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# The Elderly at Risk for Periodontitis and Systemic Diseases

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The challenges to society of managing the services and well being of older subjects will consume an increasingly larger proportion of human and financial resources. From a macroeconomic perspective, the United States could afford to let health spending grow more rapidly than the overall gross domestic product, but only by pricing low-income Americans out of health care [1]. This development would specifically affect older subjects, because most retirees choose not to include dental insurance in their health insurance plans. Periodontitis has an infectious etiology. The oral infectious burden resulting from periodontitis may aggravate systemic health in the elderly.

Both "periodontal disease" and "elderly" are terms that lack firm definitions. The definition of "elderly" is routinely based on chronologic age rather than on biologic age. Preferably, the biologic age should define whether an individual is elderly. Nevertheless, three groups of older subjects are often identified based on chronologic age: (1) young-old (65–74 years), (2) old-old (75–84 years), and (3) oldest old (>85 years). The current periodontal literature is insufficient to describe how the prevalence and severity of periodontitis are distributed among these three defined groups of elderly people.

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The Surgeon General's Report on Oral Health in America [2] includes specific concerns about periodontal conditions in older Americans. The report projected that more than 20% of older people have periodontitis, that men are more often affected than women, and that older people with low income are at greater risk. In Europe and North America, the proportion of older people in society is growing rapidly. Major concerns have been raised about how these people will be cared for. Between 2001 and 2002, the United States' national health expenditures increased by 9.3%, 5% faster than the growth of the national economy [3]. It is likely that medical care will consume most of these resources. The questions of whether periodontal care support is sufficient to manage the periodontal treatment needs of the elderly and whether the treatment modalities are appropriate and available from a cost perspective are currently not well surveyed. In fact, there is a trend in periodontal therapy toward aesthetic dentistry, such as papilla preservation surgery, and toward dental implants. Both approaches may be of little relevance to the elderly and their periodontal treatment needs, as well as too expensive.

The recent discoveries that have resulted in the development of periodontal medicine as a subdiscipline in periodontology also indicate that having periodontitis may be an indicator of risk for or subclinical coexistence with other diseases. Dentists should therefore develop knowledge and skills in identifying older subjects at risk for other diseases, with a focus on infectious and chronic inflammatory-driven conditions. This proposal does not necessarily mean that dentists should diagnose medical conditions, but rather that they should refer subjects who meet specific risk profiles to physicians for further evaluation. This measure may be especially prudent in patients who plan to have invasive, extensive, and expensive dental treatments.

At the 1999 World Workshop in Periodontology, a revised diagnostic classification system was developed [4]. The new classification system replaced the previously commonly used term "adult periodontitis" with the new term "chronic periodontitis." The term "chronic periodontitis" was adopted at the workshop because it was perceived that periodontal disease can occur at any age and be found both in the primary and secondary dentition. Similarly, the previously used diagnostic terms "localized juvenile periodontitis," "early onset periodontitis," and "rapidly progressive periodontitis" were replaced by the new term "aggressive periodontitis." Both chronic and aggressive periodontitis can have localized (ie, less than 30% of teeth/surfaces affected) or generalized patterns of severity. These changes in terminology removed previous perceptions of age-related periodontal disease patterns. Under the new paradigm, there should be no differences between the etiology or pathogenesis of periodontitis in older subjects and younger subjects. In the present report on periodontal disease in the elderly, periodontal disease will be considered only as chronic periodontitis. No reports on aggressive periodontitis in the elderly currently exist.

A Medline (PubMed) search on May 18th, 2004 yielded 303 published documents using the search term "early onset periodontitis," 420 published reports using the search term "localized juvenile periodontitis," 258 reports for the term "rapidly progressive periodontitis," and 186 documents for "aggressive periodontitis." Notwithstanding, several documents might have been listed under one or more of these search terms. In contrast, a similar search using the term "periodontitis and older subjects" resulted in 65 published studies, and "periodontitis and elderly subjects" produced 486 reports. However, few of these studies specifically reported on periodontal conditions or outcomes of therapy in subjects 65 years of age or older.

These studies tend to display an enormous heterogeneity in the definitions of "older" or "elderly." Subjects aged 65 or older were excluded from participation in the vast majority of studies on periodontal therapies, including most of the classic studies on surgical and nonsurgical therapies [5]. Furthermore, none of the studies reported on treatment efficacy at the subject level. Almost all periodontal intervention studies performed between 1980 and 1995 only included subjects who were younger than 60 years. When such studies included older subjects, they never provided data on specific outcomes of periodontal treatments in this older cohort. It appears to have been taken for granted that the causes, pathogenesis, and progression of periodontitis in older subjects do not differ from those in younger adults and that, consequently, routine periodontal treatment outcomes should not differ by age. The same can be said of recent studies on the outcome of dental implant treatments. Few studies report oral implant success outcomes in older subjects.

