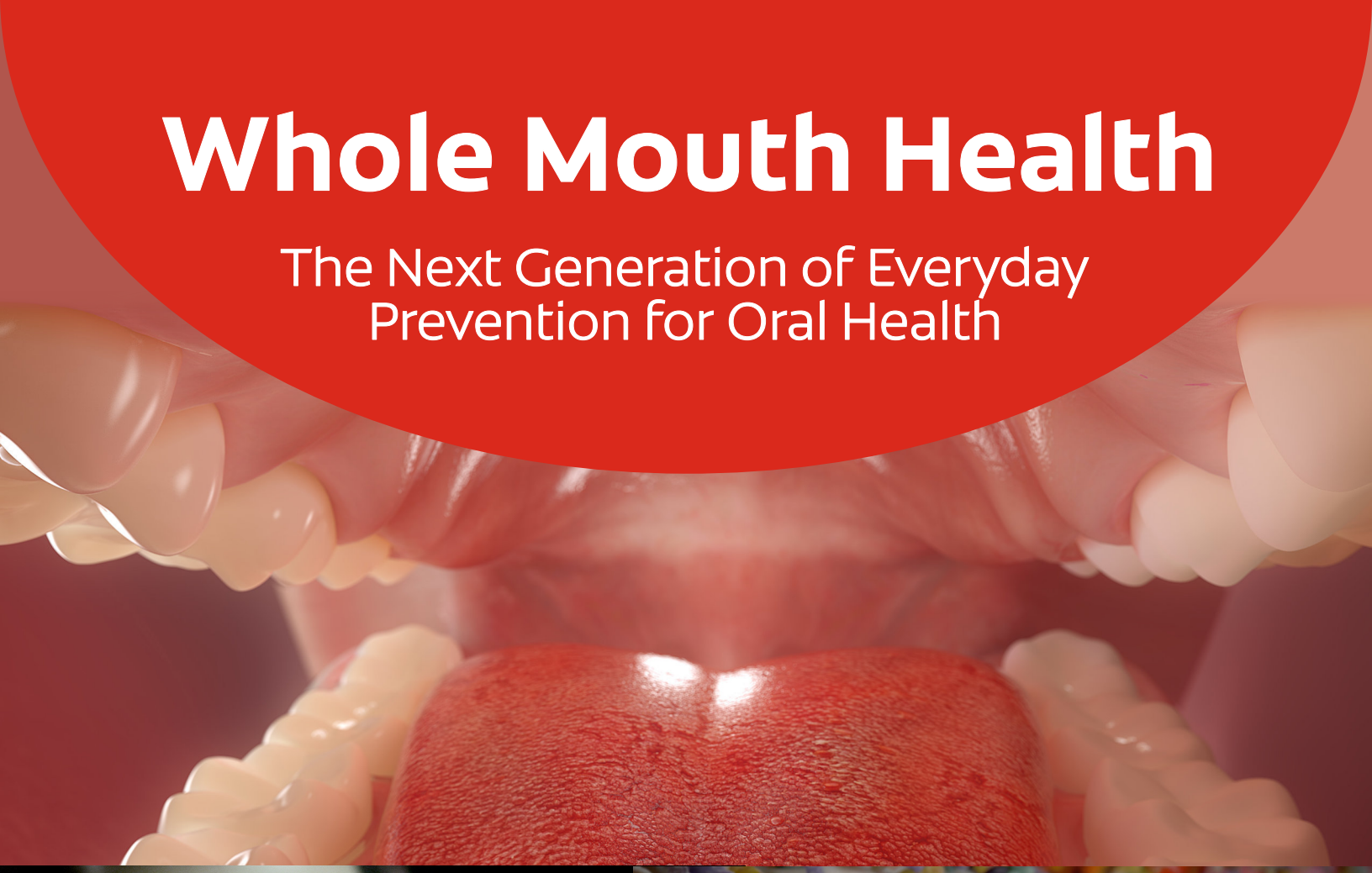
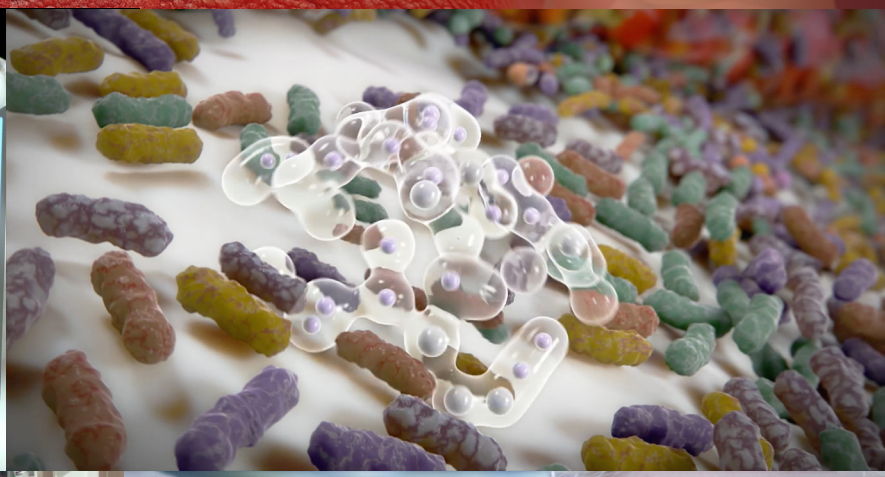
Whole Mouth Health

The Next Generation of Everyday Prevention for Oral Health





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Colgate-Palmolive Company
300 Park Avenue
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Foreword

Colgate is committed to offering everyone a future to smile about. We hold that such a future requires taking responsibility to improve oral health in the world. To realize this goal, Colgate not only continuously works to develop best-in-class oral care technologies, we also create and promote a broad framework of education, increased awareness and prevention activities regarding oral care.

