

Periodontal Risk Assessment (PRA) for Patients in Supportive Periodontal Therapy (SPT)

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Summary: The subject risk assessment may estimate the risk for susceptibility for progression of periodontal disease. It consists of an assessment of the level of infection (full mouth bleeding scores), the prevalence of residual periodontal pockets, tooth loss, an estimation of the loss of periodontal support in relation to the patient's age, an evaluation of the systemic conditions of the patient and finally, an evaluation of environmental and behavioral factors such as smoking. All these factors should be contemplated and evaluated together. A functional diagram may help the clinician in determining the risk for disease progression on the subject level. This may be useful in customizing the frequency and content of SPT visits.

Key words: periodontitis, maintenance, recurrent periodontitis, risk assessment, risk evaluation, periodontal infection, reinfection, bleeding on probing, residual pockets, bone loss, smoking

Oral Health Prev Dent 2003; 1: 7-16.

Submitted for publication: 21.06.02; accepted for publication: 14.11.02.

Clinical diagnosis during supportive periodontal therapy (SPT) has to be based on the health status obtained following successful active periodontal treatment. This, in turn, means that new baseline parameters will have to be established once the treatment goals of active periodontal therapy are reached and periodontal health is restored (Claffey, 1991). Under optimal circumstances, SPT would be able to maintain stable clinical attachment levels for many years. Hence, it is apt to determine the clinical parameters which may serve as early indicators for a new onset or recurrence of the periodontal disease process, i.e. reinfection and pro-

gression of periodontal breakdown of a previously treated periodontal site.

From a clinical point of view the stability of periodontal conditions reflects a dynamic equilibrium between bacterial challenge and an effective host response. Whenever changes occur in either of these aspects, homeostasis is disturbed. Hence, it is evident that the diagnostic process must be based on a continuous monitoring of the multilevel risk profile. The time intervals between diagnostic assessments should be chosen based on the overall risk profile and the expected benefit for the patient. It should be understood that, so far, the use of individual risk profiles to determine the content and frequency of preventive services has been demonstrated to be very cost-effective (Axelsson and Lindhe, 1981a,b; Axelsson et al, 1991).

By virtue of their previous disease experience, all patients under a periodontal maintenance program represent a population with a moderate to high risk for recurrent periodontal infection. As opposed to the general population without such a history, periodontal patients need to participate in a well-organized recall system which should provide both a

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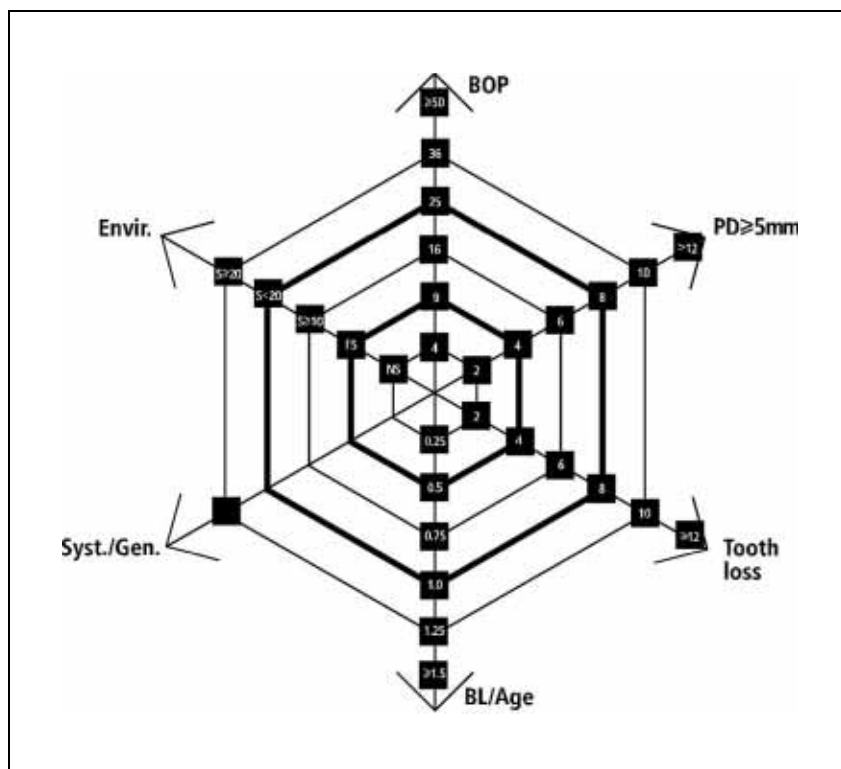


