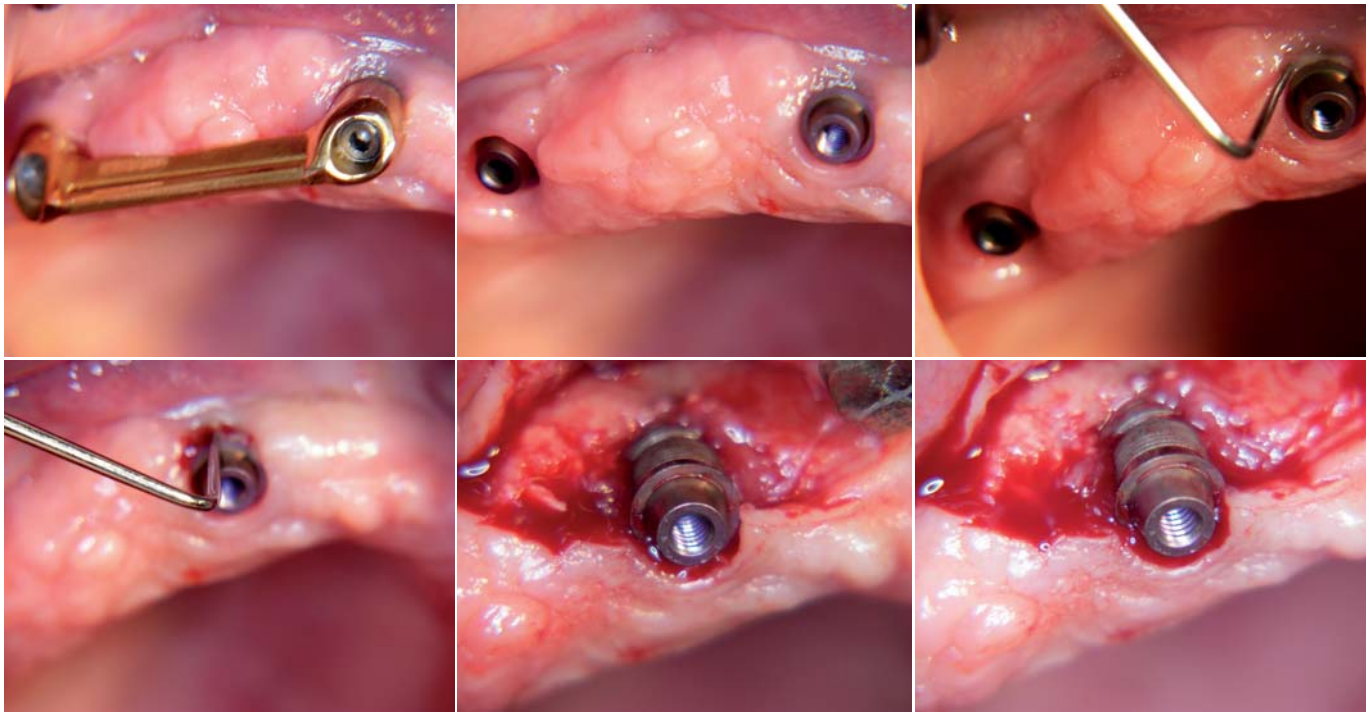
Integration of diode laser surface decontamination in periimplantitis therapy—a twelve year review of a fit for practice concept

author_Georg Bach, Germany

_**After many years** of great euphoria, a certain disillusion has spread in implantology, which is especially due to the reason that implants with corresponding suprastructures do not last forever, like it has often been pointed out. Anyway, complications cannot totally be excluded. Professor Herbert Deppe, Chair for the Dental Surgery and Implantology Department of Munich University, has recently reported on the fact that approximately an eights of incorporated implants show periimplantary lesions after about 10 years. In the beginning, the main fear was that enossal implants had to face early complications. Nowadays, this is no more the case since sophisticated surgery techniques and improved implant surfaces have reduced these risks. One still has to worry about long-term sequelae shown in artificial abutments caused by periimplantary lesions after some years of strain. However, periimplantitis is mainly induced by bad oral hygiene and/or the inability to carry out mouth care (eg in old patients), and it is not associated to a certain type of implant (system-independent). Numerous therapy approaches have been made to preserve artificial abutments suffering from periimplantitis. A four phase treatment model is usually applied (hygienization phase, surgical resective phase, reconstructive and augmentative phase, recall phase). This model has considerably been enhanced by the launch of diode or injection lasers, which have



