

Development of an application and proposal of recommendations to increase awareness of periodontal diseases for patients: concepts, rationale and use

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Abstract

Objective: To develop an application for patients, aimed at promoting disease awareness and making evidence-based recommendations to seek professional care or preventive strategies.

Materials and Methods: Three expert periodontists identified parameters that, according to the evidence, could represent socio-demographic characteristics, signs, symptoms or medical conditions that can be important to alert the patient about periodontal health. Each parameter was transformed into a self-questionnaire with a single response, which could be completed using a web application. A focus group was convened with professionals and patients who provided feedback on understanding and relevance, and made suggestions for improvement.

Results: Several meetings were held to analyze all the possible characteristics/parameters/situations/habits involved in periodontal diseases. The parameters taken into account were bleeding, mobility or loss of teeth due to mobility, gingival recession, visible plaque or calculus, redness or swelling, halitosis, age group to which the patient belongs, frequency of visits to the dentist, diabetes, smoking habit, use of toothpastes, and use of devices for interdental hygiene. To achieve the simplicity of the application, the experts transformed the parameters into 12 questions.

Conclusion: The use of this tool in a structured manner helps achieving better patient–professional communication and provides guidance throughout the use of preventive strategies.

Keywords: *Periodontal disease. Gingivitis. Signs. Prevention.*

Introduction

Periodontal diseases are known to be extremely prevalent worldwide. Depending on the criteria used for the diagnosis, the prevalence rate of gingivitis is more than 90% in all ages, whereas that of periodontitis is 80% in adults (Trombelli *et al.*, 2018). The Global Burden of Disease Study indicated that periodontitis is the sixth most prevalent disease worldwide (Kassebaum *et al.* 2014). Therefore, it needs to be treated as a public health problem.

It has been traditionally recognized that periodontal diseases are caused by bacteria present in oral biofilms. However, an increasing body of evidence suggests that they are inflammatory diseases triggered by

dysbiotic biofilms. In this sense, in the causal chain of periodontal diseases, much more evidence has been published and needs to be considered in individual- and community-based approaches (Tonetti *et al.* 2015; Murakami *et al.*, 2018).

Furthermore, it has been demonstrated that periodontal diseases are not confined to oral tissues, but also represent an inflammatory burden in the whole body, affecting other body systems and impacting the patient's quality of life (Aslund *et al.*, 2018; Llanos *et al.*, 2018).

At present, periodontal diseases are considered as chronic noncommunicable diseases. This leads to a different approach in terms of prevention, diagnosis, and treatment. Therefore, management of periodontal diseases should include different components, from systemic health status, socioeconomic background, to intraoral diagnostic tools (Wolf *et al.*, 2021).

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Different systems using self-reported outcomes of periodontal diseases have also been proposed, some of which have been appropriately validated, to increase the possibility of guiding professionals and patients in achieving more in-depth evaluations (Blicher *et al.*, 2005). Furthermore, self-awareness of periodontal diseases is considered to be of utmost importance. In this sense, dissemination of information to the public is part of the professionals' duties. This can be done using different types of media — at present, web-based instruments are widely used.

Considering the high prevalence of periodontal diseases and understanding them as chronic noncommunicable diseases, it is imperative to increase patients' awareness and to make recommendations that might help in controlling the burden posed by these diseases.

The present web-based application is aimed at promoting individuals' recognition and making evidence-based recommendations related to periodontal diseases.

Concepts and rationale of the application

The concepts involved in the application were identified by an expert panel comprising clinicians from Latin America (specifically Brazil, Mexico, and Colombia) with knowledge of the periodontal literature and vast clinical experience. Several meetings were held to scrutinize all possible characteristics/parameters/situations/habits involved in periodontal diseases. To achieve simplicity of the application, the experts understood that the number of questions should not exceed twelve. Different tests were conducted on the concepts of the application, and, after an in-depth discussion, the following parameters were considered important and used for the application: Bleeding, mobility or loss of teeth due to mobility, gingival recession, visible plaque or calculus, redness or swelling, halitosis, age group to which the patient belongs, frequency of visits to the dentist, diabetes, smoking habit, use of toothpastes, and use of devices for interdental hygiene.

