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The conclusions of the 2nd Meeting of the Brazilian Oral Health Panel

Mônica Andrade Lotufo
Assistant Editor

The "Brazilian Oral Research" (BOR) Journal publishes articles on basic and on applied research, as well as a supplement featuring the Annals of the SBPqO Anual Meeting. Only occasionally does the BOR put out special issues of broader interest to the dental community, with the support of corporate partners from the Dentistry marketplace.

The present special issue was based on the 2nd Meeting of the Brazilian Oral Health Panel, where several Brazilian researchers discussed important topics pertaining to oral health problems affecting the Brazilian population. The result of this meeting was a collection of up-to-date literature review articles covering the principal points discussed at the panel.

Although counting on the financial support of a corporation, all of the articles were duly submitted to at least two *ad hoc* reviewers and were accepted only after all of the comments and suggestions were fully addressed.

Based on the positive reader response to the special issue published previously (Vol. 21, Special Issue 1, April 2007), the BOR proudly presents this new special issue featuring articles resulting from the 2nd Meeting of the Brazilian Oral Health Panel. We on the Journal's Editorial Board greatly value the opinion of our readers and welcome any comment or suggestion in regard to the publication of special issues, so that we may plan future releases of this kind. Our email address is *bor@sbpqo.org.br*.

We also wish to thank the contribution and participation of all the members of the 2nd Meeting of the Brazilian Oral Health Panel.

Combining efforts to solve Brazil's oral health problem

Kátia Regina H. C. Dias
President of the SBPqO

In October 2007 the Johnson & Johnson Company (Johnson & Johnson do Brasil Indústria e Comércio para Saúde Ltda.) hosted the first meeting of the Brazilian Oral Health Panel in the city of São Paulo, a meeting of renowned professionals in dentistry, including some partners of long-term projects, such as the "Boca Limpa, Saúde Total" (Clean Mouth, Total Health) and the "ASBLA – Atualização em Saúde Bucal Latino-Americana" (Update on Latin American Oral Health).

The aim of the meeting was to create a panel to discuss oral health in Brazil. The group was formed by representatives from different regions in the country and of various specialties, such as Restorative Dentistry, Epidemiology, Pediatric Dentistry, Periodontics and Prosthodontics. The idea was to discuss dentistry-related problems that affect the Brazilian population, mainly caries and periodontal diseases. In addition, the discussion addressed causes and treatments, and determined the best way to spread the message of prevention in public health.

The first meeting of the Brazilian Oral Health Panel addressed epidemiological data from the survey developed by the Brazilian Ministry of Health and published in 2003. The panel noted that Brazil has advanced in the prevention of caries in children, in the past decade; however, the situation among adolescents, adults and the elderly is still one of the worst in the world. Even among children, gingival problems and difficulties in obtaining dental care persist. Striving to change this framework, the Federal Government established a National Policy on Oral Health, through the "Brasil Sorridente" (Smiling Brazil) Program, which combines several actions in oral health, geared to people of all ages.

The group concluded that, despite the efforts of the Federal Government and the creation of programs addressing oral health and culminating in the reduction of the DMFT in some cities, the situation remains alarming, since much of the Brazilian population still has no access to preventive care or even dental treatment. Something must be done. Short- and long-term actions need to be implemented. How can the group contribute to solving the problem?

With the support of Johnson & Johnson (Johnson & Johnson do Brasil Indústria e Comércio para Saúde Ltda.), all the participants of the group have volunteered to develop and publish proposals for short- and long-term actions, aiming at reducing the prevalence of caries and periodontal disease, and thus impacting public health favorably.

The results of the literature, the clinical and the laboratory reviews performed by the group are now being released in a special issue of BOR sponsored by Johnson & Johnson, strictly observing all the peer-review publishing procedures.

This special issue presents five review articles:

- Oral Health in Brazil – Part I: Public Oral Health Policies
- Oral Health in Brazil – Part II: Dental Specialty Centers (CEOs)
- Reviewed evidence about the safety of the daily use of alcohol-based mouthrinses
- Association between periodontal diseases and systemic diseases
- Halitosis: a review of associated factors and therapeutic approach

The solution to our problems cannot be expected to come from the government! Something needs to be done imperatively. Teachers, researchers and opinion leaders on one hand, and an insightful multinational company on the other hand, share a commitment to seeking solutions to the oral health problems affecting Brazil. It's a partnership that is bound to succeed!

Contents

Oral Health in Brazil – Part I: Public Oral Health Policies

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Abstract: This paper reviews the historical development of public health policies in Brazil and the insertion of oral health in this context. Since 1988, Brazil established a Unified National Health System ("Sistema Único de Saúde" - SUS), which was conceived to assure access to health actions and services, including oral health. However, a history of lack of access to health services and the health problems faced by the Brazilian population make the process of building and consolidating the SUS extremely challenging. Since 2004, the Oral Health National Policy has proposed a reorientation of the health care model, supported by an adaptation of the working system of Oral Health teams so that they include actions of health promotion, protection and recovery. Human resources should be prepared to act in this system. The qualifying process must take in consideration knowledge evolution, changes in the work process and changes in demographical and epidemiological aspects, according to a perspective of maintaining a balance between technique and social relevance.

Descriptors: Public health / history; Health policy; Oral health; Brazil.

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Introduction

Over the last few decades, there have been great changes in the political, social and economic scenarios in Brazil. The nation restored democracy at the end of the 1980s after more than 20 years of military dictatorship, thus regaining the right to freedom of expression in matters concerning public policy guidelines, including in the health area.

The Human Development Index (HDI) in Brazil was 0.80 in 2005, a result that, for the first time, placed Brazil among the nations with the highest human development indexes.[1] Compared to the previous years, Brazil has advanced in three dimensions of the index: Longevity, income and education.

The indexes of inequality in income distribution have presented discrete reductions between 1990 and 2001, but in spite of falling, according to the World Bank, Brazil is one of the countries with the greatest social inequalities in Latin America and in the world.

In search for an explanation for social exclusion in Brazil, Pochmann, Amorim[2] (2003) have reported on its novel characteristics. According to these authors, social exclusion was initially marked by economic, political and social underdevelopment and by the genre of capitalism reproduced here, which was responsible for keeping a historically marginalized population distant from the fruits of economic growth. Thus, regions with broad exclusions marked by poverty, hunger, low income and low educational levels were created, which most frequently involved migrants, the illiterate, women, large families and the Afro-Brazilian population.

A new social exclusion has followed and may be explained by the increase of a significant part of the population that stands in a situation of social vulnerability. It affects social segments that were previously relatively preserved from the social exclusion process, such as young people with a high educational level, people older than 40 years of age, non Afro-Brazilian men and monoparental families. It is characterized by unemployment, informal work, urban violence explosion and by vulnerability of youth.[3]

Countries in Latin America, including Brazil, suffer from bad income distribution, illiteracy and low levels of education as well as precarious housing and environmental conditions, decisive factors in the population's life and health conditions.

The importance of the complexity of the health-illness process is the first step towards understanding that public policies, including oral health, must be directed to the well being of the population in general, guaranteeing the people's quality of life.

But for a country that has its roots profoundly anchored in a past of social exclusion and inequality of income distribution, there are still sectors that have to be developed and consolidated. In order to diminish social exclusion, access to essential goods and services, which directly impacts on the life quality of the population and, consequently, on the quality of public health, needs to be improved.

This paper reviews the historical development of public health policies in Brazil and the insertion of oral health in this context.

The Brazilian health system

Until the Constitution of the Republic was promulgated with the creation of the "Sistema Único de Saúde" - SUS (Unified National Health System),[4] the health sector was historically organized in a dichotomic way: on one hand, a public health sector and, on the other, a social security assistance sector.[5]

The public health sector, connected to the Ministry of Health (MS) and the State (SES) and Municipal (SMS) Secretaries of Health were responsible for controlling endemics and epidemics and implementing vaccination actions and sanitary education with a repressive style of intervention at the individual and social levels. The social security assistance sector was responsible for providing ambulatory and hospital medical assistance only for formal workers and their dependents.[6,7] When a citizen was registered in the formal job market, a monthly contribution to social security was deducted from his/her salary to assure the right to health care services, but only to this sector of the population.

A movement known as the Sanitary Reform, based on popular battles against the military dictatorship and maintained by different social segments, sought to implement a unified national system of health in the country (no longer divided between public health and social security) and for all citizens (not restricted to formally employed workers).

This movement was also influenced by a global proposal of Health Promotion, conceived to go beyond the limits of the health sector and that calls for an articulation with other sectors and for a stimulus of social participation, as stated in the Declaration of Alma-Ata in 1978 and in the Ottawa Letter in 1986.

In Brazil, the 8th National Health Conference (CNS) was held in 1986. It brought together organized civil society representatives, health care workers and managers of health services. On this occasion, a document was written "for the democratization of health care and society" with proposals for the organization of a health system according to the ideas of the Sanitary Reform.

During this period a National Constituent Assembly was being created and the representatives would be responsible for the creation of a New Constitution after the fall of the military regime. There was great political agreement among the members of the Assembly and the participants of the 8th CNS that the main deliberations of the Conference be accepted.[7]

The new Constitution of the Republic[4] acknowledged health as being a right of every person and a duty of the State, and it instituted the "Sistema Único de Saúde" - SUS (Unified National Health System). The SUS is not a service or institution but rather a system that comprehends a set of facilities, services and actions that interact with a common objective. It was designed to have the same organizational principles throughout the national territory.

The principles of this system, among others, are universalization, where access to actions and health services is guaranteed to each and every citizen; decentralization, where management has a sole command in each sphere of the government (federal, state and municipal) and the system is organized according to local needs (an important aspect since the national territory is vast and has great social, economic and epidemiological differences); integrality, because health services, in their diverse degrees of complexity, should develop actions of promoting, protecting and restoring health; participation of the community in the decisions related to health care by means of Health Advisors; and complementariness of the private sector, whether by contracting services when there is insufficiency of these by the public sector, or by allowing private enterprise to offer health services to the population.

After such a long history of lack of access to health services and given the health problems faced by the Brazilian population, characterized not only by the diseases prevalent in developed countries, but also by chronic-degenerative illnesses, one can imagine the extent of the challenge of building and consolidating the SUS.

The Brazilian oral health system

Implementation of public oral health care began in the decade of 1950 with the creation of the Dentistry Subsector connected to the "Serviço Especial de Saúde Pública" - SESP (Special Service of Public Health Care). It had been created in 1942 by means of an Agreement of Technical Cooperation between the governments of Brazil and The United States and maintained with the support of the Rockefeller Foundation. During the following decade, the SESP began to expand its action nationally, and was transformed into the Public Health Care Services Foundation (FSESP) connected to the Ministry of Health.

The two main actions taken at the time were: fluoridation of the public water supply, carried out experimentally in 1953 in the municipality of Baixo Guandu (in the state of Espírito Santo) and creation of a network of dental care in the form of the "Sistema Incremental" - SI (Incremental Dental Care Program). The SI was the first organized system of public oral health care. The aim of the SI was to provide dental care to a certain population (in the Brazilian case, school children from the first year of primary education), with the elimination of accumulated needs by means of curative procedures (vertical action) and posterior maintenance of health in

the subsequent years with the use of fluorides (horizontal action).[5,7,8]

This model influenced all the initiatives of the government during the second half of the XXth century, but the SI began to be reproduced uncritically, without an epidemiological focus, giving priority to curative actions that reduced the SI to a simple programmed technique in schools of the state public education network.[7]

Although a broad worldwide debate had begun emphasizing the economic and social determination of health since the 1960s, as opposed to the curative approach of disease control, the oral health practices in Brazil continued individualized.

Following the recommendations of the World Health Organization (WHO), the International Dentistry Federation (FDI), the International Association for Dental Research (IADR) and the international studies that had demonstrated the benefits of the addition of fluoride substances for caries control, the country finally adopted a technique of systemic public water supply fluoridation, making it obligatory since 1975.[9]

Public water supply fluoridation is the most effective action to promote oral health. Its epidemiological impact is an average 50% to 60% reduction in the prevalence of dental caries after 10 years of constant use. It was considered one of the ten greatest actions in public health in the XXth century[10] and almost 210 million people around the world benefited from it.

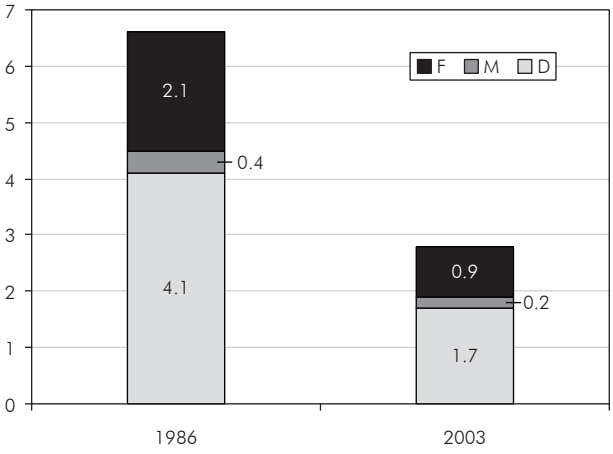
Epidemiological data have shown that the prevalence of caries was 49% higher in cities that did not use this systemic method. The missing and decayed components of the DMFT index were also significantly higher than those observed in the communities that received this benefit.[11]

However, until 2004, only 60% of the Brazilian municipalities with public water supply had implemented water fluoridation. Guaranteeing water fluoridation is a great victory, but guaranteeing adequate levels of fluoride content (0.07 ppm) is also important to prevent the population from being exposed to an overdose, which could pose a risk of dental fluorosis, or to an underdose, which would not bring any benefit to the effort of reducing the prevalence of dental caries.

There are no doubts about the importance of public water supply fluoridation in the country, but, with the creation of the SUS in 1988, a need to define guidelines for oral health care emerged. Until that time, the practice of dental care was acknowledged as being inefficient, having low coverage, displaying a monopolistic and mercantile nature, having low resolution and being geographically and socially badly distributed. Dental care at schools was given priority, and the other citizens were offered only emergency care.

The "Política Nacional de Saúde Bucal" – PNSB (Oral Health National Policy) was created in 1989. It stated that the dental care system should be structured to offer primary care services to all of the population according to the principles of the SUS. Thus, oral health teams should remain in Health Care facilities, and no longer in schools. A severe epidemiological situation was acknowledged in Brazilian oral health, mainly as regards dental caries in childhood (Graph 1).

Therefore, priority was given to actions in the age group from 6 to 12 years because of the eruption of permanent teeth and because of the efficiency of educational attitudes and topical preventives at this stage.



