Received: 11 August 2019 | Revised: 30 November 2019 | Accepted: 13 January 2020

DOI: 10.1111/clr.13585

NOVEL DEVELOPMENT

CLINICAL ORAL IMPLANTS RESEARCH WILEY

Implant Disease Risk Assessment IDRA–a tool for preventing peri-implant disease

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Abstract

Objective: This treatment concept paper introduces a risk assessment tool, the Implant Disease Risk Assessment, (IDRA) which estimates the risk for a patient to develop peri-implantitis.

Materials and methods: The functional risk assessment diagram was constructed incorporating eight parameters, each with documented evidence for an association with peri-implantitis.

Results: The eight vectors of the diagram include (1) assessment of a history of periodontitis (2) percentage of sites with bleeding on probing (BOP) (3) number of teeth/implants with probing depths (PD) ≥5 mm (4) the ratio of periodontal bone loss (evaluated from a radiograph) divided by the patient's age (5) periodontitis susceptibility as described by the staging and grading categories from the 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases (Journal of Periodontology, 89 Suppl 1, S159-S172, 2018) (6) the frequency/compliance with supportive periodontal therapy (7) the distance in mm from the restorative margin of the implant-supported prosthesis to the marginal bone crest and (8) prosthesis-related factors including cleanability and fit of the implant-supported prosthesis.

Conclusion: The combination of these factors in a risk assessment tool, IDRA, may be useful in identifying individuals at risk for development of peri-implantitis.

KEYWORDS

disease progression, disease susceptibility, patient compliance, peri-implant disease "peri-implant mucositis", peri-implantitis, periodontal diseases, periodontal pocket, risk assessment, risk factors, risk indicators

1 | INTRODUCTION

In the past decades, risk assessment has become a focus of attention in clinical research. Several periodontal risk assessment tools have been developed and validated to varying extents (Heitz-Mayfield, 2005; Lang, Suvan, & Tonetti, 2015). At the 11th European Workshop on Periodontology (2015), five risk assessment tools were addressed in a systematic review (Lang et al., 2015). Of the five, one risk assessment tool, the Periodontal Risk Assessment (PRA) (Lang & Tonetti, 2003) was highlighted as having been validated in nine international studies. All of these studies indicated that patients at high risk for periodontal re-infection and

progression of disease after active periodontal treatment could be identified by using the six criteria of the PRA. These criteria are summarized in a hexagonal functional diagram, that identifies patients as either being low-, moderate- or high-risk patients. The PRA is available open access at the following website (http://www.perio-tools.com/PRA) in 23 languages. Consequently, the PRA is widely used by the profession with a frequency of over 500 hits per day.

As the etiology and pathogenesis of peri-implant diseases have received increasing attention, it is time to develop a similar risk assessment tool for the prediction of the development of peri-implantitis. While a risk assessment predominantly evaluates the subject risk, it may also address the implant site. The Implant Disease Risk Assessment (IDRA) is used with the purpose of minimizing the chance of developing peri-implant tissue breakdown. By understanding the key factors associated with the development of peri-implant diseases documented in the literature the clinician may selectively address such factors to improve the outcomes for implant therapy. The IDRA may be used to evaluate risk for both edentulous and partially dentate patients. However, with edentulous patients, there may be some limitations.

The analyses of results from recent studies addressing risk factors/indicators for biological complications associated with dental implants have identified eight important factors, listed below, that may contribute to the development of peri-implantitis. On the other hand, the control of such factors would minimize the chance of the development of biological complications.

2 | ASSIGNMENT OF RISK

As for the PRA, there is not one single factor that can be attributed to the development of peri-implant disease. By analyzing the current literature, the following eight parameters have been identified: 1. History of periodontitis 2. Percentage of sites with BOP 3. Prevalence of PD ≥ 5 mm. 4. Bone loss in relation to the patient's age. 5. Periodontitis susceptibility as analyzed by the 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases (Tonetti, Greenwell, & Kornman, 2018) 6. Supportive periodontal therapy 7. Implant restorative depth 8. Prosthesis-related factors.

These eight parameters have been combined in an octagon that visualizes the risk for disease development (Figure 1). A comprehensive evaluation using this functional diagram will provide an individual total risk profile and determine the need for measures targeting risk reduction. Each vector has its own scale for risk profiles. As additional factors become evident from the literature modifications of the diagram may be appropriate.