During the discussion, the panel understood that some of the questions/parameters were of utmost importance and were thus considered as "gold parameters," indicating that they have more weight in the final recommendation. The presence of plaque, calculus and visible signs of inflammation were included as gold parameters in this application. It is important to emphasize that such parameters can be self-perceived and are therefore important in increasing awareness. The presence of halitosis, which is highly impacting, is related to gingivitis and periodontitis. Considering the idea of awareness, perceiving or being notified of halitosis is important in achieving the objectives of the application (Morita *et al.*, 2001). The other questions/parameters, which were also important but had lesser weight in the final recommendation, were considered as "silver parameters."

It should be emphasized that all questions/parameters were supported by the EFP/AAP classification system, and considered as vital to the diagnosis, prevention, and clinical management of periodontal diseases and for studies on self-reported periodontal disease.

Evidence for the Gold Question Periodontal Parameters

Have you noticed that your gums bleed?

Gingival bleeding is not considered normal. The gingival inflammation experienced by the majority of individuals is a response of the organism to a dysbiotic biofilm (Murakami *et al.* 2018). Gingival inflammation has been well correlated with plaque control, which is part of a healthy lifestyle. Good oral hygiene has been demonstrated to be associated with less inflammatory signs in the gingival tissues (Löe *et al.*, 1965). Furthermore, individuals with higher severity of periodontal diseases tend to present higher degrees of gingival inflammation (Lang *et al.*, 1986). In this sense, if gingival bleeding occurs when brushing, flossing, or eating or even spontaneously, it is a clear sign of gingival inflammation. When gingival inflammation is present, the individual will at least be diagnosed with gingivitis (if it occurs in more than 10% of the sites). In addition, individuals with periodontitis very frequently present gingival inflammatory signs, such as gingival bleeding (Papapanou *et al.*, 2018).

Have you noticed increased mobility or have you lost teeth due to mobility?

Determining the cause of tooth loss is a very difficult task because the majority of individuals do not recall the reason for the extractions, especially if they happened many years ago. In this sense, although periodontal disease may lead to tooth loss, a large proportion of tooth loss is caused by dental caries (Kassebaum *et al.* 2014). However, mobility is a patient-perceived sign that might be considered today as one of the patient-reported outcome measures (Uy *et al.*, 2022). Mobility is an important sign of periodontal breakdown. Also, if the patient is certain that he/she has lost mobile teeth, it is definitely caused by periodontal disease (Helal *et al.*, 2019). The EFP/AAP classification considers tooth loss caused by periodontitis an important sign for condition grading (Tonetti *et al.*, 2018).

Have you noticed that your gums have receded or that the roots of your teeth are visible?

Gingival recession has been considered to clearly indicate loss of attachment. The prevalence of gingival recession has increased worldwide for two main reasons: (i) the teeth are retained despite needing extraction, further exposing them to periodontal diseases, and (ii) the teeth become more exposed to injuries from traumatic toothbrushing (Heasman *et al.*, 2015;

Heasman *et al.*, 2017). Both reasons are not of the same origin, but demonstrate an individual's susceptibility to clinical attachment loss when challenged. The prevalence of gingival recession in adult populations is also dependent from the cutoff point used, but is estimated to be over 50% (Gorman, 1967).

Have you noticed that you have tartar/bacterial plaque in your teeth?

The presence of dental calculus and plaque indicates poor oral hygiene and habits. Increasing individuals' awareness of such bacterial deposits is important because they are associated with higher prevalence of periodontal diseases. The main reason for including such signs in the web-based application is to increase awareness of the need for better plaque control and for seeking professional care.

Have you noticed that the gums around your teeth present redness or increase in volume?

The inclusion of other self-perceived inflammatory signs, in addition to gingival bleeding, is important to increase awareness of other possible signs of inflammation. These signs include redness and loss of contour that are present with underlying hyperemia and swelling (Murakami *et al.*, 2018). For example, if the individual does not perceive gingival bleeding, he/she might perceive other inflammatory signs, which are also important to support the recommendations included in the application.

Have you perceived or has anyone pointed out to you that you have bad breath?