The evolving understanding of mouth biology, modern patient demands and advances in oral care technology drive the need to consider what will be "the next generation of prevention" to achieve and maintain oral health. Colgate believes this need is best met by a Whole Mouth Health approach that elevates the importance of oral prevention and of achieving better oral health outcomes for all patients.

We define "Whole Mouth Health" as a holistic approach that brings together perspectives and insights from oral biology, behavioural sciences, practice management and public health coupled with advanced oral care technologies. Whole Mouth Health takes into consideration a new paradigm of adopting patient-centered dentistry, which can help dental practitioners yield personalized and participatory care focused on patient empowerment and everyday prevention.

A partnership of leaders in dental, medical and behavioural sciences and Colgate developed this white paper, "Whole Mouth Health – the next generation of prevention for oral health." These experts informed both the structure and content of this white paper.

We hope this white paper will inspire dental teams to take a proactive approach about prevention in practice and empower all their patients to achieve Whole Mouth Health.

Whole Mouth Health

The Next Generation of Everyday Prevention for Oral Health

Abstract

Clinical studies well document that patients can prevent tooth decay and periodontal disease when engaged in good oral hygiene practices. However, the continued high global prevalence of these oral diseases, with accompanying significant public health burdens, demonstrates that toothbrushing alone for most people may be insufficient intervention to achieve and maintain good oral health. Therefore, patients' comprehension of oral hygiene must go beyond tooth cleaning goals. Indeed, a more effective approach to everyday prevention of dental diseases may be achieved by the adoption of a Whole Mouth Health model. This standard is consistent with the recognition that oral health is a component of overall, systemic health and wellbeing; the adoption of patient-centered dentistry as a best-practice; and the prioritization of improved patient outcomes via prevention. This new paradigm also would involve the development and use of next-generation therapeutic oral care products that leverage the chemistry and biology of the mouth, particularly the management of the human oral microbiome and control of biofilms on all mouth surfaces — the teeth, tongue, cheeks and gums — to augment the established effectiveness of routine mechanical oral hygiene practices. By encompassing these definitions, concepts, behaviors as well as evidence-based oral care products, Whole Mouth Health can become an achievable new and holistic standard to achieve and maintain oral health.

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Oral Health Diseases Remain a Public Health Burden

One in two: Around the world, about half of the population, some 3.5 billion people (48 percent), has tooth decay, periodontal disease or tooth loss.[2] This substantial public health burden has remained mostly static in the last 25 years,[3] despite known prevention practices and goals to reduce the impact of oral diseases by 2020 set by the World Health Organization (WHO), International Association for Dental Research and the Fédération Dentaire Internationale (FDI)[4] World Dental Federation Assembly.[5]

In 2012, WHO declared that almost all adults have dental caries, as did 60 to 90 percent of school-aged children.[6] Untreated decay of permanent teeth is the most widespread noncommunicable global health condition – affecting about one in three people worldwide for a total of 2.52 billion, according to WHO's 2015 Global Burden of Disease Study, which ranked 291 conditions.[7,8] Decay of deciduous teeth affects 573 million globally (7.8 percent), severe periodontitis, 538 million (7.4 percent), and tooth loss, 276 million (4.1 percent) per the same 2015 study.[9] Notably, almost a fourth of adults older than 70 (23.7 percent) around the world lost some or most of their teeth.[10]

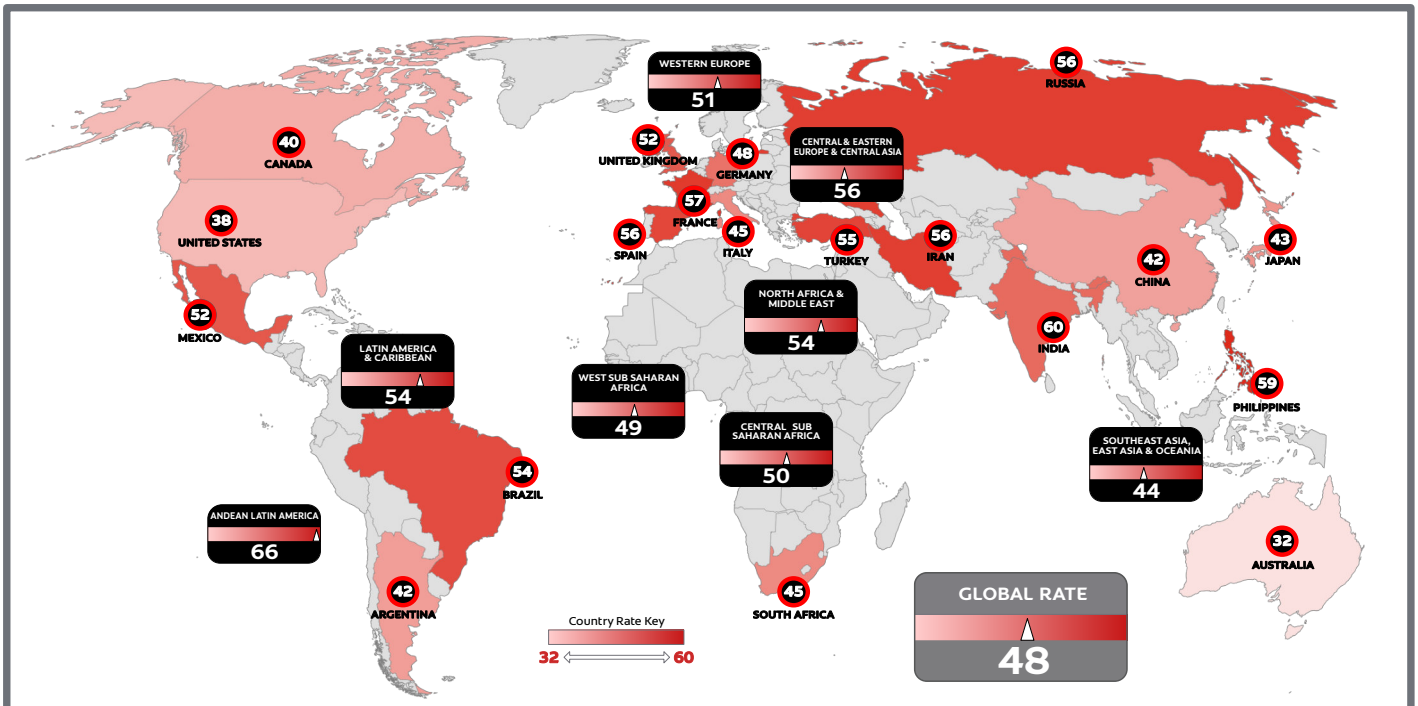
Because of these high rates, global health loss stemming from oral conditions outranks that of 34 types of cancer and is comparable to health loss due to schizophrenia, hypertensive heart disease and all maternal conditions together.[11] Country-level tallies of oral conditions vary because of several factors including social-economic circumstances, behavior and health risks, and deficiencies in data collection.[12,13] While oral conditions are more prevalent in low- and middle-income countries, poor and disadvantaged population groups experience higher oral health burdens in all countries, notes the WHO.[14]