Fig 1 Functional diagram to evaluate the patient's risk for recurrence of periodontitis. Each vector represents one risk factor or indicator with an area of relatively low risk, an area of moderate risk and an area of high risk for disease progression. All factors have to be evaluated together and hence, the area of relatively low risk is found within the center circle of the polygon, while the area of high risk is found outside the periphery of the second ring in bold. Between the two rings in bold, there is the area of moderate risk.

continuous risk assessment and adequate supportive care. Without this, the patients are likely to experience progressive loss of periodontal attachment (Axelsson and Lindhe, 1981a; Kerr, 1981; Becker et al, 1984; Cortellini et al, 1994, 1996). The assessment of the risk level for disease progression in each individual patient would enable the practitioner to determine the frequency and extent of professional support necessary to maintain the attachment levels obtained following active therapy. The determination of such risk levels would thus prevent both undertreatment, and excessive overtreatment, during SPT (Brägger et al, 1992).

SUBJECT RISK ASSESSMENT

The patient's risk assessment for recurrence of periodontitis may be evaluated on the basis of a number of clinical conditions whereby no single parameter displays a more paramount role. The entire spectrum of risk factors and risk indicators ought to be evaluated simultaneously. For this purpose, a functional diagram has been constructed (Fig 1) including the following aspects:

1. Percentage of bleeding on probing,
2. Prevalence of residual pockets greater than 4 mm (≥ 5 mm),
3. Loss of teeth from a total of 28 teeth,
4. Loss of periodontal support in relation to the patient's age,
5. Systemic and genetic conditions, and
6. Environmental factors, such as cigarette smoking.

Each parameter has its own scale for minor, moderate and high-risk profiles. A comprehensive evaluation of the functional diagram will provide an individualized total risk profile and determine the frequency and complexity of SPT visits. Modifications may be made to the functional diagram if additional factors become important according to new evidence.

Compliance with the recall system

Several investigations have indicated that only a minority of periodontal patients complies with the prescribed supportive periodontal care (Wilson et al, 1984; Mendoza et al, 1991; Checchi et al,

1994; Demetriou et al, 1995). Furthermore, it has been established that treated periodontal patients who comply with regular periodontal maintenance appointments have a better prognosis than patients who do not comply (Axelsson and Lindhe, 1981a; Kerr, 1981; Becker et al, 1984; Cortellini et al, 1994, 1996). Non- or poorly compliant patients should be considered to be at higher risk for periodontal disease progression. A report that investigated the personality differences of patients participating in a regular recall program as compared to patients who did not, revealed that patients who did not take part in a maintenance program following periodontal therapy had higher incidences of stressful life events and less stable personal relationships in their lives (Becker et al, 1988).

ORAL HYGIENE

Since bacterial plaque is by far the most important etiologic agent for the occurrence of periodontal diseases (for review, see Kornman and Löe, 1993), it is evident that the full mouth assessment of the bacterial load must have a pivotal impact in the determination of the risk for disease recurrence. It has to be realized, however, that regular interference with the microbial ecosystem during periodontal maintenance will eventually obscure such obvious associations. In patients treated with various surgical and non-surgical modalities, it has been clearly established that plaque-infected dentitions will yield recurrence of periodontal disease in multiple locations, while dentitions under plaque control and regular supportive care maintain periodontal stability for many years (Rosling et al, 1976; Axelsson and Lindhe, 1981a,b). Studies to date have not identified the level of plaque infection compatible with maintenance of periodontal health. However, in a clinical set-up, a percentage of tooth surfaces covered by visible plaque of 20–40% might be tolerable in most patients. It is important to realize that the full mouth plaque score has to be related to the host response of the patient, i.e. compared to inflammatory parameters.

1. Percentage of sites with bleeding on probing (BOP)

Bleeding on gentle probing represents an objective inflammatory parameter which has been incorporated into index systems for the evaluation of periodontal conditions (Löe and Silness, 1963; Mühlemann and Son, 1971) and is also used as a parameter by itself.

