostic knowledge required, so as to understand the need for validated diagnostic tests and determine when a relationship of causality is involved. The literature review shows that it is impossible to define an “ideal posture” in combination with an “ideal occlusion” and vice versa, that there is no biological plausibility for a pathologic interrelationship between occlusion and body posture, and that there is no evidence that stabilometric and/or posturographic tests have any diagnostic validity. Occlusal therapies cannot therefore be regarded as medically acceptable for the treatment of postural problems and conversely postural/physical therapies cannot be used to treat occlusal problems.

## Introduction

Research over the last three decades has answered many questions on temporomandibular disorders (TMDs). The RDC/TMD project provided validated criteria for the diagnosis of different forms of TMDs<sup>1</sup>, although their validity for the differential diagnosis of orofacial pain is still unclear. Magnetic resonance imaging has shed light on disc displacement disorders even though their etiology is still uncertain<sup>2</sup>. The project “Orofacial Pain: Prospective Evaluation and Risk Assessment” uncovered several risk factors for TMDs and confirmed the biopsychosocial nature of the disorders and their complex etiology. It is therefore meaningless to view TMDs as being monocausal or to consider that any single cause will be either necessary or sufficient<sup>3,4</sup>. Epidemiological and clinical studies have shown that TMDs often improve spontaneously and that in only around 10 to 15% of cases do they become chronic, as is indeed also the case with other musculoskeletal pain conditions such as lower back pain<sup>5</sup>. Lastly, randomized or quasi-randomized clinical trials have reported that all treatment methods are equally effective and that treatment success rate is not therapy specific but due to an interaction

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of confounding factors such as spontaneous remission, counseling and information, context effect, patient expectation and cognitive changes<sup>6</sup>.

Many dental practitioners unfortunately insist on their misconception that TMDs are monocausal and continue to manage TMDs with occlusal therapies. In addition, there has been trend to treat postural problems by occlusal means, assuming that there is a causal relationship between so-called “malocclusion” and problems related to body posture including musculoskeletal pain and vice versa. This trend has persisted despite the Consensus Document published in 2009 which reiterated that reversible and/or irreversible occlusal therapies are not justified for the treatment of postural problems and that physical and rehabilitation therapies are not justified for the treatment of occlusal problems<sup>7</sup>.

While in medicine an intervention must be justified by evidence-based data, those that adhere to this particular movement have based treatments on unvalidated posturologic or kinesiologic tests<sup>8,9</sup> and on their own clinical experience of body posture problems and musculoskeletal pain often disappearing after occlusal therapy. The observation that an occlusal therapy, the insertion of an occlusal appliance or a bite change to a position determined by postural tests leads to pain remission is considered by many dentists to be proof that an occlusal “wrong bite” correction is etiologically related to these conditions, since their removal is associated with the disappearance of the symptoms.

Inherent to the propensity to stay true to this clinical success is the risk of attributing external validity to one’s own clinical experience, to rely on expert opinion and conclude that if a treatment leads to clinical success it is because it removed the underlying cause. This thinking trap, known as “satisfaction of search” or “premature closure”, is a major cognitive error that is being introduced into the decision-making process. The clinician is satisfied with the first explanation or finding and thus fails to investigate further<sup>10-13</sup>. The cognitive error impedes the dentist from understanding that occlusal intervention is not just a “mechanical” action aimed at modifying the occlusion but is in fact a complex therapeutic procedure associated with other actions that greatly contribute to pain remission. These include the clinician’s speaking positively about the treatment, providing encouragement, developing trust and offering reassurance and a supportive relationship. Since the beliefs and expectations associated with a therapeutic procedure can mimic, enhance and mask the beneficial responses to pharmacological agents<sup>14</sup>, it is likely that they have the same effect also with non-pharmacological therapies.

As this consensus paper is as part of a scientific event taking place at Expo 2015 in Milan, the authors chose to address once more the topic of TMDs and body posture with the aim of warning both the scientific community and also laypersons against the use of invasive or irreversible therapies to manage these disorders. The motivation for the warning is both financial and ethical<sup>15</sup>, where the use of such therapies may

lead to the chronicity of the disorder with serious psychosocial and financial consequences for the patient.

### Body posture and motor control

A brief description of postural and motor control should be given in the consensus paper to emphasize the complexity of motor control.

While knowledge of motor control has significantly progressed in the last few decades, the mechanisms and strategies involved are far from being adequately understood. It is still a matter for discussion as to how the central nervous system (CNS) coordinates the co-contraction of about 600 muscles to maintain neuromuscular stability within certain ranges to control the degrees of freedom of more than 200 joints<sup>16</sup>.

The postural network not only assists in stabilizing the body in relation to gravity but also acts as an interface between motor action and perception while establishing a relationship between the body and the external world. Posture also reflects psychological conditions since posture is controlled also by the motor system’s emotional component<sup>17-19</sup>.

When a person is standing upright the CNS continuously corrects any mechanical perturbation with neuromuscular adjustments<sup>16</sup>. These perturbations may be simple in nature such as the daily reduction in body height from intervertebral disc compression<sup>20</sup>, liquid movements, cardiac and respiratory muscle contractions and muscle fatigue<sup>21</sup> or may be more complex such as when switching from high-heels into flat shoes, or vice versa, or on leaning forward to shake hands. Motor adaptations in response to pain also result in postural changes designed to protect injured tissues. Under such conditions, long lasting adaptations may have the potential to become structurally frozen, which might then result in future relapse due to biomechanical disadvantages<sup>22,23</sup>.

In order to maintain the equilibrium of the body the CNS integrates information from multiple sensory sources (e.g. visual, vestibular, and proprioceptive). This input is used to sense and correct any mismatch between the intended and the actual position. There are comprehensive models that seek to explain how the CNS programs a motor act, e.g. the internal reference model and the efference-copy model<sup>24,25</sup>. Unfortunately these provide only crude pictures of the actual neurobiological reality<sup>26</sup>.

Postural control is multivariate in nature, involving the many degrees of joint freedom (details in Kilby et al.<sup>27</sup>). The permanent balance re-establishment process<sup>21</sup> is regulated by partially innate and partially learned motor programs<sup>28</sup>. The innate ‘postural body scheme’ that provides an internal representation of the body geometry and the body orientation with respect to the gravitational axis is minimally affected by externally driven changes in sensory input such as gravity changes<sup>29,30</sup>. Learned motor programs enable body equilibrium to be maintained for example by anticipatory body position changes as well as by

activation of postural reactions in which a group of muscles contract together as a unit (postural synergies), and whose activation is adaptable to task-specific conditions<sup>31,32</sup>. In the early phase of automatic postural responses, peripheral sensory inputs trigger pre-set synergies. If the response is inadequate to recover postural equilibrium, the cortex intervenes to provide additional and voluntary postural adjustments, such as touching a wall or taking a step (details in Jacobs and Horak<sup>33</sup>). The postural response to a loss of equilibrium may thus be to step forwards or to put a hand out in front of the body and leaning against any support where there is one. These responses are context specific<sup>32-34</sup>.

### Narrative review on occlusion and body posture

There is a functional relationship between mandibular and craniocervical function<sup>35,36</sup>, where different occlusion types are often associated with different head positions<sup>37-41</sup> and where patients with myogenous TMDs often have comorbid neck disorders<sup>42</sup> although the relationship between TMDs and head and cervical posture remains controversial and unclear<sup>43,44</sup>. On the other hand, systematic reviews have concluded that the evidence for the hypothesis that experimental alterations of mandibular position may alter body posture is scanty due to the limited quality of the studies<sup>9,45-49</sup>.

Newer and better-designed investigations have confirmed that the effects of an experimental manipulation of the mandibular position on body posture and sway, or of the provocation of a leg length discrepancy on the masticatory system are inconsistent<sup>50-54</sup>. Biting on a 4 mm thick silicon panel positioned in different parts of the dental arch led to significant but not specific changes of the spine position when standing and walking, the alterations being independent of the silicon panel location<sup>50</sup>. A task unspecific alteration of body posture was observed also during symmetric and asymmetric clenching, both causing the same variations in body-sway behavior and the distribution of foot pressure in bipedal stance<sup>55</sup>. Additionally, although submaximum symmetric clenching reduced body sway behavior during bipedal and unipedal stance, it did not significantly alter the basic strategy of human posture control, neither the relative positions of the body segments<sup>56</sup> nor the joint angles or general muscular co-contraction pattern of the lower extremities<sup>57</sup>. Moreover, the introduction of a small occlusal interference in centric occlusion for two weeks did not lead to predictable changes in static or dynamic body posture<sup>58</sup>.

Wearing experimental insoles to alter body weight distribution over a two-week period did not significantly influence body posture, mandibular kinematics or the activity of masticatory muscles<sup>54</sup>. By contrast, the experimental application of thick insoles or wooden panels to elicit a large leg length discrepancy modified body posture and dental occlusion<sup>59,60</sup>. Interestingly, and supporting the unspecific effect of these manipulations, the

changes in mandibular position were recorded only for the position of the left condyle independently of the left-right position of the wooden panel<sup>60</sup>.

Stabilometry and/or posturography are used to differentiate between healthy subjects and patients with TMDs although a systematic review concluded that TMDs do not appear to be correlated to body sway at a clinically relevant level<sup>9</sup>. Studies published thereafter did not change this conclusion because the study quality remained low. A systematic review published one year later underlined once more the lack of evidence for a global body postural misalignment in patients with TMDs<sup>44</sup>. This is not surprising considering the large variation in body posture in the population<sup>61</sup>, a fact that may also be responsible for the contrasting observations and that makes it difficult, if not impossible, to draw conclusive common guidelines.