Prevention in Focus

The FDI notes that for reductions in oral conditions and the related expenditures, oral health must be fully integrated into disease prevention and health promotion strategies addressing entire populations who also require access to care[15]

Recognizing what oral health is and its relationship to systemic health as well as having a strong focus on preventative oral health measures are vital to such initiatives and changing the oral disease continuum.

2018 age-standardized per-capita rate for all oral conditions (selected countries & regions)



Oral conditions include untreated dental caries, severe chronic periodontitis and total tooth loss (Adapted from Kassenbaum 2017, Appendix 2 Table 1)

The burden is particularly notable in children because early caries experience has life-long consequences. More than one in four surveyed countries, 27 percent of 209 nations, reported average DMFT* scores in 12 year-olds of greater than 3 to the WHO in 2015, some 245 million teeth.[16] Regionally, DMFT ranged from a high 2.97 in South-East Asia to a low of 1.06 in Western Pacific in 2015,[17] but SCI* scores reveal greater ranges in severity, such as 3.7 in Germany, 3.6 in the US, 4.3 in South Africa, 7.5 in Honduras and 7.1 in China.[18]

With such considerable oral disease burden, the impact on health care budgets is significant. Caries can account for 5 to 10 percent of healthcare budgets in industrial-ized countries.[19] Worldwide dental diseases cost $356.80 billion directly and another $187.61 billion indirectly in 2015.[20] Regionally, high-Income North America, Australasia, Western Europe, High-Income Asia Pacific and East Asia spend the most on dental expenses, while productivity losses related to dental disease are highest in Western Europe, Austral-asia, High-Income North America, High-Income Asia Pacific, and Central Europe. [21]

Because of such a substantial public health burden, modifying current approaches to preventive oral health care is necessary.

Oral Health is Integral to General Health and Wellbeing[23]

In 2000, the U.S. Department of Health and Human Services stated oral disease and conditions can "...undermine self-image and self-esteem, discourage normal social interaction, cause other health problems and lead to chronic stress and depression as well as incur great financial cost. They may also interfere with vital functions such as breathing, food selection, eating, swallowing and speaking, and with activities of daily living such as work, school, and family interactions."[24]

Moreover, untreated tooth decay and periodontal disease have follow-on health effects that can cause harm beyond the oral cavity. Tooth loss impacts the ability to eat and, hence, nutrition, which, for example, in children can be detrimental to growth.[25] Periodontal disease can increase the risk of complications in people with diabetes and may be associated with cardio-vascular disease, gastrointestinal and pancreatic cancers, and, in pregnant women, with increased risk for preterm or low-birth-weight babies.[26]

These implications are addressed by the breadth of a new definition of oral health. In 2016, FDI received global approval and acceptance for their effort to bring precision and clarity to the diverse aspects of defining oral health, including related research, education, practice, policy and advocacy.[27] The definition states: "Oral health is multifaceted and includes the ability to speak, smile, smell, taste, touch, chew, swallow, and convey a range of emotions through facial expressions with confidence and without pain, discomfort, and disease of the craniofacial complex."

> *"Whole mouth health is the absence of oral disease, which is good for your general health, too."*
>
> **—Mariano Sanz**, MD, DDS
> Professor of Periodontology,
> Complutense University, Spain

Significantly, this definition also notes the importance of oral health as "a fundamental component of health and physical and mental wellbeing.... It reflects the physiological, social, and psychological attributes that are essential to quality of life; [and] it is influenced by the person's changing experiences, perceptions, expectations, and ability to adapt to circumstances."[28] This specificity, while recognizing the different aspects of oral health, reinforces that oral health is not isolated from overall health.[29] The description also enables dentistry to consider and support patients in their entirety while striving to preserve and maintain health.[30]

Oral Health Requires Empowering All Patients

To succeed in improving patients' adoption of preventive oral care, dental health professionals can and should go beyond providing just routine care and instead engage patients as coaches helping to motivate and optimize their behavior. This approach is a hallmark of patient-centered care (PCC), which 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."[31]

*The DMFT index records the number of decayed (D), missing (M) and filled (F) teeth (T) and is a measure used calculate population-based estimates of oral health status, frequently among children aged 12 years. A point is added for each of the 32 adult teeth that is either decayed, missing or filled. The Significant Caries Index (SCI) represents an estimate of severity using that averages the DMFT score for the third of a country's population with the highest DMFT scores.[22]