Although there is no established acceptable level of prevalence of bleeding on probing in the dentition above which a higher risk for disease recurrence has been established, a BOP prevalence of 25% has been the cut-off point between patients who maintained periodontal stability for 4 years and patients with recurrent disease in the same time frame in a prospective study in a private practice (Joss et al, 1994). Further evidence of BOP percentages between 20 and 30% determining a higher risk for disease progression originates from studies of Claffey et al (1990) and Badersten et al (1990).

In assessing the patient's risk for disease progression, BOP percentages reflect a summary of the patient's ability to perform proper plaque control, the patient's host response to the bacterial challenge and the patient's compliance, especially when only few residual pockets remain after active periodontal therapy. The percentage of BOP, therefore, is used as the first risk factor in the functional diagram of risk assessment (Fig 1). The scale runs in a quadratic mode with 4, 9, 16, 25, 36 and > 49% being the critical values on the vector.

Individuals with low mean BOP percentages (< 10% of the surfaces) may be regarded as patients with a low risk for recurrent disease (Lang et al, 1990), while patients with mean BOP percentages > 25% should be considered to be at high risk for periodontal breakdown.

2. Prevalence of residual pockets ≥ 5 mm (residual pocket greater than 4 mm)

The enumeration of the residual pockets with probing depths greater than 4 mm represents – to a certain extent – the degree of success of periodontal treatment rendered. Although this figure *per se* does not make much sense, when considered as a sole parameter, the evaluation in conjunction with other parameters such as bleeding on probing and/or suppuration will reflect existing ecological niches

from and in which reinfection might occur. It is, therefore, conceivable that periodontal stability in a dentition would be reflected in a minimal number of residual pockets. Presence of high frequencies of deep residual pockets and deepening of pockets during supportive periodontal care has, in fact, been associated with high risk for disease progression (Badersten et al, 1990; Claffey et al, 1990).

In assessing the patient's risk for disease progression, the number of residual pockets with a probing depth of ≥ 5 mm is assessed as the second risk indicator for recurrent disease in the functional diagram of risk assessment (Fig 1). The scale runs in a linear mode with 2, 4, 6, 8, 10 and ≥ 12 being the critical values on the vector.

Individuals with up to 4 residual pockets may be regarded as patients with a relatively low risk, while patients with more than 8 residual pockets as individuals with high risk for recurrent disease.

3. Loss of teeth from a total of 28 teeth

Although the reason for tooth loss may not be known, the number of remaining teeth in a dentition reflects the functionality of the dentition. Mandibular stability and individual optimal function may be assured even with a shortened dental arch of premolar to premolar occlusion, i.e. 20 teeth. The shortened dental arch does not seem to predispose the individual to mandibular dysfunction (Witter et al, 1990, 1994). However, if more than 8 teeth from a total of 28 teeth are lost, oral function is usually impaired (Käyser, 1981, 1994, 1996). Since tooth loss also represents a true end point outcome variable reflecting the patient's history of oral diseases and trauma, it is logical to incorporate this risk indicator as the third parameter in the functional diagram of risk assessment (Fig 1). The number of teeth lost from the dentition without the third molars (28 teeth) is counted, irrespective of their replacement. The scale runs also in a linear mode with 2, 4, 6, 8, 10 and ≥ 12 being the critical values on the vector.

Individuals with up to 4 teeth lost may be regarded as patients in a low risk category, while patients with more than 8 teeth lost may be considered as being in a high-risk category. Rationale for this stems from the significance of further tooth loss in terms of preservation of the function of the dentition.