A discussion about the relationship between mandibular, head and body posture would be incomplete without considering the contribution of the vestibular system that encodes position and the movement of the head in three-dimensional space, establishing the link between one's own body representation and the outside world<sup>62</sup>. It is not surprising therefore that extensive and early convergence between vestibular and proprioceptive signals exists and that vestibular disorders may be associated with TMDs and vice versa. Patients with Ménière's disease, for example, have been shown to significantly differ in masticatory muscle activity during maximal voluntary clenching compared with healthy controls<sup>63</sup> and vestibular symptom relief occurred in these patients after TMD treatment<sup>64</sup>. Whether the existence of oligo- and polysynaptic pathways between the vestibular labyrinth and the jaw muscles (the so-called vestibulo-masseteric reflex)<sup>65</sup> can be taken as proof of a causal relation between these disorders remains however speculative. Importantly, it must be underlined that, similar to investigations on mandibular position and body posture, this literature is also limited and hence its significance remains controversial.

### Discussion

In addition to the lack of scientific evidence for pathophysiological interactions between posture deviations and painful musculoskeletal disorders of other body segments<sup>66</sup>, the observation that an alteration of mandibular position may lead to changes in head and body position also cannot be taken as a proof that the occlusion is "wrong" and must be corrected. On the contrary, the observation raises several questions. Firstly, are there predictable biomechanical interactions between the masticatory and the craniocervical structures? Secondly, do the statistically significant differences express body adaptation to alterations in the anatomy and sensory input or do they reflect clinically relevant changes? Thirdly, are the posturographic tests valid for the diagnosis of a pathological condition? Fourthly, is the altered body sway in patients with TMDs really caused by the TMDs?

As regards biomechanical interactions it seems very unlikely that neck muscle disorders can be triggered by predictable biomechanical interactions between the masticatory and craniocervical structures, just as it is illusory to assume the existence of pathological “muscular chain reactions”<sup>67</sup> from the masticatory system “downstream” to other body segments and vice versa. The neck musculature might even represent a kind of firewall against these interconnections, because the coupling between masticatory and neck muscles seems too weak to lead to a robust co-contraction and therefore to painful overloading of the neck muscles when performing submaximal clenches and vice versa<sup>68</sup>. Even bending and rotating the neck does not significantly influence jaw muscle activity during submaximal biting tasks<sup>69</sup>. The high comorbidity of TMDs and neck muscle pain can moreover hardly be explained by biomechanical interactions since submaximal clenching performed in the contraction range as may be expected during actual jaw clenching<sup>70,71</sup> leads only to very low level co-activation (ca. 10% MVC) of the neck muscles<sup>72</sup>. The comorbidity between masticatory and craniocervical and even lower back pain is likely to be due to central sensitization as previously hypothesized<sup>73</sup>. These and the above mentioned studies showing the non-specific reaction of body posture to experimental occlusal alterations contradict the hypothesis that the activity of the jaw muscles affects the kinematics and posture of distant joints or body segments via biomechanical fascial-muscle-chains.

An additional aspect of the discussion of coupling between the masticatory system and false posture is the assumption of symmetry within the different body segments. It is well-known there is no such thing as a symmetrical human body<sup>61</sup>. Anatomical asymmetry of all body segments should thus be regarded as physiological variations of the ideal, which is a man-made construct. Asymmetry dominates in the human body: handedness and footedness is associated with neuromuscular asymmetry from lateralized muscular differences<sup>74,75</sup>, asymmetric excitability of the motor system<sup>76</sup> and anatomical and functional cortical asymmetries<sup>77</sup>.

To be clinically relevant, alterations must be of a magnitude that exceeds the ability to adapt. To evaluate whether medical intervention may have clinical implications it is important to know the magnitude of change, e.g. the effect size. Statistical significance simply indicates the degree of probability that an observed difference is real, but not the strength of the phenomenon. Computation of the effect size of several tests analyzing whether a mandibular position change affects body posture revealed a very small effect, which is therefore unlikely to be clinically relevant<sup>49</sup>. A diagnostic test must be valid and reliable, e.g. must correctly diagnose the disease and allow clinicians to reach the same correct diagnosis consistently. It must moreover change the pre-test probability by significantly increasing the likelihood of acceptance or refutation of the working hypothesis. Tests that do not change pre-test

probability are unnecessary and give rise to needless costs. Unfortunately, to the best of our knowledge, the validity of the stabilometry and posturography tests (expressed by its sensitivity and specificity) has never been calculated. The analysis of the published data leads us to suppose that these values are low, making the test clinically useless. This is supported by the fact that the sensitivity and specificity of stabilometry for the diagnosis of even more complex neurological disorders is at best modest, demonstrating the limited clinical utility of these tests in the decision making process<sup>78-80</sup>. This is not surprising if we consider that body sway is often increased also in patients with several disorders that are often comorbid in TMDs patients, such as migraine with or without concomitant TMDs<sup>81</sup> even during pain free periods<sup>82</sup>, neck pain<sup>83</sup> and lower back pain<sup>84-87</sup>. In other words, body sway variations are not specific for one disease/disorder: patients with different disorders and/or diseases may show the same balance impairment and patients with the same disease/disorder may have different balance impairments<sup>78,88</sup>. TMDs are very often comorbid with headache, cervical and low back pain and, to the best of our knowledge, posturography studies did not specifically exclude patients with these comorbidities (see for example Ries et al.<sup>89</sup>). It is consequently impossible to accurately diagnose whether the “altered” body sway in the presence of a TMD is due to the TMD or to another comorbid condition or to both.

Stabilometry is influenced by several factors: sampling duration, habituation and first-trial effect, the presence of a visual fixation point, age, circadian rhythms, disease severity, and cognitive and emotional factors, particularly attention, mood, fear and anxiety, traits that are common to TMD patients<sup>78,90-93</sup>. In addition to this the degree of masticatory muscle contraction and of neck extension also influence body sway<sup>55,94</sup>. Lack of control of these variables may explain the results heterogeneity<sup>93</sup>. This is a hallmark of posturographic tests in general<sup>86,95</sup> and not only for TMDs, a fact that further adds to reducing the validity of this diagnostic test. In fact one of the prerequisites for an association to represent a cause-effect relationship is the consistency of the findings; the other requirements are strength, specificity, temporality, biological gradient, plausibility, coherence, experimental evidence and analogy<sup>96</sup>.

Finally, it is still unknown what body sway actually represents in clinical terms and there is no consensus as to whether sway is beneficial or unhelpful. Normative data on body sway in healthy individuals have been collected for men and women and for different age groups<sup>97</sup>. In the dental literature the recorded data are not however related to norm values. It thus remains clinically unclear whether a sway is “good” or “bad”. To further add to the controversial role of stabilometry as diagnostic aid, body sway did not always increase but sometimes even decreased in the presence of a disorder and body sway can be reduced even by just slightly touching the leg with the fingers<sup>98,99</sup>.

The CNS moreover activates the postural muscles only to the degree necessary to stabilize the upright stance and not to minimize body sway<sup>100</sup>.

The introductory remarks on the generally good prognosis for TMDs, on the non-specificity of the TMDs treatments and the arguments reviewed in this discussion clearly show that it is not ethical to treat occlusal problems to solve postural problems and vice versa. Indeed, medical intervention is indicated when: the medical condition (e.g. the occlusion) is recognized as a real health problem, the diagnostic tests are valid with good specificity and sensitivity; the patient's condition will worsen unless a therapy is applied that specifically addresses the patient's particular problem; the procedure is clinically efficacious according to evidence-based criteria, i.e., not just to a placebo effect, and the disease or disorder cannot be resolved by performing a less invasive procedure, so the invasiveness of the clinical procedure can be based on its benefit-to-risk ratio<sup>101</sup>.

## Conclusions

The present scientific literature shows there is high inter-individual variability and adaptability that makes it impossible to define an "ideal posture" in combination with an "ideal occlusion" and vice versa. Secondly there is a lack of biological plausibility for a pathologic interrelationship between occlusion and body posture. Thirdly, there are inconsistent findings from stabilometric and/or posturographic tests, and fourthly there is a lack of data on their diagnostic validity. Occlusal therapies cannot therefore be considered medically acceptable for the treatment of postural problems and conversely postural/physical therapies cannot be used to treat occlusal problems.

## Competing interests

The Authors disclose that they have neither financial nor personal relationship with people or organizations that could influence their work.

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# Development of the perio-focus green paper for stakeholder consultation on the impact of the global burden of periodontal disease on oral health, wellbeing and nutrition of mankind

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## Introduction

This report describes the development process and presents a draft report for the Milan World exhibition 2015: Feeding the Planet, Energy for Life, as well as illustrating the consultation stages leading to the finalization of a report calling for global action to better prevent, diagnose and manage periodontitis.

The rationale for the process stems from recent reports that have highlighted the enormous burden that severe periodontitis represents for mankind as a whole with more than 750 million people affected<sup>1</sup> and with severe periodontitis having a great impact in disability-adjusted life years relating to oral conditions as of 2010<sup>2</sup>. Periodontitis is a silent public health issue in many countries in both the industrialized world and in the developing countries. Current knowledge shows that periodontitis can however be effectively prevented, easily diagnosed in its earlier stages and effectively treated to preserve the dentition of the majority of the people for their lifetime.

Having been invited by the Italian Society of Orthodontics (SIDO) to take part at a global oral health event at EXPO Milan on October 30th 2015, a process was initiated to gather input from different geographic areas so as to produce a draft document on the current state of affairs as assessed by leading professional societies around the world. To this end, the Italian Society of Periodontology secured

input from the President of the European Federation of Periodontology, the President of the American Academy of Periodontology and the outgoing President of the Asian Pacific Society of Periodontology. The authors of this manuscript thus came up with a paper document covering the current epidemiology and public health relevance of periodontitis as well as identifying opportunities for action on three fronts: the prevention, diagnosis and treatment of periodontitis. The document aimed to generally formulate the issues to be applied to specific national scenarios and health systems. The following draft statements were put forward for current consultation by the relevant stakeholders.

## Opportunity 1 - Prevention

Specific preventive actions have been drawn up on the basis of the conclusions of the recent European Workshop of Periodontology on primary and secondary prevention of periodontal and peri-implant diseases<sup>3</sup>.