There is overwhelming evidence that bacterial biofilms are the most important etiologic agents for the initiation and progression of peri-implant diseases (Berglundh et al., 2018). Studies assessing self-performed plaque control have shown a strong association with poor plaque control and peri-implantitis (Schwarz, Derks, Monje, & Wang, 2018). In patients with a history of periodontitis, the prevalence of peri-implant disease was greater when the full mouth plaque score (FMPS) was above 25% (Aguirre-Zorzano, Estefania-Fresco, Telletxea, & Bravo, 2015). However, studies have not yet identified the level of biofilm control compatible with the maintenance of peri-implant health. In addition, a plaque score obtained at a single time-point may not necessarily reflect the patients' routine level of self-performed plaque control. The host response to the biofilm is considered more important than the plaque score per se; therefore, it is appropriate to relate plaque score to the inflammatory parameter bleeding on probing percentage (BOP %). Hence, the percentage of BOP rather than the FMPS is included as a parameter in the risk assessment diagram.

2.1 | History of periodontitis

There is strong evidence from longitudinal and cross-sectional studies that patients with a history of periodontitis are susceptible to peri-implantitis (Derks et al., 2016; Karoussis et al., 2003; Kordbacheh Changi, Finkelstein, & Papapanou, 2019; Roccuzzo, De, Angelis, Bonino, & Aglietta, 2010). Hence, a patient who has a history of periodontitis or who has lost teeth to be replaced by implants due to periodontitis is at high risk. In contrast, a patient having lost teeth due to caries, trauma or agenesis is at low risk for the development of peri-implantitis. The history of periodontitis can be evaluated by assessing the presence of periodontal bone loss on radiographs or by examining dental records to determine the reason for tooth loss. The patient may also be able to provide the reason for tooth loss.

2.2 | Percentage of sites with BOP

Bleeding on gentle probing represents an objective inflammatory parameter, which has been incorporated into known index systems, for the evaluation of periodontal (Löe & Silness, 1963; Mühlemann, 1973) and peri-implant conditions (Mombelli, van Oosten, Schürch, & Lang, 1987). Percentage of sites with BOP may also be used as an individual assessment parameter representing the host response to the bacterial challenge.

The incorporation of the BOP% into the PRA established a BOP prevalence of 25% as a cutoff point between patients who maintained periodontal stability for 4 years and patients with recurrent disease in the same time frame (Joss, Adler, & Lang, 1994; Matuliene et al., 2008). Further evidence of BOP % (ranging between 20%–30%) determining a higher risk for periodontal disease progression was demonstrated in a number of studies (Badersten, Nilveus, & Egelberg, 1990; Claffey, Nylund, Kiger, Garrett, & Egelberg, 1990; Matuliene et al., 2008). Bleeding on probing at implant sites was also shown to be associated with disease progression (Karlsson et al., 2019; Luterbacher, Mayfield, Brägger, & Lang, 2000; Giovanni Serino & Turri, 2011). The percentage of BOP is, therefore, used as a second risk indicator in the IDRA functional