Manifestation of periimplantitis
On probing, secretion is released at the mesial implant, though the clinical appearance is inconspicuous and further probing leads to a substantial bleeding. After mobilization of the soft tissues, the typical crater-shaped periimplant bone defect becomes visible.

later been complemented by CO_2 laser, Er:Yag laser and Er,Cr:YSGG laser respectively. Since the mid-nineties, diode lasers belong to the established wavelengths used in dentistry. Today, diode lasers with short pulse technique are predominant, though it all started out with the cw mode. High performance diode lasers emit monochromatic, coherent light of wavelength 810 nm, which is especially well absorbed by dark surfaces. Thanks to these physical conditions, the injection laser (= diode laser) is perfectly suitable for incisions applied in standard dental surgery, as well as for the resection of benign tumors in the oral cavity, the uncovering of implants and for application in mucogingival surgery. The good cutting properties of diode lasers are due to the extraordinary absorption of laser light by the hemoglobin located inside the tissue. Additional to soft tissue surgery, the diode laser is also used for decontamination of surfaces coverd with microbes (on implants and teeth). It could be demonstrated that especially the gram-negative, anaerobe microbiological spectrum was properly damaged by laser light (Bach und Krekeler (1995; 2000)). In compliance with reasonable peformance and time parameters, which have been confirmed sustainably by clinical long term studies (Moritz (1996), Gutknecht (1997), Bach et. al. (1995, 1996, 1998, 2000, 2001)), a thermic or morphological damage of the implant surface and the surrounding bone tissue can definitively be excluded (Bach and Schmelzeisen (2002)). It was the aim of the present study to demonstrate and evaluate a treatment model for periimplantitis therapy, which shows sustainable results and which is absolutely suitable for practice. There is no doubt that the conventional methods for periimplantitis treatment, which have often been described in literature, permit adequate surface cleaning and thus also the reduction of pathogenic microorganisms on the implant surfaces. Nevertheless, the complete removal of relevant bacteria cannot be ensured. Moreover, the conventional removal of biofilms has only little influence on those bacteria infiltrating the soft tissue. The integration of diode laser light in periimplantitis therapy must be seen as a new approach.

_Material and method

Ten patients (with n = 17 implants) have been treated and examined for a period of more than 12 years (since May 2007). In spring 1995, all of them suffered from periimplantitis on their artifical titanium abutments.

_Pathogenesis of periimplantitis

Periimplantitis therapy represents a border area between implantology and parodontology. The causes for parodontitis and periimplantitis are bacterial infections, in particular they are biofilm based infectious diseases. Gram-negative and anaerobe microbes are mainly responsible for the destruction of the parodontal and periimplantary supporting tissue. As a rule, one of the following microbes causes parodontopathy in case of one of both biofilm based infectious diseases:

_ *Actinobacillus actinomycetemcomitans*
_ *Prevotella intermedia* and
_ *Porphyromonas gingivalis*

Whereas periimplantitis is mainly caused by the following microbes:

_ *Fusobacteria*
_ *Prevotella intermedia* and
_ *Porphyromonas gingivalis*

The principal object of periimplantitis therapy carried out in our dental clinic was to remove the biofilm and hence the removal of the mentioned pathogenic microorganisms.

_ Patients treated

For detailed data, age and sex of the patients, please see Figs. 1 and 2. It should be mentioned that an accumulation of the diseases first incidence is registered in the middle years (age: 30 to 50 years) in both groups. Sex-specific differences could not be ascertained.

Age	Number of patients
20–30 years	1
30–40 years	3
40–50 years	3
50–60 years	2
60–70 years	1

Fig. 1_ Age pattern of the examined and treated patients in 1995.

Sex	Number of patients
Female	5
Male	5

Fig. 2_ Evaluation according to the sex of the examined and treated patients.