4. Loss of periodontal support in relation to the patient's age

The extent and prevalence of periodontal attachment loss (i.e. previous disease experience and susceptibility), as evaluated by the height of the alveolar bone on radiographs, may represent the most obvious indicator of subject risk when related to the patient's age. In light of the present understanding of periodontal disease progression, and the evidence that both onset and rate of progression of periodontitis might vary among individuals and during different time frames (Van der Velden, 1991), it has to be realized that previous attachment loss in relation to the patient's age does not rule out the possibility of rapidly progressing lesions. Therefore, the actual risk for further disease progression in a given individual may occasionally be underestimated. Hopefully, the rate of progression of disease has been positively affected by the treatment rendered and, hence, previous attachment loss in relation to patient's age may be a more accurate indicator during SPT than before active periodontal treatment. Given the hypothesis that a dentition may be functional for the most likely life expectancy of the subject in the presence of a reduced height of periodontal support (i.e. 25–50% of the root length), the risk assessment in treated periodontal patients may represent a reliable prognostic indicator for the stability of the overall treatment goal of keeping a functional dentition for a lifetime (Papapanou et al, 1988).

The estimation of the loss of alveolar bone is performed in the posterior region on either periapical radiographs, in which the worst site affected is grossly estimated in per cent of the root length or on bitewing radiographs in which the worst site affected is estimated in millimeter. On bitewing radiographs, one millimeter is considered to be equal to 10% bone loss. The percentage is then divided by the patient's age. This results in a factor. As an example, a 40-year-old patient with 20% of bone loss at the worst affected posterior site would score $BL/Age = 0.5$. Another 40-year-old patient with 50% bone loss at the worst affected posterior site would score $BL/Age = 1.25$.

In assessing the patient's risk for disease progression, the extent of alveolar bone loss in relation to the patient's age is estimated as the fourth risk indicator for recurrent disease in the functional diagram of risk assessment (Fig 1).

The scale runs in increments of 0.25 of the factor BL/Age, with 0.5 being the critical value to discriminate between low and moderate risk and 1.0 being the value for moderate and high risk. This, in turn, means that a patient who has lost a higher percentage of posterior alveolar bone than his/her own age is at high risk regarding this vector in a multi-factorial assessment of risk.

It may be argued that the incorporation of only the worst site with bone loss in the posterior segment may overestimate an individual's rate of periodontal destruction when only an isolated advanced bony lesion is present due to local etiologic factors, while an underestimation of the rate of destruction may exist in a case of generalized advanced disease. Nevertheless, in patients successfully treated for periodontitis it has recently been demonstrated that the worst site with bone loss in the posterior segment may, indeed, represent the past history of destruction of the entire dentition (Persson et al, 2003).

5. Systemic and genetic aspects

The most substantiated evidence for modification of disease susceptibility and/or progression of periodontal disease arises from studies on Type I and Type II (insulin-dependent and non-insulin-dependent) diabetes mellitus populations (Gusberti et al, 1983; Emrich et al, 1991; Genco and Löe, 1993).

It has to be realized that the impact of diabetes on periodontal diseases has been documented in patients with untreated periodontal disease, while, as of today, no clear evidence is available for treated patients. It is reasonable, however, to assume that the influence of the systemic conditions may also affect recurrence of disease.

In recent years, genetic markers have become available to determine various genotypes of patients regarding their susceptibility to periodontal diseases.

Research on the Interleukin-1 (IL-1) polymorphisms has indicated that IL-1 genotype positive patients show more advanced periodontitis lesions than IL-1 genotype negative patients of the same age group (Kornman et al, 1997). Also, there is a trend to higher tooth loss in the IL-1 genotype positive subjects (McGuire and Nunn, 1999). In a retrospective analysis of over 300 well maintained periodontal patients, the IL-1 genotype positive pa-

tients showed significantly higher BOP percentages and a higher proportion of patients which yielded higher BOP % during a one-year recall period than the IL-1 genotype negative control patients (Lang et al, 2000). Also, the latter group had double as many patients with improved BOP % during the same maintenance period indicating that IL-1 genotype positive subjects, indeed, represent a group of hyper-reactive subjects even if they are regularly maintained by normally effective SPT (Lang et al, 2000). In a prospective study over 5 years on Australian white and blue collar workers at a university campus, the IL-1 genotype positive age group above 50 years showed significantly deeper probing depths than their IL-1 genotype negative counterparts, especially when they were non-smokers (Cullinan et al, 2001).

In assessing the patient's risk for disease progression, systemic factors, if known, are only considered as the fifth risk indicator for recurrent disease in the functional diagram of risk assessment (Fig 1). In this case, the area of high risk is marked for this vector. If not known or absent, systemic factors are not taken into account for the overall evaluation of risk.