- Gingival bleeding is a leading risk factor for the onset and progression of periodontitis and is first sign of disease. Public health campaigns, professional information and oral health care products labeling should highlight this and encourage patients to seek professional care whenever gingival bleeding is present and persistent.
- Patient motivation paired with detailed instruction on the use of mechanical plaque control aids, such as brushing, interdental cleaning and oral rinsing, are key to the management of gingivitis and the prevention of periodontitis.
- Appropriate periodontal diagnosis and the assessment of patient risk factors and attitudes should determine the appropriate professional preventive care and treatment needs.
- There remains the need for universal implementation

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- of periodontal screening by oral health care teams.
  - Professional mechanical plaque removal is important but must not be the sole means of professional preventive care. Education and behavioural changes are essential for sustained improvements to periodontal health.
  - Professional preventive care alone is insufficient for patients with a clinical diagnosis of periodontitis or of peri-implantitis, as these first require treatment for their condition.
  - The public should be aware that self-medication with effective chemical plaque control agents may mask more serious underlying periodontal disease and so patients should seek professional advice following periodontal examination.
  - The long-term success of periodontal therapy requires participation in a secondary prevention program specifically designed to meet the needs of these individuals at higher risk of disease recurrence.
  - For optimal long-term tooth retention, patients participating in secondary prevention programs need an active periodontal therapy stage that will achieve individually set treatment goals.
- Improve public and professional awareness in relation to the standard of care of periodontitis in its different stages of severity.
  - Improve access to evidence-based treatment by addressing the incorrect perception that periodontitis can be effectively managed by self-care or self-medication with mouth rinses, toothpastes, herbal or homeopathic remedies, or by professional tooth cleaning alone.
  - Improve public and professional awareness on how improvements in oral health relate to the quality of life, in association with the treatment of periodontitis.
  - Improve public and professional awareness on personalized prognoses based on the specific patient profile and the stage of the disease.
  - Improve public and professional awareness of the consequences of incomplete periodontal treatment when indicated: the higher risk of the progression of periodontitis and tooth loss in the presence of incomplete outcomes from phase 1 periodontal treatment, as evidenced by the persistence of periodontal inflammation (bleeding on), deep periodontal pockets and furcation involvement.
  - Improve public and professional awareness of the inadequacy of limiting treatment of periodontitis to the delivery of preventive professional care alone.
  - Improve public and professional awareness of the role of dental implants as a part of the rehabilitation of masticatory dysfunction consequent upon stage-3 periodontitis and not as a way of treating periodontitis.
  - Improve public and professional awareness of the need for complete treatment of periodontitis before proceeding with tooth replacement with tooth or implant supported restorations.
  - Improve public and professional awareness of the advances periodontal treatment has made in recent decades with the consequence that periodontal prognosis has changed and that teeth with advanced disease may be saved such as, for example, with regenerative periodontal therapy.
  - Improve public and professional awareness of the interdependence between periodontal health and general health, and work towards the taking of action to address common risk factors such as smoking, nutrition, sedentary lifestyles and obesity, both as regards periodontitis and other chronic diseases.
  - Improve public and professional awareness of the potential dental care savings associated with the delivery of appropriate periodontal care.
  - Improve public and professional awareness of the potential medical care savings associated with the delivery of appropriate periodontal care in specific groups such as that of diabetics.

More information is reported in the consensus statements of the four workshop working groups<sup>4-7</sup>.

### Opportunity 2 - Diagnosis

Opportunities for early detection and diagnosis were based on a 3-stage process: diagnosis:

- Self-detection of symptoms and signs of disease by the patients, with the promotion of awareness and the need for a professional examination.
- Professional periodontal screening to segment the population into those with good periodontal health, those with gingivitis and those with periodontitis, coupled with preventive care for these conditions.
- Comprehensive periodontal examination and diagnosis for the planning of appropriate treatment of periodontitis.

### Opportunity 3 – Treatment of Periodontitis

Overwhelming evidence indicates that periodontitis can be treated and effectively managed in the majority of cases. Since the science supporting periodontal treatment is strong, the following priorities should be addressed nationally to improve access to available care, that is to:

- Improve public awareness of the early signs of periodontitis and the need for professional diagnosis to identify gingivitis and periodontitis.
- Improve access to care; informing patients that periodontitis can be effectively managed and that management is more cost-effective in the early stages of the disease.

### Conclusions

The draft preventive, diagnostic and therapeutic actions discussed above will be finalized after completion of an

ongoing consultation phase among stakeholders. The draft paper for consultation can be accessed on the EFP website at <http://prevention.efp.org/wp-content/uploads/2016/01/greenpaper-v3.pdf>. The final version of the paper will be put forward for formal endorsement by professional organizations, government and non-government agencies worldwide and eventually published in the peer reviewed scientific literature.

### Competing interests

The Authors disclose that they have neither financial nor personal relationship with people or organizations that could influence their work.

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## 360-Degree prevention of oral disease

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### Abstract

5 benchmark criteria for the creation of a virtuous cycle roadmap. The five criteria:

- 1) Preventive actions; 2) Appropriate nutrition; 3) Healthcare policies;
- 4) Pre-cancerous disease evaluation and cancer treatments; 5) Eating disorders.

The “consensus paper” data very clearly emphasize the importance that oral cavity disease represents for the world’s population, both from the socio-economic and the clinical and epidemiological points of view. If we consider decay for example, the studies did not show any geographical areas free from disease or highlight significantly different incidences in relation to the overall average. The same studies have put much emphasis on the critical importance of preventive action such as oral hygiene and fluorine intake, with education and training programs in place for the family. Good nutrition control is certainly a priority tool in combatting dental caries while other oral diseases require monitoring, particularly in relation, to food safety. Both microbiological and chemical contamination of food may lead to the development of substances that are harmful to health, firstly dental health because of the immediate exposure and contact that the teeth have with these substances. Many countries within and outside Europe have been making commendable efforts towards the creation of early warning systems from government agencies that monitor food fraud safety. It should on the other hand be emphasized that the approach of many health systems that give low priority to oral health appear to be acting in a short-sighted fashion both in view of the demographic changes (an aging population) and in view of the epidemiological evidence. In Italy too, most dental treatments are not included in the LEA. Prevention, therefore suffers the negative consequences of this. The importance of orally focussed preventive action, is even clearer when we consider that the oral cavity may be a precancerous site for which early detection has a major role to play. Eating habits are now being carefully evaluated to consider any correlation between the development of certain cancers and dietary habits. The role of the dentist is unique in this respect. The assessment of risk factors for the onset of oral cancer is key to early detection while the negative effects on the oral cavity from cancer treatments themselves must also not be overlooked.

Eating disorders, finally, are also another important factor in the development of diseases of the oral cavity and should therefore be carefully evaluated and addressed in the light of the epidemiological data that indicates their sharp increase in recent times. Oral diseases may be multi-factorial in origin so cooperation between different kinds of medical specialists is key to the development and implementation of effective diagnostic and therapeutic strategies. According to this logic, the Mission of FISM focuses on knowledge sharing between different medical associations for cross synergies as driver for change. The synergy can be used to facilitate diagnosis, greater efficacy of treatments and the development of a well functioning network.

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The continuous monitoring of food safety is the first step in oral disease prevention. For this reason specific and dedicated alerting systems have been developed domestically and in Europe as a whole (RASFF).

A preliminary comparison of domestic food safety legislations shows common trends, which can be summarized as follows:

- a) All countries show some interest in food safety and the establishing of rules;
- b) The appointment of new national agencies to report to governmental authorities and promote the adoption of action plans, research, studies and publishing in the area of food safety;
- c) The strengthening of consumers' rights in terms to accessing food information;
- d) The establishment of control systems on foods for humans and for animals coupled with a progressive system of penalties that addresses the risks and hazards associated with food fraud and poor food handling conduct at any level (from the field to the table). In many countries consumers are increasingly selective and informed in relation to the food market both as individuals and through consumer associations. Food safety has now become a top priority in European political strategies and the data of the European alerting system Report are now generally available.

**The European Alerting System Data Report**

Italy leads the European rankings as regards food risks and warnings recorded, with 16.3% of total European alerts delivered to the authorities are from Italy. In 2014 there were 3,097 alerts compared with 3,136 in the previous year, 506 of which came from Italy. In 2013 Italy submitted 534 alerts (17% of the total) as compared with the 3,436 issued in 2012 through the RASFF Agency and the 3,721 issued in 2011. The alerting system's efficiency is critical

for guaranteeing the health and safety of the population.

In detail, the Agency received:

- 137 alerts issued by the Assessorati alla Sanità, ASL and Comando Carabinieri for Healthcare Safety;
- 369 alerts issued by Healthcare Ministry local subsidiaries (USMAF, UVAC an PIF).

There are of course many potential health hazards conveyed by foods.

In the category of microbiological contaminants a huge number of alerts concerned the presence of Salmonella (476 alerts), followed by E. Coli and Listeria monocytogenes with 122 and 98 alerts respectively.

Phyto-pharmaceutical residues were the chemical contaminants most frequently notified by the RASFF, followed by mycotoxins and heavy metals.

Other high frequency warnings have been related to the presence of allergens not indicated in the product label (78), with the trend remaining steady as compared with the previous year.

China is in first place for number of alerts (469), followed by Turkey and India.

As consistently highlighted in previous years, most non-compliance can be attributed to incorrect application of the self-control systems on the part of Food Industry workers (OSA).

Studying such microbiological contamination and the presence of dangerous substances in foods, it is evident that the mouth is the first point of contact point for these during eating. The first place damage can arise is therefore in the mouth. Given this then surely oral disease identification should be a useful alarm bell for an understanding of unexpected and inexplicable organic disorders.

As is well-known, most dental treatments are not included in the LEA and this limits the potential of oral disease prevention initiatives, giving rise to uneven geographic prevention accentuated by the current economic crisis.

Target area of intervention	Intervention Type	Short-term prevention goals	Long-term goals
Developmental Age.	National guidelines for the prevention and clinical management of dental trauma in children.	Shared protocols on dental trauma in children.	Reduction in permanent damage Lower future costs.
	Guidelines for the promotion of oral health and prevention of oral diseases in childhood (2013 review).	Unique indications evidence-based (eg. fluorine systemic or topical prophylaxis).	Lower future costs. Better quality of life.
Addicts.	Inclusion of drug dependent patients in specific programs based on precise treatment lines in the various fields of dentistry.	Better treatment acceptance and compliance; safety of care.	Better social rehabilitation.
Geriatric care (frail elderly and / or institutionalized).	Specific programs (on a regional basis) for the frail elderly and / or institutionalized.	Better response to specific needs and access to care.	Better quality of life.