PCC arose from the field of medicine and is gaining adoption as a best-practice in dentistry, as it's foundation of good communication and shared decision making leads to high-quality care and improved oral outcomes in patients.[32,33]

> *"We know that drilling and filling cavities is only relieving the symptoms, not really curing the disease. Prevention of caries and periodontal disease, or their progression, are the keys to maintaining health"*
>
> —**Elmar Reich**, DDS, DMD, PhD, Professor, ZAHNprofiLAXE-Praxis, Germany

PCC is fueled by what is known as the P4 approach to health care, so named for its four attributes: predictive, preventive, personalized and participatory.[34]

To be predictive, P4 uses data analytics and the resulting insights into health can lead to preventive care designed to improve patient health, rather than a sole focus on treating acute illness. Personalized and participatory care means a customized approach to informing the patient and enabling his or her decision making to optimize care.

> *"The modern patient wants to build a relationship with the dentist, hygienist, the assistant and receptionist, so he or she can ask questions and have open communication with the healthcare professional, whomever it is on the team"*
>
> —**Lisa Knowles**, DDS Consultant and Founder, Beyond 32 Teeth, USA

In adapting PCC for dentistry, several models have developed fundamental principles that address respectful interactions with patients for both their physical and emotional support and in consideration of how information is relayed, understood and acted upon.[36] In general, these can be summarized as:[37,38]

The disease context: What is the nature of the oral disease and how is the patient experiencing it?

The patient as a whole person context: How is the oral disease manifesting within the patient's own biosocial circumstance?

The dental team-patient relationship: How is the empathy and compassion expressed by the dental team developing a long-term trusting relationship with the patient that will enhance decision-making?

The dental team-patient shared responsibility: How do both the dental team and patient conceptualize the patient's oral health experience?

Understanding these principles helps dental practices enlist every employee as a member of a coaching team that can surround and engage a patient.

Through thoughtful discussions and active listening, dental professionals can understand their patients better, meet their information needs and address related concerns while supporting their adoption of preventive care that can ultimately improve their oral health and wellbeing.

One key area of preventive care in dentistry is focused on supporting the patient to adopt and maintain an effective daily oral care routine. To address this, the dental team can use proven behavioral approaches to help their patients realize why they might want to change or optimize their self-care routines to achieve and maintain oral health.[39] This engagement can lead to patients setting and agreeing to commit to personal goals. Decision making that resides with patients is a known motivator in aiding oral care compliance. Such positive communication outcomes lead to patient empowerment and feeling valued.[40] Also, dental professionals who incorporate understanding, empathy and non-judgmental interactions into their conversations build a trusting relationship with patients.[41] Praise from dental professionals can

What is P4?

P4 is named for its four attributes: predictive, preventive, personalized and participatory.

P4 medicine proactively uses systems biology and digital technology to gather and analyze data from and for clinical practice, with an emphasis on "quantifying wellness and demystifying disease for the well-being of the individual."[35] Because these explorations involve the calculation and modeling of health and disease at population and patient levels, practitioners can apply and translate the resulting learnings and insights to their individual patients. Moreover, because P4 considers the complex biological interactions underlying health and disease states, its practice is holistic, comprehensive and requires a focus on the entire patient, not just his or her symptoms.

help patients experience feelings of positive accomplishments, which acts as a reinforcement and links their time in the dental chair to rewarding interactions with the dental team, rather than feelings of dread or failure.

> *"An important aspect of behavioral reinforcement is having a reward directly linked to the behavior that you're trying to reinforce. Like people realizing that tooth brushing takes away the fuzzy teeth feeling, which is the biofilm, and creates a clean mouth feeling, a reward itself that reinforces the desired oral care behavior"*
>
> —**Eleanor Putnam-Farr**, PhD, MBA
> Assistant Professor of Marketing,
> Rice University, USA.

When successful, the use of PCC principles in chairside connections helps patients become open to the dental team sharing and reinforcing prevention-based oral hygiene standards and behaviors, beyond the basic "tooth brushing conversation".

Helping patients to recognize that both hard (teeth) and soft (tongue, cheeks and gums) tissue surfaces play roles in the mouth's complex ecosystem can increase their understanding of the value of preventative oral care. Dental professionals can further share information on oral health risks and disease, assist in real time with optimized techniques and instruct on oral care product benefits. They should also be prepared to provide further knowledge re- sources, such as a website link, as part of the visit. In this age of immediate information, many patients want instant access to explanations or statistics while pursuing answers to their questions.

Through this dialogue, the dental team can readily evaluate whether patients fully grasp the importance of a daily self-care routine, while also helping patients assess if they can execute related tasks with precision or completeness.[42] Additionally, patients should be helped to develop a fuller appreciation of the impact of behavioral factors on their oral health, such as the need to reduce dietary sugar, tobacco smoking or unhealthy use of alcohol or improve a poor diet.[43,44]

In sum, such discussions help patients in two major ways: They become open to investing in their oral health every day to benefit their overall health and they improve their health literacy, which influences their ability to comply with guidance and engage in effective self-care practices.[45] Of note, these conversations and generally PCC approaches should extend to all types of patients because of the strong effects that the "expert" information transferred by the dental team can have on future, long-term behavior.[46]

When successful, patient centric care results in dental patients who recognize the importance of oral health in their general wellbeing, comprehend how their overall health and behaviors influence their oral health, and adopt good preventive oral care as part of their everyday health.[47,48] Long-term clinical studies document that PCC activities and communications combined with regular professional dental cleanings and effective plaque removal through improved self-care with appropriate oral care products do result in improved oral health.[49]

Oral Health Relies on Daily Self-Care

Twice-daily tooth brushing, and maybe flossing, for some patients is just a cleaning behavior – food debris is cleared, teeth feel cleaned and breath is freshened. Their greater recognition of the role of daily oral care as prevention against common oral diseases may not be significant, let alone their appreciation of its impact on their overall health and quality of life.