Research on the association and/or modifying influence in susceptibility and progression of periodontitis of physical or psychological stress is sparse (Cohen-Cole et al, 1981; Green et al, 1986; Freeman and Goss, 1993). The hormonal changes associated with this condition, however, are well documented (Selye, 1950).

6. Cigarette smoking

Consumption of tobacco, predominantly in the form of smoking rather than snuffing or chewing, affects the susceptibility and the treatment outcome of patients with chronic periodontitis. Classical explanations for these observations have included the association between smoking habits and poor oral hygiene as well as unawareness of general health issues (Pindborg, 1949; Rivera-Hidalgo, 1986). More recent evidence, however, has established that smoking per se represents not only a risk marker, but also probably a true risk factor for periodontitis (Ismail et al, 1983; Bergström, 1989; Bergström et al, 1991; Haber et al, 1993). In a young population (19–30 years of age), 51–56% of periodontitis was associated with cigarette smoking (Haber et al, 1993).

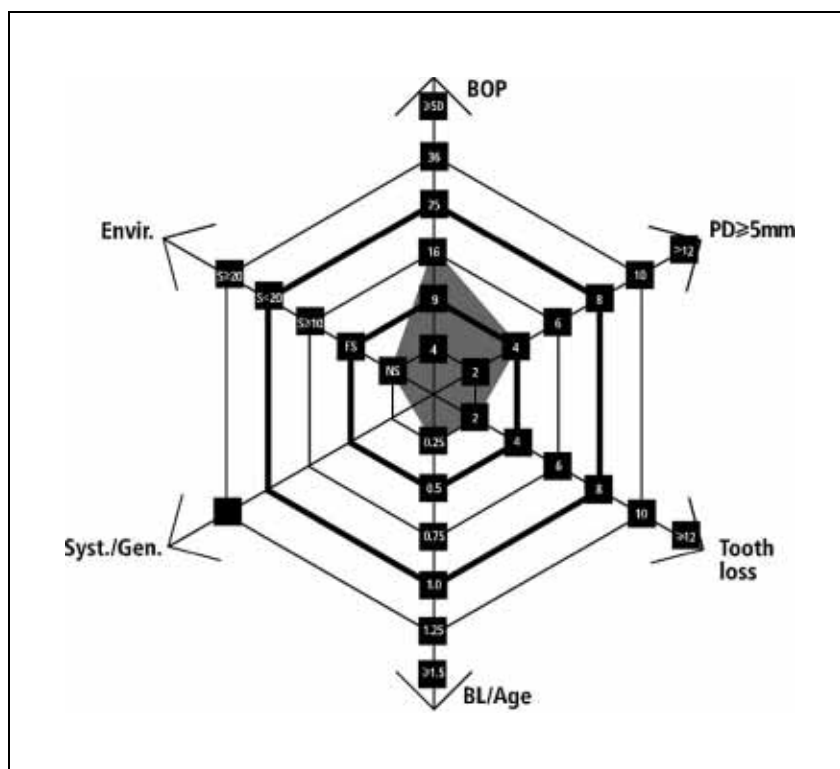


Fig 2 Functional diagram of a low-risk maintenance patient. BOP is 15%, 4 residual pockets ≥ 5 mm are diagnosed, 2 teeth had been lost, the bone factor in relation to the age is 0.25, no systemic factor is known and the patient is a non-smoker.

The association of smoking and periodontitis has been shown to be dose-dependent (Haber et al, 1993). It has also been shown that smoking will affect the treatment outcome after scaling and root planing (Preber and Bergström, 1985), modified Widman flap surgery (Preber and Bergström, 1990), and regenerative periodontal therapy (Tonetti et al, 1995). Furthermore, a high proportion of so-called refractory patients have been identified as consisting of smokers (Bergström and Blomlöf, 1992). The impact of cigarette smoking on the long-term effects of periodontal therapy in a population undergoing supportive periodontal care has been recently reported. Smokers displayed less favorable healing responses both at reevaluation and during a 6-year period of SPT (Baumert-Ah et al, 1994). In spite of the paucity of evidence relating cigarette smoking to impaired outcomes during supportive periodontal care, it seems reasonable to incorporate heavy smokers (≥ 20 cigarettes/day) in a higher risk group during maintenance.

