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General health screening as part of a periodontal examination

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Cardiovascular disease (CVD) and type 2 diabetes are common systemic illnesses with reliable, predictive risk factors. CVD is the number one killer worldwide accounting for nearly 30% of deaths and type 2 diabetes has reached epidemic proportions in many western industrialized countries. Both of these illnesses can go undiagnosed in an alarming number of people for significant periods of time. The relationship between oral health and systemic health has become the focus of much discussion and research in recent times. It is now widely accepted that periodontal disease is associated with systemic illnesses such as CVD and type 2 diabetes. Cigarette smoking and obesity are major risk factors accounting for a large portion of the global disease burden. Many periodontal patients may be at risk of systemic conditions but be asymptomatic and undiagnosed. With an aging population who are mostly retaining their natural dentition, the need for periodontal management will continue to rise in the future. Dental professionals are well placed to perform general health screening for their patients. Therefore, risk assessment during the periodontal examination may facilitate the early identification of the large proportion of people who are unaware of their risk status. As identification and intervention of patients with increased risk factors is key to lowering the systemic disease burden, general health screening during periodontal examinations may present an important opportunity for many patients.

Keywords: *risk factors*; *systemic illnesses*; *cardiovascular disease*; *type 2 diabetes*; *cigarette smoking*; *obesity*

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Despite significant improvements in the awareness and prevention of chronic systemic illnesses in western industrialized countries, lifestyle-related diseases are limiting gains in life expectancy. Obesity, lack of physical activity, and the use of tobacco can lead to heart disease, stroke, diabetes, and many other serious health problems. In 2008, the Australian Institute of Health and Welfare (AIHW) reported that although approximately 84% of the population rated their health as good or excellent:

1. 19% of male and 17% female adults in Australia were obese with a further 41% of male and 25% of female adults being overweight
2. 50% of adults were not sufficiently physically active
3. approximately 17% of people aged 14 years and over smoked daily (1)

Dentists are ideally placed to screen patients for increased risk of several serious systemic illnesses – including cardiovascular disease (CVD) and type 2 diabetes. The AIHW, Dental Statistics Research Unit (DSRU) reports that around half of all Australian adults visit their dentist annually (2). During these visits dentists have the ability to screen patients, increase patient awareness, provide education, and make appropriate referrals. A US study found that of men aged 40 years and older who had no reported cardiovascular risk factors and who had not seen a general medical practitioner in the previous 12 months but had seen a dentist, 18.3% were at an increased risk of experiencing a serious CVD event within 10 years (3).

Screening for systemic illnesses

The relationship between oral health and systemic health is the focus of much current discussion and research and is the theme of this issue of the *Journal of Oral Microbiology*. The association between periodontal disease and systemic illnesses including CVD, diabetes, premature low birth weight (PLBW) infants, osteoporosis, respiratory disease, and rheumatoid arthritis has been discussed. The oral and systemic burden of infection and inflammation carried by adults with moderate to severe periodontal disease places this group of individuals at an

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inherently higher risk of these illnesses than those without periodontal disease in general adult populations (4–9). As such, this group would benefit greatly from general health screening during the periodontal examination.

Patients attending dental clinics for periodontal therapy usually require a series of appointments for examination, diagnosis, and therapy. Following a course of therapy, they are most often placed on a maintenance program for ongoing monitoring of their periodontal status. During this series of visits, there exists an excellent opportunity for dentists to screen patients for systemic illnesses and make them aware of potential risk factors. Patient education regarding the links between oral health and systemic health and the risks for systemic illnesses can be discussed as well as referral to medical practitioners where appropriate.

A recent study carried out in the US (10) surveyed practicing general dentists to assess their attitudes toward, acceptance of, and perceived barriers to screening for medical conditions in the dental setting. The overwhelming majority of respondents thought it was important and were willing to conduct screening. The data also suggested that dentists had the necessary attitudes, beliefs, and intentions to incorporate screening into their dental practices. Furthermore, the results suggested that the large majority of dentists were willing to refer patients to a medical practitioner for further disease assessment and diagnosis. In addition to patient awareness of their risk factors, this is obviously another critical component of the prevention and management of systemic illnesses.

Risk assessment

Risk assessment can be defined as the process by which qualitative or quantitative assessments are made of the likelihood for adverse events to occur as a result of exposure to specified health hazards or by the absence of beneficial influences (11). The World Health Organization reports that more than one-third of the world's deaths can be attributed to a small number of risk factors (12). The five leading global risks for mortality in the world are high blood pressure, tobacco use, high blood glucose, physical inactivity, and overweight and obesity. They are responsible for raising the risk of chronic diseases across countries of all income groups (12).