Table 1: Source: our processing on Health Report data 2012-2013

Rank	Condition Name	Overall		Men		Women	
		n°	%	n°	%	n°	%
1	Untreated caries of permanent teeth	2,431,636	35.29	1,194,051	34.37	1,237,585	36.23
2	Tension-type headache	1,431,067	20.77	655,937	18.88	775,131	22.69
3	Migraine	1,012,944	14.70	371,072	10.68	641,873	18.79
4	Fungal skin diseases	985,457	14.30	516,167	14.86	469,291	13.74
5	Other skin and subcutaneous diseases	803,597	11.66	417,129	12.01	386,468	11.32
6	Severe periodontitis	743,187	10.79	378,407	10.89	364,780	10.68
7	Mild hearing loss	724,689	10.52	386,147	11.11	338,543	9.91
8	Acne vulgaris	646,488	9.38	311,349	8.96	335,140	9.81
9	Low back pain	632,045	9.17	334,793	9.64	297,252	8.7
10	Untreated caries of deciduous teeth	621,507	9.02	352,085	10.13	269,421	7.89
36	Severe tooth loss	158,284	2.3	67,264	1.94	91,020	2.66

\*Numbers of cases reported in thousands.

Table 3: Overall prevalence of oral diseases (from Marcenes 2013)

1990 Mean Rank [95% UI]			2010 Mean Rank [95% UI]		
1.0	[1-2]	01 Lower respiratory infections	1.0	[1-2]	01 Ischemic heart disease
2.0	[1-2]	02 Diarrheal diseases	2.0	[1-3]	02 Lower respiratory infections
3.4	[3-5]	03 Preterm birth complications	3.2	[2-5]	03 Cerebrovascular disease
3.8	[3-5]	04 Ischemic heart disease	4.8	[4-8]	04 Diarrheal diseases
5.2	[4-6]	05 Cerebrovascular disease	6.5	[4-9]	05 HIV/ AIDS
6.3	[5-8]	06 COPD	6.7	[3-11]	06 Malaria
8.0	[6-13]	07 Malaria	7.2	[3-11]	07 Low back pain
9.9	[7-13]	08 Tuberculosis	7.9	[5-11]	08 Preterm birth complications
10.1	[7-14]	09 Protein-energy malnutrition	8.1	[5-11]	09 COPD
10.2	[7-15]	10 Neonatal encephalopathy	8.4	[4-11]	10 Road injuries
68.8	[58-87]	69 Severe tooth loss	76.9	[50-116]	77 Severe periodontitis
85.3	[61-121]	86 Untreated caries*	79.3	[56-115]	80 Untreated caries*
90.0	[61-125]	90 Severe periodontitis	80.0	[61-103]	81 Severe tooth loss

COPD, Chronic Obstructive Pulmonary Disease; HIV/AIDS, Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome.

\*Untreated caries included caries in both deciduous and permanent teeth.

Table 4: Disability-adjusted Life-years (DALYs) for oral pathologies in 1990 and 2010 (Marcenes 2013)

Individual patient behaviour could however result in a change of course and targeted prevention initiatives that can be effective when operated on a large scale.

The Healthcare State of the Country report of 2012-2013 identifies some areas (Table 1) of prevention activities in dentistry, two extremes of age, the at-risk groups and the need to take account of relevant epidemiological and demographic changes in recent years.

Oral health is given low priority in many health systems despite the recent survey on the Global Burden of Disease (GBD) which ranks the prevalence of caries at first place among the 291 diseases analysed. It was estimated that between 5% and 20% of the world's population is affected by periodontitis, which is the most common cause of tooth loss. Cancer of the mouth is five times more common in men than women, and ranks 8th among the neoplastic diseases. Between 1990 and 2010 (Tables 3 and 4), the GBD for oral conditions, although it has declined in individual terms, it has increased in the total population due to the aging of the population and its growth. While

the Burden of Disease has decreased in terms of tooth loss, probably due to major advances in prevention in high-income countries, in many developing countries changes in diet (particularly the higher intake of sugars) has since an increase in caries and in severe periodontitis in the young people, which will result in tooth loss in the future if not properly treated.

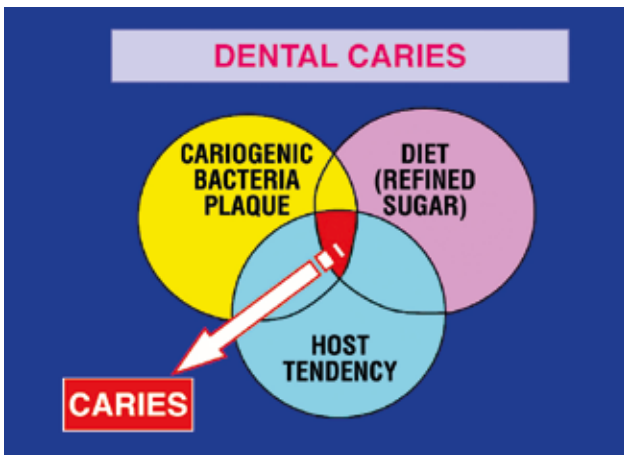
The availability of better epidemiological data, in view also of recent health initiatives proposed in Europe (Health 2020), it may be possible to outline a sustainable framework for oral health prevention and promotion as supported by indicators that show such initiatives to be effective. The recent Cochrane review has however highlighted the difficulty of correctly measuring the effectiveness of preventive activities in schools; cornerstone of the proposed programs by the WHO, along with empowerment and health literacy. Given the importance of carious pathologies in all geographic areas studied, we should look at tooth decay in more detail.

Tooth decay is a bacterial disease characterized by the



progressive and localized destruction of hard dental tissues with resulting cavity formation following prolonged exposure to organic acids of bacterial origin. Caries often set infection processes in motion, in addition to the destruction of most of the dental crown, pulp and peri-apical tissue. The disease not only affects the enamel and the dentin but also the cementum when exposed to the oral environment (root caries). Tooth decay is widespread in many countries around the world, especially in the industrialized world where sugar intake is higher, and is one of these countries' most compelling public health problems.

There is today well-documented scientific evidence on the pathogenesis of this disease. Caries is defined as a multifactorial disease that originates from an alteration in homeostasis between the host and the microbiota residing in the oral cavity, particularly in dental plaque. This balance is critically affected, in the genesis of caries, by the assumption of dietary carbohydrates. The factors that



trigger the disease, which must be present simultaneously, are thus the presence of cariogenic bacteria in dental plaque, the use of refined sugars from the diet and the -host tendency. The following graph shows the factors involved in caries onset.

It has been conclusively proven that the first stage of caries consists in enamel demineralization resulting from the lowering of local pH following high concentrations of organic acids produced by plaque bacteria during the fermentation of certain carbohydrates. Not all dental plaque has this ability to produce organic acids or, therefore, the same cariogenicity. This does not so much depend on the thickness of the plaque but on its composition, where these cariogenic bacteria must be present.

Plaque is thus an essential prerequisite for the development of caries, which develops mainly in those areas of the oral cavity where plaque more easily accumulates due to the difficulty in reaching it using normal oral hygiene procedures. The saliva has an important buffering effect on plaque acidity. A regular flow of saliva dilutes the organic acids

Figure 1a: World energy (kcal/capita/day) from refined sugar, other and total sugars and sweeteners

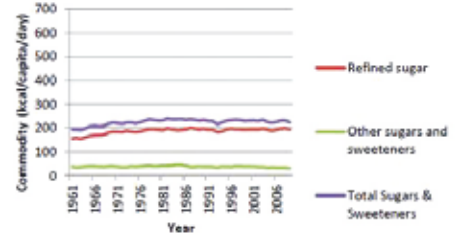


Figure 2a: Africa energy (kcal/capita/day) from refined sugar, other and total sugars and sweeteners

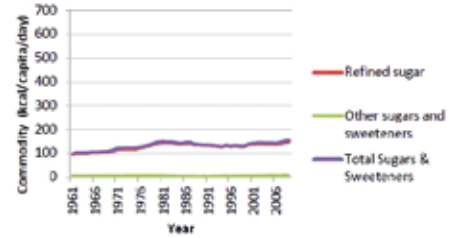


Figure 3a: Americas energy (kcal/capita/day) from refined sugar, other and total sugars and sweeteners

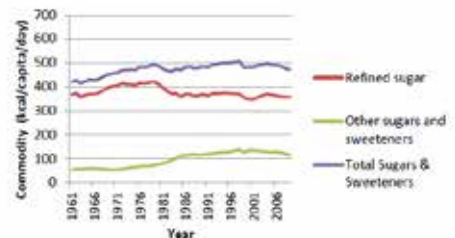


Figure 5a: Europe energy (kcal/capita/day) from refined sugar, other and total sugars and sweeteners

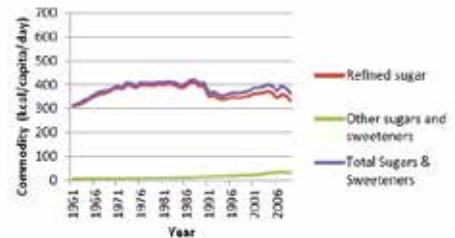


Figure 4a: Asia energy (kcal/capita/day) from refined sugar, other and total sugars and sweeteners

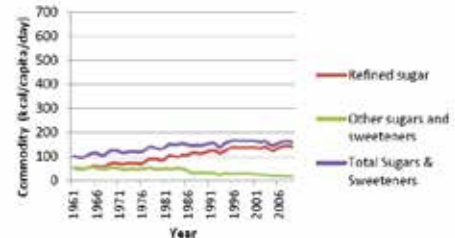
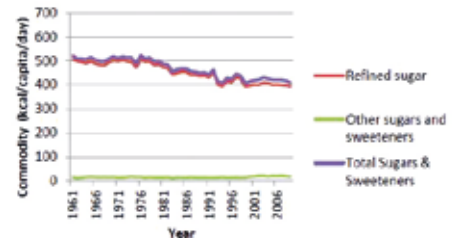


Figure 6a: Oceania energy (kcal/capita/day) from refined sugar, other and total sugars and sweeteners



produced, facilitating the return to a normal pH after ingestion of carbohydrate-rich foods. It is well-known that patients with decreased saliva secretion (xerostomia), often following radiation therapy, tend to suffer from more aggressive forms of tooth decay.