Halitosis is a clinical condition in which 90% of the cases are related directly with the mouth (Van Den Broek *et al.*, 2007). Periodontal diseases — gingivitis and periodontitis — together with coated tongue are the major causes of halitosis (Morita *et al.*, 2001). Therefore, it has been postulated that the presence of halitosis indicates poor oral hygiene (Rösing *et al.*, 2011). It has been demonstrated that more than 50% of individuals experience halitosis at one time or another (Nachnani, 2011). Thus, these individuals should seek professional care to clinically manage halitosis. The inclusion of halitosis as a parameter to be considered in a self-reported questionnaire for periodontal diseases is of utmost importance.

Evidence for the Silver Question Periodontal Parameters

What age group are you in?

Severe periodontitis is estimated to affect 11% of the world population, and its prevalence (extension and severity) increases with age (Kassebaum *et al.*, 2014; Frencken *et al.*, 2017). The influence of age on

periodontitis is complex, suggesting that age is an important risk indicator, but aging *per se* is not a risk factor (Papapanou *et al.*, 1991; Billings *et al.*, 2018). The age parameter is included in the web-based application mainly because although severe periodontitis can occur throughout life, the global incidence of severe periodontitis is estimated to peak at around 38 years of age. In addition, changes in susceptibility to periodontitis occur due to exposure to proinflammatory conditions and changes in the healing capacity of cells and tissues (Kassebaum *et al.*, 2014; López *et al.*, 2017).

How often do you visit your dentist?

Good oral hygiene is usually achieved with a combination of self-care and a regular maintenance care program (Axelsson *et al.*, 2004; Mombelli, 2019). Without efficient oral hygiene and maintenance care, the beneficial effects of various periodontal therapies would disappear (Axelsson *et al.*, 1981; Westfelt *et al.*, 1983; Becker *et al.*, 1984). The importance of patients' motivation and adherence to periodontal health maintenance has been widely acknowledged (Tonetti *et al.*, 2015). The main objective of including the frequency of periodontal maintenance care (impact of patient compliance) is based on the evidence in systematic reviews on the incidence and severity of periodontal disease being modified by this variable (Becker *et al.*, 1984; Lee *et al.*, 2015). A 3-month recall interval is assumed to provide periodontal stability following periodontal treatment in almost all patients, whereas intervals of more than 6 months increase the risk of disease recurrence (Becker *et al.*, 1984). It should be highlighted that the dentist, using his/her knowledge and considering the disease characteristics in each patient, is responsible for establishing maintenance intervals.

Have you been diagnosed with diabetes mellitus (DM)?

The main disease that affects the course of periodontitis is diabetes mellitus (DM), which has also been recognized as a risk factor for periodontal diseases (Genco *et al.*, 2020). An evident bidirectional relationship was observed between type 2 DM and periodontitis. Moreover, accumulating evidence indicates that periodontal inflammation *per se* may contribute to the onset and persistence of hyperglycemia (Taylor *et al.*, 2008). A systematic review reported positive associations between high glucose levels and periodontitis onset and progression, and showed an 86% increase in the incidence or progression risk of having periodontitis among patients with inadequately controlled DM, compared with those without DM or with adequately controlled DM (Nascimento *et al.*, 2018). Another study demonstrated that the prevalence rates of diabetes were 13.1% and 9.6% among subjects with and without periodontitis, respectively (Ziukaite *et al.*, 2018). In addition, there is a moderate certainty

for a small but significantly higher risk of tooth loss in DM patients than in non-DM patients (Winning *et al.* 2017; Weijndijk *et al.*, 2021). DM is an important modifying factor of periodontitis and must be included in the clinical diagnosis as a descriptor; thus, it was also used as a parameter in the application.

You currently smoke or have smoked?