Graph 1 - Dental caries experience. DMFT index [decayed (D), missing (M) and filled (F) teeth] among 12-year old children. Brazil, 1986 and 2003. *Sources*: Brasil. Ministério da Saúde. Levantamento epidemiológico em saúde bucal: Brasil, zona urbana, 1986.[14] and Brasil. Ministério da Saúde. Projeto SB Brasil 2003.[11]

However, this model, by giving priority to specific groups, frequently excluded those that did not belong to them, and this offended the constitutional right to equal and universal access of the entire population to health services.[12]

Although edentulism is usually not considered a public health problem, it should be pointed out that it is caused by caries and/or periodontal disease, principally in adults and elderly people. In a great number of countries in the world, dental loss is still considered a natural consequence of aging. The United States have 26% of edentulous individuals in the group from 65 to 69 years of age and some countries in Europe, such as Italy, Austria and Lithuania, have less than 20% of completely edentulous individuals between 65 and 74 years of age.[13]

In 1986, 40% of adults and 72% of elderly Brazilians were edentulous.[14] Seventeen years later, the preliminary results of the World Health Research conducted in Brazil by the Ministry of Health and Oswaldo Cruz Foundation (FIOCRUZ)[15] pointed to a percentage of 37.8% of individuals over 50 years of age without a single natural tooth present in the mouth.

For adolescents, adults and elderly people the situation is still very distant from an optimal oral health status. This also happens in developed countries, because the practice of dental care adopted by the majority of countries gives priority to curative treatment, mainly in children, to the detriment of actions of a collective nature with the goal of health promotion. This practice has shown to be inefficient for improving oral health and the situation for adults is still precarious all over the world.

In subsequent governments, few actions were adopted with the intention of improving the oral health condition of the population. Creation of the "collective procedures" in 1991 stands out as it made the municipalities plan actions, collective in scope, which were complementary to the curative individual actions. They involved supervised brushing with the distribution of toothbrushes, dentifrices and topical fluoride application after epidemiological survey, performed weekly by an oral health team in previously determined locations. In general, these actions were performed in primary schools.

A new perspective in planning oral health actions in the public sector was adopted in 2000, with the inclusion of oral health teams in the "Programa de Saúde da Família" - PSF (Family Health Program) that was created in 1994. This program was developed as a strategy to restructure the model of primary care of the SUS. The fundamental basis of its action is territorialization, with a focus on determining the social and epidemiological needs of a given population and overseeing the application of health actions. It also aimed at ensuring proper integration with the other levels (secondary and tertiary) of health care by the SUS. Therefore, it should not be analyzed as an isolated and vertical process of the Brazilian public health structure.[16]

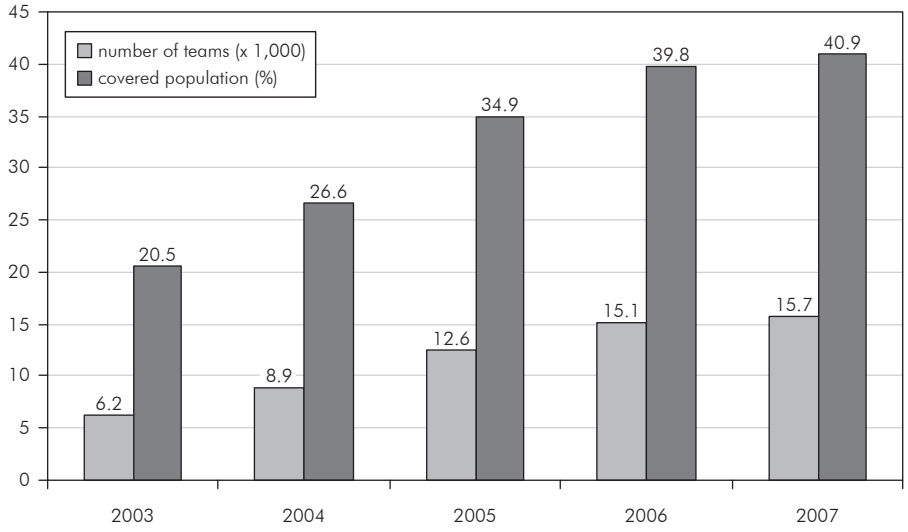
In this context, oral health must also have a structured focus on the concept of health promotion that is integrated with the other health areas.

People normally seek health services when they notice some illness which, according to Moysés *et al*.[12] (2008), generates a mistaken model of practice, based on care giving to a self-referred complaint, and results in protracted procedures and few resolutions.

Furthermore, according to the authors, the intention of the PSF is to break these dental practices that have been rooted in the day-to-day activities of health facilities for centuries, by instituting principles that may guide health teams in establishing territories for priority care, in controlling oral illnesses and in focusing on their epidemiological impact in the medium and long terms. Families have been receiving health professional home visits with the purpose of giving guidance and following up the health-illness process in the family circle.

The Ministry of Health has provided the municipalities with financial incentive to create PSF teams, including an oral health team (composed of a dentist and an assistant) and this has contributed to an increase in the number of professionals involved and in the number of people covered by the program (Graph 2).

At the beginning of 2004, the Ministry of Health released a new Oral Health National Policy[17,18] integrated to the "Plano Nacional de Saúde: um pacto pela saúde no Brasil" (National Health Plan: a



Graph 2 - Number of oral health teams in the Family Health Program (x 1,000) and covered population (%). Brazil, 2003-2007.

health covenant in Brazil) that emphasizes the need to increase access to oral health care.

To this end, with an integral view of the health-illness process, the PNSB proposes a reorientation of the health care model, supported by an adaptation of the working system of Oral Health teams so that they include actions of health promotion, protection and recovery. The intention is to rationally increase access to integrated oral health care, where "care lines" (since childhood through adolescence, adulthood and old age) may have a centralized flow that includes the stages of welcoming, information giving, attendance and referral (including referral and contra-referral), in order to result into resolution actions.[19]

In order for this change in dental care practice to occur, important processes are necessary to increase and qualify assistance to guarantee access to primary care, and also to improve the structure of secondary and tertiary care. These specialized dental services, in the SUS circle, correspond to no more than 3.5% of total dental clinical procedures.[17]

Among the actions included in the policy and financed by the Ministry of Health are:

a. Implementation of the "Centros de Especialidades Odontológicas" (CEO) (Dental Specialties Centers). These centers have been distributed in all the municipalities of the Brazilian states with a history of reference in specialized health care in other areas. In the CEOs, clinical procedures complementary to primary care procedures include periodontal surgery, endodontic treatment, minor oral surgeries, diagnosis and support for the treatment of oral lesions, and treatment provided to special patient groups;
b. Distribution of products to oral health teams to perform restorative and preventive clinical procedures that increase the resolution of primary care procedures;
c. Increased incentives to PSF oral health teams by supplying more modern dental equipment;
d. Financial support for the implementation of fluoridation of the public water supply in the municipalities that have not yet implemented this procedure.[17,18]

This policy also includes a permanent epidemiological and information vigilance system that follows up the impact of actions, assesses and plans distinct strategies and/or adaptations that are needed according to the different socioeconomic profiles of the Brazilian population. Thus, an agenda of scientific research that involves the study of the main oral health problems and the development of technological alternatives to address them is a fundamental part of this policy and has been encouraged.

In order to effectively implement these actions in the medium to long terms, follow-up by and effective participation of the society are necessary. This process is made possible in the day-to-day activities

of the SUS by means of Municipal and State Health Counseling existent throughout the national territory, as well as by the participation in Health Conferences convened for permanent dialogue and debate of the participants involved in building a system that is dynamic and democratic.

Human resources

It is necessary to qualify dentists to be able to plan, execute and assess individual and collective actions directed towards the socioeconomic as well as the epidemiological needs of the population, whether to work in the private or in the public sector.

In 2005, there were more than 45 thousand health establishments in the SUS and, among these, 60% offered dental services.[20]

In 2008, Brazil will exceed 187 million inhabitants. Data from the "Conselho Federal de Odontologia" - CFO (Federal Dentistry Council), updated in May 2008, registered 219.702 dentists throughout the national territory graduated from more than 185 Dentistry Colleges. The proportion is 1 dentist to 851 inhabitants. As regards assistants, there are fewer than 70 thousand that work in the country.[21]

To adopt the need for increasing the number of dentists in the labor market as a criterion, based on the assumption that there are many people that do not have access to oral health services due to lack of professionals, did not and will not suffice to revert the oral health epidemiological situation in Brazil.

As regards access to dental services, the report from the Brazilian SB Project 2003 has affirmed that 13.5% of the Brazilian population has never been to a dentist.[11]

It is known that, in addition to a quantitative unbalance, the country suffers from an irregular distribution of professionals. In order to plan this distribution, social and epidemiological criteria must be adopted. In the State of São Paulo, for example, the number of dentists registered at the Regional Dentistry Council is higher in municipalities that present the best social indicators such as average income, index of life conditions and income distribution, which denotes the preferential private nature of professionals.[22]

The present guidelines of the National Council of Education, expressed in the national curricula directives for Dentistry Courses, reinforce the importance of educating dentists to "act on all the levels of health care (...) based on ethical and legal principles, as well as to understand the social, cultural and economic realities in their environment, and to direct their activities towards transforming these realities to the benefit of society".[23]

Even though an education for health professionals must include traditional tasks of a technical nature, it is necessary for them to understand that working in health care means acquiring knowledge and skills for interlocution, addressing a public and principally incorporating the political universe that surrounds them in this exercise.

The best qualification of future professionals must be accompanied by education and integration of other professionals in the Oral Health Team, such as dental office assistants and dental hygienists. According to Narvai[24] (2003), "the oral health team is the new subject of a new dental practice seeking to create and consolidate a practice that is effectively capable of promoting oral health". Rational integration of these professionals allows an increase in productivity, quality and income of the work system, provided that an adequate proportion between assistants and dentists is observed.

The educational process must consider the accelerated rhythm of the development of knowledge, the changes required in the work process, and the transformations in demographic and epidemiologic aspects, following a perspective of balancing technical excellence and social relevance.[25]

Thus, at the end of 2005, the "Programa Nacional de Reorientação da Formação Profissional em Saúde - Pró-Saúde" (National Program for the Reorientation of Professional Education in Health - Pro-Health) was created with the technical and financial support of the Ministry of Health and the Pan-American Health Organization so that higher education courses in Dentistry could undergo a process of curricular change. It is hoped that this reorientation in the professional education process will promote a teaching / service providing integration that may assure an integral approach to the health-illness process as its central axis.[25,26]

Research and publication in oral health

One problem in research and publication in health sciences is the concentration of financial, scientific and technological resources in the hands of few countries of the North Hemisphere. Nowadays, Brazil is considered one of the Innovative Developing Countries (IDC).[27,28]

Between 1985 and 2004, the number of published scientific articles increased 12-fold in Brazil. The total number of epidemiological articles indexed in MEDLINE/PubMed and Institute for Scientific Information/Thomson Scientific – ISI more than doubled.[29] Zorzetto *et al*.[30] (2006) observed a substantial increase in the scientific production in health and biological sciences in the 20 most productive Brazilian universities, which are responsible for 78.7% of the papers in these areas.

Evolution of the Brazilian production in public health research can be observed when considering the number of studies presented in the Dental Research for Communital Action category ("Pesquisa Odontológica de Ação Coletiva - POAC)" at the Annual Meeting of the "Sociedade Brasileira de Pesquisa Odontológica" - SBPqO) (Brazilian Society for Dental Research), the Brazilian Division of the International Association for Dental Research – IADR (Graph 3). Another issue to be considered in the quality of research is the evolution of Bioethics and its impact on policy and procedure of the research/publication process involving human beings.[31,32]

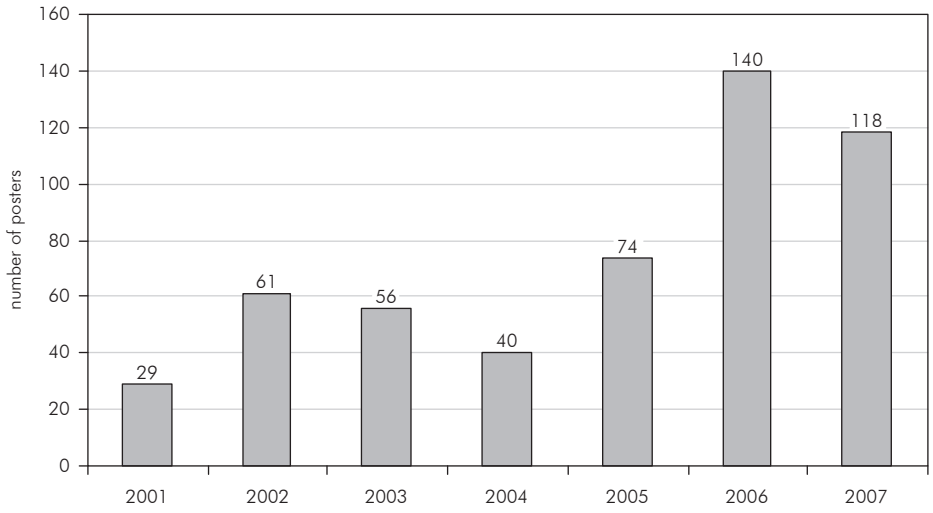
Final considerations

Health care in Brazil must be thought of within the social and economic context in which the country lives, which is characterized by social inequality and a high rate of unemployment. In order to address the pressures of accelerated urbanization, an aging population, increase in the rate of illnesses typical of underdevelopment, among others, a combination of acceptable employment conditions, security, basic education, adequate diet, availability of water, sewerage, waste disposal services and better environment conditions are required, with an emphasis on the prevention of diseases and promotion of the quality of life of the population.

In view of the Brazilian social and epidemiological situation and the importance of determinant factors in the health-illness process, public policies must be directed to health promotion, with strategies emphasizing the creation of conditions favorable to the development of health and the qualification of health care professionals.

Change in behavior or habit is only one of the objectives of health education. The purpose of education is human freedom, that is to say, propitiating that individuals be the subjects of their own learning and true participants in the educational activities so as to develop a critical thinking capable of analyzing the social context of their problems in order to seek solutions.

Thus, it is necessary first to educate socially committed professionals capable of producing changes,



Graph 3 - Posters presented in the Dental Research for Communital Action category - POAC (2001-2007) at the Annual Meeting of the SBPqO.

not only in the illness pattern of the population, but fundamentally creating awareness of the importance of the population's participation in planning, executing and controlling the actions and services provided to the community.

The knowledge held by the organized civil society about the oral health needs and the limitations of the system (that still exist) will only favor the development of public policies that are suited to the epidemiological profile and improve the oral health quality of the population.