It is also our belief that it is worthwhile to analyse dental

disease in relation to the socio-epidemiological situation, considering the different geographical areas with their particular nutritional habits.

In most industrialized countries the intake of dietary sugar has remained stable over time with similar trends on a continent by continent basis as indicated in the “WSRO Report on Trends in Per Capita Sugar Supply, 1961 - 2009”. The report considers sugar consumption per capita over the last 50 years (figures from 1b to 6b).

The European Food Safety Authority recognizes a link between the frequent consumption of sugar-rich foods (as well as others containing fermentable carbohydrates, including starch) and dental caries, especially in the absence of good oral hygiene and fluoride prophylaxis.

The focus of the WHO on the prevention of caries has been reconfirmed by their publication in early 2015 of their “Guideline on sugar intake for adults and children”. This important guideline stresses that no more than 10% of daily energy intake should come from added sugars. According to the WHO keeping sugar intake below 10% of the total energy intake reduces the risk of becoming overweight or obese and of tooth decay. A reduction in dental caries has also recently been observed, especially in children and adolescents.

The trend is mainly attributable to the use of fluoride-based toothpastes and to improvements in oral hygiene.

Indeed, as shown in Figure 2, the issue of dental caries is largely under control in many European and non-European areas due to effective daily oral hygiene and

fluorine. As seen in most of the countries studied, moderate consumption of sugars is not a major risk factor, except for highly predisposed individuals or for those not making proper use of fluoride-based toothpaste.

In Europe, for example, children aged between 5 and 7 years are not generally affected by tooth decay in the primary dentition. Where there are caries they usually affect a single tooth. The prevalence of tooth decay in European children of 12 years declined in the eighties, a trend that continued in the 90s and the oral health goals established by WHO for 2000 were achieved.

Good oral hygiene and the use of fluoride are now considered the main factors in tooth decay prevention and oral health. It should be recalled that dental caries is the most prevalent of all diseases worldwide, with most carious lesions concentrated in the lower-middle classes. It must also be noted that the accessing of monitoring and care services may be more difficult for people in the less affluent groups. These social classes are thus a main target for dental health education programs as are schools, which should have a role in educating children of the importance of oral hygiene and a correct diet.

We would in conclusion suggest some useful strategies for the combatting of decay. These in particular include:

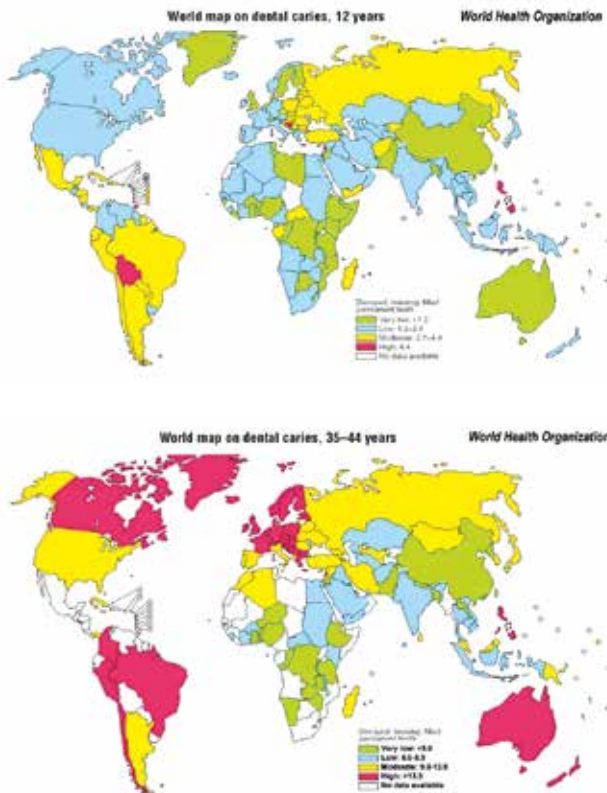
- 1) Lowering the intake of refined sugars in the diet;
- 2) Proper oral hygiene;
- 3) The use of fluoride;
- 4) Occlusive sealing of dental surfaces.

Caries are not however the only important pathology of the oral cavity.

The mouth can be the site of precancerous diseases for which early detection becomes particularly important. In this regard, notice should be taken of discoloration of oral tissues, which may be sign of malignancy. Such lesions are often neglected because they may be symptom-free and localized in regions that are out of reach and difficult to observe until actual degeneration to malignancy is triggered to become symptomatic, usually with the presentation of burning, pain or bleeding etc. Precancerous lesions may be whitish (leukoplakia) or red (erythroplakie) and occurrence may be in any region of the mouth (the lip, palate, floor of the mouth, gums, cheeks or tongue) before the development of the carcinoma.

Risk factors for oral cancer are smoking, alcohol, HPV and EBV infections, lichen planus and other skin diseases, recurrent candidiasis, anaemia, liver disease, certain genetic diseases, “ferroprive” anaemias and immune diseases.

Early detection of precancerous lesions can mean that wound healing is achieved and hence the prevention of transformation into cancer. In general precancerous oral lesions become cancerous after going through an intermediate stage of dysplasia. They are described as low and high-risk lesions for malignant degeneration, and only correct tissue typing is capable of predicting their



development and indicate suitable therapies. The dentist is a specialist that is well able to detect tissue colour variations and understand the importance of specific symptoms such as burning, foreign body sensation or bleeding.

Preventive measures are also of great importance in cervical cephalic tumours for the reduction of the incidence of recurrence and of second cancers.

We are today witnessing a growing interest in diet as a means of improving overall well-being and, more specifically in the field of oncology, in considering diet-based intervention as critical for support therapies in relation to side effects and for a positive effect on cancer-related survival and overall patient's survival. Some studies have analysed possible correlations between dietary habits (measured with the special dietary-index) and risk of development of malignant tumours of the cervical cephalic and oral cavity, all of which have shown the overall benefits deriving from the Mediterranean diet.

Similarly work has been carried out in relation to the potential negative effects of cancer treatments (chemotherapy and radiotherapy) on the oral cavity, the so-called mucositis, which shows the possible impact of nutrition and diet on such iatrogenic diseases.

This consensus paper on 360-degree oral cavity pathology prevention cannot be considered exhaustive where it has not considered certain significant nutritional problems and their correlations with the development of oral diseases.

Anorexia and bulimia seem to be disorders that are typical of our time. The incidence of anorexia nervosa (AN) has almost doubled since the sixties while the prevalence of bulimia (NB), diagnosed among teenage girls and young people, stands at around 1% (Fairburn, Beglin, 1990). These disturbing figures show that eating disorders may be an increasingly common factor in range of intrapsychic, family-related and environmental stress factors.

Anorexia is "a complex modification of all eating habits" (Rossini), based primarily on a distorted body image (judged as being too fat, even where emaciated). The loss of appetite is due to the persistence of the psychopathological picture. Bulimia is on other hand characterized by the repetition of paroxysmal episodes of indiscriminate ingestion of large amounts of food, accompanied by changes in mood and behaviour designed to eliminate ingested food or to limit its effects on body weight.

Eating disorders (ED) are indicate a problematic relationship with food and may reflect the conditioning that weight and body shape have on self-confidence. These conditions are much more frequent in females and occur mainly in adolescence and in early adulthood. Their spread is greater in industrialized countries and groups considered particularly at risk include dancers, athletes and university students. The aetiology is likely multifactorial and is determined by the interaction between genetic, biological, psychological and socio-cultural factors. They are characterized by frequent medical complications, a high psychiatric comorbidity and a remarkable tendency to become chronic and recurrent. Self-harming and suicidal

thoughts also frequently accompany these conditions.

AN is typified by progressive weight loss due to the significant reduction in food intake, by the stubborn pursuit of thinness and an overwhelming fear of gaining weight. The decisive factor is the tendency to deny or hide the disease: people with AN are rarely concerned about weight loss, even if this is significant; in the case of bulimia food restriction and behaviour relating to control and elimination are markedly ego-syntonic: in the presence of these syndromes the patient's behavior is radicated and not not recognized as signs of a disturbance. Typically people with an eating disorder do not ask for treatment and display a remarkable resistance to making any changes in their behavior.

Some epidemiological studies assessing how many people diagnosed with AN seek treatment have estimated percentages of between 43% and 53%, while in the case of bulimia the percentages are lower (11-40%). In Italy these data seem to be confirmed by the scarce epidemiological studies. The average age of onset fluctuates between 15 and 19 years for anorexia and between 20 and 24 for bulimia. The eating disorders are more common in females with a female to male ratio of 10: 1 for anorexia and 30 to 1 for bulimia.

The most common oral complication of these pathologies, as reported in patients with frequent vomiting, is the erosion of dental enamel, especially on the palatal and lingual surfaces of the teeth, which is secondary to chronic contact with the acidic juices regurgitated from the stomach. This may also be responsible for dental cavities and irritant gingivitis.

## Conclusions

The five benchmark criteria

- 1 Prevention activities
- 2 Appropriate nutrition
- 3 Healthcare policies
- 4 Pre-cancerous disease evaluation and cancer treatments
- 5 Eating behaviour disorders

The data above clearly shows very clearly the importance of oral cavity pathologies for the world's population both from a socio-economic from the clinical epidemiological point of view. As regards decay, the studies did not indicate geographical areas that are free from such disease or highlight different incidences from the average. The same studies very much highlight the importance of prevention, including oral hygiene and fluorine intake, and also the importance of education and training aimed at the family. Actions that address the question of proper nutrition are certainly a priority in the fight against dental caries while other oral diseases require monitoring above all food safety. Food contamination, both microbiological and chemical, may lead to the development of substances that are harmful to health, starting with dental health as the teeth come into immediate contact with the substance.