Patients' daily self-care to manage oral biofilms, and simultaneously prevent common oral diseases like caries and periodontal diseases, should entail brushing with fluoride toothpaste supplemented by additional effective antimicrobial agents. Toothpastes are ideal because of their ubiquitous availability in a variety of formulations devised to deliver actives and employ features patient expect, such as a pleasant taste, that also aid compliance.[50, 51]

The evolution of toothpastes has incorporated ingredients to improve oral health and provide a variety of

How to Engage Patients in their Daily Oral Health

1. Ask questions to elicit patient's personal oral health goals.
2. Provide one or two specific personalized recommendations.
3. Explain clear and perceptible benefits of these recommendations.
4. Work to gain the patient's commitment to his or her oral health goals.
5. Provide appropriate oral care product samples that relate to patient needs.

functions. Ancient toothpastes, dating to 5000 BC Egypt, varied in ingredients from powdered ox hooves' ashes to burnt eggshells to pumice to crushed oyster shells.[52] Modern toothpastes and mouthwashes add ingredients to help prevent or treat specific oral diseases and conditions beyond keeping teeth and gums clean, such as decreasing tooth sensitivity or enhancing tooth whiteness.[53]

Fluoride has been added to toothpastes to help prevent dental decay since 1914.[54] Fluoride inhibits formation and halts progression of caries and helps reverse those at an early stage.[55] Successful studies of fluoride-enhanced water supplies in the US and Canada led to recommendations for fluoride incorporation into public water supplies by the U.S. Public Health Service in the 1940s and 1950s.[56] The efficacy of water fluoridation in preventing and controlling dental caries spurred a variety of fluoride-incorporating oral care products.[57] Studies document that fluoride concentrations of 1,000 to 1,500 parts per million in toothpaste renders tooth enamel less susceptible to the deleterious cavity-causing oral bacteria in dental plaque, reducing caries by 20 to 30 percent.[58]

Augmenting toothpaste formulations with antimicrobial actives has aided in reducing the growth and metabolic activity of gum dwelling harmful bacteria to thwart biofilms and dental disease.[59] For example, a toothpaste containing fluoride and an antibacterial has been shown in clinical studies to significantly reduce plaque, gingivitis, bleeding gums and tooth decay[60] as well as the regrowth of plaque biofilm.[61, 62]

Since the incorporation of fluoride and antimicrobials into toothpastes, new research of the oral bacterial population's diversity and function has added to the understanding of the oral microbiome and revealed the opportunity for optimized use of antibacterials. "Today, many mechanisms might explain why agents have limited efficacy in controlling the mouth's microbes when formed into biofilms vs floating more freely in the oral cavity. These mechanisms include the microbe's slow growth rates, their responses to stress and their biological development to tolerate agents, as well as the ability of the biofilm structure to prevent the agent's penetration."

New knowledge about the oral microbiome is informing the development of next-generation oral care products aimed at more effectively reducing the bacteria by only "just enough" to control the risk of dental disease while creating and supporting their beneficial functions consistent with health. Such antibacterial product designs, when successful, would likely control biofilm and promote oral health through subtle, more targeted effects.

Oral Health Must Address the Microbiome

The human microbiome is the community of microorganisms that exist on and within the human body, usually harmoniously.[63] These organisms obtain food or other benefits from people via a symbiotic and commensal relationship and in return play a defining role in overall human health,[64] including digestive track maintenance, host defense and antiinflammation activity among other tasks.[65]

Human microbial cohabitants comprise a very large community, almost the same in number as the body's cells. Overwhelmingly, these corporal residents are different strains of bacteria,[66] but also include varieties of fungi, viruses, protozoa and other microorganisms.[67]

Recent studies, newer technologies like genetic sequencing and mapping, and data analytics escalate both the amount of data available about the dynamic nature of the human microbiome as well as the understanding of its participation in human health status.[68] For example, the enormous public-private

collaboration of several U.S. federal agencies, academic institutions and nonprofit organizations participating in the National Microbiome Initiative supports interdisciplinary studies addressing the fundamental questions about microbiomes in humans and other ecosystems.[69] The Initiative also develops platforms to crunch data and share the information and resulting insights,[70] revealing new perspectives of the dynamic role of the microbiome in health and disease.

Understanding the Oral Microbiome

Awareness of the human oral cavity microbiome traces back to van Leeuwenhoek's 1683 report of observing animalcules in his tooth plaque, "white matter, which is as thick as if twere batter."[71] Since then, nearly 5,000 peer-review publications have shared the results of oral microbiome research, more than 40 percent of which have appeared since 2011.[72]

Catalyzing such investigations are a variety of efforts, notably the Human Microbiome Project (HMP) of the U.S. National Institutes of Health, which is characterizing the microbiomes of the oral cavity and four other body areas of healthy people.[73] Data from the HMP and other programs has informed the Human Oral Microbiome Database, a project of the U.S. National Institute of Dental and Craniofacial Research (NIDCR), which already has tallied more than 770 species in the human upper digestive and upper respiratory tracts, including that dwelling in the oral cavity, pharynx, nasal passages, sinuses and esophagus.[74]

In the human oral cavity, billions of microbes comprise an ecosystem that colonizes both the hard tooth surfaces as well as the soft mucosa tissues.[75] When this ecosystem is in balance, health usually prevails. However, hygiene, diet, tobacco use, stress and other factors can lead to imbalances, a state called dysbiosis, with associated detrimental health effects.[76,77]