As regards the health needs of the population, strategies adopted at the communital level, such as water supply fluoridation, addition of fluoride to dentrifices and structuring communital actions within the scope of the SUS have contributed to decrease the dental caries indexes in children (Graph 1). Nevertheless, formulating a broader national oral health policy is required to meet the needs of the entire Brazilian population from all age groups. Policy must no longer be characterized by addressing only the "future generations" and by mutilating the adult population.

Brazilian Public Oral Health has entered the XXIst century with important challenges, such as to universalize assistance and information in order to alter the epidemiological profile of the adult population; to implement a rational work system by means of oral health teams; and to increase access of the Brazilian population according to a holistic perspective of health that takes into account the profile of each population and at the same time promotes equality.

Maturation and consolidation of Public Oral Health in Brazil has shown that building a model, previously believed to be utopian, is feasible and will eventually culminate in a broader Oral Health National Policy. As with all processes, this "health consciousness" does not come into being overnight, but one can say that it is in full development.

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Oral Health in Brazil – Part II: Dental Specialty Centers (CEOs)

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Abstract: The concepts of health promotion, self-care and community participation emerged during the 1970s and, since then, their application has grown rapidly in the developed world, showing evidence of effectiveness. In spite of this, a major part of the population in the developing countries still has no access to specialized dental care such as endodontic treatment, dental care for patients with special needs, minor oral surgery, periodontal treatment and oral diagnosis. This review focuses on a program of the Brazilian Federal Government named CEOs (Dental Specialty Centers), which is an attempt to solve the dental care deficit of a population that is suffering from oral diseases and whose oral health care needs have not been addressed by the regular programs offered by the SUS (Unified National Health System). Literature published from 2000 to the present day, using electronic searches by Medline, Scielo, Google and hand-searching was considered. The descriptors used were Brazil, Oral health, Health policy, Health programs, and Dental Specialty Centers. There are currently 640 CEOs in Brazil, distributed in 545 municipal districts, carrying out dental procedures with major complexity. Based on this data, it was possible to conclude that public actions on oral health must involve both preventive and curative procedures aiming to minimize the oral health distortions still prevailing in developing countries like Brazil.

Descriptors: Brazil; Oral health; Health policy; Program development; Dental Specialty Centers; Health program and project evaluation.

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Introduction

Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. This concept is current, and means that an individual has to feel well in several ways to be considered healthy.[1]

Nowadays, caries and periodontal disease are, more clearly than ever, viewed as infectious diseases processes. Thus, a medical model of treatment and non-restorative approaches have been advocated, including, on one hand, caries control measures and remineralization methods for initial lesions, and on the other, scaling and root planing (SRP) and the employment of some therapeutic agents like mouthwashes.[1,2]

The concepts of health promotion, self-care and community participation emerged during the 1970s, primarily out of concerns regarding the limitations of professional health systems. Since then, there has been a rapid growth in these areas in the developed world, showing evidence of effectiveness of such interventions, according to Bhuyan[3] (2004). These areas are still at an early stage in the developing countries. There is a window of opportunity for promoting self-care and community participation for health promotion.[3]

This study is a sequel to the previous article "Oral Health in Brazil – Part I: Public Oral Health Policies". The aim of this literature review is to present the Dental Specialty Centers (CEOs), an alternative to complement the preventive programs developed by the Brazilian government that includes more specific and more complex dental care procedures.

To this end, Brazilian government data and literature published from 1929 to the present day were considered, using electronic searches by Medline, Google and hand-searching. The descriptors used were Brazil, Oral health, Health policy, Health programs, and Dental Specialty Centers.

Dental Specialty Centers (CEOs)

Based on the findings of the Brazilian Oral Health Status survey – SB Brasil – in 2003,[4] the need to organize the providing of dental care procedures of medium complexity became evident, in order to meet the SUS (Unified National Health System) requirements. These data highlighted the severity of the oral health situation and also the precocity of dental loss, as well as the inequality prevailing in the access to dental services, which is the reality of almost 56% of the totally edentulous elderly.[5]

Based on these data, public health policies were developed according to the epidemiologic profile of the population and having integrality as a principle. Thus, the purpose of the "Brasil Sorridente"[6] program as an Oral Health National Policy is to correct distortions in the management of resources, carrying out effective new modes of action to assure greater access to oral health care, as well as to promote the qualifying of professionals to provide the health services offered by SUS.

Encouraging the construction of Dental Specialty Centers (CEOs) throughout the country is one of the strategies included in the municipal and regional health plans for each state.[7]

Dental Specialty Centers (CEOs) are oral health facilities of the SUS system which are part of the National Registry of Health Establishments (CNES) and are classified as Specialized Clinics or Specialty Ambulatories. The CEO is responsible for endodontic treatment, dental care for patients with special needs, minor oral surgery, periodontal treatment and oral diagnosis (focusing on oral cancer diagnosis), in addition to other specialties to be defined according to the needs of each area.

The first data regarding CEO installation and distribution showed 336 facilities, spread over 268 municipal districts in 25 states and in the Federal District (Table 1).

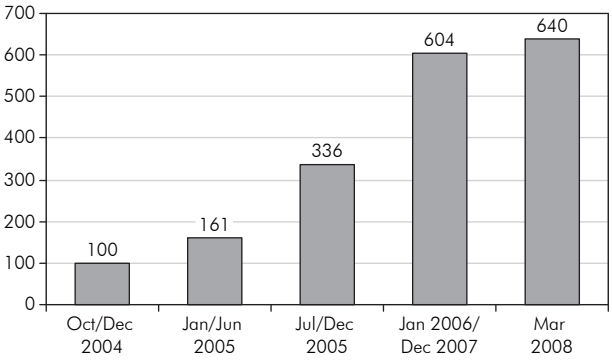
Until March 2008, 640 CEOs were installed all over the country, in 545 municipal districts (Graph 1).

The goal for 2010 is to have 950 CEOs working all over the country (source: National Oral Health Coordination[6] – MS, May 28, 2008).

In order to obtain the resources required for installation, 226 CEOs were accredited in advance. Between January 2005 and December 2006, more

Table 1 - Number and distribution of CEOs among Brazil's administrative regions. *Source*: Ministry of Health, 2005.

Region	Number of CEOs established
Center-West	33
Northeast	104
North	17
Southeast	125
South	57
Total	336



Graph 1 - Dental Specialty Centers established. Brazil, Oct/2004 – March/2008.

than 12.1 million dental procedures were performed in these centers.

The CEOs are one of the main actions of the "Brasil Sorridente" Program, and the treatment offered therein is a continuation of the work performed by the primary care network, which is also the case of the municipalities following the "Saúde da Família" (Family Health) Strategy, and is carried out by the oral health staff.[6,7]

The Professionals of the primary care network are responsible for addressing patients' first needs, and then guiding them to the Dental Specialty Centers only when more complex procedures are required.

Each accredited Dental Specialty Center started to receive resources from the Ministry of Health, as per Ministry of Health regulation MS n. 1571 of July 29, 2004.[7] A partnership among states, municipal districts and Federal Government is responsible for the implementation of the Specialty Centers: The Ministry of Health contributes with one share of the resources and the states and municipal districts contribute each one with the other shares.

Each CEO provides the specialized clinical care that the primary care facilities were unable to accomplish. The centers also have a dental prosthetic laboratory to do the laboratorial work required to provide prosthetic services, even for those provided at other dental facilities.

Regional Dental Prosthetic Laboratories (LRPDs) are establishments registered in the CNES (National Registry of Health Establishments) as Health Facilities to Support Diagnosis and Therapy (SADT). They are prepared to carry out procedures involving, at least, removable partial dentures and other acrylic denture services.

The laboratories can work adjoined to the CEOs, having a public nature, i.e. structured and managed by the municipal district, or work independently, having a private or even public nature. The main difference between the two kinds of LRPDs is that the facilities that work independently from the CEOs have to accomplish 40 removable partial denture procedures (cast metal framework) monthly.

The Human Resources team for the LRPD is constituted at least by 1 technician in dental prosthesis, or 1 dentist, working 40 hours a week, and dental prosthesis assistants.

The CEOs also offer appointments for oral diagnosis, focusing on the identification of oral cancer. This type of disease can be treated with successful rates, but 65% of all the identified cases are already in advanced stages. Every year, nearly 3 thousand people die from oral cancer in Brazil, while 30 million people have never gone to a dentist.[4]

Until the "Brasil Sorridente" Program was initiated by the government in March 2004, only 3.3% of the dental care provided by the SUS (Unified National Health System) were specialized treatments. Before this period, almost every procedure involved primary care, such as dental extraction, dental amalgam restorations, topical fluoride application and composite restorations.

Resources

The Ministry of Health transfers funds of R$40,000 to build, increase, rebuild, and purchase

both instruments and dental equipment for type I CEOs (three dental chairs), and R$50,000 for expenses with type II CEOs (four or more dental chairs). Furthermore, type I CEO managers receive R$6,600 per month for expenses, while type II CEO managers receive R$8,800 per month. For type III CEOs (minimum of seven dental chairs), the money destined for building or physical space suitability is R$80,000.

All citizens have the right to benefit from the services offered by the CEOs, but, if they want to use this service, they must first be seen by the primary care team, at health stations and basic health facilities.[7]

Patients cannot book an appointment at the centers by themselves. The health teams will assess the severity of the problems and then will book appointments for the patients at the specialty center. The health facilities continue the work performed by the professionals of the Family Health Program (PSF).

To register a CEO, a municipal or state manager must submit a proposal to the State Two-party Managerial Committee ("Comissão Intergestores Bipartite" - CIB). In the proposal, the type of CEO required (I, II or III) must be specified. The proposal must contain identification of the Municipal or State applicant and health facility, and a carbon copy must be submitted to the CNES, including a description of the services offered. It must comply with the Master Plan of Regionalization and indicate the CEO's range area. It should also indicate to which local authority, region or micro-region it will be assigned, and also the population it will give assistance to. A certificate, from managers, stating that all the infrastructure and resources requests meet the requirements of a Ministry of Health regulation ("Anexo I – Portaria GM/MS nº 1.571, de 29 de julho de 2004") must also be submitted.[7]

The CIB then sends a request for registration to the Ministry of Health. Once it is accepted, the federal institution will issue a decree for the official registration. An LRPD registration is similar to that of a CEO. One of the requirements is that it observes the proportion of one LRPD to 100,000 inhabitants.

The Ministry of Health also provides resources to implement CEOs, as provided by a Ministry of Health regulation ("Portaria GM/MS nº 283, de 22 de fevereiro de 2005).[8]

Final considerations

Conventional wisdom for many years was that caries was the main reason for tooth loss before age 35, and periodontal disease was the main reason after age 35. This belief was based on some old and rather dubious data.[9,10]

Even as late as 1978 there was a report that 8-10% of teeth are lost to periodontal disease by age 40, and that such loss increases rapidly after that age.[11]

We are in agreement with Burt, Eklund[12] (1999) that this historical picture has changed considerably in recent years. According to the authors, since the mid-1980s, studies from a number of countries and among different types of populations have consistently found that caries is the principal cause of tooth loss at most ages, with the possible exception of the oldest (i.e., those over 60 years).

In Brazil tooth loss is a serious public health problem, and the percentage of adults with total loss is high. A number of research studies have been carried out to determine the reasons for tooth loss[13,14,15], all of which have shown tooth decay as the most important factor for tooth loss, followed by periodontal disease.

Educational level and age factors are associated to tooth loss. Tooth retention throughout the life course should be the main concern for both dental surgeons in general and all professionals working in public health services.[15]

In Brazil, less than 22% of the adult population and less than 8% of the elder people present healthy gum tissue. The data are from "SB Brasil 2003", the most complete oral health survey in the country.[4]

Furthermore, it is already possible to follow the impact of actions on oral health all over the country, especially regarding the reduction in the dental extraction indexes. Since 2002, about 2 million teeth were not extracted owing to these actions. This is an important health indication and it shows an improvement in the quality of oral health care in Brazil.

Water fluoridation, supervised toothbrushing, controlled fluoride mouthwash programs, use of sealant on pit and fissures, and early diagnosis and

treatment of dental caries and periodontal diseases are all effective measures, but the oral health needs of a population are far more extensive than the ones mentioned here.

According to Leske *et al.*[16] (1993), traditionally the prevention of oral diseases has been well-founded on three levels: i - primary prevention, related to the initiation of the disease; ii - secondary prevention, where the aim is to stop the progression of the disease and also disease recurrence; iii - tertiary prevention, where the goal is to avoid tooth loss (loss of function).

Statistics show that the Brazilian Government's Oral Health Program (within the SUS), with strong public oral health policies applied all over the country (see "Oral Health in Brazil – Part I: Public Oral Health Policies", also published in this issue), is an effective effort to reach the first prevention level. Two prevention levels, however, remain uncovered by the government's actions. The loss of teeth due to periodontal disease and/or to endodontic infections, and the replacement of the teeth by dental prostheses are still inaccessible to a great portion of Brazil's population, and only Dental Schools and few municipalities have had the resources to treat a small portion of those needs.[17]

Thus, the Dental Specialty Centers (CEOs) are a valid alternative to complement the population's needs all over the country. However, as Brazil has a continental dimension, great challenges still have to be overcome. In spite of the social policies undertaken and some favorable economic factors, more centers and more specialists must still be better distributed over the country's different regions in order to achieve a better balance in oral care health to the population as a whole.

The closest program to that of the Brazilian Dental Specialty Centers (CEOs) is one developed in Cuba,[12] but its data is not available for comparison.

Distribution of the CEOs all over the country should be proportional to the population size and oral health needs of each region.[18] It is already possible to confront data from the first survey (2005, 336 CEOs) with that of the latest survey, still unpublished (2008, 640 CEOs). According to these data, an increase of 90.5% has been observed in the total amount of CEOs.

It will be a long journey, and more educational, preventive and also curative health measures must be taken in order to reach the Brazilian government's goal for 2010[19], i.e. to have 90% of children aged 5-6 years free of dental caries, and with a DMFT index < 1 at the age of 12. But the program is working well, including tooth replacement by dental prosthesis, and it is very important for the population to have the possibility to treat their teeth with good quality, improving health and quality of life.

Based on the data presented here we conclude that public actions on oral health must involve both preventive and curative procedures in order to minimize distortions in the oral health of the populations of developing countries. To this end, the Dental Specialty Centers are a valid and welcome social program in Brazil.