Commendable efforts have been made by many countries



within and outside European countries in creating early warning systems from government agencies working on food related fraud, monitoring and food safety in general. It must be emphasized on the other hand that many health systems give low priority to oral health. This would appear rather short-sighted in the light of demographic changes resulting in an aging population and considering also the epidemiological evidences. Even in Italy most dental treatments are not included in the LEA. Preventive action suffers the negative consequences of this lack.

The critical importance of prevention in diseases of the mouth stands out even more clearly when we consider that the mouth can be a precancerous site, where early detection is crucially important. Eating habits are now being carefully evaluated for possible correlations between the risk of developing certain cancers and dietary habits. The dentist's role is, in this respect, unique. The assessment of risk factors related to oral cancer onset is key step to early detection.

The negative effects cancer treatments have on the oral cavity also cannot be overlooked.

Finally, eating disorders are too an important factor to the development of certain diseases of the mouth and should therefore be carefully evaluated and addressed in view of the epidemiological data that shows a sharp increase in the incidence of these disorders in recent years.

Oral diseases may have multi-factorial origins and, for this reason, cooperation between medical professional with different specialisations will be key to success in the development and implementation of effective diagnostic and therapeutic strategies. According to this logic, the mission of the FISM is to encourage the sharing of knowledge among the various medical associations for cross synergies that can be a useful driver for change. Such synergies can facilitate diagnosis, ensure more effective treatment and identify contact to improve network activity.

## ABBREVIATIONS - TERMINOLOGY

L.E.A. = Basic Levels of Care

G.B.D. = Global Burden of Disease

R.A.S.F.F. = Food and Feed Safety Alerts

U.S.M.A.F. = Nautical, Airborne and Custom Health Offices

U.V.A.C. = Veterinary Offices for EU regulations compliance

P.I.F. = Custom Inspection Site

O.S.A. = Food Market Workers

D.C.A. = Nutritional Behaviours Disorders

A.N. = Anorexia Nervosa

B.N. = Bulimia Nervosa

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## Competing interests

The Authors disclose that they have neither financial nor personal relationship with people or organizations that could influence their work.



# The nature and challenges for oral hygiene in a multiethnic society

Robyn Watson<sup>a\*</sup>

## Abstract

Chronic diseases are accelerating globally, advancing across all regions and pervading all socioeconomic classes. Unhealthy diet and poor nutrition, physical inactivity, tobacco use, excessive use of alcohol and psychosocial stress are the most important risk factors. Childhood caries and Periodontal disease are components of the global burden of chronic disease. Chronic disease and periodontal disease have the same essential risk factors. In addition, severe periodontal disease is related to poor oral hygiene and to poor general health (e.g. the presence of diabetes mellitus and other systemic diseases).

The ultimate burden of Childhood caries and periodontal disease (tooth loss), as well as signs of such are described from World Health Organization (WHO) epidemiological data. High prevalence rates of complete tooth loss are found in upper middle-income countries, whereas the tooth-loss rates modest for low-income countries.

Around the world, social inequality in childhood caries and tooth loss is profound within countries.

Inter-country and in-country variations are found in the prevalence of these diseases and these variations relate to socio-environmental conditions, behavioral risk factors, general health status of people (e.g. diabetes and HIV status) and oral health systems. National public health initiatives for the control and prevention of childhood caries and periodontal disease should include oral health promotion and integrated disease-prevention strategies based on common risk-factor approaches.

Capacity building of oral health systems must consider the establishment of a financially fair service in access to care. Prevention of oral disease, whether it is periodontal disease or tooth decay, will not work if the populations at risk can not access care.

By identifying the barriers to care, specific action steps can be taken to increase oral health awareness and access for high risk populations<sup>1</sup>.

Cultural competence in health care may be defined as an understanding of the importance of social and cultural influences on patients' health beliefs and behaviors; considering how these factors interact at multiple levels of the health care delivery system; and, finally, offering some examples of interventions that take these issues into account to assure quality health care delivery to diverse patient populations.

## Introduction

### The nature and challenges presented by multicultural patient populations.

With greater diversity comes the need for improved cultural sensitivity, especially among health care workers. Insensitivity to cultural differences can impede the ability of patients to access and effectively receive health care<sup>5</sup>. All

aspects of health care, including dental care, must adapt to improve cultural competency. While cultural initiatives are common in education, social services, law, and medicine, related educational resources in dentistry and dental hygiene are limited<sup>2</sup>.

Tooth decay remains the single most common, chronic disease of childhood; 5 times more prevalent than asthma<sup>2</sup>. Children suffering the highest rates and the most severe dental disease tend to be of preschool age and disadvantaged by poverty, minority status or social conditions.

Dental disease, untreated, results in pain, infection, and may inhibit general growth and development<sup>3</sup>.

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Periodontal disease and chronic oral infections are considered a risk factor for cardiovascular disease, inadequate glycemic control in diabetics and more recently, adverse pregnancy and birth outcomes.

The European Federation of Periodontics Manifesto ([http://www.efp.org/efpmanifesto/EFP\\_manifesto\\_full\\_version.pdf](http://www.efp.org/efpmanifesto/EFP_manifesto_full_version.pdf)) which was released after Eurperio 8 in London also states that; absence of work, social inequality and poor quality of life all impact on escalating public health costs. The EFP Manifesto also states that: “There is emerging evidence for associations between periodontal disease and other diseases: chronic obstructive airway disease, chronic kidney disease, rheumatoid arthritis, cognitive impairment, obesity, metabolic syndrome and some cancers. To date, the only evidence for causality is in relation to respiratory microorganisms that colonize the oral/periodontal biofilm and may subsequently cause a hospital-acquired pneumonia (nosocomial pneumonia) in ventilated patients”.

“Oral diseases and conditions may have a significant impact on general health. Oral health care is an important, but often neglected, component of total health care. Regular dental visits provide an opportunity for the early diagnosis, prevention, and treatment of oral and craniofacial diseases and conditions for persons of all ages, as well as for the assessment of self-care practices”<sup>4</sup>.

## Cultural diversity

**Cultural Competence Definition Approved by Taskforce**  
“Cultural Competency is the genuine sensitivity, respect, and ongoing commitment to learning about people regardless of race/ethnicity, disability, religion, creed, national origin, socioeconomic status, gender, and sexual orientation”.

The expected growth in the numbers of racial and ethnic minorities, and the concomitant growth of immigrant populations, are likely to lead to a worsening of oral health disparities. Their consequences are becoming increasingly evident as the profession strives to improve the oral health of all people. The increasing diversity of the population, together with the importance of cultural beliefs and behaviors that affect health outcomes, will require ways to enhance provider-patient communications and oral health literacy. One important means by which to promote oral health in diverse populations is to develop a dental workforce that is both culturally and linguistically competent, as well as one that is as culturally diverse as the general population.

Inconsistent patient behaviors and attitudes related to compliance with treatment regimens is often a result of cultural conflict between minority patients and their providers.

Clinical inexperience in interacting with minority patients and beliefs held by the provider about the behavior or health of minorities may contribute to a cultural dissonance between providers and patients.

Additionally, time and resource constraints imposed on

clinic visits may result in providers making snap judgments based on prototypes or stereotypic decision-making models when diagnosing and treating patients. Overlooking patients’ cultural beliefs may foster a lack of trust in the provider and their diagnoses and decrease the likelihood that a person will comply with the prescribed treatment<sup>5</sup>.

## Childhood caries

### Early dental assessment

The goal of an early dental assessment is primary prevention. This may be accomplished with timely delivery of oral health information, including on the conditions that create caries and cavities; its natural progression; and its prevention and the identification of populations at high risk for tooth decay.

The traditional approach of treating the effects of dental decay (i.e. “drilling and filling”) is being replaced by disease prevention and disease management.

Prevention focuses on the establishment and maintenance of good oral hygiene, optimizing systemic and topical fluoride exposure, and eliminating prolonged exposure to simple sugars in the diet. Prevention is the foundation for the establishment of a “dental home” by 1 year of age.

The concept of the “dental home” comes from the American Academy of Pediatrics concept of the “medical home”. This idea is that “the primary health care of infants, children, and adolescents should be accessible, continuous, comprehensive, family centered, coordinated, compassionate, and culturally effective. It should be delivered or directed by well-trained child health specialists who provide primary care and help to manage and facilitate essentially all aspects of pediatric care”<sup>6</sup>.

True Primary Prevention prevents disease occurrence by avoiding disease determinants. In tooth decay, this relates to reducing the reservoir of bacteria, reducing transmission and reducing colonization of cariogenic bacteria. (Reservoir → vector → receptor).

1. Reducing the reservoir: xylitol chewing gum (the use of chewing gum containing xylitol has been shown to inhibit mutans streptococci colonization and reduce caries in children<sup>7,8</sup> stannous fluoride and chlorhexidine (with dental repair)
2. Reducing transmission: avoid sharing utensils, cleaning pacifier in mouth etc.
3. Reducing colonization: oral hygiene (brushing with fluoridated toothpaste), diet control (reducing the frequency of carbohydrates) and topical fluoride application (e.g. fluoride varnish)<sup>8</sup>

Studies in Belfast<sup>9</sup> and Glasgow<sup>10</sup> address coherent attitudes towards tooth brushing, sugar snacking and childhood caries. Attitudes were significantly different in families from deprived and non-deprived backgrounds and in families of children with and without caries. Parents’ perception of their ability to control their children’s tooth brushing and sugar snacking habits were the most significant predictor of whether or not favorable habits

were reported. Some differences were found by site and ethnic group.

These studies supports the hypothesis that parental attitudes significantly impact on the establishment of habits favorable to oral health. An appreciation of the impact of cultural and ethnic diversity is important in understanding how parental attitudes to oral health vary. Further research should examine in a prospective intervention whether enhancing parenting skills is an effective route to preventing childhood caries.