_Inclusion and exclusion criteria

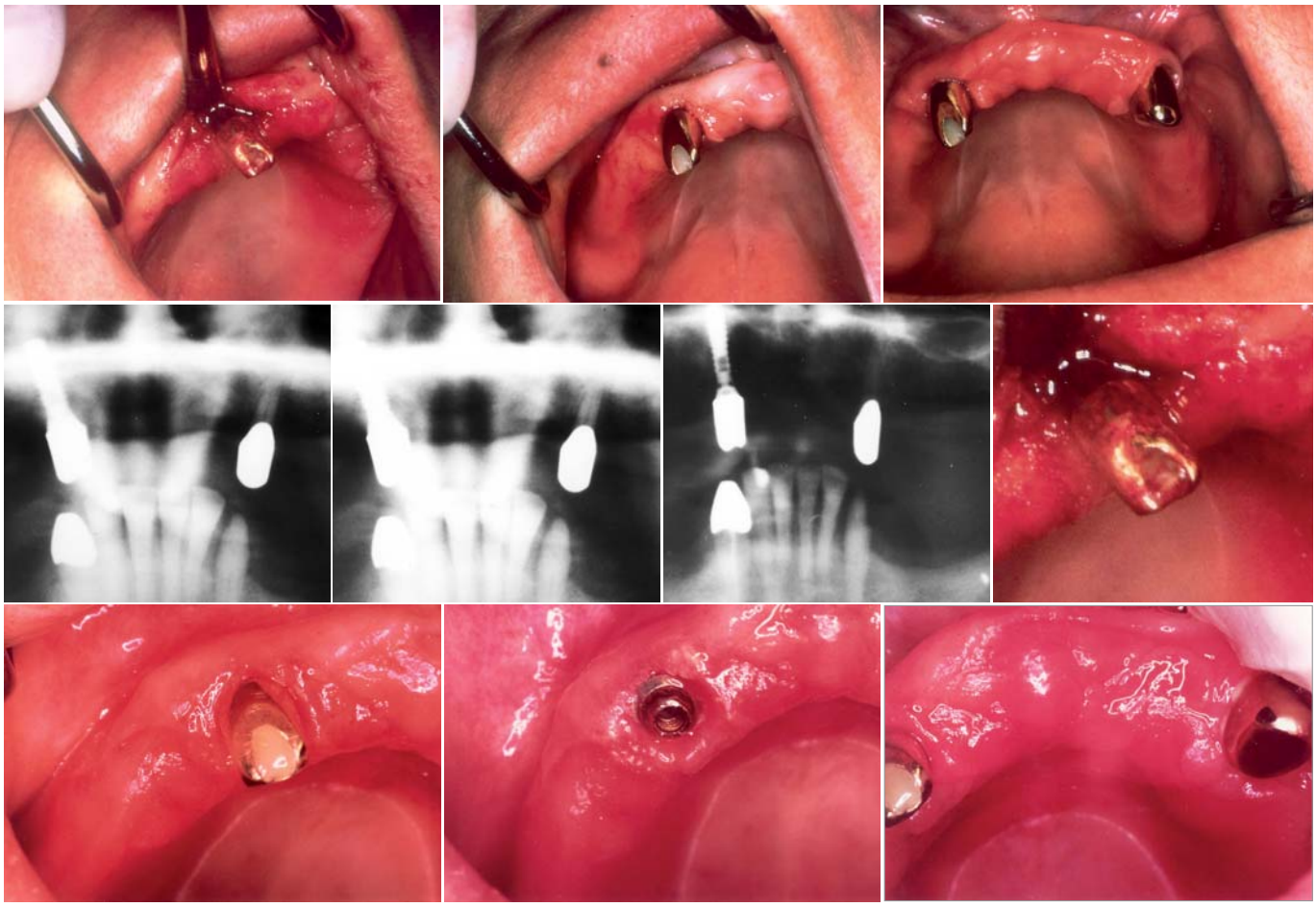
All patients involved had to meet strict inclusion criteria as there were:

_ Clinically visible inflammatory signs like BOP (bleeding on probing) and high probing depths
_ Radiovisible periimplantary bone lesions ("crater")

Exclusion criteria were:

a) Severe primary diseases
b) Nicotine or alcohol abuse
c) Lack of compliance

Due to the strict inclusion and exclusion criteria only a limited number of people could be admitted for this study.