## Prevalence of periodontitis and impact of tooth loss in older subjects

A major problem in periodontal research is the lack of agreement on what constitutes periodontitis and severity of periodontitis. The current classification system for periodontitis (briefly discussed earlier) has either not been used or used with a wide range of different cut-off levels (ie, number of sites with probing depth or clinical attachment loss >2 mm). It is hence difficult to assess and compare data on the prevalence of periodontitis over time and between different regions or countries from one study to another. In addition, different dental treatment paradigms over the last 50 years have resulted in tooth extractions' being attributable partly to dental disease severity, partly to insurance benefits, but also to the more liberal attitude toward extraction in the past.

Midbuccal or midlingual gingival recession is common in many subjects and is often a consequence of tooth-brush trauma. In older subjects, however, midbuccal and midlingual gingival recession are accompanied by interproximal recession. In younger subjects, a hyperinflammatory response to infection results in edema and pseudopocketing, possibly resulting in the recording of increased pocket probing depth. In older subjects, it appears that interproximal recession and loss of attachment and alveolar bone run parallel, resulting in destruction of the periodontium in the absence of increased probing depth [6]. Notably, studies have shown that subjects with diabetes mellitus are at greater risk for clinical attachment loss, which is accompanied by an increase in gingival recession [7].

Since the mid-1960s, several studies have demonstrated a decrease in the prevalence and severity of periodontitis. However, many currently older people were young adults in the 1950s and 1960s and might have established periodontal disease at that time. Only those in the generation who remain dentate are of concern in more recent epidemiologic studies. These constitute subjects who either (1) were resistant to periodontitis, (2) received successful periodontal therapy, (3) received partially successful periodontal therapy, or (4) have periodontitis because they either were therapy-resistant or never sought care. Because tooth loss results from many factors, it is impossible to determine whether teeth were extracted as a result of periodontitis. It would therefore be difficult to assess how many subjects who were born between, for instance, 1910 and 1915 and are currently living are susceptible to periodontitis. It is easier to account for diseases such as cardiovascular disease, which result in death as an indisputable outcome measure.

Few epidemiologic studies have included older individuals. The National Health and Nutrition Examination Survey (NHANES) III study has suggested that the prevalence and severity of periodontitis increase with advancing age [8]. One study conducted among older Japanese (N = 761) demonstrated that a large majority (97%) had evidence of attachment loss and they had lost an average of three teeth [9]. The same study also demonstrated that men had more evidence of periodontitis than women and that periodontitis was more prevalent in subjects older than 80 years, especially in those with fewer than 19 remaining teeth. However the study also indicated that subjects with only nine or fewer remaining teeth had less evidence of periodontitis than those with more teeth. This finding suggests that these subjects had received therapy with selective extractions of teeth affected by periodontitis. A study of older subjects in Pomerania, Germany has confirmed that tooth loss is predominantly an effect of caries and not periodontitis [10]. Thus, the cause of tooth loss remains a difficult problem to resolve in periodontal epidemiologic studies.

Studies have shown that tooth loss in very old subjects ( $\geq$ 80 years) can have a significant impact not only on chewing abilities but also on general physical abilities [11]. A Norwegian study finding that approximately 30% of subjects older than 80 years were edentulous, with large geographic variations, indicated that the oral health goals for the year 2000 suggested by the World Health Organization/Federation Dentaire International were far from being met in large areas of Norway when the data were collected (1996 to 1999) [12]. Current United States statistics from the Centers for Disease Control and Prevention (CDC) suggest that 50% of subjects aged 65 years or older have most of their teeth (ie, 23 or more) remaining [13]. However, these statistics do not include nursing home residents and are based on self-reports. The United States appears to exhibit large geographic differences in edentulousness, from approximately 10% in Hawaii to 50% in some Southern states. The CDC report anticipates that the rate of edentulousness will increase in older subjects, because many of them lack or will eventually lose dental insurance and be unable to afford dental (periodontal) care.

One of several problems with clinical periodontal research is the question of whether clinical measures of periodontitis can accurately predict the progression of disease. Any measure of dental or periodontal disease is in principle a surrogate measure aimed at assessing tooth mortality. Tooth loss may occur for many reasons and may be difficult to assess in clinical trials. For example, teeth may be lost as a consequence of (1) disease progress (ie, caries becoming endodontic lesions; periodontitis resulting in advanced bone loss, tooth mobility, and loss of function; acute inflammatory exacerbation), (2) prosthetic indications (irrational to treat), and (3) economic and social realities. With regard to the progression of periodontitis in older subjects, probing attachment loss cannot be confirmed as a valid surrogate measure for tooth loss [14]. At the same time, there appears to be an explanatory relationship between a past history of tooth loss and the extent of alveolar bone loss in older subjects [6]. Radiographic assessments might thus be more useful than clinical periodontal measures. However, rarely is the extent of alveolar bone loss defined from radiographic measurements and accounted for in epidemiologic studies.