Smoking is one of the main behavioral risk factors of periodontitis and should thus be considered as a parameter in any survey on periodontal diseases. The mechanisms by which tobacco smoking affects periodontitis incidence and progression include the effect of smoking on the microbiota composition, with increased prevalence of periodontal pathogens, on the immune response, and on the healing capacity of the periodontium (Shchipkova *et al.* 2010). Smoking may mask clinical signs of gingivitis, such as bleeding on probing (Söder *et al.*, 2002; Matthews *et al.*, 2012; Chapple *et al.*, 2018). Individuals who smoked more during their lifetime had worse periodontal condition (greater incidence and faster progression of periodontitis) than non-smokers (Zeng *et al.*, 2014). A recent systematic review showed a significant positive association between tobacco smoking and high risk of periodontitis in prospective longitudinal studies. Pooled adjusted hazard ratios estimated that smoking increases the risk of periodontitis by 85% (hazard ratio = 1.85, 95% CI = 1.5–2.2) (Leite *et al.*, 2018). Current evidence from clinical studies indicated that smoking cessation improves patients' periodontal health and quality of life (Leite *et al.*, 2018). Moreover, if smoking were eliminated in the population, the risk of periodontitis would be reduced by approximately 14%, as estimated using the population attributable risk fraction (Leite *et al.*, 2018; Ramseier *et al.*, 2020).

How often do you brush your teeth with toothpaste?

It is well established that the accumulation of dental plaque on teeth leads to gingivitis (Löe *et al.*, 1965) and, in some cases, chronic periodontitis (Kinane *et al.*, 2005). Mechanical teeth cleaning using toothbrush, dental floss, and other interdental hygiene devices can reliably control plaque (Chapple *et al.*, 2015). However, in clinical practice, complete removal of the microbial biofilm via mechanical cleaning is limited by the patient's dexterity, difficult-to-access oral niches (furcations, fissures, concavities), and aspects related to the shape, design, and quality of the recommended oral hygiene products (Van der Weijden *et al.*, 2015). The use of a manual toothbrush has been shown to achieve an average dental plaque score reduction of 42% (30–53%) in a single brushing exercise (Slot *et al.*, 2012). Brushing teeth with toothpaste

has an additional effect to mechanical cleaning using a toothbrush alone (dental plaque score reduction of 50%). Therefore, a good practice guide would be to use dentifrices. Toothpaste is important in delivering fluoride to prevent tooth decay, as well as anti-inflammatory agents for controlling gingivitis, such as zinc salts. The indications of dentifrices with active ingredients intended for patients with gingivitis are associated with long-term use to prevent bacterial biofilm formation (Valkenburg *et al.*, 2019). The use of a dual zinc plus arginine dentifrice containing zinc (zinc oxide, zinc citrate) 0.96%, 1.5% arginine, and 1450-ppm fluoride as sodium fluoride in a silica base significantly reduces dental plaque and relieves gingivitis (Delgado *et al.*, 2018), as well as reduces oral malodor (Hu *et al.*, 2018), compared with a regular fluoride dentifrice containing 1450-ppm fluoride as sodium fluoride in a silica base after 3 and 6 months of use.

How often do you use dental floss or brushes for interdental hygiene?

The interdental surfaces of molars and premolars are the important sites for plaque accumulation. As these surfaces cannot be efficiently reached by toothbrush filaments and are not easily visible, caries and periodontitis develop on these surfaces more often than on visible sites (Löe, 1979; Sälzer *et al.*, 2020). Many devices are used for interdental cleaning, including dental floss and interdental brushes. The size and shape of the interdental space, gingival contour, tooth alignment, and patients' dexterity and motivation influence the type of interdental device to use. In many countries, the use of interdental cleaning is still low (Duque *et al.*, 2020), and whether dental floss is effective in removing plaque remains controversial. A meta-analysis revealed that there is no evidence indicating that unsupervised flossing reduces inflammation (Kotsakis *et al.*, 2018). However, the lack of evidence does not imply that flossing is not effective. On the contrary, two systematic reviews reported moderate evidence of the efficacy of interdental brushes in reducing plaque and relieving gingivitis. At present, interdental brushing remains as the most effective and recommended method for interdental plaque control to improve gingival health (Sälzer *et al.*, 2020; Kotsakis *et al.*, 2018).

Recommendations for patients

The recommendations provided by this application are based on the findings of the possible characteristic parameters/situations/habits in the survey, as well as on evidence and expert opinion.