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Reviewed evidence about the safety of the daily use of alcohol-based mouthrinses

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Abstract: Current scientific knowledge provides clear evidence that alcohol-based mouthwashes can be beneficial in a daily oral health routine, including dental hygiene and plaque control. Several issues are worth discussing, in spite of the wealth of supporting evidence. Despite some undesirable effects to some people, like burning sensation, and some contraindications, like the use by infants, alcohol addicts and patients with mucosal injuries, there is no reason to avoid the use of alcohol-containing mouthwashes as long as they are used following proper guidance by dental professionals and the manufacturers' instructions. The alleged correlation between oral cancer and alcohol-based mouthrinses presents so little, weak, inconsistent and even contradictory evidence in the literature that any kind of risk warning to patients would be uncalled for. Antimicrobial mouthrinses are safe and effective in reducing plaque and gingivitis, and should be part of a comprehensive oral health care regimen that includes brushing, flossing and rinsing to prevent or minimize periodontal disease.

Descriptors: Alcohol, ethyl; Mouthwashes / Adverse effects.

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Introduction

In the past decades, mouthrinses have served a variety of purposes, among which is the therapeutic prescription to treat halitosis and minor mouth infections, besides other oral care problems.[1]

The extensive use of various types of rinsing solutions has led to studies aiming at investigating side effects of the widespread use of such products.[1]

The alcohol content of mouthrinses, besides having antiseptic properties, serves the purpose of breaking down or dissolving active principles, in addition to that of preserving the formula components,[2,3] although such content does not directly contribute to effective biofilm and gingivitis control.[4,5] Nevertheless, it is common knowledge that, like other substances, alcohol may have certain side effects. As of the 1970s, a number of studies have been published suggesting a possible connection between the daily use of alcohol-based mouthrinses and the development of oropharyngeal cancer, and that has led researchers to question the safety of using alcohol as a component of mouthrinses.[2]

This paper aims to review the literature about the side effects of the use of alcohol-based mouthrinses.[1]

Literature Review

This review has the purpose of discussing the major potentially harmful effects that may question the safe use of alcohol-based mouthrinses.

Xerostomia

Xerostomia is a subjective perception of dryness of the mouth resulting from one or more factors that affect the quantity and quality of the salivary flow. It may lead to soft tissue discomfort, difficulty in chewing and swallowing, caries, insomnia, fungal infection and halitosis. All these conditions may cause a negative impact on a patient's life quality.[6]

A comparative study investigating the effects of mouth rinsing with an alcohol-based solution against mouth rinsing with an alcohol-free solution does not point to significant differences between both types of solutions after a week's use as regards salivary flow and dry mouth symptoms in healthy adult subjects.[7]

Burning or sore sensation

Some patients have reported a burning or sore sensation in the oral tissues after using an alcohol-based mouthrinse.[4]

Alcohol may cause a painful sensation that is directly subordinated to its concentration level and to length of rinsing. Alcohol-based mouthrinses are not recommended for patients with existing soft tissue injury.[2,8,9]

The longer the rinsing the more painful it feels. This sensation declines and eventually ceases when the product is no longer used. While ethanol is the key pain-inducing factor, other agents may also augment the symptom.[9] Recent research reveals that the burning and painful sensation in the soft tissues is also felt when alcohol-free solutions are used.[10]

Lower alcohol level and the addition of a mild flavoring agent have yielded good results in reducing the burning or sore sensation.[7]

Diluting the product for initial use and then gradually increasing its concentration has shown to have higher acceptance by patients.[11]

Mouthrinse ingestion by children

Ethanol ingestion is an uncommon yet well-documented cause of hypoglycemia in children. Hypoglycemia induced by alcohol ingestion, followed by convulsions, was originally recorded in 1961. Later work that investigated the ingestion of mouthrinses show that these alcohol-based oral care products can be potentially lethal.[12,13] According to the American Association of Poison Control Centers, 6% of the 251,012 cases of human poisoning in 1983 were caused by alcohol and glycol ingestion. Of these, 86.2% of the subjects were children below six years of age.[14] In 1994, the Centers received 2,937 calls reporting ingestion of alcohol-based mouthrinses. These figures stand for 168 recorded exposure cases for every 100,000 children below six years of age. For a child weighing only 26 pounds, 5 to 10 ounces of a mouth-

rinse containing 26.9% of ethanol stands for about 2 ounces of alcohol, which can be potentially lethal.[15]

The literature relates that ethanol can affect normal glycogenolysis and glyconeogenesis, causing hypoglycemia conditions brought about by children ingesting the solution.[12,16] However, it should be noted that, contrary to what happens with adults, poor nutritional conditions or long fasting before alcohol ingestion are not necessarily determining factors of hypoglycemia in children.[12]

Poisoning is one of the most frequent causes of infant death. It should be highlighted that little ingestion of ethanol, whether in the form of beverages or other alcohol-based liquids, can potentially induce death by hypoglycemia.[12,17,18]

Alcohol-based mouthrinses whose packaging does not warn against its use by infants can be easily purchased in the market.[1] The American Dental Association (ADA) and the Food and Drug Administration (FDA) have recently required that industries that produce mouthrinses at a higher than 5% ethanol concentration bear in their packaging a safety seal device and labels that clearly inform caution procedures regarding the intake of such solutions by children.[1,15]

Use by alcohol addicts

The sale of alcoholic beverages on Sundays is forbidden in several American states. Some reports discuss the case of alcohol addicts who are craving for alcohol and so resort to alcohol-based aftershave lotions, fuels or mouthrinses as a substitute for alcoholic beverages.[18,19] The dependence on such products has been recorded and is primarily related to easy access to such products rather than to social or financial factors.[19]

When taken in large quantities, mouthrinses can contribute to severe metabolic acidosis, multiple organ failure, and even death.[20]

The use of alcohol-based mouthrinses is not recommended for those who are recovering from alcohol addiction, as it can drive them back to craving for alcohol and addiction.[21]

Mouthwashes and oral cancer

Tobacco smoking and alcohol consumption are the primary cause of oral and pharyngeal cancer, while sun irradiation is the primary cause of lip cancer, but there are also other minor risk factors as nutrition, occupation and metabolic gene polymorphisms. Nowadays more researchers are considering clinical studies that would investigate the link between human papillomavirus (HPV) and some oral cancers.[22] However, oral cancer can occur in the absence of tobacco and alcohol.[23,24]

In 2008, more than 14,000 new cases of oral cancer are estimated to occur in Brazil. It is the fifth most common type of cancer in men and the seventh in woman[25]. Approximately 75% of the patients are diagnosed in advanced stages resulting in a 50% rate of mortality in five years. Most of the patients are smokers and heavy drinkers.[25]

A great consumption of alcohol moderately increases the risks of cancer of the mouth, pharynx, esophagus and liver.[26] However, alcohol (ethanol) is not carcinogenic in animals.[7] It is recognized that the risk or oral cancer associated with alcoholic beverages is related to certain carcinogens found in the beverage (e.g. urethane) rather than the alcohol itself.[21] The ethanol in mouthwashes does not contain the trace amounts of carcinogens found in alcoholic beverages and ethanol has never been demonstrated to be carcinogenic either in laboratory animals or in humans.[21]

It is well established that alcohol-containing beverages strongly enhance the effect of smoking in producing cancer, although the exact mechanism is unknown. Researchers have suggested that the ethanol in beverages acts by altering the surface of cells or mucosal tissues of the oral cavity, and that this alteration may increase the exposure to or facilitate the action of the carcinogens in tobacco or even in the beverages themselves. Another explanation is that the alcohol could act by a systemic mechanism.[23,27] The relationship between alcohol and oral cancer may be even more complex, involving liver damage and increase in DNA transcription errors during cell regeneration, and additional factors such as the severe dietary deficiencies very common among alcohol abusers.[23]

Several epidemiological and experimental studies have been published in the last three decades about alcohol-based mouthrinses and oral cancer[23,24,28-35]

(Table 1) besides other review papers and Official Statements.[26,36-41]

The first publication that suggested a link between oral cancer and alcohol-containing mouthwashes was a case/control study performed with 200 patients with oral cancer and 50 general surgical patients as a control group.[35] It identified 11 people who did not smoke or consume alcohol bever-

Table 1 - Mouthwash and Oral Cancer - an overview of epidemiological studies (updated and adapted from Blanc, Baruzzi[38], 2007).

Publication and Year	Study	Characteristics and Critical Analysis	Mouthwash alcohol content	Conclusions
Weaver *et al.*[35] (1979)	• Case/control • 200/50 (11/10)	• Small sample • Lack of comparability between cases and control	Considered	Significant excess risk only in non-smokers and non-drinkers.
Blot *et al.*[42] (1983)	• Case/control • Women • Telephone interview • 206/352	No consistent dose-response relationship	Unknown	• No association among women • Slightly increased risk in non-smokers
Wynder *et al.*[43] (1983)	• Hospital-based investigation • Case*/control • 571/568 • (157/157 women)	• Lack of comparability between cases and controls • No dose-response relationship in non-smoking and non-drinking women • Possibility of confounding by tobacco and alcohol use	Not reported	• No association among men • Doubtful moderate association in women
Mashberg *et al.*[44] (1985)	• Veterans Hospital-based • Case*/control • 95/913 males at risk	Tobacco and alcohol consumption was considered	Considered	Inverse association between mouthwash use and oral cancer, regardless of the amount of alcohol consumption
Young *et al.*[45] (1986)	• Multi-hospital based • Case*/control • 317/306	Neither tobacco nor alcohol consumption were controlled	Not reported	No association
Kabat *et al.*[34] (1989)	• Multi-hospital based • Case*/control • 125/107	Frequencies, duration of use, and dilution or rinsing practices were considered	Not reported	No association
Winn *et al.*[37] (1991)	• General population • Case*/control • 866/1249	• Adjusted for tobacco and alcohol consumption • Increased risk related to duration and frequency of mouthrinse use	Considered	Increased risk, 40% in males and 60% in females
Winn *et al.*[24] (2001)	• General population • Case/control • 342/521	• Unable to evaluate the accuracy of the reporting of tobacco, alcohol or mouthrinse use • No evidence of a dose-response effect for any of several measures of mouthrinse use	Considered	No association
Guha *et al.*[27] (2007)	• Multi-center based • Case*/control • Europe (E) and Latin America (LA) • 924/928 (E) • 2,286/1,824 (LA)	Mouthwash use was strongly correlated with the presence of oral lesions due to the symptoms	Not reported	A significant risk factor for all sub-sites
Marques *et al.*[26] (2008)	• Multi-hospital based • Case*/control • 309/468	No information about when mouthwash use began	Not reported	Daily mouthwash use showed a stronger association to pharynx than to mouth

*Includes lips and/or pharynx, and/or larynx, and/or salivary glands.

ages, although 10 out of the 11 used mouthwashes, including nine who used a product with 27% of alcohol. Although no overall relative risk was provided, the authors reported that the case/control study results were not statistically significant.[35]

Researchers re-contacted subjects in an earlier case/control study of oral cancer among women in southern United States.[42] The original investigation had focused on the use of tobacco and beverages, but not on mouthwash use. It identified 255 case subjects (237 of whom were interviewed) and 502 control subjects (410 were interviewed). For all forms of oral and pharyngeal cancer, a relative risk of 2.0 to 4.0 among women who dipped snuff, 3.0 among women who smoked, and about 5.0 among women who consumed alcohol was reported. Researching the same subjects about the use of alcohol-containing mouthwash through a telephone interview with 206 case subjects and 352 control subjects, a relative risk of only 1.2 for mouthwash use was obtained. The author found no association between mouthwash use and oral cancer among tobacco users.[42]

In a hospital-based investigation of 571 patients with oral cancer and 571 control subjects, the results were negative for mouthwash use and oral cancer among men, but the crude data indicated a moderate association between daily mouthwash use and oral cancer, with a relative risk of 2.8, although the results showed no relationship between oral cancer and duration of mouthwash.[43] No information was available about the alcohol content of the products used or whether the mouthwash was used to conceal tobacco or alcohol odors in the breath.[43]

In a study conducted among 95 men with oral cancer and 913 men serving as control subjects from the New Jersey Veterans Hospital, the authors found a weak, inverse association between mouthwash use and oral cancer.[44] The relative risk for users was 0.8 in the overall data and 0.9 after controlling for smoking or beverage consumption. Among mouthwash users, an inverse association was found between oral cancer and the alcohol content of the mouthwash used. A relative risk of 0.6 was observed for the users of the product with the highest alcohol content. It is important to remember that the public of the Veteran's Hospital are typically heavy smokers and alcohol consumers.[44]

In a multi-hospital case/control study of 317 oral cancer patients and 306 control subjects who had cancer of the head and neck "not thought to be related to tobacco use" or cancer of the larynx, the relative risk with mouthwash use was 1.0 among men and 0.5 among women. The results were similar for cancer of the mouth and oropharyngeal and hypopharyngeal cancer. Again, no information about the alcohol content was available for the products used neither was there any information about the time at which product use began, whether before or after the first signals of the disease.[45] The study results were distinctly negative, but issues may be raised about the study's design. For example, combining the first control group, which had a presumably typical smoking pattern, with the second control group (cancer of the larynx), which probably had a high level of smoking, may be questioned. Interpretation of the results may also be questioned, as the negative findings for mouthwash use were validated despite the fact that neither smoking nor drinking were controlled.[45]

In another multi-hospital-based investigation of 125 case subjects and 107 control subjects, the authors found no association between mouthwash use and oral cancer. Although no information was available regarding the alcohol content of the products used, this study provided an important finding for interpreting all mouthwash studies.[34] Moderately strong associations (2.6 to 3.2) were found among woman who used mouthwashes to disguise breath odors of tobacco or alcohol. However, the relative risk was only 0.7 or 0.8 among women who used mouthwashes to conceal food odors or for other reasons.[34]

In a case/control study of oral epithelial dysplasia among 127 subjects from two large pathology laboratories,[46] the authors examined eight variables describing mouthwash use and the alcohol content of the products used. The general findings were negative, as were those for all eight variables. They found that the relative risk varied inversely with the percentage of alcohol in the mouthwash used, even after the authors controlled for smoking and bever-

ages. The conclusion was that there is no relationship between mouthwash use and oral epithelial dysplasia.[46]

In a large case/control study with 342 case subjects and 521 control subjects from Puerto Rico with oral cancer, the authors affirmed that they were unable to evaluate the accuracy of the reporting of tobacco, alcohol and mouthwash use. They found no association between mouthwash use and oral cancer.[24] The crude and adjusted relative risk were both 1.0 and there was no evidence of a dose-response effect for any of the several measures of mouthwash use. The findings were positive for mouthwash use (relative risk of 2.8) among nonsmokers who abstained from alcohol. The authors considered these subjects to be the most likely to demonstrate any actual effect of mouthwash use on oral cancer. This consideration is speculative at best, especially in view of the strong interaction between alcohol abuse and smoking in the etiology of oral cancer. The extreme imprecision of the relative risk of 2.8 (95% confidence interval, 0.8-9.9) may indicate that chance is a highly credible explanation for the findings.[25]