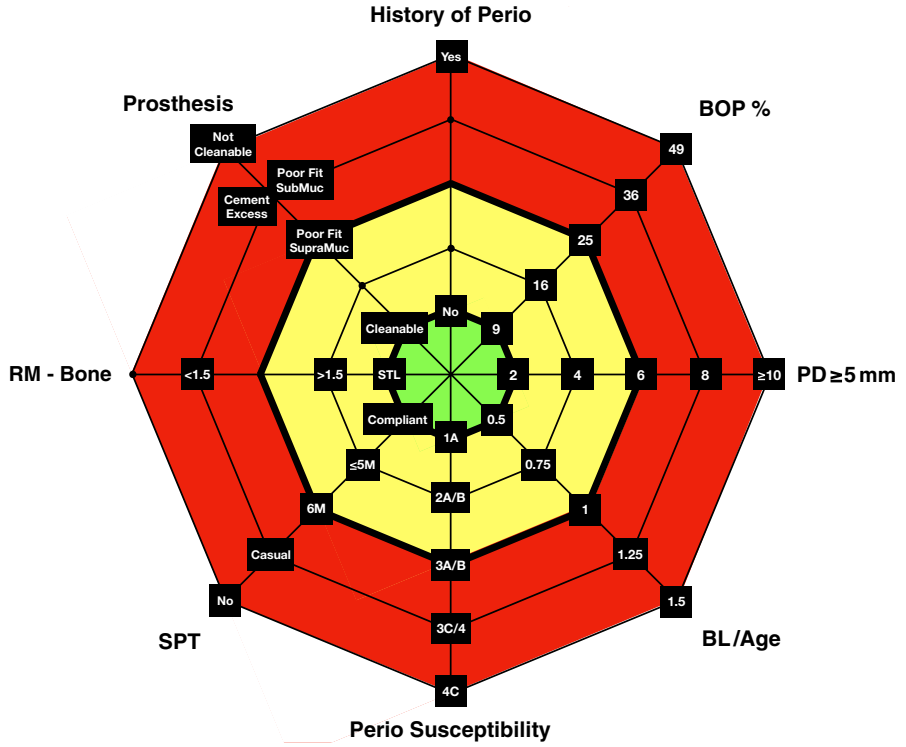

FIGURE 1 Implant Disease Risk Assessment (IDRA) functional diagram. Each vector represents one risk parameter with an area of relative risk. When factors are evaluated together low risk is represented by the area within the center of the octagon (green shading). Moderate risk is represented by the area of the octagon between the first and second ring in bold (yellow shading). High risk is represented by the area outside the second bold ring of the octagon (red shading). Parameters: **History of Perio** History of periodontitis (yes/no). **BOP %** Percentage of implant and tooth sites with positive BOP. **PD ≥ 5 mm** Number of sites with PD ≥ 5 mm at implants and teeth. **BL/Age** Periodontal bone loss in relation to the patient's age. Bone loss is estimated from a periapical or bitewing radiograph at the most severely affected tooth—In periapical radiographs, the % alveolar bone loss is compared with the distance 1 mm apical from the cemento-enamel junction to the root apex. In bitewing radiographs, the % alveolar bone loss is calculated with 10% per 1 mm. **Perio Susceptibility** The patient's susceptibility to periodontitis. Staging and Grading according to the 2017 World Workshop on Classification of Periodontal Diseases (Tonetti et al., 2018). **SPT** Supportive Periodontal Therapy (Compliant with SPT, recall interval ≤5 months, recall interval 6 months, casual attender, no supportive therapy). **RM-Bone** Distance from the restorative margin (RM) of the implant prosthesis to the marginal bone crest (STL–soft tissue level implant, >1.5 mm, <1.5 mm). This is determined from a radiograph. **Prosthesis**. Assessment of factors related to the implant-supported prosthesis. (cleanable, poor fit with supramucosal margins, poor fit with submucosal margins, excess cement, not cleanable)

diagram. The scale runs in a quadratic mode of 9, 16, 25, 36, and >49% being the critical values on the vector. This assessment encompasses the BOP% for all tooth and implant sites. Individuals with low BOP % (<10%) may be regarded as patients with a low risk for disease development (Lang, Adler, Joss, & Nyman, 1990), while patients with BOP% >25% should be considered to be at higher risk for tissue breakdown.

2.3 | Prevalence of probing depths ≥5 mm

High numbers of deep periodontal pockets (PD ≥ 5 mm) and deepening of pockets during SPT has been associated with high risk of periodontal disease progression (Badersten et al., 1990; Claffey et al., 1990). It has also been shown that putative periodontal pathogens from deep residual pockets at teeth may colonize implant sites (Mombelli, Marxer, Gaberthuel, Grunder, & Lang, 1995). Furthermore, the presence of higher numbers of residual pockets was associated with peri-implantitis development in the medium (Cho-Yan Lee, Mattheos, Nixon, & Ivanovski, 2012) to long-term (Pjetursson et al., 2012). In assessing the patient's risk for peri-implant disease development, the number of tooth and implant sites with a PD ≥ 5 mm is assessed as the third risk indicator in the IDRA functional diagram. The scale runs in a linear mode with 2, 4, 6, 8, ≥10 being the critical values on this vector. Individuals with one or two pockets with a PD ≥ 5 mm may be regarded as patients at low risk, while patients with more than six sites with PD ≥ 5 mm are regarded as individuals at high risk for development of biological complications.

2.4 | Periodontal bone loss in relation to age

The extent and prevalence of periodontal attachment loss as evaluated by the height of alveolar bone on radiographs may represent the most obvious indicator of subject risk for periodontal

disease progression when related to the patient's age (Papapanou, Wennström, & Gröndahl, 1988).

Periodontal bone loss has been identified as a risk factor for the development of peri-implant disease in two large randomly selected population studies (Derks et al., 2016; Kordbacheh Changi et al., 2019). Therefore, the extent of alveolar bone loss in relation to the patient's age is estimated as the fourth risk indicator for disease development in the functional IDRA diagram.

The estimation of the loss of alveolar bone is performed in either periapical radiographs in which the worst tooth site affected is grossly estimated in % of the root length or on bitewing radiographs in which the worst site affected is estimated in mm. On bitewing radiographs, 1 mm is considered to be equal to 10% bone loss. The percentage is then divided by the patients age resulting in a factor. As an example, a 40-year-old patient with 20% of bone loss at the worst affected site would score BL/age = 0.5. Another 40-year-old patient with 50% bone loss at the worst affected site would score BL/age = 1.5.