The responses of the participants were classified into three zones according to an alert strategy of having a periodontal compromise, and were color-coded (traffic light) in

three levels: green, low possibility of being compromised; yellow, moderate possibility; and red, very high possibility (Table 1). After the participant completes the questionnaire, the software sends a report containing general recommendations developed by the researchers. The report also explains the significance of the participant's responses to each parameter in the context of their periodontal

health status, including the signs and symptoms observed. The recommendations are classified as follows: 1) recommendations for the control of each parameter (Table 2), 2) general recommendations for the individuals (Table 3), 3) oral health and medical recommendations (Table 4), and 4) recommendations focused on lifestyle changes and adoption of good oral hygiene habits (Table 5).

Table 1. Standard possibility levels of periodontal diseases or altered periodontal conditions.

Color code levels	Low possibility	Moderate possibility	High possibility
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Table 2. Parameter classification (PC) with questions (Q), possible answers (A), and individual parameter recommendations (R) in the green, yellow, and red zones, respectively.

Characteristics/ parameters/ situations/habits	Green zone	Yellow Zone	Red Zone
<p>PC: Gold/ gum bleeding</p> <p>Q: Have you noticed that your gums bleed?</p>	<p>A: Never</p> <p>R/Gum bleeding is not normal! Continue to sanitize your mouth correctly, and if you notice persistent bleeding, seek professional care.</p>	<p>A: Yes, when I brush and floss. Sometimes also when I eat</p> <p>R/Gum bleeding is not normal! The occurrence of bleeding when cleaning the mouth is a sign of inflammation/disease. Try to be more dedicated to proper oral hygiene (including interdental hygiene with dental floss) and visit a dental professional for proper diagnosis and treatment.</p>	<p>A: Yes, my gums bleed spontaneously and occasionally when I brush and floss. Sometimes also when I eat.</p> <p>R/Gum bleeding is not normal! When this sign appears spontaneously or when you eat a hard food, such as apple, it is indicative of a high degree of inflammation that needs treatment. Seek professional care.</p>
<p>PC: Gold/ tooth mobility or lost teeth</p> <p>Q: Have you noticed increased mobility or have you lost teeth due to mobility?</p>	<p>A: NO</p> <p>R/The lack of mobility in the teeth does not indicate healthy gums. Watch out for signs of inflammation and continue to properly sanitize your mouth. If you've never lost teeth due to clinical attachment loss, it means you don't have advanced periodontal disease. Watch out for signs of gum inflammation, and continue to take appropriate oral hygiene measures.</p>	<p>A: I have seen and felt some tooth mobility</p> <p>R/The start of tooth mobility can be a sign of periodontal disease. Also, watch out for the presence of redness and bleeding, and promptly visit a dentist.</p>	<p>A: Yes, my teeth are definitely moving</p> <p>R/Advanced mobility with varying degrees occurs in advanced stages of periodontal disease. Only a dentist can assess this stage and provide the correct treatment. Loss of teeth due to clinical attachment loss is indicative of advanced stages of periodontal disease. Visit a dentist promptly.</p>
<p>PC: Gold/ visible dental plaque or calculus</p> <p>Q: Have you noticed that you have tartar/bacterial plaque in your teeth?</p>	<p>A: NO, I have not seen or felt this</p> <p>The absence of tartar and dental plaque is a reflection of good oral hygiene practices and habits. However, dental plaque may not be visible.</p>	<p>A: I may have dental plaque and tartar</p> <p>The presence of dental calculus and plaque is indicative of poor oral hygiene measures and habits. It is important for individuals to have increased awareness of such deposits, because they are associated with high prevalence of periodontal diseases.</p>	<p>A: Yes, I have definitely seen and perceived this</p> <p>The presence of dental calculus and plaque is indicative of poor oral hygiene measures and habits. It is important for individuals to have increased awareness of such deposits, because they are associated with high prevalence of periodontal diseases</p>
<p>PC: Gold/Gingival recession</p> <p>Q: Have you noticed that your gums have receded or that the roots of your teeth are visible?</p>	<p>A: NO, I haven't seen this</p> <p>Gum retraction (longer teeth) is a sign of tissue loss. It can be due to hygiene trauma or illness. Watch out for this. Brush your teeth gently at least twice a day using soft brushes</p>	<p>A: Yes, it is possible that my roots are visible</p> <p>Gum retraction (longer teeth) is a sign of tissue loss. It can be due to hygiene trauma or illness. Watch out for this. Brush your gently teeth at least twice a day using soft brushes.</p>	<p>A: Yes, my dental roots are definitely visible</p> <p>Advanced gum retraction (long teeth) is a sign of destruction of the supporting tissues. Pay attention to this, and seek professional care.</p>

Table 2. (Continuation) Parameter classification (PC) with questions (Q), possible answers (A), and individual parameter recommendations (R) in the green, yellow, and red zones, respectively.