Age-related alterations in the periodontium are not inevitably manifested as loss of probing attachment or alveolar bone [15]. In fact, data suggest that subjects who are clinically healthy from a periodontal perspective may have a continuous increase in the distance between the alveolar bone level and the cement-enamel junction (CEJ) to about the age of 50, with no additional increase in this distance thereafter [16]. Using mean values at different age groups and two standard deviations may provide upper ranges for what can be considered a normal distance between bone level and CEJ.

In older subjects, this process may be more difficult, because the response to infection may not be reflected in probing depth. In older subjects, it appears that interproximal recession and loss of attachment and alveolar bone run parallel, resulting in destruction of the periodontium in the absence of increased probing depth [16]. Longitudinal studies of older subjects ( $\geq 60$  years) in Australia demonstrated that subjects with diabetes are at greater risk for attachment loss, but also that most attachment loss can be attributed to increase in gingival recession [7].

The susceptibility and severity of periodontitis are defined by three major factors: (1) the microbiologic infection, (2) host-intrinsic factors, including genetic predisposition to inflammatory responses, and (3) extrinsic factors (eg, behavioral, socioeconomic factors).

## The microbiologic etiology of periodontitis in the elderly

One early experimental gingivitis study [17] showed that supragingival plaque developed faster in older subjects (65-78 years) than in young subjects (20-24 years). This finding might be explained in part by differences in periodontal status but could also suggest that growth conditions in older subjects favor rapid colonization of aerobic bacteria. The infectious etiology to chronic periodontitis in adults is well established and illustrated by a large number of reports [18–20]. Presently, the primary focus of study of infection and periodontitis is on three pathogens forming the "red complex" (Porphyromonas gingivalis, Tannerella forsythia, and Treponema denticola), which have been associated with established chronic periodontitis. It remains unclear whether the colonization pattern of these pathogens differs between younger and older adults. T. forsythia appears to be common both in older subjects with gingivitis only and those with periodontitis [21]. The occurrence of *P. gingivalis* has been shown to increase with age, whereas the levels of Actinobacillus actinomycetemcomitans, a pathogen associated with aggressive periodontitis in young adults, decrease with increasing age [22].

# The immune system and periodontitis in the elderly

A decline in immune responses occurs with aging. Immune characteristic changes in older subjects are complex, encompassing an increase in serum immunoglobulin levels, a switch from naive to memory T lymphocytes, an increase in serum natural killer cells, and an increase in interleukin (IL)-1, IL-6, and tumor necrosis factor- $\alpha$ . Thymus-derived T lymphocytes are key cells in the adaptive immune system and are important in both the cellular and humoral immune responses to infection [23,24]. T lymphocyte levels affects mucosal responses and production of IgM antibodies and cytokines and effects a decline in phenotypic markers of T- and B-cell subsets [25]. Age-related changes in immune responses have also been reported, suggesting that peripheral blood mononuclear cell proliferation and IL-2 production decrease with age [26]. Serum IgG levels against P. gingivalis, a pathogen associated with periodontitis, appear to increase with age [27]. This increase may simply suggest that long-lasting exposure to the antigen is not sufficient to provide immunity against P. gingivalis infection. In fact, the combination of an increase in serum IgG titers and a decline in the efficacy of cellular immunity may result in an increased risk for periodontitis with increasing age. The current American Academy of Periodontology classification of periodontitis may be misleading, and there may be a need to consider specific periodontal disease patterns in the elderly subject. Pronounced gingival recession affecting interproximal spaces in combination with alveolar bone and attachment loss in older subjects may be explained by immune responses to periodontal infection that differ from those in younger adults [28].

## Self-perception, quality of life, and periodontitis in the elderly

Chronic periodontitis is a slowly progressive disease. It is unclear whether cultural and historical factors affect a subject's perception of disease progression. If a subject perceives periodontitis as an unavoidable disease, this self-perception undermines any attempt at prevention. Interestingly, older subjects appear to have a rather accurate self-perception of their risks for periodontitis progression and future tooth loss [29]. Social and ethnic characteristics are major contributory and explanatory factors to the severity of periodontitis in older subjects. These findings are supported by other studies of the self-perceived benefits of periodontal health, including studies in younger subjects seeking specialist care [12].

Self-efficacy can be defined as an individual's perception of control over his or her well being and ability to perform specific forms of health behavior to effect a change in health outcomes. Major efforts must be dedicated to improving health self-perceptions and understanding of periodontal treatment needs. Tools for defining self-efficacy and means for improving health knowledge, attitudes, and behavior are cost-effective ways of reducing the impact of social factors on the prevalence and severity of periodontal disease. The response to therapy may be enhanced when clinicians consider treatment alternatives that are consistent with the limitations of the patient's self-efficacy—especially when treating older subjects.