In the cases of CVD and type 2 diabetes, there are reliable risk factors that are indicative of increased likelihood of the development and progression of these diseases.

The early identification and intervention of patients with increased risk factors for systemic illnesses can greatly reduce their long-term mortality and morbidity. It is especially important in young to middle age adults – despite their lower relative risk, because the early and prolonged intervention of the identified risk factors can have significant and positive effects on long-term health. Lifestyle modification including smoking cessation, weight control, increased physical activity, and adopting a high-quality diet has the potential to bring about a significant reduction in long-term risk (13). As these lifestyle choices and behaviors usually develop early in life, their identification and the implementation of preventive initiatives can significantly affect long-term outcomes.

Cardiovascular disease (CVD)

CVDs include a variety of heart and vascular conditions including coronary heart disease (CHD), atherosclerosis, acute myocardial infarctions, and stroke. CVD accounts for nearly 30% of deaths worldwide (12).

The Framingham heart study (14) is the most widely applied, well recognized and validated tool for assessing the increased risk of experiencing a severe CHD event within 10 years. It described seven traditional cardiovascular risk factors (see Table 1) that are additive in predictive power. Wilson et al. (14) reported the accuracy of a simple algorithm in assigning absolute risk for CHD (including angina pectoris, myocardial infarction, coronary insufficiency or unstable angina, and CHD deaths), whereby a 10% Framingham risk score meant a patient had a 10% likelihood of experiencing a CHD event within 10 years. Risk categories were defined as low risk (<10%), intermediate risk (10–20%), and high risk (>20%).

The global risk assessment score is calculated by adding the number of Framingham points that are weighted for each of the risk factors – age, total cholesterol, high density lipoprotein-cholesterol (HDL-C), blood pressure measurement, diabetes, and smoking (14). This score is then used to determine the relative risk, which is a ratio of the absolute risk of a given individual to that of a low-risk group. While the Framingham score is useful for estimating risk, it does not adequately account for severity of some individual risk factors such as heavy smoking or severe hypercholesterolemia – especially where only one severe risk factor is present (13). For example, a heavy

Table 1. The major risk factors for cardiovascular disease as defined in the Framingham heart study (13, 14)

Major independent risk factors for cardiovascular disease
Cigarette smoking
Elevated blood pressure
Elevated serum cholesterol
Elevated serum LDL-cholesterol
Low serum HDL-cholesterol
Diabetes mellitus
Advancing age

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smoker with no other traditional risk factors would be underscored using the Framingham score.

Further to the traditional risk factors predisposing and conditional risk factors for CHD were identified and are listed in Table 2 (13). The predisposing risk factors were those that worsen the independent risk factors. The conditional risk factors were associated with increased risk for CHD but their causative, independent, and quantitative contributions to CHD had not been well documented at that time.

A recent study (15) evaluated emerging risk factors for CHD (Table 3), including periodontal disease, for their ability to further stratify the intermediate risk group. It concluded that the current evidence did not support the routine use of any of these for further risk stratification and that in many cases more good-quality studies were required. In the case of periodontal disease, this review and meta-analysis suggested that it was an independent, though relatively weak, risk factor for CHD. This conclusion is supported by several other studies (16–19) while others have failed to do so (20–23).

The support for a causal relationship between periodontal disease and CVD would come from long-term interventional studies that have been limited by their scale and associated costs. However, to date there is evidence from biological studies supporting the role of molecular mimicry as a possible mechanism for the association between periodontal disease and CVD (24). As a significant number of patients with CHD do not possess any of the traditional Framingham risk factors, the discussion by Helfand et al. (15) regarding the necessity of further research to elucidate additional independent risk factors and those which are able reclassify intermediate risk patients cannot be overemphasized.

The American Heart Association (AHA) and the National Vascular Disease Prevention Alliance of Australia (25, 26) have very useful online cardiovascular risk calculators that may assist dental professionals in screening their patients.