Characteristics/ parameters/ situations/habits	Green zone	Yellow Zone	Red Zone
<p>PC: Gold/ gum redness or volume increase (enlargement)</p> <p>Q: Have you noticed that the gums around your teeth present redness or increase in volume?</p>	<p>A: No, my gums are pink and possibly healthy</p> <p>R/If you don't notice inflammatory signs such as redness and swelling, continue to clean your mouth properly.</p>	<p>A: Yes, possibly changing color and slightly inflamed</p> <p>R/Mild or moderate gingival redness and swelling are early signs of inflammation or disease. Dedicate yourself more to oral hygiene, and seek professional care.</p>	<p>A: My gums are definitely red and/or enlarged.</p> <p>R/Severe gingival redness and swelling are signs of inflammation or disease. Dedicate yourself more to oral hygiene, and seek professional help.</p>
<p>PC: Gold/bad breath</p> <p>Q: Have you perceived or has anyone pointed out to you that you have bad breath?</p>	<p>A: No, I have never perceived it nor has anyone ever told me</p> <p>Bad breath is not normal and is a sign of oral disease in more than 90% of cases. Continue taking proper oral hygiene measures, including tongue cleaning.</p>	N/A	<p>A: Sometimes I perceive this and have been told</p> <p>Bad breath is, in more than 90% of cases, of oral origin. Dentists are responsible for treating bad breath. Initially, devote yourself to oral hygiene, and clean your tongue. The use of mouthwashes can be helpful. If the problem persists, seek professional care.</p>
<p>PC: Silver/age</p> <p>Q: What age group are you in?</p>	<p>A: I am less than 40 years old</p> <p>R/In your age group, the risks of periodontal disease are low. Maintain a healthy lifestyle by properly sanitizing your mouth.</p>	<p>A: I am between 40 and 65 years old</p> <p>R/In your age group, the risks of periodontal disease increase. So be sure to watch out for signs of inflammation. Visit your dentist regularly.</p>	<p>A: I am over 65 years old</p> <p>R/In your age group, it is important that you look out for signs of gum inflammation, and visit your dentist more often and whenever you notice signs of inflammation.</p>
<p>PC: Silver/ maintenance care program</p> <p>Q: How often do you visit your dentist?</p>	<p>A: At least once a year</p> <p>R/Visiting the dentist at least once a year is important and, if you notice inflammation (one who has been diagnosed with periodontal disease, smokes, or is diabetic), increase this frequency.</p>	<p>A: I have not been to the dentist in the last 2 years</p> <p>R/In recent years, the visits to the dentist have not been regular. This increases the risk of periodontal disease. Regularize your visits to the dentist (at least once a year, or as directed by the professional).</p>	<p>A: I haven't been to the dentist in more than 2 years</p> <p>R/Your pattern of visiting the dentist is inappropriate. Visit your dentist, as you may be developing oral diseases and may have aggravations that generate greater future impacts. Follow the frequency recommendation that the dentist suggested for you.</p>
<p>PC: Silver/ diabetes</p> <p>Q: Have you been diagnosed with diabetes mellitus (DM)?</p>	<p>A: NO, my tests and my doctor say that I do not have diabetes or prediabetes</p> <p>R/You are not diagnosed with DM. Continue having a healthy lifestyle.</p>	<p>A: I have a diagnosis of diabetes, but it is under control</p> <p>R/You have DM and you are under control. Maintaining this control is critical to overall and oral health.</p>	<p>A: YES, I have diabetes and this uncontrolled</p> <p>R/DM increases the risk of periodontal disease. See your doctor to control it, and visit a dentist to monitor your oral health.</p>
<p>PC: Silver/smoke</p> <p>Q: You currently smoke or have smoked?</p>	<p>A: NO, I neither smoke nor have I smoked</p> <p>R/Glad you've never been a smoker! Continue this behavior, which is part of a healthy lifestyle.</p>	<p>A: I'm a former smoker</p> <p>R/If you quit smoking more than a year ago, congratulations! If you still smoke a few cigarettes, consider quitting altogether, as smoking increases the risk of many diseases, including periodontal disease.</p>	<p>A: Yes, I currently smoke</p> <p>R/You currently smoke, and for your overall health, it's important that you quit. Smoking increases the risks of periodontal diseases. If you smoke, your gums may not bleed, but the disease may be present. Cigarettes aggravate many chronic diseases, affect the gums, and can cause tooth separation, mobility, and even tooth loss.</p>