In assessing the patient's risk for disease progression, environmental factors such as smoking

must be considered as the sixth risk factor for recurrent disease in the functional diagram of risk assessment (Fig 1). While non-smokers (NS) and former smokers (FS; more than 5 years since cessation) have a relatively low risk for recurrence of periodontitis, the heavy smokers (HS; as defined by smoking more than one pack per day) are definitely at high risk. Occasional smokers (OS; < 10 cigarettes a day) and moderate smokers (MS; 10–19 cigarettes a day) may be considered at moderate risk for disease progression.

CALCULATING THE PATIENT'S INDIVIDUAL PERIODONTAL RISK ASSESSMENT (PRA)

Based on the six parameters specified above, a multi-functional diagram is constructed for the PRA. In this diagram, the vectors have been formed on the basis of the scientific evidence available. It is obvious that ongoing validation may result in slight modifications.

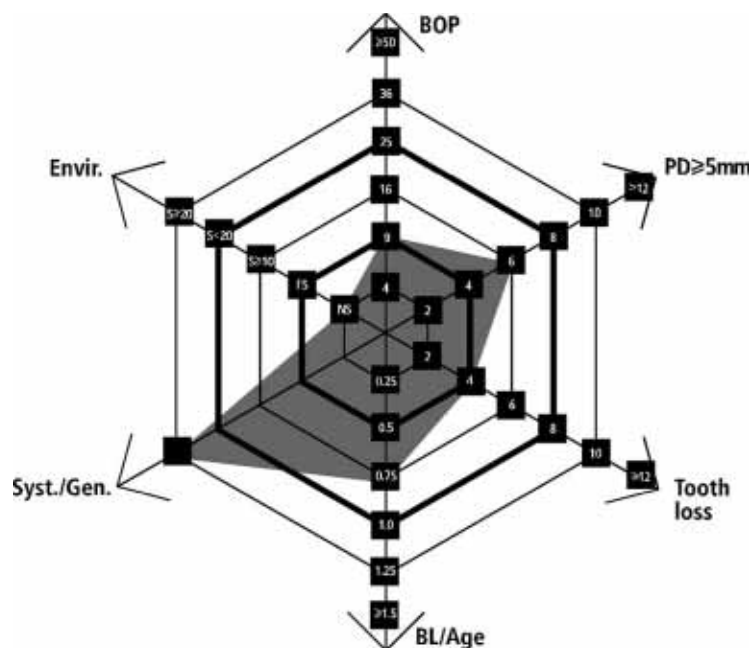


Fig 3 Functional diagram of a medium-risk maintenance patient. BOP is 9%, 6 residual pockets ≥ 5 mm are diagnosed, 4 teeth had been lost, the bone factor in relation to the age is 0.75, the patient is a Type I diabetic, but a non-smoker.

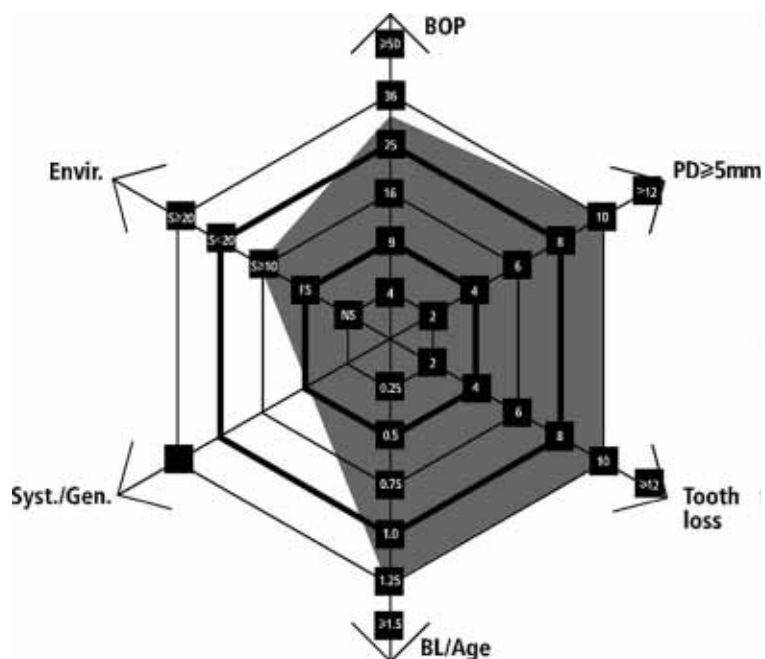


Fig 4 Functional diagram of a high-risk maintenance patient. BOP is 32%, 10 residual pockets ≥ 5 mm are diagnosed, 10 teeth had been lost, the bone factor in relation to the age is 1.25, no systemic factor is known and the patient is an occasional smoker.