Table 2. The conditional and predisposing risk factors for cardiovascular disease as defined Grundy et al. (13)

Predisposing risk factors	Conditional risk factors
Obesity	Elevated serum triglycerides
Abdominal obesity	Small LDL particles
Physical inactivity	Elevated serum homocysteine
Family history of premature CHD	Elevated serum lipoprotein (a)
Ethnic characteristics	Prothrombotic factors (e.g. fibrinogen)
Psychosocial factors	Inflammatory markers (e.g. C-reactive protein)

Table 3. Emerging risk factors for CHD as reviewed by Helfand et al. (15)

Risk factor	Strength of evidence
C-reactive protein level	Good
Coronary artery calcium score	Fair
Lipoprotein (a) level	Fair
Homocysteine level	Fair
Leukocyte count	Fair
Fasting glucose concentration	Fair
Periodontal disease	Fair
Ankle-brachial index	Poor
Carotid intima-media thickness	Poor

Type 2 diabetes

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from a deficiency of insulin action. This is the result of either inadequate insulin secretion and/or diminished tissue responses to insulin. Frequently, both of these dysfunctions coexist in the same patient. The chronic hyperglycemia associated with diabetes leads to long-term complications including CVD, nephropathy leading to renal failure, retinopathy with potential loss of vision, and peripheral neuropathy (27). The current classification of diabetes can be found in Table 4.

Diabetes has reached epidemic proportions in many western industrialized countries (28). The National Health and Nutrition Examination Survey (NHANES 2005–2006) data (29) from the US shows that 12.9% of adults aged 20 years and older had diabetes with an

Table 4. The classification of diabetes by the American Diabetes Association (27, 63)

Type of diabetes	Characteristics
Type 1 diabetes	Results from β-cell destruction Usually leads to absolute insulin deficiency Accounts for 5–10% of people with diabetes
Type 2 diabetes	Results from progressive insulin secretory defect on the background of insulin resistance Accounts for approximately 90–95% of people with diabetes
Other types of diabetes	Due to other causes e.g. genetic defects, endocrinopathies, and drug- or chemical-induced
Gestational diabetes mellitus (GDM)	Diabetes diagnosed during pregnancy Complicates approximately 4% of pregnancies in the USA

additional 29.5% with impaired fasting plasma glucose (FPG) or impaired glucose (IGT) tolerance. It is reported that approximately 40% of the US population has undiagnosed diabetes (29). This group of patients is particularly alarming as they are unaware of their condition and may be suffering from progressive retinal, renal, and cardiovascular complications.

The classic symptoms of marked hyperglycemia include polyuria, polydipsia, weight loss (sometimes with polyphagia), and blurred vision. However, these symptoms are non-specific and they tend to develop gradually so they are poor indicators of diabetes. Obesity is the leading risk factor for type 2 diabetes (30). Since 1997, The American Diabetes Association has recommended diabetes screening as part of routine medical care for all adults 45 years and older and younger adults who are overweight or possess any of the high-risk factors defined in Table 5. In the absence of abnormal findings, this screening should be repeated every 3 years.

In 2007, the International Diabetes Federation (IDF) published a consensus on the prevention of type 2 diabetes (31). The IDF recommended screening by health care professionals and provided a simple checklist for risk factors that can be found in Table 6. Similarly, the American Diabetes Association and Diabetes Australia have online diabetes risk tests (32, 33) that could be useful in identifying patients at high risk. Individuals who are determined to be at risk should be referred to a medical practitioner for evaluation.

Cigarette smoking

Cigarette smoking is one of the most important causes of death globally. It is one of the leading risks for CVD, respiratory diseases and cancer – accounting for 11% of the global disease burden and 18% of deaths in high-income countries (12). Smoking acts synergistically with other risk factors, substantially increasing the risk of CHD (34). A substantial decrease in CHD and stroke mortality is reported for former smokers compared with continuing smokers (35, 36).

Smoking is the leading preventable cause of death and the benefits from smoking cessation are widespread, even in heavy smokers. Not only do former smokers significantly reduce the risks of the development of systemic illnesses but they also reduce the risks of complications from existing smoking-related diseases. Smoking cessation is associated with improvements in lung function and relief from respiratory symptoms such as coughing, wheezing, and shortness of breath. These effects are apparent very soon after quitting and are sustained with long-term abstinence (37).