The largest study performed until the moment with 924 cases and 928 controls in Central Europe, and 2,286 cases and 1,824 controls in Latin America[27] about oral health and the risk of squamous cell carcinoma concluded that periodontal disease and daily mouthwash use may be independent causes of cancer of the head, neck and esophagus.[27] The authors did not relate when the subjects began using mouthwashes, whether with the first symptoms of the disease, or even which kinds of alcohol-containing mouthwash were used. They suggest that, in order to be reliable, future studies should stratify by alcohol content, brand, reason to use, and how long the mouthwash was retained in the mouth.[27]

A review of the evidence conducted by the Food and Drug Administration (FDA) and American Dental Association (ADA) found the following four deficiencies:[11] 1) lack of a dose-response analysis based on frequency and/or duration of mouthwash use and inconsistent findings between studies, 2) lack of a scientific or biological basis to explain inconsistent findings between males and females, 3) absence of correction for alcoholic beverage ingestion and tobacco use, and 4) inclusion of cases of pharyngeal cancer as oral cancer, an improper classification. As mouthwashes are only used in the oral cavity, the findings are inconsistent, often contradictory and do not fulfill basic pharmacological requirements.[11]

In a recently published case/control study performed in seven reference hospitals with 309 patients with squamous cell carcinoma of the mouth and pharynx and 468 controls matched by sex and age,[26] the authors found that daily mouthwash showed a stronger association to pharynx (odds ratio 4.7, 95% CI 1.8-12.5) than to mouth cancer (odds ratio 3.2, 95% CI 1.6-6.3). For those patients who answered that they had regular gum bleeding, the authors found a stronger association too (odds ratio 3.1, 95% CI 1.2-7.9). They concluded that gum bleeding, no dental care and daily mouthwash use were factors associated with oral cancer regardless of tobacco and alcohol consumption. The authors comment about the potential bias involved in their own study. As in others studies, the fact that the subjects may use mouthwashes to reduce the aftertaste left by smoking or drinking may be an important potential bias in the multiple logistic regression analysis adjusted for smoking and alcohol consumption.[26] In Brazil, where the study was conducted, a self-medication culture is widespread among the population, so the first symptoms of the disease could have led patients to search for a self resolution. Thus, mouthwash use could have been a consequence and not a cause of the disease, particularly considering that data on mouthwash brand, frequency of use and time at which the use began were not recorded.

Final remarks

The rationale for the daily use of antimicrobial mouthrinses is well known and can be divided in two main arguments: 1) the inadequacy of the mechanical plaque control performed by most people for the control and prevention of periodontal diseases, and 2) as a method of delivering antimicrobial agents to mucosal sites throughout the mouth that may harbor pathogenic bacteria capable of recolonizing supragengival and subgengival tooth surfaces, thereby providing a complementary mechanism of

plaque control.[32] Antimicrobial mouthrinses are safe and effective in reducing plaque and gingivitis, and should be part of a comprehensive oral health care regimen that includes brushing, flossing and rinsing to prevent or minimize periodontal disease.[6] Most mouthwashes with antiplaque properties (essential oil and some chlorhexidine mouthwashes) contain denatured alcohol as a delivery vehicle. Nevertheless, a review by the Food and Drug Administration and the American Dental Association found that the evidence about oral cancer and alcohol-containing mouthwashes is inconsistent and contradictory.[21]

The literature reviewed here indicates that despite some undesirable effects to some people, like burning sensation, and some contraindications, like the use by infants, alcohol addicts and patients with mucosal injuries, there is no reason to avoid the use of alcohol-containing mouthwashes as long as they are used following proper guidance by dental professionals and the manufacturers' instructions.

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Association between periodontal diseases and systemic diseases

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Abstract: Current evidence suggests that periodontal disease may be associated with systemic diseases. This paper reviewed the published data about the relationship between periodontal disease and cardiovascular diseases, adverse pregnancy outcomes, diabetes and respiratory diseases, focusing on studies conducted in the Brazilian population. Only a few studies were found in the literature focusing on Brazilians (3 concerning cardiovascular disease, 7 about pregnancy outcomes, 9 about diabetes and one regarding pneumonia). Although the majority of them observed an association between periodontitis and systemic conditions, a causal relationship still needs to be demonstrated. Further studies, particularly interventional well-designed investigations, with larger sample sizes, need to be conducted in Brazilian populations.

Descriptors: Periodontitis; Cardiovascular diseases; Pregnancy complications; Diabetes *mellitus*; Lung diseases.

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Introduction

The understanding of the etiology and pathogenesis of periodontal diseases and their chronic, inflammatory and infectious nature[1] necessitates admitting the possibility that these infections may influence events elsewhere in the body. At the same time, recognition of the interaction between oral diseases and some systemic conditions entails that dentists and periodontists should direct their practice and knowledge not only to events strictly related to the oral cavity but also consider systemic conditions and diseases which may change or interfere with established preventive and therapeutic approaches.

The concept that oral diseases could influence distant structures is, to a certain extent, a return to the theory of focal infection. The evidence supporting this theory dates from around 1900 and it was based on the expert opinion and personal clinical experience of a few physicians and dentists. Some reports of questionable scientific merit have also supported the influence of dental sepsis on systemic health.[2] The return of this concept since the end of the 80's has been investigated in a quite different scenario. Advances in the methods of scientific investigation were undoubtedly decisive in this context. The development of epidemiological studies and statistical analysis, the enhanced understanding of biological plausibility by means of advances in molecular biology, microbiology, immunology and genetics, the possibility of successfully treating periodontal diseases, caries and endodontic infections and retaining teeth instead of extracting them, all these factors have led dental and medical researchers and clinicians to resume the study of the relationship between oral diseases and systemic conditions with a more scientific approach.

This paper discusses the relationship between periodontal diseases and the most studied systemic conditions: cardiovascular diseases, adverse pregnancy outcomes, diabetes *mellitus* and respiratory diseases. Each section presents the current state of the field, indicates questions to be answered and presents studies performed in Brazilian populations.

Periodontal diseases and cardiovascular diseases

Cardiovascular diseases (CVD) are a group of diseases that include congestive heart failure, cardiac arrhythmias, coronary artery disease (including atherosclerosis and myocardial infarction), valvular heart disease and stroke. Among these, atherosclerosis, a major component of cardiovascular diseases, is characterized by the deposition of atherosclerotic plaques on the innermost layer of walls of large- and medium-sized arteries. End-stage outcomes associated with atherosclerosis include coronary thrombosis, myocardial infarction and stroke.

CVD and periodontitis are both chronic and multifactorial diseases, and share some of their risk factors: age, male gender, lower socioeconomic status, smoking and psychosocial factors such as stress.[3] Recently, periodontal disease (PD) has been investigated as a potential factor contributing to the onset and development of CVD.

Several mechanisms that could explain this association have been investigated. The host response to the presence of periodontal pathogens may trigger the production of inflammatory mediators such as C-reactive protein, TNF-α, PGE_2, IL-1β and IL-6, which can accelerate the progression of pre-existing atherosclerotic plaques[4] and are related to an increased number of adverse cardiovascular events.[5] Also, several studies demonstrated the ability of periodontal pathogens to induce platelet aggregation and the formation of atheromas.[6,7]

A systematic review published in 2003[8] studied the evidence supporting the association between PD and CVD. Thirty-one human studies were selected. The authors concluded that "periodontal disease may be modestly associated with atherosclerosis, myocardial infarction and cardiovascular events". Other three systematic reviews[9-11] reported a modest but significant association between CVD and periodontal disease.

Another question is whether periodontal treatment can decrease the risk for adverse cardiovascu-

lar events. However, so far there is limited evidence regarding this question. Cardiovascular events may take several years to occur, so the possible benefits of periodontal therapy are difficult to observe in interventional studies. Some investigations reported the effects of periodontal treatment on surrogate endpoints, such as C-reactive protein, which is associated with CVD.[12] However, a recent systematic review concluded that, up to now, there is no evidence that periodontal treatment can significantly reduce C-reactive protein levels.[13]

Few studies regarding this association have been conducted in the Brazilian population. One case-control study and two cross-sectional studies were retrieved from the Medline and Scielo databases, using the words "periodontitis", "periodontal", "cardiovascular", "infarction" and "atherosclerosis" (Table 1).

The case control study, conducted in Southern Brazil, found a significant association between periodontitis and acute coronary syndrome.[16] One cross-sectional study[14] observed significant association between periodontal disease and severe obstruction of coronary artery. However, the authors did not present multivariate analysis with adjustment for confounders related to periodontitis and CVD. The other cross-sectional study[15] did not present a multivariate analysis to investigate the association between the two conditions, and reported that periodontal disease was elevated in patients with Ischemic Coronary Atherosclerosis. Some potential methodological biases should be considered in order to avoid erroneous conclusions about a causal relationship between periodontal disease and adverse cardiovascular events in these populations. The criteria adopted to define periodontal disease exposure in these studies must also be carefully analyzed. More interventional studies, with larger sample sizes, need to be conducted in the Brazilian population.

Adverse pregnancy outcomes and periodontal diseases

This section will focus particularly on the relationship between periodontal diseases and preterm birth and low birth weight, which has been extensively studied in last years all over the world.

The first study to report the influence of poor oral health on the birth of low weight and preterm infants was performed by Offenbacher and colleagues.[17] They obtained obstetric and demographic information from the studied patients' prenatal records and performed full mouth periodontal examinations in 93 mothers who gave birth to preterm or low weight infants and compared them to those of 31 mothers who had term deliveries and normal weight infants. Multivariate analysis showed that the women with more than 60% of sites with clinical attachment loss of 3 mm or more were seven

Table 1 - Studies assessing the relationship between periodontal disease and cardiovascular diseases in Brazilian populations.

Authors	Study design	Population	Periodontal outcome or exposure	Cardiovascular disease outcome	Findings and conclusions
Accarini, de Godoy[14] (2006)	Cross-Sectional	361 patients from a Hospital in São Paulo (SP)	30% of sites with clinical attachment level and/or periodontal pocket depth ≥ 5 mm	Severe obstruction of coronary artery (at least one obstruction ≥ 50%)	Significant association between periodontal disease and severe obstruction of coronary artery (OR 2.571, CI 1.192-5.547)
Barilli *et al.*[15] (2006)	Cross-Sectional	634 patients from a Hospital in Ribeirão Preto (SP)	Presence of periodontal disease according to Community Periodontal Index	Ischemic Coronary Atherosclerosis	Periodontal disease was elevated in patients with Ischemic Coronary Atherosclerosis
Rech *et al.*[16] (2007)	Case-control	58 cases (acute coronary syndrome) and 57 matched controls from a hospital in Gravataí (RS)	Presence of periodontal pockets, attachment loss and gingival inflammation	Presence of acute coronary syndrome	Significant association between periodontitis and acute coronary syndrome (OR 5.1 CI 1.7-14.8)

times more likely to have an adverse pregnancy outcome than periodontally healthy women (OR = 7.5; CI 1.98-28.8).

The etiology of preterm birth is multifactorial, but inflammation is the common pathway that leads to uterine contractions and cervical changes with or without premature rupture of membranes. Inflammation associated to preterm birth can be mainly attributable to intrauterine infection and bacterial vaginosis, and the latter accounts for up to 40% of the cases of spontaneous preterm labor and preterm birth. There is also a causal relationship between bacterial vaginosis and preterm birth[18] and the presence of significantly higher levels of proinflammatory cytokines and prostaglandins in the amniotic fluid. This is a common finding in women with bacterial vaginosis who deliver preterm.[19,20] At the same time, an infection remote to the genital tract can also trigger preterm birth, and this is the case for pregnant women with periodontal disease.

Biological plausibility of the link between both conditions, periodontal disease and preterm birth, does exist and can be summarized in three potential pathways.[20,21] One of them refers to the hematogenous dissemination of inflammatory products from a periodontal infection, while the second potential pathway involves the fetomaternal immune response to oral pathogens. The third pathway proposed to explain the theoretical causal relationship between periodontal disease and preterm birth involves bacteremia from an oral infection.

Since 1994, several studies have been conducted concerning the relation between periodontal diseases and preterm birth and diverse findings have been reported all over the world. There appears to be an association between both conditions, but whether periodontitis is a confounding factor, a marker or one of the causes of preterm birth remains unclear.[22] The reader is referred to additional studies in order to get acquainted with the larger body of literature on this theme.[23,24]

It is important to point out that, in spite of the high number of studies published, only a few of them are randomized clinical trials, which represents the research design that generates the weightiest evidence when assessing claims of causation. In this context, two clinical trials should be mentioned. The first one was performed by Lopez *et al.*[25] (2002) in Chile with 163 pregnant women who received periodontal treatment during pregnancy and 188 women who received the same treatment after delivery. Preterm/low birth weight rate was 1.8% for the test group and 10.1% for the control group. The authors demonstrated that the presence of periodontitis was significantly associated with preterm/low birth weight in the population studied (OR 4.7, CI 1.29-17.13). The other randomized clinical trial was performed in the United States[26] with 413 pregnant women who received monthly oral health instruction and scaling as needed and 410 pregnant women who were submitted to brief monthly oral exams during pregnancy. Preterm birth occurred in 12% and 12.8% of the patients from the test and control groups, respectively. Periodontal treatment significantly improved all periodontal parameters but it did not improve preterm delivery (OR 0.93, CI 0.63-1.37).

Conflicting findings have been found not only in these two clinical trials but also in the literature published since 1994 in this area. Several criteria, such as the definition of periodontal disease, experimental design, compliance with treatment and the time of periodontal treatment delivered in clinical trials, controlling for confounding variables and outcome definition are pointed out in order to understand the diversity of the results presented. Another issue addressed in this discussion is the fact that different populations may not share the same risk factors to both conditions, periodontal diseases and adverse pregnancy outcomes. It will thus be necessary to conduct studies taking into account socioeconomic, biologic and environmental determinants for each population.

Specifically in the Brazilian population, some studies were performed and are detailed in Table 2. Five case control studies and two cross sectional studies were retrieved from Medline with the words "periodontitis", "preterm birth", "low birth weight" and "Brazil". Two other studies were not included because of inadequate outcome measure[27] and partial data reporting.[28]

One cross sectional study performed in the state of Santa Catarina found no association between

Table 2 - Studies assessing the relationship between periodontal disease and adverse pregnancy outcomes in Brazilian populations.