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 the alveolar bone than his/her age is at high risk regarding this vector in a multifactorial assessment.

2.5 | Periodontitis susceptibility

In 2017, the World Workshop on Classification of Periodontal and Peri-implant diseases proposed a new system for the classification of periodontal diseases encompassing extent, severity and complexity in a staging modality (Tonetti et al., 2018). In addition, the progression rate and hence the susceptibility to disease was incorporated with a grading modality (Tonetti et al., 2018).

It, therefore, seems logical to add the staging and grading for periodontal disease as a vector influencing disease development and progression for peri-implant diseases.

According to the IDRA (Figure 1), only Stage 1 Grade A represents low risk. Stage 2 represents moderate (from the middle node in the moderate range) or higher risk. Stage 3 represents moderate (from the outer node in the moderate range) or higher risk. Stage 4 represents high risk. Regarding grading: Grade B represents moderate (from the middle node in the moderate range) or higher risk and Grade C represents high risk.

The number of teeth that have been lost due to periodontitis is incorporated in the staging of the 2017 classification.

As the evidence for an association with peri-implantitis remains equivocal regarding cigarette smoking and diabetes mellitus, these modifying factors are considered as potential risk indicators or emerging risk factors (Schwarz et al., 2018). Therefore, they are not represented in the IDRA by individual vectors; instead, they are incorporated within the grading of the 2017 classification of periodontal diseases. This classification assigns a non-smoker to Grade A (slow rate of progression), a smoker <10 cigarettes per day is Grade B (moderate rate of progression) and a smoker ≥10 cigarettes per day represents Grade C (high risk of progression).

A patient with no diagnosis of diabetes is assigned as Grade A (slow rate of progression). A patient with diabetes and HbA1c < 7.0% is Grade B (moderate rate of progression) and HbA1c ≥ 7.0% is Grade C (rapid rate of progression).

2.6 | Supportive periodontal therapy (SPT)

There is strong evidence that a regular recall system rendering appropriate supportive care is of utmost importance for peri-implant health and stability (Costa et al., 2012; Monje et al., 2016; Roccuzzo, Bonino, Aglietta, & Dalmasso, 2012). Therefore, the sixth vector of the IDRA deals with the compliance of patients and supportive care rendered by the clinician. Obviously, no supportive care represents a high risk for peri-implant disease development while full compliance with a recommended and calculated maintenance care interval results in low risk for disease development. A systematic review (Monje et al., 2016) determined that a recall interval of less than or equal to 5 months, on average may represent a time frame compatible with maintenance of peri-implant health.

2.7 | Distance from the restorative margin (RM) of the implant-supported prosthesis to the bone

A large population study identified the distance of ≤1.5 mm from the restorative margin of the implant-supported prosthesis to the marginal bone crest at time of restoration as a risk indicator for peri-implantitis (Derks et al., 2016). Hence, it is relevant to consider this distance in a risk assessment for the development of peri-implantitis. While a soft tissue level implant usually has a supramucosal restorative margin and hence represents low risk for disease development, a distance of the restorative margin to the bone crest of ≤1.5 mm was demonstrated to be at higher risk. Therefore, the IDRA functional diagram assigns low risk for a soft tissue level implant, moderate risk as a distance of 1.5 mm, and high risk as a distance of <1.5 mm. This is determined from a radiograph made at the time of restoration. If a radiograph at the time of prosthesis delivery is not available a radiograph should be taken at the time of examination and risk assessment.

2.8 | Implant prosthesis-related factors

Several studies have indicated that the design and contours of the implant-supported prosthesis may lead to areas that are not cleanable. Consequently, biofilms accumulate and may initiate peri-implant disease (Serino & Ström, 2009). Furthermore, iatrogenic factors such as poor marginal fit and submucosal excess cement deposits provide