A Cochrane systematic review of several large randomized clinical trials (38) included analyses of the effects of smoking cessation on cardiovascular risk and found a substantial reduction in the risk of CVD after quitting. Even patients with diagnosed CHD can experience up to

Table 5. American Diabetes Association: criteria for testing asymptomatic adults younger than 45 years who are overweight (63)

Additional risk factors
Physical inactivity
First-degree relative with diabetes
Members of high-risk ethnic populations
Women who delivered a baby weighing >9 lb or were diagnosed with GDM
Hypertension (≥140/90 mmHg or on therapy for hypertension)
HDL-C level <35 mg/dl and/or triglyceride level >250 mg/dl
Women with polycystic ovarian syndrome
People with impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) on prior test result
Other clinical conditions associated with insulin resistance
History of CVD

Table 6. Screening for risk of type 2 diabetes – recommendations from the International Diabetes Federation (31)

Risk factor	
Age	≥45 years
Obesity	
Most easily measured by waist circumference with cut points that are gender and ethnic group specific. Example is for Europid adults	Male ≥94 cm Female ≥80 cm
Family history	
Immediate family member or other relatives diagnosed with diabetes	
Cardiovascular history	
History of raised blood pressure and/or heart disease	
Gestational history	
Previous occurrence of gestational diabetes	
Drug history	
Use of drugs that predispose to type 2 diabetes	Nicotinic acid Gucocorticoids Thyroid hormone Beta-adrenergic antagonists Thiazides Dilantin Pentamidine Antipsychotic agents Interferon-alpha therapy

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50% reduction in the risk of sudden cardiac death and total mortality when they quit smoking after the initial infarction (39).

Smokers with comorbidities such as respiratory and CVDs have a greater and more urgent need to stop smoking. This group often gains motivation to quit smoking from their illness and studies show that intervention with smoking cessation advice following hospitalization with a coronary event is associated with a 50% long-term quit rate (40). This success rate is remarkable compared to the average 12-month abstinence rates without intervention in the general population, which is reported to be 5.7% (41).

An excellent review by Zee (42) outlines the relationship between smoking and periodontal disease. It is reported that smoking is a significant risk factor for the development of periodontal diseases (43–45) and that smokers carry 2.5–3.5 times greater risk of severe periodontal attachment loss compared to non-smokers (46). Risk calculations suggest that 40% of chronic periodontitis cases may be attributed to smoking (47). With this in mind, many patients attending for periodontal examination will be smokers and will benefit greatly from smoking cessation advice.

Smoking cessation programs and therapies are available in most countries and include both behavioral support and effective pharmacological preparations. The adjunctive use of nicotine replacement therapies and other antismoking drugs (e.g. Bupropion) have been shown to significantly increase smoking cessation success rates (47).

In Australia, there is a government-funded online and telephone support program – Quit Now (51). This program provides information about the effects of smoking on the body and provides advice and support for both smokers and health care professionals. Randomized clinical trials report that routine smoking cessation counseling by dental professionals increases the success rates for their patients (48–50). A trial in a periodontal clinic reported an abstinence rate at 12-months follow-up of 13.3% in the intervention group compared to 5.3% in the control group (49).

As dental professionals have been shown to be effective in increasing the number of patients who successfully quit smoking (47), the routine screening of patients for cigarette smoking during the periodontal examination is recommended. Once identified, smokers should be offered assistance and encouragement to quit. The 5 As for smoking cessation – ask, assess, advise, assist, and arrange follow-up can be found in the Australian smoking cessation guidelines for Australian general practice (51) (see Table 7) and form a useful guide for practitioners in assisting their patients to quit smoking.

Table 7. A summary of the 5 As for smoking cessation from the smoking cessation guidelines for Australian general practice found at Quit Now http://www.quitnow.info.au/internet/quitnow/publishing.nsf/Content/home (51)

The 5 As	
Ask	Do you smoke? Have you ever smoked?
Assess	How do you feel about your smoking at the moment? Are you ready to stop smoking now?
Advise	While I respect that it is your decision, I strongly suggest you stop smoking.
Assist	Minimal intervention is to provide written information on smoking cessation and offer referral. Affirm decisions to quit, offer encouragement to quit, and congratulate recent smoking cessation.
Arrange follow-up	Monitor progress, congratulate and affirm decision to quit, review progress, and encourage use of support services.

Obesity

Obesity is a complex multifactorial chronic condition, involving social, behavioral, cultural, physiological, metabolic, and genetic factors. The World Health Organization estimated that in 2005, more than 1 billion people worldwide were overweight and more than 300 million were obese (12). Globally, 44% of the diabetes burden and 23% of the ischemic heart disease burden are attributable to overweight and obesity (12). Physical inactivity was identified as a major contributor to the current global increase in obesity. The WHO estimates that physical inactivity causes approximately 27% of diabetes and approximately 30% of ischemic heart disease burden globally (12). Conversely, physical activity reduces the risk of CVD, some cancers, and type 2 diabetes (12).