### Caries Risk Assessment

Advances in the understanding of dietary influences and fluoride on dental disease become instrumental in supporting early intervention

Every child should have an examination and oral health risk assessment by 12 months of age by a dentist or qualified pediatric health care professional<sup>11</sup>.

The Caries Risk Assessment Tool (CAT), provided by the American Academy of Pediatric Dentistry<sup>18</sup> was designed to assist both dental and non-dental health professionals in assessing the risk of tooth decay in infants, children and adolescents.

The CAT<sup>18</sup> can be used to determine the relative risk of caries for the patient (*Table 1*)

Questions directed at dietary practices, fluoride exposure, oral hygiene, utilization of dental services, socioeconomic status and general level of health can help determine if a child is at low, moderate or high risk of dental disease.

### Periodontal Disease

Periodontal disease (periodontitis or “gum disease”) is a chronic infection caused by bacteria existing at the gum line in the form of plaque and calculus.

Periodontal disease causes inflammation and bleeding gingiva and, if not treated, leads to tissue destruction, tooth mobility and eventually tooth loss.

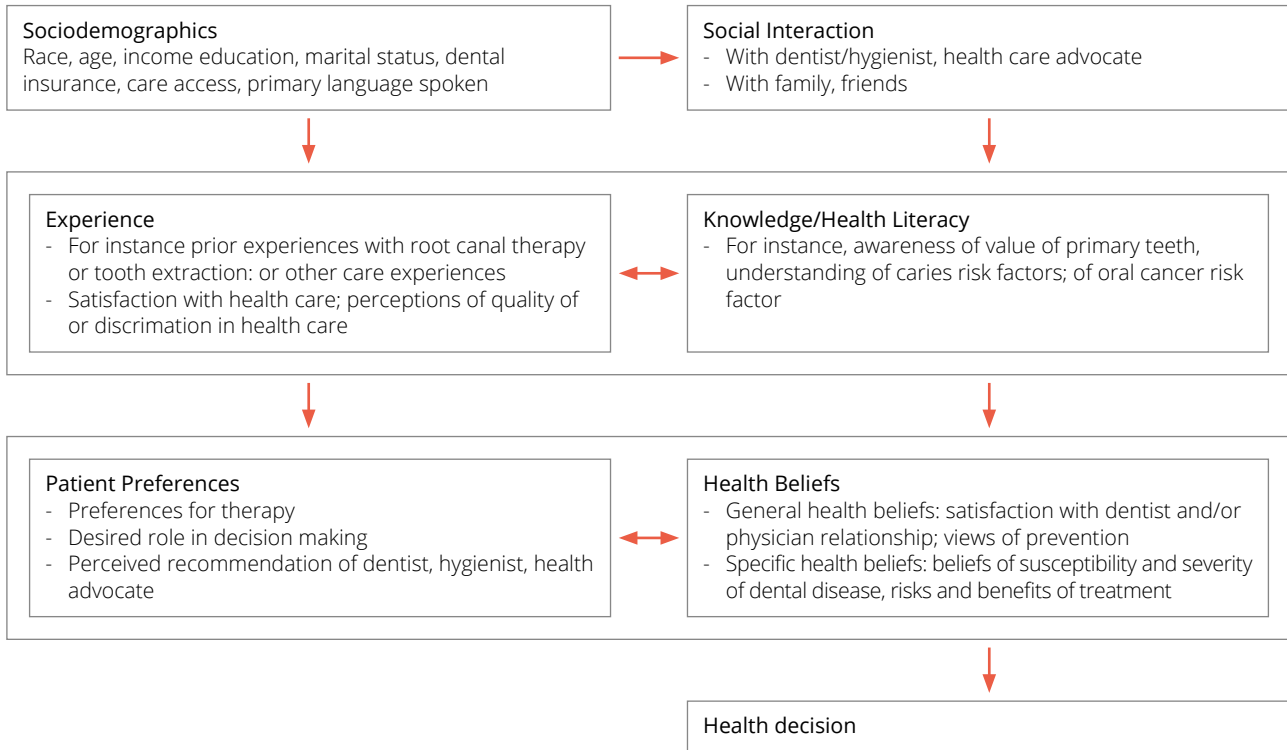
Growing body of research supports an association between periodontal disease and Pre-term low birth-weight

Untreated periodontal disease in adults causes pain, tooth loss, loss of appetite, poor nutrition and increased risks for cardiovascular disease, stroke, pneumonia and complications of diabetes.

Gingival bleeding is highly prevalent among adult populations in all regions of the world; advanced disease with deep periodontal pockets (6 mm or more) affects;

AAPD Caries-risk Assessment Tool (CAT)			
Caries-risk indicators	Low risk	Moderate risk	High risk
Clinical conditions	<ul style="list-style-type: none"> <li>- No carious teeth in the past 24 months</li> <li>- No enamel demineralization (enamel caries “white spot lesions”)</li> <li>- No visible plaque; no gingivitis</li> </ul>	<ul style="list-style-type: none"> <li>- Carious teeth in the past 24 months</li> <li>- 1 area of enamel demineralization (enamel caries “white spot lesions”)</li> <li>- Gingivitis*</li> </ul>	<ul style="list-style-type: none"> <li>- Carious teeth in the past 12 months</li> <li>- More than 1 area of enamel demineralization (enamel caries “white spot lesions”)</li> <li>- Visible plaque on anterior (front) teeth</li> <li>- Radiographic enamel caries</li> <li>- High titers of mutans streptococci</li> <li>- Wearing dental or orthodontic appliances</li> <li>- Enamel hypoplasia</li> </ul>
Environmental characteristics	<ul style="list-style-type: none"> <li>- Optimal systemic and topical fluoride exposure</li> <li>- Consumption of simple sugars or foods strongly associated with caries initiation, primary at mealtimes</li> <li>- High caregiver socioeconomic status</li> <li>- Regular use of dental care in a established dental home</li> </ul>	<ul style="list-style-type: none"> <li>- Suboptimal systemic and topical fluoride exposure</li> <li>- Occasional (ie 1,2) between meal exposure simple sugars or foods strongly associated with caries initiation</li> <li>- Midlevel caregiver socioeconomic status (ie eligible for school lunch program or SCHIP)</li> <li>- Irregular use of dental services</li> </ul>	<ul style="list-style-type: none"> <li>- Suboptimal topical fluoride exposure</li> <li>- Frequent (ie, 3 or more) between meal exposure simple sugars or foods strongly associated with caries initiation</li> <li>- Low caregiver socioeconomic status (ie, eligible for Medicaid)</li> <li>- No usual source of dental care</li> <li>- Active caries present in the mother</li> </ul>
General health conditions			<ul style="list-style-type: none"> <li>- Children with special health care needs</li> <li>- Conditions impairing saliva composition/flow</li> </ul>

Table 1: Caries Risk Assessment tool - CAT<sup>18</sup>



Factor	Description
Individual preferences	The patient's desired role in decision making, the patient's own assessments of risks and benefits of a particular decision, along with the dentist's recommendations for treatment
Experience	The patient's involvement in decision making, previous experiences with dental care (including perceptions of discrimination in receiving such care), and perceptions of the quality of care as well as satisfaction with it and trust in the dental profession
Knowledge	Including the dimension of health literacy – includes the awareness of the value of oral health, and the accuracy of the patient's understanding of the prevention
Social interactions	Interactions that might influence health decisions include those with the dentist and dental office or clinic staff, and with friends and family members
Sociodemographic variables	Variables such as race, age, income, education, marital status, and health insurance coverage and access to dental care

Figure 1: Health decision Model<sup>31</sup>

10% to 15% of adults worldwide. The available evidence shows that important risk factors for periodontal disease relate to poor oral hygiene, tobacco use, excessive alcohol consumption, stress, and diabetes mellitus. Integrated preventive strategies based on the common risk factors approach are recommended for public health practice<sup>12</sup>.

**EFP Manifesto states: “Periodontitis is a chronic multifactorial inflammatory disease initiated by bacterial microorganisms and characterized by a severe chronic inflammation that leads to progressive destruction of the tooth supporting apparatus, tooth loss and eventually to masticatory dysfunction.**

It:

- is common;
- reduces chewing function;
- impairs aesthetics;

- causes tooth loss;
- causes disability;
- leads to social inequality;
- reduces quality of life;
- has a significant impact upon escalating public health costs.

In addition, periodontitis is a chronic inflammatory disease with potentially negative consequences for general health. Cross-sectional and prospective epidemiological studies have shown that periodontitis increases the risk of poor glycemic control in patients with diabetes mellitus as well as diabetes complications and associated morbidity. Successful periodontal interventions also improve glycemic control in type 2 diabetes patients. Periodontitis is also independently associated with cardiovascular diseases and adverse pregnancy outcomes in some populations.