Authors	Study design	Population	Periodontal outcome or exposure	Adverse pregnancy outcome	Variables included in the final model	Findings and conclusions
Cruz et al.[29] (2005)	Case-control	102 cases and 200 controls from a public hospital in Feira de Santana (BA)	≥ 4 sites with clinical attachment levels ≥ 4 mm	Low birth weight (< 2,500 g)	No adjustment for classic confounding variables	Significant association between low birth weight and periodontitis for mothers with low educational level (OR 3.98, CI 1.58-10.10)
Lunardelli, Peres[30] (2005)	Cross-sectional	449 women from a maternity hospital in Itajaí (SC)	≥ 1 site with probing depth ≥ 3.5 mm ≥ 4 sites with probing depth ≥ 3.5 mm	• Preterm birth (< 37 weeks) • Low birth weight (< 2,500 g) • Preterm and low birth weight	Periodontal disease, schooling, parity, previous low birth weight, body mass index, number of prenatal visits, genitourinary infection, hypertension, dental treatment and oral health guidance	No significant association between periodontal disease and prematurity when maternal health variables were included (OR 2.7, CI 0.7-9.7)
Moliterno *et al.*[31] (2005)	Case-control	76 cases and 75 controls from a public maternity hospital in Rio de Janeiro (RJ)	≥ 4 sites with probing depth ≥ 4 mm and clinical attachment level ≥ 3 mm	Preterm birth (< 37 weeks) and low birth weight (< 2,500 g)	Periodontitis, genitourinary infection, race, prenatal location, arterial hypertension, vaginal bleeding, alcohol use, smoking, number of prenatal visits, diabetes and educational level	Significant association between low birth weight and periodontitis (OR 3.48, CI 1.17-10.36)
Bassani *et al.*[32] (2007)	Case-control	304 incident cases and 611 controls from three hospitals in Porto Alegre (RS)	≥ 3 sites with clinical attachment level ≥ 3 mm	Low birth weight (< 2,500 g) at > 27 weeks of gestational age	Maternal age, parity, prenatal care, smoking, previous preterm or low birth weight, hypertension, pre eclampsia and weight change during pregnancy	No association between periodontitis and low birth weight (OR 0.93, CI 0.63-1.41)
Siqueira *et al.*[33] (2007)	Case-control	263 cases and 1,042 controls from a public hospital in Belo Horizonte (MG)	≥ 4 sites with probing depth ≥ 4 mm and clinical attachment level ≥ 3 mm	Preterm birth (< 37 weeks), low birth weight (< 2,500 g) and intrauterine growth restriction	Educational level, maternal age, prenatal visits, chronic hypertension, primiparity, previous abortion, previous preterm birth and maternal periodontitis	• Significant association between preterm birth and periodontitis (OR 1.77, CI 1.12-2.59) • Significant association between low birth weight and periodontitis (OR 1.67, CI 1.11-2.51) • Significant association between preterm birth and intrauterine growth restriction (OR 2.06, CI 1.00-4.19)
Santos Pereira *et al.*[34] (2007)	Cross-sectional	68 women with preterm labour and 56 women with term labour from a university hospital in Campinas (SP)	≥ 1 site with clinical attachment level ≥ 1 mm and bleeding on probing	Preterm labour (gestational age < 37 weeks, admitted in the hospital for intravenous tocolysis)	Age, ethnicity, parity, schooling, marital status and number of prenatal visits	• Significant association between preterm birth and periodontitis (OR 4.9, CI 1.9-12.8) • Significant association between low birth weight and periodontitis (OR 4.2, CI 1.3-13.3)
Siqueira *et al.*[35] (2008)	Case-control	125 cases and 375 matched controls from a public hospital in Belo Horizonte (MG)	≥ 4 sites with probing depth ≥ 4 mm and clinical attachment level ≥ 3 mm	• Pre eclampsia • Blood pressure > 140/90 mm Hg on two occasions after 20 weeks of gestation and ≥ 1+ urine dipstick value	Maternal age, primiparity, chronic hypertension, number of prenatal visits, previous preterm birth and maternal periodontitis	• Significant association between pre eclampsia and preterm birth (OR 3.15, CI 1.04-9.52) • Significant association between pre eclampsia and maternal periodontitis (OR 1.52, CI 1.01-2.29

periodontitis and preterm birth when a high number of variables were included in the analysis.[30] Another cross sectional study performed in the state of São Paulo showed that periodontitis may be a risk indicator for women with a diagnosis of preterm labor.[34]

Four case control studies investigated the relationship between periodontitis and low birth weight. Three of them found a significant association between both conditions[29,31,33] and the fourth failed to demonstrate an association between periodontitis and the birth of infants with less than 2,500 g.[32] It is important to mention that in one of the studies there were no adjustment for classic confounding variables related to periodontitis and low birth weight.[29] Studies performed in the city of Belo Horizonte also evaluated the association of periodontitis with preterm birth, intrauterine growth restriction and preeclampsia and the authors showed significant association with all the adverse pregnancy outcomes investigated.[33,35]

Similarly to the investigations in other populations, studies in the Brazilian population may indicate an association between periodontitis and adverse pregnancy outcomes. However, potential methodological biases should be thoroughly analyzed in order to avoid erroneous and premature conclusions. Moreover, the limited number of randomized clinical trials published up to now in the international literature and the absence of studies with this design in the Brazilian population prevents us from offering a definitive conclusion.

Periodontal disease and diabetes *mellitus*

Diabetes is a group of metabolic diseases characterized by hyperglycemia and results from either a deficiency in the secretion of insulin and/or reduced insulin action.[36] In type 1 diabetes, there is an absolute deficiency of insulin. In type 2 diabetes, there is the involvement of resistance to insulin and an inability of the pancreas to compensate for this resistance. Severe hyperglycemia can cause numerous symptoms, including polyuria, polyphagia, polydipsia, weight loss and blurred vision.[37] There is peripheral vascular insufficiency, causing scarring disorders and physiological changes that reduce the immunological capacity, thereby increasing the susceptibility to infection. A greater glucose and calcium content in the saliva favors an increase in the amount of calculus and irritating factors to oral tissues, leading to periodontal disease, which is the most common dental manifestation in the oral cavity among diabetic patients (75%).[38]

Chronic periodontal disease and diabetes *mellitus* are common chronic conditions in adults throughout the world.[39] Severe periodontal disease often coexists with diabetes and is considered the sixth most common complication of the disease.[40] A number of studies have demonstrated that poor blood sugar control may contribute to poor periodontal health[41-47] and that such individuals have a 2.8-fold greater chance of developing destructive periodontal disease[42] as well as a 4.2-fold greater chance of having progressive alveolar bone loss.[48] The increased risk of developing periodontal disease cannot be explained by age, gender or hygiene.[49] The interrelationship between periodontal disease and diabetes provides an example of a systemic disease predisposing individuals to oral infection and, once the infection is installed, it exacerbates the systemic disease.[39]

The interrelationship between diabetes and periodontal disease is established through a number of pathways[50] and is bidirectional.[51] Diabetes is a risk factor for gingivitis and periodontitis.[52,53] Blood sugar control is an important variable in the relationship between diabetes and periodontal disease. Individuals who have poor control over glycemia have a greater prevalence and severity of gingival and periodontal inflammation.[54-56] It has been suggested that hyperglycemia promotes periodontitis and its progression.[51,57-62]

One of the mechanisms to explain the relationship between diabetes *mellitus* and periodontal disease suggests that the presence of periodontal disease may induce or perpetuate a state of chronic systemic inflammation, as demonstrated by the increase in the C-reactive protein, interleukin-6 (IL-6) and fibrinogen levels found in individuals with periodontitis.[63] Periodontal infection may elevate the state of systemic inflammation and exacerbate the resistance to insulin, as the inflammatory pro-

cess induces this resistance. Furthermore, it may induce increased levels of IL-6 and TNF-α, which is similar to obesity inducing or exacerbating the resistance to insulin.[64]

The synergism between diabetes and periodontal disease has been demonstrated in a number of studies. It has been made clear that effective periodontal treatment can improve some complications of diabetes, especially hyperglycemia, and that severe periodontitis is associated to poor blood sugar control. Periodontal treatment improves blood sugar control, especially in individuals with type 2 diabetes, and its association to low glycated hemoglobin levels has been demonstrated.[60]

A number of studies have found that non-surgical periodontal treatment improves the metabolic control of diabetic patients, thereby influencing a reduction in glycated and glycemic hemoglobin levels.[65] Patients with diabetes have a good response to periodontal treatment, whether in the short or long term, and this response is similar to that observed in non-diabetic patients. However, if the diabetes is not well controlled, the recurrence of periodontal disease is more frequent and more difficult to control. The influence of diabetes over periodontal disease is well established, but the effect of periodontitis and its treatment over the control of diabetes remains unclear.[66]

In Brazil, few studies have been carried out assessing the relationship between diabetes and periodontal disease. There are also few studies addressing the benefits of periodontal treatment regarding blood sugar control. Table 3 presents the studies carried out in the Brazilian population. These studies were retrieved from the Medline, Scielo and Lilacs databases, using the words "periodontitis", "Brazil", "Brazilian" and "diabetes".

In 2003, Rodrigues *et al.*[49] assessed 30 individuals with type 2 diabetes *mellitus* and periodontitis. The authors divided the patients into two groups – one group underwent mechanical periodontal treatment and the other group underwent that treatment

Table 3 - Studies assessing the relationship between periodontal disease and diabetes *mellitus* in Brazilian populations.

Authors	Population	Diabetes	Findings and conclusions
Novaes Jr *et al.*[67] (1991)	30 diabetics / 30 controls aged 5 to 18 years	Type 1	Greater mean indices of plaque, gingivitis and alveolar bone loss among diabetics when compared to healthy controls.
Novaes Jr *et al.*[44] (1996)	30 diabetics / 30 controls aged 30 to 77 years	Type 2	A one-year follow up found no difference in probing depth, but there was a significant difference in insertion loss between diabetics and controls.
Novaes Jr *et al.*[68] (1997)	11 diabetics	Type 1	Although the patients did not receive periodontal treatment over a 10-year period, there was a slight increase in plaque, gingivitis, probing depth and bone loss.
Novaes Jr *et al.*[69] (1997)	30 diabetics / 30 controls aged 30 to 77 years	Type 2	Using the BANA test, there was no significant difference between diabetics and controls.
Rodrigues *et al.*[49] (2003)	30 diabetics	Type 2	Patients were divided into 2 groups – one received conventional therapy and the other received therapy + doxycycline. There was a 10% reduction in glycated hemoglobin level, with statistical significance for the group that only received mechanical treatment.
Martorelli de Lima *et al.*[70] (2004)	11 diabetics aged 35-55 years	Type 1	Patients had pockets with depths ≥ 5 mm treated with conventional therapy and sub-gingival administration of doxycycline gel or conventional therapy + placebo. Better results were obtained in the group that used doxycycline.
Souza *et al.*[71] (2006)	44 diabetics / 19 controls	Type 2	No difference in blood sugar control was found, not even following non-surgical periodontal therapy associated or not to systemic doxycycline.
Drumond-Santana *et al.*[72] (2007)	159 diabetics	Type 1 Type 2	Using the OHIP-14 index, the impact of periodontal disease on the quality of life of diabetic individuals was assessed. It was concluded that diabetics with periodontitis suffered a greater negative impact on quality of life than periodontally healthy diabetics or those with gingivitis.
O'Connell *et al.*[73] (2008)	30 diabetics	Type 2	No additional effect from doxycycline associated to conventional mechanical therapy was found.

associated to the use of amoxicillin and clavulanic acid. Glycated hemoglobin levels, glycemia and clinical periodontal parameters were assessed at baseline and three months following therapy. The authors concluded that non-surgical periodontal therapy improved blood sugar control in both groups and the reduction of glycated hemoglobin was only statistically significant in the group that did not make use of antibiotics.

To assess the effect of the sub-gingival administration of doxycycline as an auxiliary aid in periodontal treatment among patients with type 1 diabetes, Martorelli de Lima *et al.*[70] (2004) treated 11 individuals, who were required to present two sites with probing depths ≥ 5 mm and bleeding or suppuration upon probing. For one group, the treatment consisted of scaling and root planing therapy associated to the sub-gingival administration of a 10% doxycycline hyclate gel, whereas the other group received scaling and root planing associated to a placebo gel. The authors concluded that the use of doxycycline produced additional favorable effects over the scaling and root planing alone.

Souza *et al.*[74] (2006) studied the effect of periodontal therapy on glycated hemoglobin levels in 63 non-insulin-dependent diabetic adults, who were divided into four groups: Group 1 – healthy controls; Group 2 – diabetics with no periodontal disease; Group 3 – diabetics with periodontitis submitted to periodontal therapy; and Group 4 – diabetics with periodontitis submitted to periodontal therapy associated to the administration of systemic doxycycline. The authors found no statistically significant difference in blood sugar control following periodontal therapy with or without the use of systemic antibiotics.

In a double-blind, placebo-controlled study assessing the effect of periodontal therapy (scaling and root planing) on glycated hemoglobin levels and biomarkers, O'Connell *et al.*[73] (2008) treated 30 patients with type 2 diabetes. One group was treated with doxycycline and mechanical therapy and the other group was treated with mechanical therapy alone. The authors concluded that there was an improvement in blood sugar control, but there was no significant difference between the use and non-use of doxycycline.

Current evidence is insufficient to determine whether periodontal treatment, whether associated to antibiotic therapy or not, is effective in controlling glycated hemoglobin and blood sugar levels in patients with diabetes.

Periodontal diseases and respiratory diseases

Respiratory diseases is the term for diseases of the respiratory system, including lung, pleural cavity, bronchial tubes, trachea, and upper respiratory tract. They range from a common cold to life-threatening conditions such as bacterial pneumonia or chronic obstructive pulmonary disease (COPD), which are important causes of death worldwide.

COPD is a pathological and chronic obstruction of airflow through the airways or out of the lungs, and includes chronic bronchitis and emphysema. Its main risk factor is smoking, but air pollution and genetic factors are also strongly implicated.

Pneumonia (both community-acquired and hospital acquired) is an acute infection of the lung and is characterized by cough, breath shortness, sputum production and chest pain. It is caused by the micro-aspiration of oropharyngeal secretions containing bacteria into the lung, and failure of the host to clear the bacteria.