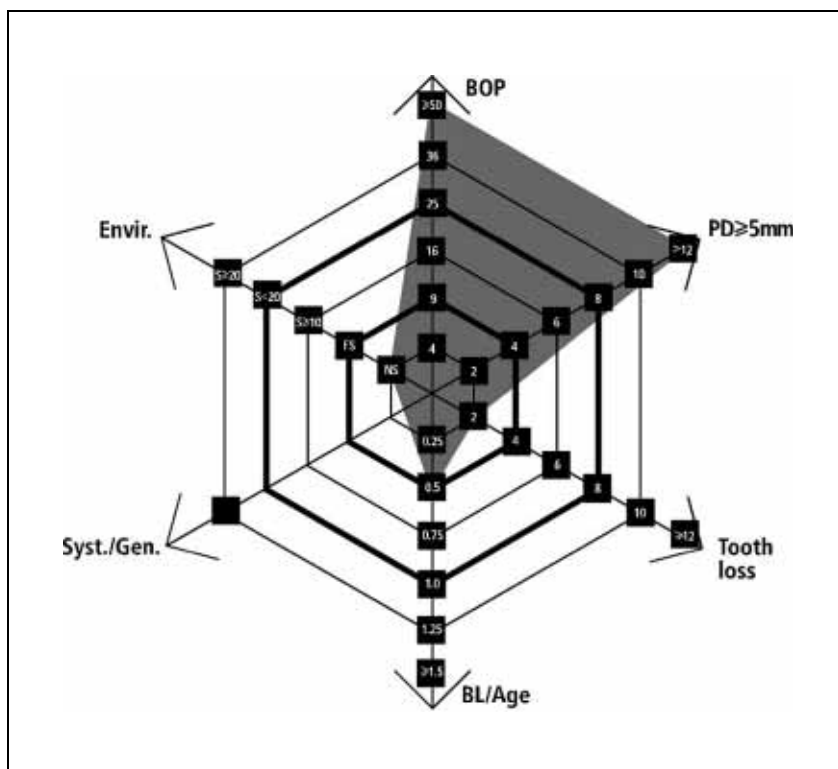


Fig 5 Functional diagram of another high-risk maintenance patient. BOP is close to 50%, more than 12 residual pockets ≥ 5 mm are diagnosed, but only 2 teeth had been lost. The bone factor in relation to the age is 0.5, no systemic factor is known and the patient is a non-smoker. Additional periodontal therapy may change this patient's risk into the moderate or even low-risk category, since BOP and residual pockets would be affected.

A **low PRA** patient has all parameters within the low-risk categories or – at the most – one parameter in the moderate-risk category (Fig 2).

A **moderate PRA** patient has at least two parameters in the moderate category, but at most one parameter in the high-risk category (Fig 3).

A **high PRA** patient has at least two parameters in the high-risk category (Fig 4).

In a high-risk patient who yields high BOP percentages and high numbers of residual pockets (Fig 5), the patient's risk for disease progression may be reduced into the moderate category if further periodontal therapy is provided. These two parameters (BOP and residual pockets) are easily affected by therapy, while other parameters, such as numbers of missing teeth or systemic and genetic factors are either irreversible and cannot be reduced or may only be affected with great additional efforts (smoking cessation). The factor determining the percentage of experienced alveolar bone loss in relation to the patient's age may be reduced only during a time period of several years.

ACKNOWLEDGEMENTS

This project has been supported by the Swiss National Foundation for Scientific Research (SNF); Grant Nr. 3200-0377763.93/1, and by the Clinical Research Foundation (CRF) for the Promotion of Oral Health, University of Berne, Switzerland.

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