Periimplantitis therapy: You can see the first patient, who had undergone periimplantitis treatment, by means of diode laser decontamination, according to our model. November 1994: Manifestation of periimplantitis at implant regio 13. The panoramic tomography (detail) shows a significant bone loss at the artificial abutment. After mobilization of the soft tissue the situation of the defect becomes clearly visible. January 2008: The prothesis made in 1990, is still in the same positition. The situation of the treated regio 13 implant does not show any irritations with and without suprastructure. There is no evidence of probing depth. The panoramic tomography shows a stable bone situation. Besides the reconstructed defect of regio 13, only the root filling of 43 protrudes. This is the only difference compared to the tomography taken in 1995.

_Treatment procedure

Equal treatment procedures for all periimplantitis patients:

1. Initial therapy:
- _ Motivation and instruction of patients
- _ Cleaning and polishing
- _ Application of desinfecting agents

2. Resective phase:
- _ Forming of a mucoperiostal flap
- _ Removal of granulation tissue
- _ Decontamination by means of diode laser light ($p = 1.0$ watt, $t_{max} = 20$ sec.)
- _ Apical shifting of soft tissues

3. Reconstructive phase:
- _ If necessary, bone augmentation
- _ Where applicable, mucogingival corrections

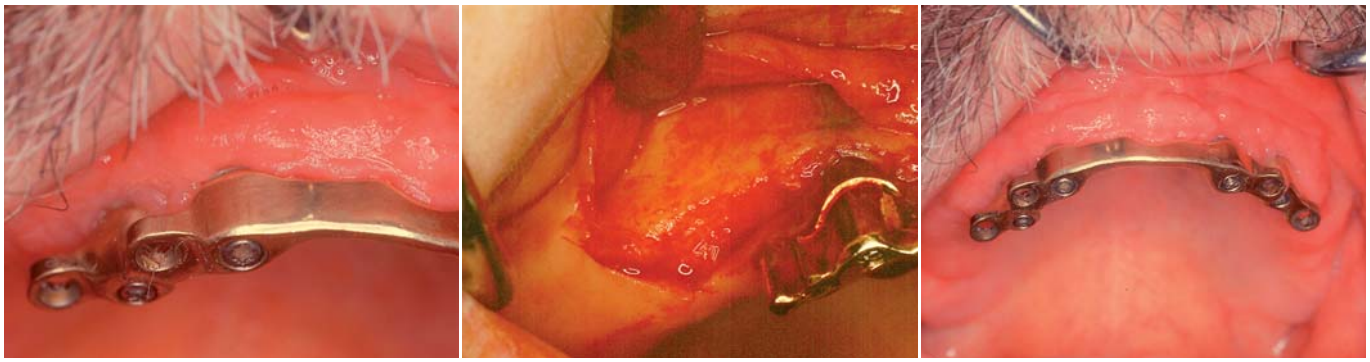
4. Recall phase:
- _ After four weeks, six months, one year and then annual evaluations of clinical findings, taking of X-rays (PSA), decontamination of eventually exposed areas by means of diode laser light.

_Image processing methods

As a rule orthopantomograms (panoramic tomography) and additionally dental films in parallel technique were chosen as an adequate image processing method. In some cases of exacerbated inflammations A/B scan ultrasonic methods were applied. A preoperative orthopantomogram and the dental film status (dental shots of the respective areas) were taken. A postoperative orthopantogram was directly taken after surgery. A panoramic tomography was taken one year later and then every two years. The advantage of the orthopantomogram is its panoramic-like view of all teeth, the osseous limbus alveolaris and important neighbouring anatomical structures. The dental film in parallel technique allows statements concerning progredience, stagnation of loss of hard and soft tissue, and it shows the course of the limbus alveolaris in a reproducible way.

_Microbiological diagnosis

Time schedule: Preoperative, four weeks postoperative, one year postoperative and in a 5 to 10-year postoperative interval germs were eliminated from the effected areas. We did not apply the classical microbiological examination technique (isolation of microbes—cultivation—pure cultures—microscopic samples—gas chromatography—antibiotic sensitivity testing—and biochemical identifi-cation, the so-called "bunte Reihen/colour ranks"). We used DNA-RNA hybridization probes instead. The advan-



tage of these hybridization probes is that no living material of the areas probed is needed for cultivation purposes, which minimized the work in the dental clinic (without direct access to an Institute of Microbiology). Additionally, the results were much faster on hand as is the case with classical microbiological examinations. The disadvantage of this rapid test is its high price. Furthermore, only special marker microbes can be detected and **not all** pocket microorganisms can be determined. The germ extraction site had to be dried carefully with a cotton swab, the paper tip was placed, and after a waiting time of 10 seconds put into a sterile storage vessel and sent to the manufactoring company for microbiological diagnosis. The company is in charge of microbiological diagnosis and evaluation of the so-called microbe marker values. The classification of marked microbes was: less than 0.1 % = negative; 0.1-0.99 % = low; 1.0-9.9 % = middle, more than 10 % = high.