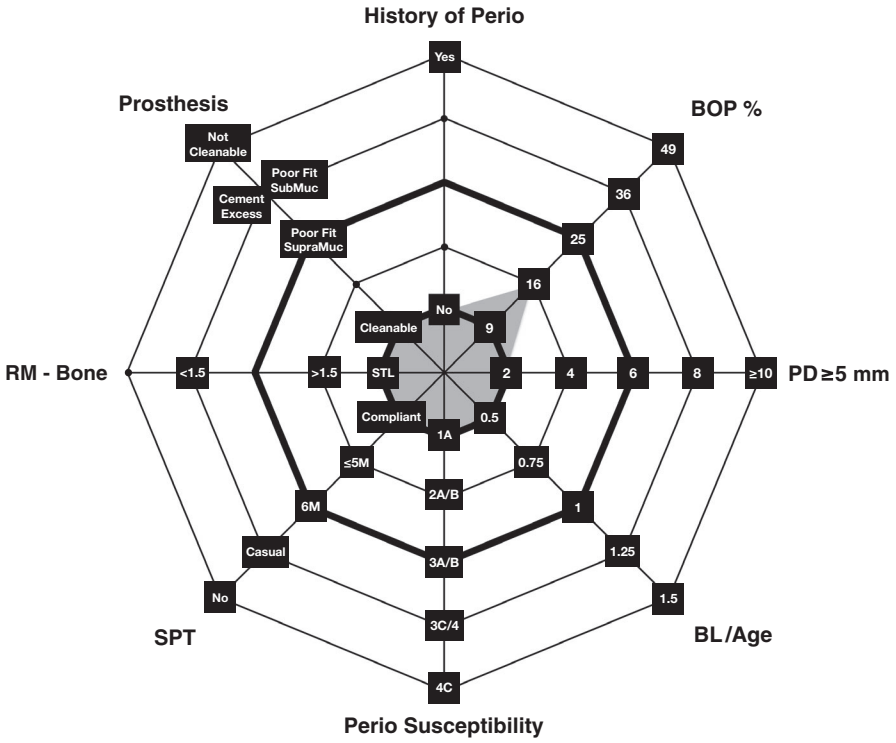

FIGURE 2 A low IDRA risk patient has all parameters in the low-risk categories or at the most one parameter in the moderate-risk category

habitats for biofilm accumulation and hence are documented factors for the development of biological complications. Recently, this has been confirmed in a large population study by (Kordbacheh Changi et al., 2019). In order to represent a low risk for disease development the prosthesis must be well-fitting, cleanable, screw-retained or with no excess cement. Conversely, an uncleanable poorly fitting prosthesis is at high risk to allow biofilm accumulation and hence develop peri-implant disease. The same applies for the presence of submucosal excess cement. A moderate risk may be attributed to a prosthesis which has compromised fit but accessible supramucosal margins. In the context of the IDRA, the term cleanable refers to the access for both the clinician and the patient to clean the prosthesis. The patient's ability to clean the prosthesis will depend on their level of skill and dexterity which may change over time.

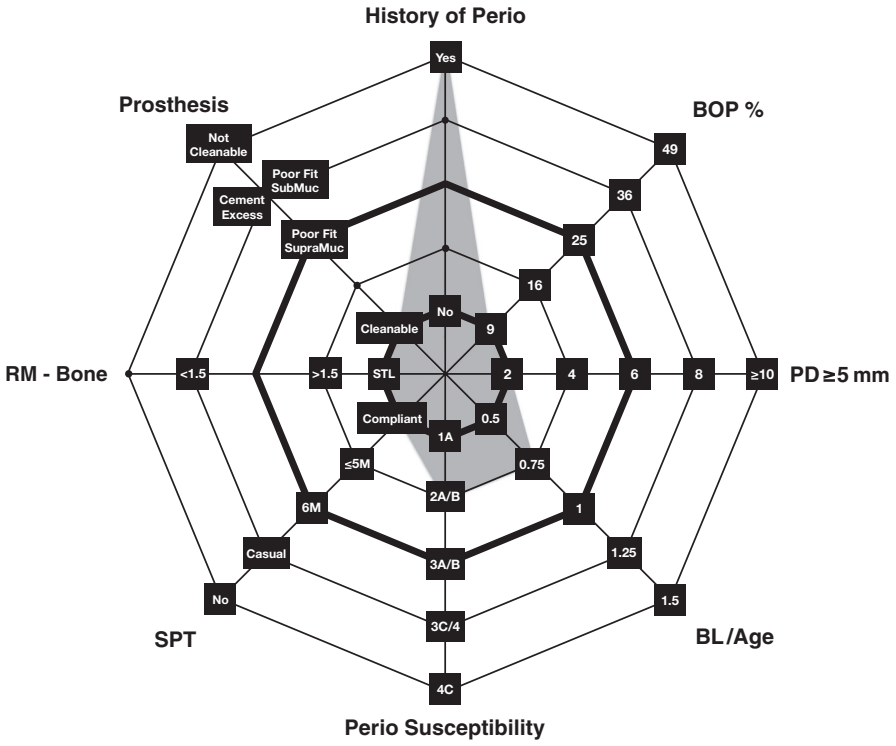

FIGURE 3 A moderate IDRA risk patient has at least two parameters in the moderate-risk category but at most one parameter in the high-risk category