There is increasing evidence that a poor oral health can predispose to respiratory diseases, especially in high-risk patients (nursing home residents, older subjects, intensive care unit patients and hospitalized individuals requiring mechanical ventilation). The oral cavity is contiguous with the trachea and may be a portal for respiratory pathogen colonization. Dental plaque can be colonized by respiratory pathogens,[75] which may be aspirated from the oropharynx into the upper airway and then reach the lower airway and adhere to bronchial or alveolar epithelium.[76]

A recent systematic review investigated if there was an association between oral health and pneumonia or other respiratory disease.[77] The authors reviewed 19 studies that met the inclusion criteria and concluded that there is fair evidence of an association of pneumonia with oral health, but there is

poor evidence of a weak association between COPD and oral health. The authors also concluded that improved oral hygiene and professional oral health care reduces the progression or occurrence of respiratory diseases among high-risk elderly adults. A recent prospective study[78] conducted with 697 elderly individuals observed that the adjusted mortality due to pneumonia was 3.9 times higher in subjects with periodontal disease.

As discussed above, the oral cavity serves as a reservoir for respiratory pathogens. So, oral hygiene interventions may reduce colonization by these pathogens and, consequently, decrease the risk for pneumonia, especially in high-risk populations. Scannapieco *et al.*[79] (2003) conducted a systematic review about the effectiveness of oral decontamination to prevent pneumonia. A meta-analysis on 5 intervention studies revealed that oral interventions improving oral hygiene through mechanical and/or chemical disinfection reduced the incidence of nosocomial pneumonia by an average of 40%. A recent multicenter trial assessed the efficacy of a 0.2% chlorhexidine gel in the reduction of the rate of pneumonia in 228 non-edentulous patients requiring endotracheal intubation and mechanical ventilation.[80] Although the intervention significantly decreased the oropharyngeal colonization by aerobic pathogens, no significant reduction in the incidence of respiratory infections was observed.

There is a lack of information about the association between oral health and respiratory diseases in Brazilian populations. One investigation conducted in Brazil was retrieved using the words "periodontitis", "oral health", "dental", "pneumonia" and "respiratory" in the Medline and Scielo databases. In this cross-sectional study,[81] 30 hospital patients with diagnosis of nosocomial pneumonia were included. Samples from tracheal aspirate, supragingival dental plaque and tongue were analyzed. Seventy percent of the bacteria isolated from the tracheal aspirate were also found in the dental biofilm. The authors concluded that dental biofilm could act as a reservoir for respiratory pathogens.

Conclusion

Most of the reviewed studies focusing on the Brazilian population demonstrated an association between periodontal disease and systemic conditions. However, more studies are needed, particularly interventional investigations, in order to establish a causal relationship between the two conditions.

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Halitosis: a review of associated factors and therapeutic approach

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Abstract: Halitosis or bad breath is an oral health condition characterized by unpleasant odors emanating consistently from the oral cavity. The origin of halitosis may be related both to systemic and oral conditions, but a large percentage of cases, about 85%, are generally related to an oral cause. Causes include certain foods, poor oral health care, improper cleaning of dentures, dry mouth, tobacco products and medical conditions. Oral causes are related to deep carious lesions, periodontal disease, oral infections, peri-implant disease, pericoronitis, mucosal ulcerations, impacted food or debris and, mainly, tongue coating. Thus, the aim of the present review was to describe the etiological factors, prevalence data and the therapeutic mechanical and chemical approaches related to halitosis. In general, halitosis most often results from the microbial degradation of oral organic substrates including volatile sulfur compounds (VSC). So far, there are few studies evaluating the prevalence of oral malodor in the world population. These studies reported rates ranging from 22% to more than 50%. The mechanical and chemical treatment of halitosis has been addressed by several studies in the past four decades. Many authors agree that the solution of halitosis problems must include the reduction of the intraoral bacterial load and/or the conversion of VSC to nonvolatile substrates. This could be achieved by therapy procedures that reduce the amount of microorganisms and substrates, especially on the tongue.

Descriptors: Halitosis/etiology; Halitosis/epidemiology; Halitosis/diagnosis; Halitosis/therapy; Mouthrinses/therapeutic use

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Introduction

Halitosis, *fetor oris*, oral malodor or bad breath are the general terms used to describe unpleasant breath emitted from a person's mouth regardless of whether the odorous substances in the breath originate from oral or non-oral sources.

Halitosis is an oral health condition characterized by consistently emanating odorous breath and may be caused by several agents including certain foods, poor oral health care, improper cleaning of dentures, decreased salivary flow rate, tobacco products or a medical condition. In 90% of cases, though, the causes of halitosis are located in the mouth and can be attributed to deep carious lesions, periodontal disease, oral infections, periimplant disease, pericoronitis, mucosal ulcerations, impacted food or debris, factors causing decreased salivary flow rate and, mainly, tongue coating.[1]

The tongue is a major site of oral malodor production, while periodontal disease and other factors seem to be only a fraction of the overall problem.[2] In addition, current social norms emphasize the importance of personal image and interpersonal relationships. Thus, halitosis may be an important factor in social communication and, therefore, may be the origin of concern not only for a possible health condition but also for frequent psychological alterations leading to social and personal isolation.[3] Although oral malodor or bad breath is an unpleasant condition experienced by most individuals, it typically results in transient discomfort.

At least 50% of the population suffer from chronic oral malodor and approximately half of these individuals experience a severe problem that creates personal discomfort and social embarrassment. The mouth air of chronic malodor sufferers is tainted with compounds such as hydrogen sulfide, methyl mercaptan and organic acids, which produce a stream of foul air that is gravely offensive to the people in their vicinity. Sufferers often make desperate attempts to mask their oral malodor with mints and chewing gum, compulsive brushing, and repeatedly rinsing with mouthwashes.[4] Currently, three methods for measuring halitosis are available: (1) organoleptic measurement, (2) gas chromatography and (3) sulfide monitoring. Although the organoleptic measurement has many shortcomings it still is the golden standard method to assess halitosis.[5]

Etiology

Although the source of oral malodor is located in the oral cavity in up to 90% of people with the condition and only a small percentage of cases may be due to non-oral causes, a serious underlying medical condition may warrant immediate referral to a physician.[6]

Halitosis and the presence of oral microorganisms

The oral microorganisms most likely to cause oral malodor are Gram-negative bacteria species including *Treponema denticola*, *Porphyromonas gingivalis*, *Porphyromonas endodontalis*, *Prevotella intermedia*, *Bacteroides loescheii*, Enterobacteriaceae, *Tannerella forsythensis*, *Centipeda periodontii*, *Eikenella corrodens*, *Fusobacterium nucleatum*.[7]

However, no obvious association exists between halitosis and any specific bacterial infection, suggesting that bad breath reflects complex interactions between several oral bacterial species. The agents that give rise to oral malodor include especially the volatile sulfide compounds, diamines, and short chain fatty acids.[8]

The principal components of bad breath are volatile sulfide compounds (VSC), especially hydrogen sulfide (H_2S), methyl mercaptan (CH_3SH), and dimethylsulfide [$(CH_3)_2S$][10] or compounds such as butyric acid, propionic acid, putrescine, and cadaverine.[9] These compounds result from the proteolytic degradation by predominantly anaerobic Gram-negative oral microorganisms of various sulfur-containing substrates in food debris, saliva, blood, and epithelial cells.[10] Substrates for volatile sulfide compounds production are sulfur-containing amino-acids such as cysteine, cystine and methionine present in saliva or gingival fluid.[11] Several microorganisms recovered from periodontal lesions of gingivitis and

periodontitis are related to produce large amounts of these volatile sulfur compounds.[10]

The bacterial interactions are most likely to occur in the gingival crevices and periodontal pockets, but oral malodor can also arise from the posterior dorsal tongue. As a consequence of its large and papillary surface area, the dorsum of the tongue can retain large amounts of desquamated cells, leucocytes, and microorganisms. Donaldson *et al.*[12] (2005), examining the microflora present on the tongue dorsum of subjects with and without halitosis, observed that the predominant species in test and control groups were *Veillonella sp.* and *Prevotella sp.* Greater species diversity was found in the halitosis samples compared with controls. The halitosis samples contained an increased incidence of unidentifiable Gram-negative rods, Gram-positive rods and Gram-negative coccobacilli. The authors stated that there was no obvious association between halitosis and any specific bacterial genus. The increased species diversity found in halitosis samples suggests that halitosis may be the result of complex interactions between several bacterial species. The role of uncultivable bacteria may also be important in contributing to this process. The same group, later[13] using molecular identification of bacteria on the tongue dorsum of subjects with and without halitosis, observed that the predominant species found in the control samples were Lysobacter-type species, *Streptococcus salivarius*, *Veillonella dispar*, unidentified oral bacterium, *Actinomyces odontolyticus*, *Atopobium parvulum* and *Veillonella atypica*. In the halitosis samples, Lysobacter-type species, *S. salivarius*, *Prevotella melaninogenica*, unidentified oral bacterium, *Prevotella veroralis* and *Prevotella pallens* were the most commonly found species. For the control samples, 13-16 (4.7-5.8%) of 276 clones represented uncultured species, whereas in the halitosis samples, this proportion increased to 6.5-9.6% (36-53 of 553 clones). In the control samples, 22 (8.0%) of 276 clones represented potentially novel phylotypes, and in the halitosis samples, this figure was 39 (7.1%) of 553 clones. They concluded that the microflora associated with the tongue dorsum is complex in both the control and the halitosis groups, but several key species predominate in both groups.

Prevalence of halitosis

There are few studies evaluating the prevalence of oral malodor in the general population, with reported rates ranging from 22% to more than 50%. In addition, approximately 50% of adults and elderly individuals emit socially unacceptable breath, related to physiological causes, upon arising in the morning.[14] Moreover, there are no universally accepted standard criteria, objective or subjective, that define a halitosis patient.[15]

Up to 50% of the U.S. population reports that their own "bad breath" has concerned them during some point in the course of their lifetime. Half of this group is indeed likely to have an ongoing sporadic or a chronic breath malodor problem.[16]

A study performed by Miyazaki *et al.*[17] (1995) examining oral malodor in 2,672 individuals aged 18 to 64 years observed that there were no significant differences in the VSC between males and females in any age group. In each age group, the measured values of oral malodor were highest in the late morning group (58.6 ppb in average), followed by the late afternoon group (52.1 ppb), while lowest values were shown in the early afternoon group (39.4 ppb). Significant correlation was observed only between VSC values and periodontal conditions and tongue coating status. The results also suggest that oral malodor might be caused mainly by tongue coating in the younger generation and by periodontal diseases together with tongue coating in older cohorts in the general population. Age was not a risk factor for increasing VSC.

Liu et al.[18] (2006) examined the prevalence of halitosis in the Chinese population and assessed the relationships between halitosis and oral health, social and behavioral factors. These authors observed that the prevalence of halitosis was 27.5% according to the organoleptic score. The level of volatile sulfur compounds (VSCs) in mouth air was significantly lower in males and in some of the age groups after lunch. And, the amount of tongue coating played the most important role in increasing VSCs concentration in mouth air, followed by periodontal status and plaque index values. DMFT, social, and behavioral factors did not contribute to halitosis. They concluded that tongue coating score, modified sul-

cus bleeding index and calculus index were factors significantly related to oral malodor in this study.

Interestingly, Al-Ansari *et al.*[19] (2006) assessed the prevalence and factors associated with self-reported halitosis in 1,551 Kuwaiti patients. The prevalence of self-reported halitosis was 23.3%. Use of the toothbrush less than once daily was the factor most strongly associated with self-perceived halitosis. Other factors significantly associated with self-perceived halitosis included current or past smoking, female gender, being 30 years of age or older, having high school education or less, history of chronic sinusitis or gastrointestinal disorders, never using miswak (a natural toothbrush made from the twigs of the *Salvadora persica* tree), and never using dental floss. They concluded that inadequate oral hygiene practices were the factors most strongly associated with self-reported oral malodor in this sample of Kuwaiti patients. Other factors with significant associations included history of gastrointestinal tract disorders, chronic sinusitis, older age, female gender, and lower education levels.

Therapeutic approach to manage oral halitosis

Successful treatment of halitosis depends on a correct diagnosis and the implementation of a cause-related therapy.[20] After a positive diagnosis for oral halitosis has been made, the treatment plan is implemented, which comprises elimination of the causative agent and improvement of the oral health status.[21] Although the multiple possible etiologies include oral and non-oral causes, the majority of breath malodor cases originate from the oral cavity. Briefly, the treatment of oral malodor can therefore be focused on the reduction of the intraoral bacterial load and/or the conversion of VSC to nonvolatile substrates.

Miyazaki *et al.*[22] (1999) established the recommended examination for halitosis and a classification of halitosis with corresponding treatment needs. Accordingly, different treatment needs (TN) have been described for the various diagnostic categories. The responsibility for the treatment of physiologic halitosis (TN-1), oral pathologic halitosis (TN-1 and TN-2), and pseudo-halitosis (TN-1 and TN-4) resides on dental practitioners. However, extra-oral pathologic halitosis (TN-3) and halitophobia (TN-5) should be managed by a physician or medical specialist and a psychiatrist or psychological specialist. Table 1 describes the 5 different categories of treatment needs according to diagnosis (Miyazaki *et al.*[22], 1999).

The management of halitosis starts by taking a detailed history of the condition, duration, severity, and impact on the patient's everyday life. Examination involves clinical, radiographic, and special tests. The contributing medical conditions, once identified, are referred for treatment accordingly. Clinical examination checks the patient's oral hygiene, caries, and periodontal status; plaque retention factors are also recorded. Radiographic examination should look for evidence of dental caries, alveolar bone defects, and defective restorations.[21] Special tests are performed to detect the foul-smelling VSCs along with the associated bacteria. The results collected can be used to confirm the diagnosis and to monitor the treatment progress. There are many diagnostic techniques among which are organoleptic measurement, gas chromatography, and halimeter examination.[23,24,25,26]

Since malodor originating from the mouth is due to the metabolic degradation of available proteinaceous substrates to malodorous gases by certain oral microorganisms, oral malodor can be ameliorated through: (1) Reduction of bacterial load, (2) reduction of nutrient availability, (3) conversion of VSC to nonvolatiles and (4) masking the malodor.[1,20,27]

Table 1 - Treatment needs (TN) for breath malodor divided in 5 categories.

Category	Description
TN-1	Explanation of halitosis and instructions for oral hygiene (support and reinforcement of a patient's own self-care for further improvement of his/her oral hygiene).
TN-2	Oral prophylaxis, professional cleaning and treatment of oral diseases, especially periodontal diseases.
TN-3	Referral to a physician or medical specialist.
TN-4	Explanation of examination data, further professional instruction, education and reassurance.
TN-5	Referral to a clinical psychologist, psychiatrist or other psychological specialist.

Reduction in total load of oral microorganisms and or bacterial nutrients in the oral cavity

Mechanical approach

Several studies have implicated the dorsum of the tongue as the primary source of VSC, both in periodontally diseased and healthy individuals.[1,28,29,30,31,32] Researchers have been able to find positive correlations between tongue coating status (amount and or presence) and the different parameters directly related with oral malodor. In this scenario, the tongue becomes the most important microenvironment to study and to target in the prevention and treatment of oral halitosis and also as a potential reservoir for periodontal pathogens.