Obesity is defined by the AHA as major risk factor for CVD. The effects of obesity include raised blood pressure and cholesterol levels, lowered high density lipoprotein-cholesterol levels, and predisposition to type 2 diabetes (13). The risk of CHD, stroke, hypertension, and type 2 diabetes grows steadily with increasing body mass (12, 52).

Obesity is most often defined by body mass index (BMI), which is calculated by dividing weight in kilograms by the square of height in meters (kg/m^2). Using the BMI, overweight is defined as BMI $\geq$25 kg/m^2 and obese as BMI $\geq$30 kg/m^2. However, studies now suggest that waist circumference, which reflects abdominal fat may be a better indicator of the risk of developing systemic illness than BMI (53, 54). Waist circumference measurements $\geq$94 cm for men and 80 cm for women represent a increased risk and measurements of $\geq$102 for

men and ≥88 cm for women indicate a substantially increased risk of type 2 diabetes, hypertension, and CVD (55).

Ford et al. (56) examined how long-term changes in weight affected the risk of type 2 diabetes and found that with increasing BMI, the risk for developing diabetes increased rapidly. It was reported that for every kilogram change in weight there was a 4.5% change in risk (56).

Recent epidemiological studies have linked periodontal disease and obesity (57, 58). A review by Pischon et al. (59) aiming at increasing the awareness of dental practitioners in treating obese patients, discussed the association and potential biological mechanisms linking these conditions. Adipose tissue is not merely a passive triglyceride reservoir. It produces a vast amount of proinflammatory cytokines and hormones that contribute to systemic inflammation and insulin resistance – which can, in turn, lead to the development of CVD and type 2 diabetes.

A study that analyzed NHANES III study population found that individuals who maintained a normal weight, exercised regularly, and consumed a high-quality diet were 40% less likely to have periodontitis (60). The authors concluded that it would be beneficial to involve dental professionals in the effort to reduce the risk of chronic health conditions, not only by improving oral health but also by promoting these healthy lifestyle behaviors.

The major public health challenge of the obesity epidemic has been recognized for many years in both the public health and scientific communities and this has led to expert committee recommendations on the identification, prevention, and treatment of obese individuals (55). There is strong evidence that weight loss in overweight and obese individuals reduces risk factors for both CVD and diabetes (55).

Management of overweight and obese individuals should include weight reduction as well as the control of accompanying risk factors. A useful website with resources for patients and health professionals has been developed by the Australian government to address the issue of obesity at a community level (61). Weight loss is most effectively achieved when an individually planned program of dietary therapy, increased physical activity, and behavioral therapy is combined (55). There is also strong evidence that the adjunctive use of weight loss drugs in addition to this program can be of benefit.

Weight loss surgery for clinically severe obesity (BMI ≥40 or BMI 35–40 with comorbid conditions) should be considered in carefully selected patients where less invasive methods of weight loss have failed.

Smoking and obesity compound cardiovascular risk but many patients fear weight gain during smoking cessation therapy. However, the clinical guidelines advise that all smokers regardless of their weight status should be encouraged to quit smoking as a primary focus (55).

Conclusions

It is now widely accepted amongst the medical and dental literature that periodontal disease is associated with systemic illnesses such as CVDs and type 2 diabetes (16–18, 62). Therefore, many periodontal patients may be at risk of these systemic conditions but be asymptomatic and undiagnosed. Screening periodontal patients for risk factors associated with these conditions could potentially make a huge impact on the associated morbidity and mortality.

As the population ages, the incidence and prevalence of chronic diseases such as CVD and type 2 diabetes are expected to increase steadily. Australian statistics show that the rate of adults who had no natural teeth more than halved from 14.4 to 6.4% in the 17-year period between 1987/1988 and 2004/2006 (64). Almost all of this reduction occurred because of the passing of older generations that lived through the first half of the 20th century when dental extractions were widespread. It has been projected that during the next four decades the decline in prevalence of complete tooth loss will continue, falling to 1% or less by the 2040s (64). One can only assume that an aging population with high retention of natural dentition will result in an increased prevalence of periodontal disease in the community. With more patients requiring periodontal management, increased opportunities for screening for systemic illnesses during periodontal examinations will present.

The first step toward the control of the systemic illness burden is the identification of people at risk. As dental professionals are well placed and willing to be involved in the general health screening of their patients, the periodontal examination may become an important opportunity for the early identification of the large proportion of people who are unaware of their risk status.

Conflict of interest and funding

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