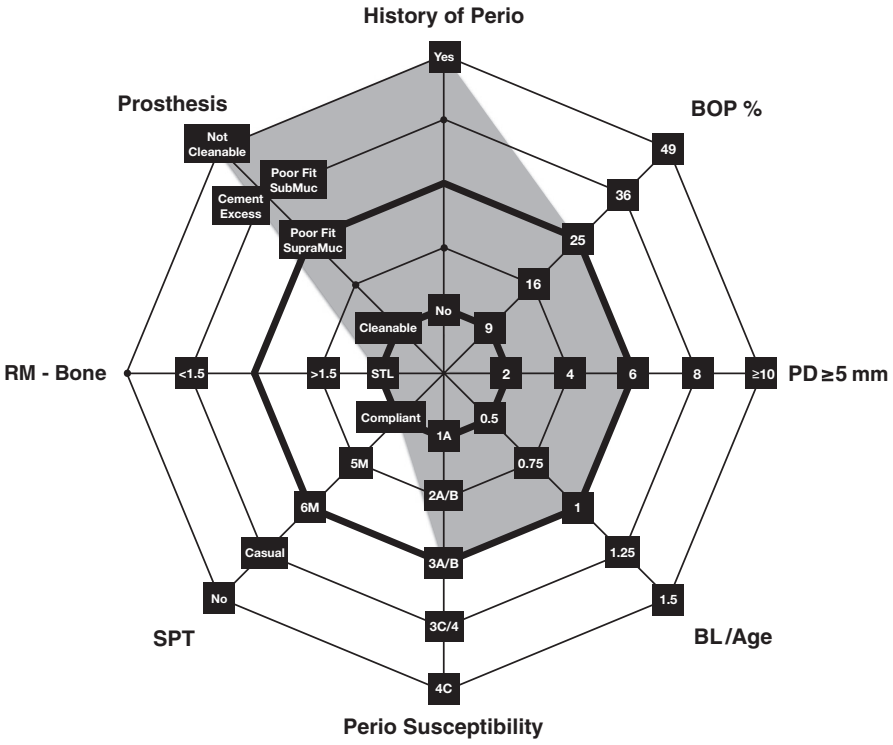

FIGURE 4 A high IDRA risk patient has at least two parameters in the high-risk category

3 | Calculating the patient's individual implant disease risk assessment IDRA

Based on the eight parameters specified above a multifunctional diagram (Octagon) is constructed for the IDRA (Figure 1). In this diagram the vectors have been formed on the basis of the scientific evidence available. It is expected that ongoing validation may result in slight modifications.

A low IDRA patient has all parameters in the low-risk categories or at the most one parameter in the moderate-risk category (Figure 2).

A moderate IDRA patient has at least two parameters in the moderate-risk category but at most one parameter in the high-risk category (Figure 3). A moderate IDRA patient may also have one parameter in the high-risk category with all other parameters in the low-risk categories.

A high-risk IDRA patient has at least two parameters in the high-risk category (Figure 4).

In a high-risk patient who yields a high %BOP and high numbers of residual pockets (PD ≥ 5 mm), the patient's risk for peri-implant disease development may be reduced into a moderate IDRA category if further successful periodontal therapy is provided. While these two parameters (%BOP, PD ≥ 5 mm) are easily modified by adequate therapy other parameters such as prosthesis fit may require replacement of the prosthesis.

One factor in the IDRA, history of periodontitis is unable to be modified and therefore must be accepted as a given. Compensation for this high risk may be achieved by minimizing the effect of the other parameters.

In an edentulous patient restored with an implant-supported prosthesis where the patient's history of periodontitis cannot be determined this parameter is not assigned. Furthermore, in an edentulous patient, it is not possible to assign the parameter bone loss/age.

If a patient has a history of peri-implantitis the risk assessment for the parameter "history of periodontitis" should be assigned as high.

This IDRA risk assessment tool will require validation through retrospective or prospective studies in multiple private practice and University settings.

In conclusion, the IDRA has the potential to be a useful tool for assessing risk for an individual patient after implant therapy. In addition, the IDRA may be useful as a checklist to identify modifiable risks prior to implant therapy and as a tool for the clinician to communicate the level of risk to the patient. The IDRA online tool is available open access at the following website (http://www.ircohe.net/IDRA).

AUTHOR CONTRIBUTIONS

L.H-M., F.H and N.P.L. conceived the idea and led the writing.