The papillary structure of the dorsum represents a unique ecological niche in the oral cavity, offering a large surface area that favors the accumulation of oral debris and microorganisms. The morphology of the dorsum of the tongue provides additional irregularities such as fissures, grooves and depapillated areas that may serve as retention areas for harboring bacteria.[1,29,33,34]

The development of a predominant anaerobic microbiota associated with tongue coating has been considered an ideal microenvironment to produce malodorous compounds, and therefore different authors have tried to assess the relationship between the morphology of the tongue and the severity of oral halitosis.[35,36]

Numerous studies have found a relationship between the mechanical removal of tongue coating and the reduction of both organoleptic scores and VSC levels, including reduction in methyl mercaptan levels and the methyl mercaptan/hydrogen sulfide ratio, in both healthy and periodontitis patients, with or without halitosis.[20,21,31,37]

Mechanical reduction of malodor and of the intraoral bacterial count may be achieved by disrupting the tongue biofilm, thus decreasing the production of VSCs and other volatile organic compounds.[32,34,38]

Various available instruments can be applied to the tongue, and by gentle pressure the majority of the tongue coating can be scraped off.[38] Brushing the dorsum of the tongue with toothpaste was more effective than brushing the teeth. The duration of these effects varies from 15 to 100 min and depends on the device used to remove the coating, i.e., toothbrush or tongue scraper, lasting longer for tongue scrapers than for toothbrushes.[39] The percentage of VSC reduction has been related to the different devices used, ranging from 33% with a toothbrush, to 42% with a specially designed tongue cleaner; and also to the periodontal health status, being higher for halitosis patients without periodontal disease (51.8%) than for periodontitis patients (49%).[33]

Other studies found a relationship between tongue cleaning and the reduction of both organoleptic scores and levels of volatile sulphur-containing compounds.[40,41] In patients with high levels of oral malodor, a regular toothbrush was statistically significantly less effective in tongue cleaning than a device that brushed and scraped, or a scraper. Because of the limited duration of the effect, efficacy remained questionable.[41] Scraping the tongue after cysteine challenge testing reduced halitosis only modestly, but brushing the tongue dorsum was remarkably effective.[42] Two weeks of tongue brushing or scraping by a group of patients free of periodontitis resulted in negligible reductions in bacteria on the tongue, whereas the amount of tongue coating decreased significantly. Therefore, tongue cleaning seems to reduce the substrates for putrefaction, rather than the bacterial load.[43]

In addition, mechanical cleaning of teeth, such as brushing the teeth and flossing reduced the amount of oral bacteria and substrates, thereby presumably reducing oral malodor.[44] Interdental cleaning and tooth brushing are essential mechanical means of oral hygiene. This home care removes residual food particles and organisms that cause putrefaction.[27] However, according to Faveri *et al.*[32] (2006), interdental flossing has no added value with regard to reducing morning bad breath. Clinical studies revealed that brushing the teeth exclusively was not very effective in reducing oral malodor scores.[42,45] A combination of tooth and tongue brushing or tooth brushing alone have a beneficial effect on bad breath for up to 1 h (73% and 30% reductions in VSC, respectively).[27]

In subjects free of caries, periodontal disease

and tongue coating, brushing the teeth exclusively had no appreciable influence on the concentration of volatile sulfur containing compounds in morning breath, when compared with no brushing and rinsing the mouth with water.[40] Since periodontitis can be a factor in chronic oral malodor,[1,27] professional periodontal treatment is mandatory. Thus, initial periodontal therapy in moderate periodontitis patients can be expected to improve breath odor parameters by reducing the number of periodontopathogens.[11,46]

Chemical approach

The goal of any antimicrobial treatment would be to reduce the proteolytic, anaerobic flora found on the tongue surface. Treatment procedure should include a debridement component, such as the use of a tongue scraper, possibly in combination with an antimicrobial mouthrinse.

Mouthrinses with antimicrobial properties can reduce oral malodor by reducing the number of microorganisms chemically. Often used active ingredients in these products are chlorhexidine (CHX), essential oils (EOs), triclosan and cetylpyridinium chloride (CPC). Mouthrinses can also reduce halitosis by chemically neutralizing odor compounds, including VSCs. Often used active ingredients of these products are metal ions and oxidizing agents.

Chlorhexidine

CHX gluconate is a cationic bis-biguanide, with a very broad antimicrobial spectrum. The American Dental Association has approved its use. Being the most studied antimicrobial agent in the treatment of gingivitis, it has also been tested for its efficacy in the treatment of oral halitosis. Results from a case-series study in halitosis patients suggested a significant effect of CHX rinsing and tongue brushing after 1 week of treatment.[47,48] In several studies, a 0.2% CHX mouthrinse produced significant reductions in volatile sulfur-containing compound levels and in organoleptic scores.[49,50] Similar results with 0.12% CHX-(di)gluconate were reported in combination with teeth and tongue brushing.[47,48]

Due to its substantivity, the anti-VSC effect of the 0.2% solution is satisfactory after 1 h but, more importantly, it shows a tendency to improve at 2 h and 3 h.[51] A commercial product containing 0.12% CHX-gluconate has been demonstrated as an effective anti-VSC product, and showed kinetics similar to that of the 0.2% CHX solution.[42] Although only moderately effective against VSC production, the lower CHX concentration maintains its effect for over 3 h.

Although being considered the gold standard mouthrinse for halitosis treatment, CHX has undesirable side effects. The safety of an effective agent that might be used repeatedly needs to be established. Ninety of 101 patients who used the 0.2% CHX rinse for 1 week responded to a questionnaire concerning adverse reactions.[47] Eighty-eight percent of the patients had at least one complaint, with 59% experiencing a change in the taste of food and 25% experiencing a burning sensation at the tip of the tongue. About 4% of the subjects reported sloughing of the tissues or gingival pain, which would be a more serious concern. As this was reported after only 1 week of unsupervised usage, one might expect even more problems if the patients were using this agent for a longer time period. An agent is needed that approaches the clinical efficacy of CHX but with better safety and comfort features.

Essential oils

Essential oils, including hydro-alcohol solutions of thymol, menthol, eucalyptol, and methyl salicylate, have been used in mouthwashes to prevent periodontal disease. Anti-plaque and anti-gingivitis activity has been demonstrated in several studies [for details see a meta-analysis published by Gunsolley[52] (2006)].

An EO mouthrinse was able to reduce the offensive gases present in morning bad breath as measured by a sulfide monitor,[50] a result that is in agreement with those of a previous short-term study,[53] in which the results indicated a reduction of the organoleptic scores by EOs, which caused a sustained reduction in the plaque odorigenic bacteria, unlike the placebo. An argument was made that the re-odoration was important to the overall activity of the product only for about 30 min after treatment and, at post-treatment times of 60-180 min, the anti-odor

activity of the product was due to its anti-microbial action.[53] That conclusion became the basis for the premise that anti-VSC agents would succeed if they had an antimicrobial component.

Rinsing with an EOs mouthrinse can have long-lasting effects in reducing anaerobic bacteria overall as well as Gram-negative anaerobes and VSC producing bacteria. The significant reductions in numbers of these bacteria produced by the EO mouthrinse, both in plaque and on the dorsum of the tongue, can play a key role in explaining the EO mouthrinse's effectiveness in reducing supragingival plaque and gingivitis as well as its effectiveness in controlling intrinsic oral malodor throughout the test period of 14 days.[54]

Triclosan

The clinical experiments performed by Young *et al.*[55] (2002) showed that mouth-rinsing with triclosan solubilized in sodium lauryl sulfate, propylene glycol and water gave a marked and long-lasting anti-VSC effect. It cannot be excluded that sodium lauryl sulfate contributed to the observed anti-VSC effect. However, the *in vitro* experiments described by the authors support the contention that triclosan exhibits an anti-VSC effect *per se*.

In the Carvalho *et al.*[50] (2004) investigation, plaque formation was not always directly associated with VSC measurements, since the triclosan and CPC mouthrinses were more effective in reducing bad breath than in reducing supragingival plaque accumulation. Therefore, it could be postulated that the superior reducing effect of these specific mouthrinses on bad breath may be related primarily to their efficacy in reducing the load of VSC-related microorganisms and oral debris in the whole mouth niches rather than only in supragingival plaque reduction.

Cetylpyridinium chloride

Quaternary ammonium compounds, such as benzalkonium and cetylpyridinium chloride, inhibit bacterial growth, but reviews concluded that the results were modest for plaque and equivocal for gingivitis. A CPC rinse used in a 6-week pre-brushing study failed to confer any adjunctive benefit to oral hygiene and gingival health compared to a control rinse.[56]

Although there is still debate over the action of cationic antiseptics in the oral cavity, what is clear is the lack of substantivity of cetylpyridinium chloride. This is highlighted by a persistence of antimicrobial activity of CPC in the mouth of only 3 h, which compares poorly with the greater than 12-hour action of CHX.[57] A more frequent use of CPC could improve plaque inhibition, but is likely to lead to compliance problems. Some studies also demonstrated that the CPC mouthrinse presented the lowest impact in reducing VSCs of morning breath when compared with other products.[50,51] This fact could be supported by the observation that this quaternary ammonium compound agent is not substantive enough to promote an essential antibacterial activity.[49]

Zinc

Metals such as zinc, sodium, tin and magnesium are thought to interact with sulfur. The mechanism proposed is that metal ions oxidize the thiol groups in the precursors of volatile sulfur-containing compounds.[58]

Morning breath odor can be successfully reduced by the sole use of an amine fluoride- stannous fluoride-containing mouthrinse twice daily, which significantly reduces the bacterial load in the saliva and retards the *de novo* plaque formation.[59] Unfortunately, both cupric and stannous ions have the potential to discolor teeth, either as a result of sulfide formation on the teeth after extended periods of use or due to the precipitation of dietary chromogen. Nonetheless, cupric chloride is the most effective metal solution for inhibiting hydrogen sulfide production at 1, 2 and 3 h after rinsing.[60] Zinc is the metal ion of choice with this purpose because of its low toxicity and its other favorable properties, such as not causing dental staining. It is known that zinc ions possessing anti-VSC effects have affinity for sulfur, forming sulfides with low solubility.

Oral products containing zinc are also effective in reducing or inhibiting oral malodor. In a study conducted by Young *et al.*[51] (2003), a 1% zinc acetate solution had excellent anti-VSC effect throughout the test period of 3 h, although the metallic taste

experienced at this concentration is a little unpleasant (as experienced by the test panel). This problem may be overcome in commercial products by masking with other ingredients.

Chlorine dioxide

Experimentally, the use of chlorine dioxide associated with chlorite anion has been shown to result in oxidative consumption of amino acids like cysteine and methionine, which are precursors of VSCs.[61] Thus, clinical use of this mouthrinse can be expected to reduce oral malodor by reducing concentrations of VSCs. Chlorine dioxide, a strong oxidizing agent, consumes oral substrates containing cysteine and methionine, thus preventing the production of VSCs.

A study evaluated the effect of a commercially available chlorine dioxide mouthrinse on VSCs levels in a panel of healthy subjects.[61] The results of that investigation demonstrated a beneficial effect of a chlorine dioxide mouthrinse on VSC control in the morning breath of healthy subjects when compared with its own placebo. Previous studies have shown the positive effects of chlorine dioxide on the inhibition of VSC formation[61] which is in agreement with those results.

A higher success rate has been reported following the use of an intraoral liquid-air spray device and an ultrasonic intraoral dental cleaner modified to deliver a 20 ppm molecular chlorine dioxide irrigant to the hard and soft tissues of the mouth.[62] The subjects of the study were instructed as to how to floss their teeth, to clean the posterior third of the tongue with a tongue blade and to rinse with a proprietary chlorine dioxide mouthrinse. Seventy eight percent of 1,343 individuals responded "yes" to a questionnaire that asked "Do you feel there has been a significant improvement in your breath odor problem?" and only 4% responded "No". Both this result and that of the Belgian clinic[62] indicate that subjects with malodor can benefit from the existing treatment modalities.

Effective combination of agents

Chlorhexidine and zinc

A CHX and zinc mouthrinse had a strong effect on volatile sulfur-containing compounds and was effective for at least 9 hours. Control rinses with CHX or zinc alone had a moderate and strong effect for 1 hour, but this effect diminished with time, respectively, fast and slightly.[51]

Cetylpyridinium and zinc ions

A CPC and zinc mouthrinse had a good synergistic effect on volatile sulfur-containing compounds levels after 1 hour, but minimally above the effect of zinc alone.[51]

Chlorhexidine, cetylpyridinium chloride and zinc-lactate

Chlorhexidine is still the gold standard mouthrinse, but it does have some side effects. Due to these disadvantages, new formulations have been developed. Since CHX and CPC are both antimicrobial agents, it seems reasonable to assume that the new marketed mouthwash that contains CHX and CPC acts by reducing the number of VSC-producing bacteria on the dorsum of the tongue. Moreover, zinc-lactate, besides its antimicrobial activity, may reduce VSC scores by transforming them into insoluble compounds. Two dual-center, double-blind, placebo-controlled studies demonstrated that a new mouthwash containing CHX (0.05%), CPC (0.05%) and zinc-lactate (0.14%) is effective in the treatment of oral halitosis.[29,63] The one adverse effect of the active mouthwash was staining of the dorsum of the tongue.

Some studies have indicated a synergistic action between CHX and cetylpyridine.[11,64] Their data illustrate that the replacement of alcohol in a CHX formulation by CPC does not change the antimicrobial activity of the mouthrinse, even though the CHX concentration is reduced to 0.05%.[11] A 0.12% CHX and 0.05% cetylpyridinium solution was compared to a 0.05% CHX, 0.05% CPC and 0.14% zinc-lactate solution, and to other 3 different commercial mouthrinses with CHX.[64] Formulations combining CHX and CPC achieved the best results, both in terms of anti-microbial activity and anti-halitosis efficacy. Conversely, a formulation combining CHX with NaF showed significantly lower anti-halitosis and anti-microbial efficacy.

Conclusions

The present review described the etiological factors related to halitosis, including prevalence data, and the mechanical and chemical therapeutic approaches. Tongue biofilm seems to be directly involved in the production of oral halitosis and may have an important role in the success of periodontitis therapy since it is a potential reservoir for periodontal pathogens. It is clear that a successful treatment of halitosis involves an appropriate diagnosis, professional therapy, mechanical plaque control, including tooth brushing and tongue cleaning, possibly combined with the use of an effective antimicrobial mouthrinse.

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