_Laser light decontamination

Decontamination formed an essential part of the whole therapy. It was carried out by means of diode laser light with 1 watt performance and 20 seconds of application time per implant under fiber contact. A special program (I = implantology-parodontology) was at our disposal, which was used together with the corresponding device (Oralia 01 IST). Performance and time limitation (1.0 watt, 20 seconds) were already fixed parameters of this program. When observing these parameters (time limitation and limitation of performance) it can be guaranteed that the disease causing microbes will be damaged sufficiently and thus, pulpa, periimplantary and periodontal tissue structures will not suffer any thermic damages (Bach and Krekeler (1995)).

_Results

Alltogether 10 patients could be examined and checked up during the whole 12 years. In 1994/1995 the "Diode Laser Basic Study" of the Department of Periodontal Surgery of the Dental Clinic in Freiburg/Germany included 50 periimplantitis patients. Due to moving, change of dentist, dead of patients and other unknown reasons the number of patients was reduced to 10, who are still patients of my dental clinic.

a) Microbiological results

For microbiological results please see Fig. 3. It must especially be emphasized that *Porphyromonas gingivalis* could nearly be completely eliminated during the whole examination period, and a significant reduction of other anerobe, Gram-negative bacteria could be achieved. We could obtain similar results for *Porphyromonas gingivalis* and *Fusobacteria* except for two cases of low concentration and one of middle concentration, these bacteria could be limited to the lower level of detection in other patients, whereas other relevant marker microbes could be considerably repressed.

b) Recurrence

One of the following results was considered to be a case of recurrence:

_ Occurrence of probing depths of more than 4 mm
_ Loss of implant
_ Recurrence of an inflammation
_ Excessive soft tissue inflammation with pocket activity

After 12 years the quota of recurrence was 23% in the periimplantitis group (4 implants). It is stated in international literature that the five year observation period recurrence rate is 30 %.

c) Losses after 140 months

Within the examination period of 12 years we suffered the following losses: two of 17 implants (12 %).

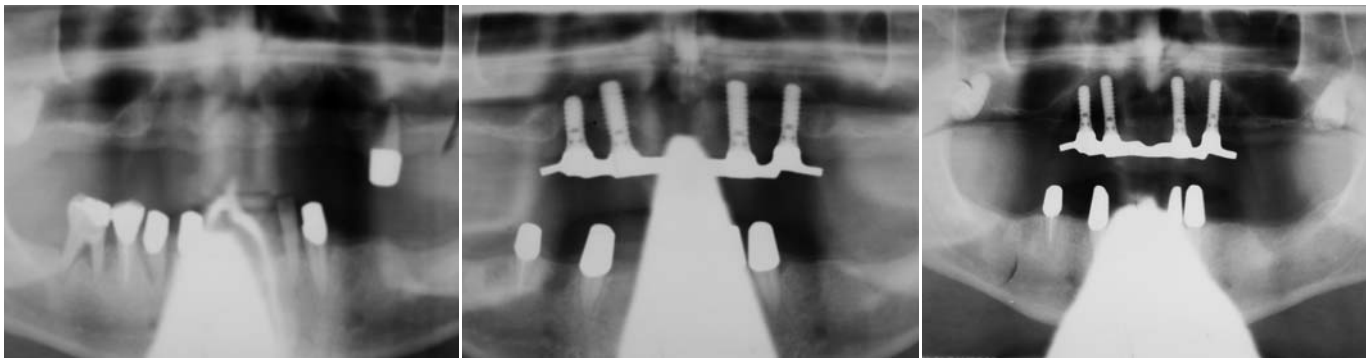
d) Radiological results

On the occasion of the one year check up, a reconstruction of the once crater-shaped defect could be found at the first thread and implant cervix respectively in all 17 implants. After five years this was the case in twelve implants, after ten years in ten implants and in nine implants, when the last X-ray control was carried out. In two implants a successive loss of the bony supporting tissue forced us to remove the artificial abutment in one case af-

Saving of a prothesis by treating periimplantitis of a strategically important implant in the upper jaw.