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REFERENCES

Aguirre-Zorzano, L. A., Estefania-Fresco, R., Telletxea, O., & Bravo, M. (2015). Prevalence of peri-implant inflammatory disease in patients

with a history of periodontal disease who receive supportive periodontal therapy. *Clinical Oral Implants Research*, *26*(11), 1338–1344. https://doi.org/10.1111/clr.12462

Badersten, A., Nilveus, R., & Egelberg, J. (1990). Scores of plaque, bleeding, suppuration and probing depth to predict probing attachment loss. 5 years of observation following nonsurgical periodontal therapy. *Journal of Clinical Periodontology*, *17*(2), 102–107.

Berglundh, T., Armitage, G., Araujo, M. G., Avila-Ortiz, G., Blanco, J., Camargo, P. M., … Zitzmann, N. (2018). Peri-implant diseases and conditions: Consensus report of workgroup 4 of the 2017 World Workshop on the Classification of periodontal and peri-implant diseases and conditions. *Journal of Periodontology*, *89*(Suppl 1), S313–S318. https://doi.org/10.1002/JPER.17-0739

Cho-Yan Lee, J., Mattheos, N., Nixon, K. C., & Ivanovski, S. (2012). Residual periodontal pockets are a risk indicator for peri-implantitis in patients treated for periodontitis. *Clinical Oral Implants Research*, *23*(3), 325–333. https://doi.org/10.1111/j.1600-0501.2011.02264.x

Claffey, N., Nylund, K., Kiger, R., Garrett, S., & Egelberg, J. (1990). Diagnostic predictability of scores of plaque, bleeding, suppuration and probing depth for probing attachment loss. 3 1/2 years of observation following initial periodontal therapy. *Journal of Clinical Periodontology*, *17*(2), 108–114.

Costa, F. O., Takenaka-Martinez, S., Cota, L. O., Ferreira, S. D., Silva, G. L., & Costa, J. E. (2012). Peri-implant disease in subjects with and without preventive maintenance: A 5-year follow-up. *Journal of Clinical Periodontology*, *39*(2), 173–181. https://doi.org/10.1111/j.1600-051X.2011.01819.x

Derks, J., Schaller, D., Hakansson, J., Wennström, J. L., Tomasi, C., & Berglundh, T. (2016). Effectiveness of implant therapy analyzed in a Swedish population: Prevalence of peri-implantitis. *Journal of Dental Research*, *95*(1), 43–49. https://doi.org/10.1177/0022034515608832

Heitz-Mayfield, L. J. (2005). Disease progression: Identification of high-risk groups and individuals for periodontitis. *Journal of Clinical Periodontology*, *32*(Suppl 6), 196–209. https://doi.org/10.1111/j.1600-051X.2005.00803.x

Joss, A., Adler, R., & Lang, N. P. (1994). Bleeding on probing. A parameter for monitoring periodontal conditions in clinical practice. *Journal of Clinical Periodontology*, *21*(6), 402–408.

Karlsson, K., Derks, J., Hakansson, J., Wennström, J. L., Petzold, M., & Berglundh, T. (2019). Interventions for peri-implantitis and their effects on further bone loss: A retrospective analysis of a registry-based cohort. *Journal of Clinical Periodontology*, *46*(8), 872–879. https://doi.org/10.1111/jcpe.13129

Karoussis, I. K., Salvi, G. E., Heitz-Mayfield, L. J., Brägger, U., Hämmerle, C. H., & Lang, N. P. (2003). Long-term implant prognosis in patients with and without a history of chronic periodontitis: A 10-year prospective cohort study of the ITI Dental Implant System. *Clinical Oral Implants Research*, *14*(3), 329–339.

Kordbacheh Changi, K., Finkelstein, J., & Papapanou, P. N. (2019). Peri-implantitis prevalence, incidence rate, and risk factors: A study of electronic health records at a U.S. dental school. *Clinical Oral Implants Research*, *30*(4), 306–314. https://doi.org/10.1111/clr.13416

Lang, N. P., Adler, R., Joss, A., & Nyman, S. (1990). Absence of bleeding on probing. An indicator of periodontal stability. *Journal of Clinical Periodontology*, *17*(10), 714–721.

Lang, N. P., Suvan, J. E., & Tonetti, M. S. (2015). Risk factor assessment tools for the prevention of periodontitis progression a systematic review. *Journal of Clinical Periodontology*, *42*(Suppl 16), S59–70. https://doi.org/10.1111/jcpe.12350

Lang, N. P., & Tonetti, M. S. (2003). Periodontal risk assessment (PRA) for patients in supportive periodontal therapy (SPT). *Oral Health & Preventive Dentistry*, *1*(1), 7–16.