Symbiotic and Dysbiotic Biofilms

Most oral bacteria exist in a complex community called a bio-film, which plays a significant role in dental disease. Bioflims occur when heterogeneous bacteria weave into an integrated matrix by attaching to each other or oral surfaces and adhering to the polymer-like substances they produce.[78]

The properties of biofilms are more than just the sum of their constituent species. These properties result from the synergistic or antagonistic effect of their multi-species bacterial communities and can be helpful or harmful to oral health. Biofilms possess their own rate of growth, genetic activity and functionality[79] different from other planktonic oral microbiome occupants. Bacteria in biofilms are influenced by their specific, residential environment, and their communal signaling ability can influence the human immune system's inflammatory response.[80,81,82,83,84]

Mouth movements, like those during talking and eating, as well as saliva flow can move shreds of plaque, a tooth-surface biofilm,[85] within the mouth.[86] Biofilm fragments in saliva and the fluid within crevices between teeth and gums serve as reservoirs to recolonize teeth.[87] Both the composition and functionality of biofilms on the hard and soft tissues of the mouth can vary significantly within a person based on oral niche, timepoint or life stage, as well as from person to person.

In a healthy state, biofilms form on the teeth and soft tissues from benign, "friendly" bacteria that include

those of the genera *Neisseria, Streptococcus, Veillonella, Granulicatella, Gemella, Prevotella, Rothia, Fusobacterium* and *Actinomyces*.[89, 90] Beneficial biofilms shield against non-oral microbes and restrict the growth of pathogenic microorganisms associated with common oral diseases like caries and periodontal diseases. By maintaining a neutral pH that balances acid and alkali production, for example, symbiotic biofilms help create a balance between the microbiome and oral cavity tissues.[91,92,93,94,95]

However, if a healthy oral microbiome is perturbed by changes in an individual's physiology or behavior, dysbiosis can occur. In milder detrimental states, dysbiotic oral biofilms contribute to common concerns like oral malodour, generated when certain bacteria metabolize the proteins and amino acids left behind after eating and drinking into airborne sulfur compounds such as hydrogen sulfide and methyl mercaptan.[96]

> *"In a healthy mouth, 'good' bacteria are predominant with a sparse population of 'bad' bacteria. But when bad bacteria actually reign over good bacteria, this microbiome is in a state of dysbiosis, which is harmful to oral health"*
>
> —**Lakshman Samaranayake**, DDS, Hon DSc
> Professor Emeritus of Oral Microbiology, The Hong Kong University, Hong Kong

In an enduring state of dysbiosis, biofilm progression at the gingival margin can lead to gingivitis inflammation and changes in the bacterial population, favoring *Porphyromonas gingivalis, Treponema denticola, Tannerella forsythia* and *Aggregatibacter actinomycetemcomitans.* These bacterial strains undermine and inhibit the response of the immune system, further increasing bacterial diversity[97,98,99,100,101] and resulting in infection and possible destruction of the bones and tissue supporting teeth.[102, 103]

More deleterious dysbiotic states may also promote cariogenic bacteria. For example, frequent contact with dietary sugars prompts ongoing bacterial-enabled conversion to acid, shifting the oral environment to favor growth of decay-causing bacteria such as *Streptococcus mutans.*[104] Moreover, some bacteria decrease their production of acid-neutralizing alkalis,[105] reducing their protective effect on dental caries.[106,107,108]

Because dysbiosis propels disease development and progression,[109] preventing it is a key goal of proactive oral care. Dental professionals need to help patients understand that overall biofilm control –removing the "fuzzy coating" from their teeth — via brushing paired with the use of appropriate oral care products is an accessible and effective way to control and manage bacteria throughout the whole mouth, specifically on teeth, tongue, cheeks and gums. Newer oral care products formulated to optimize the whole mouth's microbiome should help patients sustain ideal oral health conditions throughout life.[110,111,112.113,114,115]

Oral Health Needs Next-Generation Oral Care Products

Numerous studies support that decreasing bacteria in the whole mouth through the use of an antimicrobial correlates with significant reductions in plaque, gingivitis, and other harmful biofilm-related oral diseases.[116] Further benefits associated with bacterial control of antimicrobial formulations or with the action of additional components to include positive effects on enamel leading to whiter teeth and fresher breath.[117,118,119,120,121,122,123]

But given the recent advances in understanding the role of microbiome oral health, as well as the various factors that may lead to a dysbiotic state, the demands for new oral care products with improved effectiveness are expanding. The action of dentifrice ingredients now must be broader than simply enhancing mechanical plaque control and more refined than blanket reduction of the bacterial mass.

For example, antimicrobial ingredients for oral care products could better safeguard the mouth micro-

Periodontal Disease Diversity

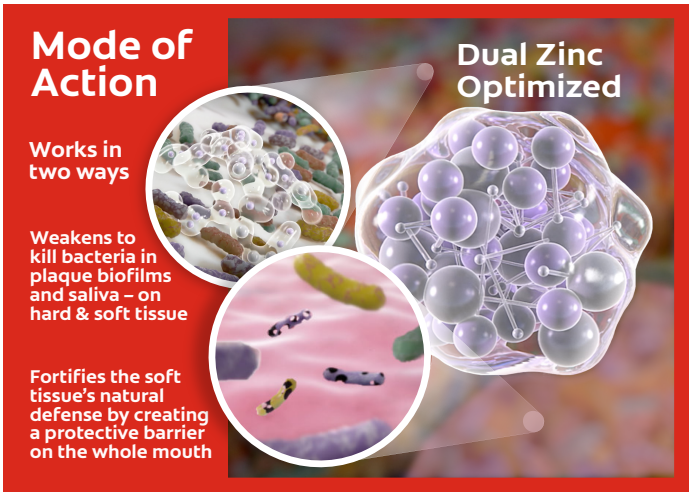
Periodontal disease may not be a single disorder. Rather, it may be a group of harmful conditions, each with a distinct genetic, bacterial and inflammatory signature, according to NIDCR-funded genome-wide association study analyzed DNA from about 1,000 people with different severities of periodontal disease.[110] Despite this diversity, effective biofilm control through daily oral hygiene remains a key strategy towards preventing occurrence and progression of periodontal diseases.