Table 2. (Continuation) Parameter classification (PC) with questions (Q), possible answers (A), and individual parameter recommendations (R) in the green, yellow, and red zones, respectively..

Characteristics/ parameters/ situations/habits	Green zone	Yellow Zone	High possibility
PC: Silver/ toothbrush and dentifrice habits	A: At least twice a day	A: Once a day	A: I don't brush my teeth often
Q: How often do you brush your teeth with toothpaste?	R/Brushing your teeth with toothpaste daily, at least twice a day, is very important. Continue this healthy habit.	R/Brushing teeth with toothpaste only once a day may not be enough to prevent oral diseases, especially caries. Increase brushing frequency.	R/Not brushing your teeth is a major risk to your oral health and is not part of a healthy lifestyle. Brush your teeth with toothpaste at least twice a day. Ask your dentist about the best toothpaste for you.
PC: Silver/ interdental oral hygiene habits	Every day	Occasionally	Never or almost never
Q: How often do you use dental floss or brushes for interdental hygiene?	Cleaning between your teeth is important for oral health. Continue this habit.	Cleaning between your teeth is important for oral health. Be sure to do this daily.	Not cleaning between your teeth is detrimental to your oral health. Teeth have to be cleaned daily on all their surfaces.

Table 3. General recommendations for patients according to their result.

General Recommendation	Green Zone	Yellow Zone	Red Zone
What does the zone of your result mean?	Low chance of periodontal diseases; however, it is suggested to review the periodontal condition with a dentist.	Higher chance of periodontal diseases. Actions may be taken to control plaque in the mouth and reduce gingival inflammation. Additionally, it is suggested to review the periodontal condition with a dentist.	Higher chance of periodontal diseases. Actions may need to be taken to control plaque in the mouth and reduce gingival inflammation. It is suggested to review the periodontal condition with a dentist as soon as possible.
How often should you visit your dentist?	Dental appointments are important to stay healthy; you should go at least once a year.	Dental appointments could be at least twice a year	Dental appointments should be at least twice a year or more frequently if necessary (sometimes every 3-4 months)
What should you tell your dentist about the result of your survey?	You can show the results of the survey to the dentist and suggest that he/she complement the survey results with a clinical examination for diagnosis to determine the need for some periodontal treatment (treatment of gum disease).	You can show the results of the survey to the dentist and suggest that he/she complement the results with a clinical examination for diagnosis to determine the need for any periodontal treatment (treatment of gum disease).	You can show the results of the survey to the dentist and suggest that he/she make a clinical diagnosis to determine the need for periodontal treatment (treatment of gum disease).
Are your survey results more important than your dentist's diagnosis?	No, these are some recommendations for your examination to make a diagnosis and perform risk assessment with the dentist.	No, these are some recommendations for your examination to make a diagnosis and perform risk assessment with the dentist.	No, these are some recommendations for your examination to make a diagnosis and perform risk assessment with the dentist.

Discussion

Evidence suggests that patients, dentists, and other health professionals hold diverse knowledge, attitudes, and practices related to the diagnosis of periodontal diseases (Duque *et al.*, 2020). The consensus on prevention and diagnosis of periodontal diseases published in 2020 proposes the development of initiatives for controlling and preventing periodontal disease in patients to allow better communication with the dentist (Duque *et al.*, 2020).

Although toothbrushing and other mechanical cleaning practices are the most important elements to avoid initiation or progression of periodontal disease, other factors, including education, motivation, manual dexterity and compliance with professional recommendation, provision of time and socioeconomic status, and risk factors, also play a role (Arweiler *et al.*, 2017; Rösing *et al.*, 2020).