Löe, H., & Silness, J. (1963). Periodontal disease in pregnancy. I. Prevalence and severity. *Acta Odontologica Scandinavica*, *21*, 533–551.

Luterbacher, S., Mayfield, L., Brägger, U., & Lang, N. P. (2000). Diagnostic characteristics of clinical and microbiological tests for monitoring periodontal and peri-implant mucosal tissue conditions during supportive periodontal therapy (SPT). *Clinical Oral Implants Research*, *11*(6), 521–529.

Matuliene, G., Pjetursson, B. E., Salvi, G. E., Schmidlin, K., Brägger, U., Zwahlen, M., & Lang, N. P. (2008). Influence of residual pockets on progression of periodontitis and tooth loss: Results after 11 years of maintenance. *Journal of Clinical Periodontology*, *35*(8), 685–695. https://doi.org/10.1111/j.1600-051X.2008.01245.x

Mombelli, A., Marxer, M., Gaberthuel, T., Grunder, U., & Lang, N. P. (1995). The microbiota of osseointegrated implants in patients with a history of periodontal disease. *Journal of Clinical Periodontology*, *22*(2), 124–130.

Mombelli, A., van Oosten, M. A., Schürch, E. Jr, & Lang, N. P. (1987). The microbiota associated with successful or failing osseointegrated titanium implants. *Oral Microbiology and Immunology*, *2*(4), 145–151.

Monje, A., Aranda, L., Diaz, K. T., Alarcon, M. A., Bagramian, R. A., Wang, H. L., & Catena, A. (2016). Impact of maintenance therapy for the prevention of peri-implant diseases: A systematic review and meta-analysis. *Journal of Dental Research*, *95*(4), 372–379. https://doi.org/10.1177/0022034515622432

Mühlemann, H. R. (1973). Experimental models in periodontic research. *Deutsche Zahnarztliche Zeitschrift*, *28*(2), 106–112.

Papapanou, P. N., Wennström, J. L., & Gröndahl, K. (1988). Periodontal status in relation to age and tooth type. A cross-sectional radiographic study. *Journal of Clinical Periodontology*, *15*(7), 469–478.

Pjetursson, B. E., Helbling, C., Weber, H. P., Matuliene, G., Salvi, G. E., Brägger, U., & Lang, N. P. (2012). Peri-implantitis susceptibility as it relates to periodontal therapy and supportive care. *Clinical Oral Implants Research*, *23*(7), 888–894. https://doi.org/10.1111/j.1600-0501.2012.02474.x

Roccuzzo, M., Bonino, F., Aglietta, M., & Dalmasso, P. (2012). Ten-year results of a three arms prospective cohort study on implants in periodontally compromised patients. Part 2: Clinical results. *Clinical Oral Implants Research*, *23*(4), 389–395. https://doi.org/10.1111/j.1600-0501.2011.02309.x

Roccuzzo, M., De Angelis, N., Bonino, L., & Aglietta, M. (2010). Ten-year results of a three-arm prospective cohort study on implants in periodontally compromised patients. Part 1: Implant loss and radiographic bone loss. *Clinical Oral Implants Research*, *21*(5), 490–496. https://doi.org/10.1111/j.1600-0501.2009.01886.x

Schwarz, F., Derks, J., Monje, A., & Wang, H. L. (2018). Peri-implantitis. *Journal of Periodontology*, *89*(Suppl 1), S267–S290. https://doi.org/10.1002/JPER.16-0350

Serino, G., & Ström, C. (2009). Peri-implantitis in partially edentulous patients: Association with inadequate plaque control. *Clinical Oral Implants Research*, *20*(2), 169–174. https://doi.org/10.1111/j.1600-0501.2008.01627.x

Serino, G., & Turri, A. (2011). Outcome of surgical treatment of peri-implantitis: Results from a 2-year prospective clinical study in humans. *Clinical Oral Implants Research*, *22*(11), 1214–1220. https://doi.org/10.1111/j.1600-0501.2010.02098.x

Tonetti, M. S., Greenwell, H., & Kornman, K. S. (2018). Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. *Journal of Periodontology*, *89*(Suppl 1), S159–S172. https://doi.org/10.1002/JPER.18-0006

How to cite this article: Heitz-Mayfield LJA, Heitz F, Lang NP. Implant Disease Risk Assessment IDRA–a tool for preventing peri-implant disease. *Clin Oral Impl Res*. 2020;31:397–403. https://doi.org/10.1111/clr.13585