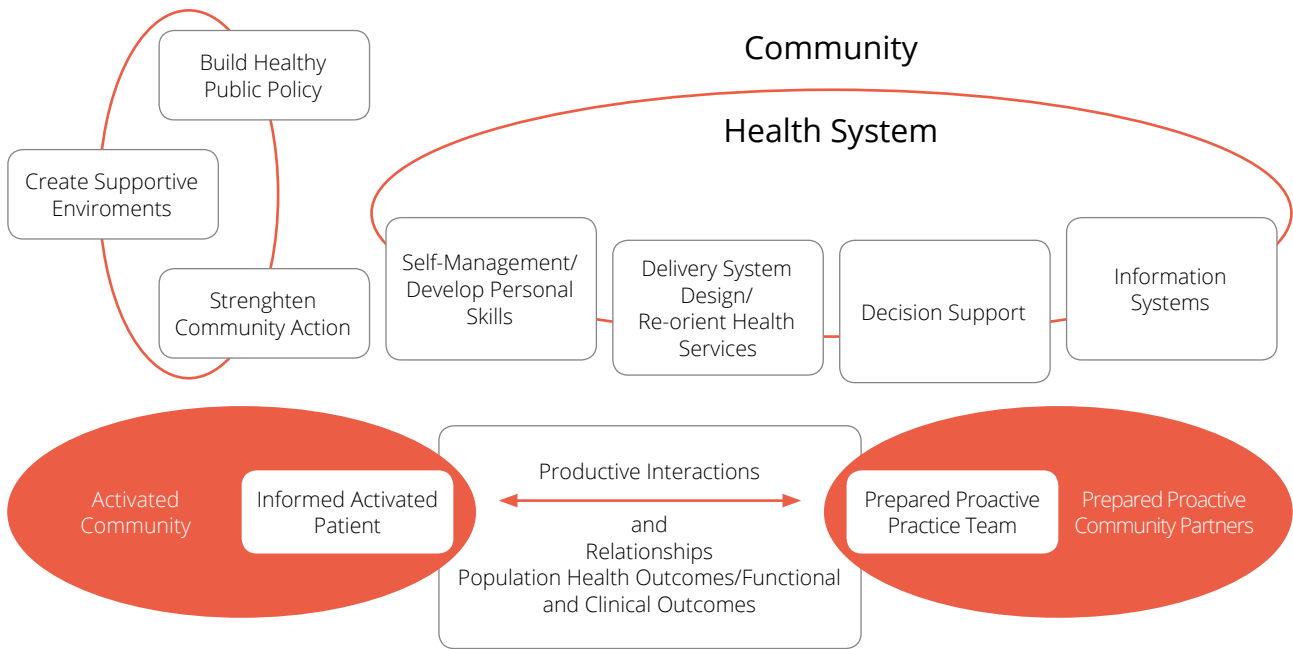


Additional emerging evidence also appears to link periodontitis with nosocomial pulmonary infections, certain types of cancer and rheumatoid arthritis”. In a systematic review<sup>13</sup> on socioeconomic status and periodontal disease, twenty-nine out of 36 studies with a cross-sectional design were in favor of the association between socio-economic factors and periodontal diseases. In the studies with a longitudinal or case-control design, there were five in favor of the association, and also six against. When smoking was included in the analysis of cross-sectional studies, a significant association between socio-economic variables and periodontal disease was found in 11 studies and no significance in another five studies. The corresponding figures for case-control studies showed four studies being significant, but also four studies showing no significance. Based on relevant study designs and including smoking in the analysis, the socio-economic variables associated with

periodontal diseases appear to be of less importance than smoking. There have been studies in various countries (e.g.; Italy<sup>14</sup>, Brazil<sup>15</sup>, Germany<sup>16</sup> and India<sup>17</sup>) that support the hypothesis that poor periodontal health outcomes of immigrants and lower socioeconomic groups are influenced by interrupted lifestyles, lack of resources and impaired access to health care.

**Health Behaviors, Culture and Oral Health**

The Constitution of the WHO presented a holistic definition of health as “a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity”. From this perspective, the roles and responsibilities of health care professionals go beyond the biological and technological sciences and enter the socio-cultural and behavioral domains of health promotion. Patients’ individual preferences and behavioral risk factors



Element	Description
Community resources and policies	Programs and policies that support improvements in health care, including partnerships that identify, create, and support needed services
Health system organization of care	Promotes safe, high quality care through leadership support for quality improvement, and effective coordination of care
Self-management support	Emphasizes patients' responsibility in managing their health through such strategies as setting goals, resolving problems, and devising action plans
Effective delivery system design	Facilitates patient visits and may include specialist expertise or case management
Decision support	Enhances provider adherence to evidence-based guidelines, which are incorporated in daily clinical practice
Clinical information systems	Provide patient data which can be used to plan an individual patient's care, identify relevant subpopulations for care.

Figure 2: Chronic Care Model<sup>32</sup>

Explanation	What do you think may be causing these symptoms?
Treatment	What kind of medicines, home remedies, or other treatments have you used to treat this illness?
Healers	Have you sought any advice from alternative or folk healers, friends or other people who are not physicians/dentists for help with your problems?
Negotiate	Try to find an option that will be mutually acceptable to you and your patient that incorporates you patient's beliefs.
Intervention	Determine an intervention with your patient, that may incorporate alternative treatment, spirituality, and healers as well as other cultural practices (eg, alcohol-free mouthrinse for religious beliefs prohibiting alcohol intake).
Collaboration	Collaborate with the patient, family members, other health care professionals, healers, and community resource providers.

Table 2: Ethnic mnemonic<sup>33,34,35</sup>

are intimately related to their socio-demographic and cultural backgrounds. The resulting oral health beliefs held by patients, and their related risk behaviors, are intimately related to patients' health-related risk behaviors, receptivity to change and ultimately on patients' health outcomes. In order to systematically understand oral health outcomes and to design effective oral health interventions, a variety of theoretical frameworks and conceptual models drawn from psychology and social science have been applied to dentistry.

**Patient centered care and cultural competence**

In addition to the need to utilize culturally and linguistically competent community residents to promote oral health, it is also clear that dental professionals themselves must gain proficiency in providing culturally competent care<sup>19,20</sup> and in enhancing the oral health literacy<sup>19</sup> of the communities they serve.

Patient centered care, as defined by the Institute of Medicine, is providing "care that is respectful of and responsive to individual patient preferences, needs, and values and ensuring that patient values guide all clinical decisions". It is thus self-evident that for such care to be maximally effective it must also be provided in a culturally competent manner. In order to ensure the highest quality care, patients need to be actively involved in decisions about their care and to receive treatment focused on their needs and preferences as well as advice and counsel from providers of care<sup>20</sup>.

It has become well recognized that patient-provider communication, and the interactions between provider and patient, play a crucial role in the effectiveness of treatment and in achieving desired outcomes<sup>22,23</sup>

In a study assessing patient centered care on primary care outcomes, Stewart et al<sup>34</sup> found that patient centered communication was correlated with patients feeling that they were actively engaged in their treatment and finding common ground with their physician. Additionally, positive perceptions were associated with better recovery from their chief concern, better emotional health subsequent to the visit, and fewer diagnostic tests and referrals.

Effective patient-provider communication results in greater patient satisfaction with the care that they receive an increase in patient compliance with treatment and consequently better outcomes. The elements of effective patient-provider communication include the following, to:

- build a relationship;
- open the discussion;
- gather information;
- understand the patient's perspective;
- share information;
- reach agreement on problems and plans;
- provide closure.

Difficulties in communication based on the patient and provider speaking different languages may be addressed by using trained interpreters who facilitate communication between patients and healthcare providers and staff<sup>23</sup>.

Culturally competent care and the use of professional interpreter services were positively correlated with perceptions of quality of care in a study of Asian-American patients with limited English language skills<sup>24</sup>. Most importantly, effective communication is essential to the achieving of positive health behaviors, reducing risk factors and improving outcomes.

However, while overcoming cultural and language barriers is a necessary prerequisite, it is not always sufficient. In cases where even the best culturally competent care is practiced, challenges may arise when there is a need to enhance motivation to change health behaviors in patients who are not motivated to change. In those situations, there may be great value in applying a specific motivational intervention, such as "Motivational Interviewing"<sup>25</sup> with a view to increasing patient motivation to change health behaviors in those patients resistant to or not motivated to change. This intervention is patient-centered and is directly tailored to the patient's readiness to change behavior. Motivational interviewing has been applied to a variety of health behaviors, including alcohol use, smoking, diet, physical activity, pain management, health screening, sexual behavior, medication adherence, as well as to oral health promotion.

**Conclusions**

Expected demographic changes over the next decade magnify the importance of addressing racial/ethnic disparities in health and health care. A framework of organizational, structural, and clinical cultural competence interventions can facilitate the elimination of these disparities and improve care for all populations.

### Start early and involve all:

Establish a child's dental home, preferably at age one, identifying high-risk children and promoting individualized preventive regimens in both medical and dental practice, developing community-based health coordinators to promote ongoing integration of oral health with general health care, developing day-care accreditation standards on oral health, and addressing the oral health needs of caregivers to promote more widespread attention to oral health

### Assure competencies:

Develop common core curricula on oral health for all health professionals and developing accreditation standards, guidelines, and performance measures that assure the inclusion of oral health promotion and, where appropriate, treatment unprofessional training and practice

### Grow an adequate workforce:

Prioritize community-based educational experiences for dentists and hygienists in training; expanding the number of pediatric and public health dentists; engaging allied personnel more effectively, especially in health promotion and disease prevention, and encouraging an expanded number of minority providers in the dental professions<sup>26,27,28</sup>.

### Empower families and enhance their capacities:

Develop media and key-contact campaigns to translate oral health needs into demands for dental educational and treatment services; and using risk-based methods to tailor care to the individual needs of children and their families while respecting family and cultural determinants of health and health behaviors.

## 7 recommendations

- Integrate the provision and promotion of oral health services into all aspects of maternal and child health program implementation, needs assessment, policies, and planning, including all programs and policies affecting children with special health care needs.
- Help train private and public health care practitioners on the oral health needs of children to ensure that these needs are covered in a comprehensive exam.
- Through training and skill building, help to increase the number and quality of dental health auxiliaries to alleviate the provider shortage in underserved areas.
- Apply expertise in providing outreach and other enabling services to ensure that every pregnant women, child and adolescent has access to full comprehensive, oral health services.
- Become involved in the development and/or acceptance of appropriate standards of care as well as more extensive performance measures to monitor what level of dental care children get.
- Collaborate with public oral health programs and

the private dental delivery system and others to raise awareness of the oral health needs of children and young people, ensure access to care, and evaluate existing and novel program approaches.

- Allocate appropriate staff, time, training and funds to identify, target, and help treat high risk children<sup>26</sup>.

Culturally competent healthcare systems that provide culturally and linguistically appropriate services have the potential to reduce racial and ethnic health disparities. When clients do not understand what their healthcare providers are telling them, and providers either do not speak the client's language or are insensitive to cultural differences, the quality of health care may be compromised<sup>28,29,30</sup>.

### Competing interests

The Authors disclose that they have neither financial nor personal relationship with people or organizations that could influence their work.

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## HOW TO CITE THE ARTICLES

- Manfrini F. Between health rights and lifestyles, to better appreciate... Italian food. *SIDO Consensus Conference "Every Mouth has its Tongue"* 2015. available at <http://www.sido.it/pdf/EveryMouthHasItstongue.pdf>
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