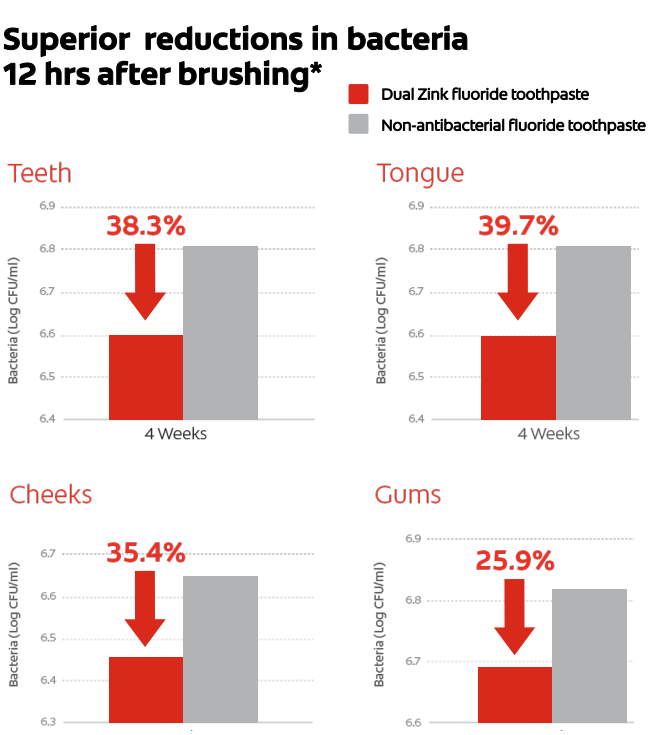
biome balance on all mouth surfaces. The design of such products could seek to subtly control the overall mix and amount of bacteria through more targeted action, enabled by more actives' effective penetration of biofilm.[124] This approach likely would benefit health-associated bacterial communities and reduce the proliferation of harmful bacteria and the related risk of dysbiosis and disease-provoking bacterial behaviors like acid production or the stimulation of the human immune response.

> *"I like the idea of a product that could address biofilm on all mouth surfaces, not just the teeth or gingival, but also on the cheeks and the tongue."*
>
> —**Ann Eshenaur Spolarich**, PhD, RDH
> Professor of Clinical Medicine and Pharmacology, Director of Research,
> A.T. Still University
> School of Dentistry and Oral Health, USA

Moreover, antimicrobial ingredients should be made available beyond the tooth structure to address the diverse microbes that occupy the 80 percent of the mouth comprised of soft tissues.[125] Even patients who routinely brush and floss effectively harbor soft tissue biofilms reservoirs[126] in the oral mucosa. Oral care products must also retain two baseline performance criteria: efficient delivery of active agents to both the hard and soft mouth tissues during brushing and 12-hour duration of action and retention on these surfaces.[127,128,129]

A recently developed formulation with promising performance against these criteria contains a specifically designed combination of dual zinc in a fluoride toothpaste.





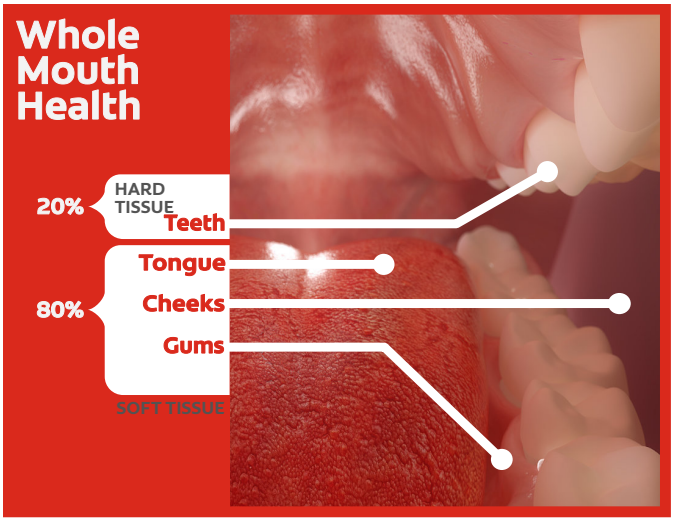
*Statistically significant greater reduction of cultivable bacteria on teeth, tongue, cheeks, and gums with Dual Zinc toothpaste vs. non-antibacterial fluoride toothpaste at 4 weeks, 12 hours after brushing. (Prasad & Mateo, July 2016, internal report)

Zinc: The Trace Element with Oral Health Benefits

The element zinc is found in trace amounts in the human diet yet has an array of health benefits. Zinc is essential for many aspects of general body metabolism.[130] When formulated and dosed appropriately, Zinc has proven therapeutic applications, such as reducing the length of the common cold and enhancing the healing of wounds.[131,132,133] As an antioxidant, Zinc has defensive roles to counter oxidative stress, including protecting against aging and supporting regenerative processes such as DNA and protein production[134,135,136] Zinc also impacts all three primary enzymatic functions: catalysis, regulation and structural integrity.[137,138,139]

About 95 percent of human cells contain zinc,[140] including skin tissues and tooth enamel and dentin, and it is found in plaque biofilms and saliva.[141] Zinc is, therefore, presumed to be present in the oral mucous membranes and soft tissues.[142]