March 1995: Just one year after the incorporation of a very sophisticated and for the patient nearly too expensive implant-supported prosthesis in the upper jaw, the manifestation of periimplantitis was detected in the first quadrant. After mobilization of the soft tissue (below) the defect situation becomes clearly visible. Four months after the surgical resective phase there were no clinical signs of irritation.

November 2007: The protesis is still in its intraoral place. Meanwhile, the patient has reached the age of 63 years. The situation of the treated implant regio 13 (total suprastructure) does not show any clinical signs of irritation in toto and in the former surgical area. There is no probing depth.



The radiological situation
We are lucky to have a panoramic tomography, taken by the pretreating dentist/referral dentist, which shows the situation BEFORE the implant´s incorporation. Please note the profound parodontal lesions (above). March 1995 (below): Only half a year after incorporation, a considerable bone loss at the artificial abutment (below) can be seen on the panoramic tomography (detail). Another half a year later (upper right) it has drastically expanded and also affects the mesial implant. This was the date, when the patient was referred to our dental clinic. The bony situation seems to be stable when looking at the panoramic tomography from 2006. Besides the 2/3 reconstructed former defect of regio 14, the nearly completely stable reconstruction of the implant regio 13 is certainly impressive.

Fig. 3_ Development of PI microbe marker values 1995–2005.

ter seven and in another case after nine years. After the last X-ray control, the remaining six implants showed losses of horizontal supporting tissue on the level of the first/second thread.

e) Importance of the present study for patients

Two implants got lost and together with their excorporation the corresponding continuous beam (in one case) and bridge reconstruction (in the other case) had to be removed as well. All the other treated implants are properly functioning, even 12 years after periimplantitis detection. Though, at the moment, not all implants are in stable conditions and again bony losses occurred after years of therapy, as already described in the Result chapter, it can certainly be judged favorably that most implants could be preserved. This is of special importance to older patients, who were not in favor of explantation, augmentation and renewed implantation or whose state of health would not have allowed or at least would have limited these highly invasive measures.

_Discussion

The authors considered the 12 year lasting continuation of this study as necessary in order to show that periimplantitis therapy can also be carried out successfully "on the conditions of a private dental clinic". It also proves that "sooner or later not every periimplantitis" leads to the loss of the artificial abutment. The extremely long term of the study was a limiting factor for the contingent of patients involved in examination and treatment. The low number of patients participating in this study was due to the strict inclusion and exclusion criteria. Nevertheless, these severe restrictions helped to minimize the risk of probable influences on the results by external factors. After years of incessant euphoria in implantology, nowadays dentists have to face a considerable number of complications. In my opinion, periimplantitis is the main challenge for today's implantology. The huge number of incorporated abutments and the growing age of our patients, which is one of the main reasons for the increasing loss of ability to handle and clean complicated suprastructures, will lead to a progredience in periimplantitis. The chief purpose of the systematic therapy in case of apparent periimplantitis is the removal of biofilm and pathogenic microorganisms (biofilm management). On the basis of the present results of implant surface decontamination, we believe the integration of diode laser decontamination to be a tried and tested means for treating periimplantitis. Additionally, it implicates a considerable lowering of recurrences and a notable improvement for the prognosis of this clinical picture._

The reference list can be requested from the editorial office.

_contact laser

Dr Georg Bach, Oral Surgeon
Rathausgasse 36
Freiburg im Breisgau, Germany
E-Mail: doc.bach@t-online.de

Date:	preoperative	4 weeks p.o.	1 year p.o.	5 years p.o.	10 years p.o.
Microbes					
Fusobacteria	2n/3m/1h	2n	2n	2n/1m	2n/1m
Prevotella intermedia	4n/2m	1n/1m	2n/1m	2n/2m/1h	2n/2m
Porphyromonas ging.	2n/4m/2h	1n/1m	2n/1m	2n/2m	2n/2m

(Legend: k.N. = no findings; n = low; m = middle; h = high)