Information dissemination to the public is one of the effective strategies to prevent the occurrence of chronic noncommunicable diseases. In this sense, a web-based application aimed at increasing people's awareness of periodontal disease needs to be developed. It is noteworthy that the application is not for the purpose of diagnosis. Diagnosis is a totally different approach and depends on the evaluation of the dentist. Furthermore, the application is not a risk assessment tool.

Periodontal health should not be considered solely in the context of reducing the levels of bacterial plaque (and consequently gingival inflammation), but should extend to a more holistic approach. There are many conditions that can increase the possibility for initiation or progression of periodontal diseases. The employment of the "traffic light" approach in three levels (red, yellow, and green) is aimed at increasing efforts so that technology can provide support to individuals in recognizing health/disease parameters that are often unknown to them. It is hoped that these alternatives will encourage the survey participants to consult their dentist not only for the care of their teeth (avoid dental caries), but also to avoid periodontal diseases that are often difficult to recognize (gingivitis and periodontitis). This recognition does not necessarily equate to self-diagnosis, but rather an alert or recommendation to visit the dentist for a periodontal evaluation (Duque *et al.*, 2020).

The application was developed with guidance from an expert panel comprising clinicians with knowledge of and experience in Periodontology. Therefore, using their acquired experience and based on the best available evidence, the set of questions was selected. The authors understand that the existing evidence does not give support for the development of a profound algorithm that could quantify periodontal status and needs.

However, in the traffic light approach, the participants were divided into three distinct groups, with each having one alert level.

It should be emphasized that from the answers to the questions, a set of general recommendations is generated. These recommendations are not intended to replace the role of the dental professional. On the contrary, the recommendations were all based on the possibilities of giving information to the dentist and expanding the communication with their patients.

The questions were categorised as gold and silver in order to give them some weight, considering the available evidence. One of the main questions included in the survey is related to gingival bleeding. It is well known in the literature that gingival bleeding is not normal, but is a reaction of the organism to dysbiotic biofilms. The literature demonstrated that gingival bleeding is a sign of inflammation and that the absence of bleeding on probing is a sign of periodontal stability (Lang *et al.*, 1990).

Several authors have made suggestions on how to customize maintenance care following periodontal therapy according to the risk. It has been recommended to evaluate a person's risk for disease recurrence, assessing the percentage of bleeding on probing, number of residual pockets > 4 mm, number of lost teeth, loss of periodontal support in relation to the patient's age, systemic and genetic conditions, and environmental factors, such as cigarette smoking (Lang *et al.* 2015).

The proposed application makes it possible for patients to better understand what is happening with their oral health and, according to the result, implement measures that include good oral hygiene, smoking cessation, adoption of a healthy lifestyle, and seeking of professional care, not only with the dentist, but also with the whole healthcare team. However, this application cannot be used as a risk assessment tool. The benefit of increasing awareness and taking appropriate measures should not be forgotten. Chronic non-communicable diseases are managed with different measures, including the work of multidisciplinary teams, developing strategies to raise awareness about the importance of preventing different diseases. The prevention of periodontal diseases is a way to raise awareness about all chronic non-communicable diseases, since these share risk factors with periodontal diseases.

This proposal is a strategy within the framework of personalized and participatory medicine in order to close the communication gaps between the general public, general dentists and periodontists. In fact, we argue that it is necessary to gradually develop other strategies to achieve networking, but with innovative models and adapted to current knowledge. The panel of experts aims to create an application that

adds value to patients and the health system by integrating current knowledge and innovations.

This model involves stratifying the patient to allow patients to be treated according to the complexity of their case and the systemic implications of the case. However, this application does not replace the role of the dentist, and the periodontist. In fact, one limitation of this study is the training of oral health professionals to take advantage of this application and be in tune with the recommendations made. In the future, strategies are suggested to allow this work in a communication network and overcome these limitations.

In summary, the use of the proposed application with continuous evaluation has the potential to increase knowledge and awareness about periodontal diseases, which is the first step toward the prevention, treatment, and management of such diseases.

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