As an antimicrobial, free zinc [Zn2+] is the most effective form but has rather modest activity.[143,144,145,146] Research suggests the zinc ion's mechanisms of antibacterial action may include inhibiting or suppressing



The teeth make up only 20% of the total surface area of the mouth

bacterial metabolism, and their nutrition, as well as co-adherence with neighboring organisms or human cells.[147,148,149, 150,151,152]

Zinc combined with citrate is readily available in fluoride toothpastes. Zinc-citrate imparts a certain stability in the dentifrice but is easily broken down in the mouth to elevate zinc levels in saliva and plaque [153,154] Zinc-citrate fluoride toothpastes have been shown able to prevent, control and reduce plaque,[155,156] significantly reduce gingivitis and malodour,[157,158, 159, 160] inhibit the crystal growth that builds dental calculus,[161,162] and maintains gingival health.[163,164]

While zinc is generally known to be effective as an antibacterial, its inclusion in oral care formulations has been beset with a number of drawbacks. To utilize zinc most effectively, it is necessary to provide sustained release to allow the metal to build up in the targeted oral tissues, a considerable challenge for a product that is present in the oral cavity on average two minutes per usage.

At the same time, because zinc is naturally present in the human body, host regulatory mechanisms are able to rapidly utilize the amount of available zinc. Hence, its substantivity as well as retention are common formulation challenges, along with neutralization of the specific taste that could prevent patients' ac- ceptance as a product for daily use.

Hence, considering the acknowledged properties of zinc and recognizing its untapped potential to deliver even more effective and targeted antimicrobial efficacy, using this naturally occurring element in a toothpaste designed for the next generation of every-day oral care appears as an obvious option.

Dual Zinc: The Formulation with Abundant Oral Health Potential

Because of zinc's numerous health benefits and activity on biofilm, combining in a fluoride toothpaste could benefit patients more comprehensively than fluoride toothpaste alone. A specifically formuated combination of different species of zinc, known as dual zinc, in a fluoride toothpaste should enable the de livery and retention of ingredients to teeth, tongue, cheeks and gums for targeted action on biofilms and - pH balance.[170] The combination of dual zinc delivers new advances towards modulating the composition and functionality of the oral biofilm, optimizing delivery and bioavailability of zinc to the oral biofilm, and supporting the natural defense mechanisms against dysbiotic oral pathogens.[171] Dual zinc is designed to inhibit bacterial nutrient uptake, metabolism and aggregation, which weakens the organisms and biofilm architecture while permitting natural balancing and clearance of the biofilm. This novel formulation also generates a protective mineral shield on both hard and soft tissue, further limiting bacteria adherence and regrowth, and strengthening all mouth surfaces (teeth, tongue, cheeks and gums) against day-to-day challenges.

The dual zinc formula has been proven to deliver comprehensive benefits and improve patient outcomes: A clinical study indicated the efficacy of the combination of a dual zinc fluoride toothpaste to reduce whole mouth bacteria after 12 hours. The bacterial load was reduced significantly by up to 38.3 percent on teeth, 39.7 percent on the tongue, 35.4 percent on cheeks, and 25.9 percent on gums, compared to a regular fluoride toothpaste, after six months of use.[172]

In a second six-month clinical study, the dual zinc formulated fluoride toothpaste significantly reduced plaque and gingivitis by 30.1 percent and 26.3 percent, respectively, when compared to ordi- nary non-anibacterial fluoride toothpaste.[173] Moreover, in addition to its potential to prevent caries and gingivitis, the new formulation has been shown to reduce stains,[174] tartar,[175] hypersensitivity[176] and oral malodour. [178]

By working with the biology and chemistry of the mouth, the dual zinc fluoride toothpaste goes beyond just teeth cleaning to protect against common oral

diseases. As part of a twice-daily regimen, it could become the cornerstone of oral care helping patients be proactive about achieving and maintain whole mouth health.

Oral Health is Whole Mouth Health

The ongoing unmet global need for improved oral health requires a proactive approach to prevention that includes optimized oral care products. The improved understanding of mouth chemistry and biology and the principle that oral health is essential to an individual's general health and wellbeing are driving a new holistic standard-of-care focused on whole mouth prevention.

This approach requires state-of-the-science tools, such as next-generation therapeutic oral care products capable of maintaining a healthy oral microbiome, particularly the control of bacteria and biofilms on all mouth surfaces. A dentifrice containing dual zinc was shown to be efficacious in clinical studies and provides multi-faceted and balanced biofilm management for the prevention of common oral diseases.[179 , 180 181182 183 184,185]

By adopting such toothpastes into daily oral hygiene regiments, patients should achieve better whole mouth protection resulting in clinically meaningful reductions in oral diseases, whiter teeth, fresher breath, food acid neutralization and tooth sensitivity.

This new paradigm will be effective by shifting the focus of dentistry from a cure approach centered on teeth to a care approach centered on patients that recognizes their health, behaviors and beliefs. Practices that team together to coach patients enable their comprehension of the relationship between preventive care and preserved health as well as encourages their empowerment to make self-care decisions. Joint professional-patient prioritization of improved long-term oral outcomes over immediate delivery of routine cleanings and acute oral care also will sustain and grow mutual efforts toward durable oral health goals.

With prevention as a defining direction, this approach is well positioned to make the health of the whole mouth — teeth, tongue, cheeks and gums — an achievable new and holistic standard of everyday prevention in oral health.

Elements of Whole Mouth Health

- Whole Mouth Health is an achievable holistic standard for oral health.
- Oral health is a component of overall, systemic health and wellbeing.
- Oral hygiene means preventive care for the teeth, tongue, cheeks and gums.
- Preventive oral care improves patient outcomes.
- Patient-centered dentistry is effective to empower patients to enhance their oral care.
- New oral product technologies should help control bacteria and biofilm on of all mouth surfaces.

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