Periodontal disease and tooth loss clearly have a significant impact on quality of life. This impact may be even more pronounced in older subjects, who may have limited financial resources and be at risk for social isolation. They may have good self-perception of their periodontal status but do not seek care because they believe it would be too expensive. The likelihood of this scenario is high, as illustrated by studies showing that older subjects without dental insurance (approximately 60% of the older United States population) may not seek regular dental care [30]. Thus, as the older dentate population increases in proportion to the total population, its access to dental care may decrease, with significant health and social consequences.

#### Socioeconomic status and periodontitis in the elderly

A recent analysis of the NHANES III data set, which included only those subjects who received a full periodontal examination and were older than 50 years (19.7% older than 69), demonstrated that the relationship between severity of periodontitis and socioeconomic status is modified by ethnicity. Higher-income African Americans (sic) had more periodontitis than did low-income African Americans, higher-income non-Hispanic whites, and Hispanics [31]. Hence, other reports on a direct relationship between the severity of periodontitis and socioeconomic status may be only partially correct [32].

Unfortunately, few studies have clarified the relationship between periodontal status and socioeconomic factors in older subjects while taking into account social, political, and historical factors. Such studies are urgently needed, given the increasing number of older subjects in society and their lack of dental insurance. Although Sweden has had nationwide generalized dental insurance for many years, a study from that nation demonstrated that low-income subjects have more severe periodontitis than subjects with higher income, suggesting that economic factors alone may not determine patient care or who seeks care [33]. This principle is illustrated by a study of Medicaid recipients in Kitsap County, Washington, who, responding to a questionnaire, placed dental care needs at the bottom of a priority list and stated that tooth loss was inevitable [34]. It appears that dental health care insurance or access to care alone will not resolve the disparities in oral health.

### Smoking and periodontitis in the elderly

Major efforts have been dedicated to informing patients about the negative impact of smoking. Such efforts may be unsuccessful in older subjects who have an intact dentition with few, if any, signs of periodontitis. From a self-perception of risk and a self-efficacy perspective, it is difficult to convince such subjects that there are benefits to quitting smoking for periodontal reasons alone. Notwithstanding, dentists providing care for older subjects should make efforts to inform them about the benefits of stopping tobacco use.

During the past 20 years, our perception of the role of smoking in the development and progression of periodontitis has been revised. Smoking previously was not considered a key factor for periodontitis, but a large volume of studies now demonstrate that subjects who smoke cigarettes are at a higher risk for periodontitis than nonsmokers. However, studies also have shown that, although smoking has an impact on alveolar bone loss, and a dose response curve appears to exist between smoking habits and severity of periodontitis, this relationship almost disappears when one controls for current oral hygiene levels [35]. Thus, oral hygiene may have a dominating impact on the susceptibility to periodontitis, with smoking as a factor that only partially contributes to elevated risk for the disease.

Recent studies of a large group of smokers and nonsmokers demonstrate that smokers have an increased risk for bleeding on probing, in combination with poor oral hygiene [36]. Measurements of probing depth as an outcome measure for periodontitis severity in smokers and nonsmokers may therefore reflect the severity of gingivitis and pseudopocketing, rather than irreversible effects on the periodontium. Studies of the effect of nonsurgical treatment in heavy smokers and nonsmokers have shown similar effects, including reduction of probing depth [37]. The impact of smoking on periodontal conditions is difficult to assess. It has been shown that less than 10% of low-income subjects between 65 and 75 are current smokers. If current and past smokers were merged into one group, the proportion of subjects with a history of smoking in this generation might reach approximately 40% [38]. Unpublished data from the study suggest that it might take 30 years of smoking or more to have an impact on periodontal conditions; by contrast, smoking had a remarkable impact on cardiovascular status in this study group.

## Systemic diseases and periodontitis in the elderly

Recent studies have suggested associations between periodontitis and systemic diseases. Specifically, diabetes mellitus, osteoporosis, and cardiovascular diseases, including stroke, are common in older subjects. Thus, periodontitis may be a risk factor for significant systemic diseases.

## Cardiovascular diseases

An association between periodontitis and cardiovascular diseases has been demonstrated in several studies [39–41]. The shared etiology may be found in a commonality of pathogens involved in periodontitis and cardiovascular disease. Thus, studies have shown that pathogens associated with periodontitis, including *P. gingivalis, Eikenella corrodens, Prevotella intermedia*, and *Streptococcus sanguis*, share the ability to invade human coronary endothelial cells [42]. Such micro-organisms may influence atherosclerotic plaque morphology, predisposing to plaque disruption and triggering an acute coronary syndrome or ischemic stroke. Furthermore, elevated serum cholesterol values have been associated with elevated serum IgG titers to *P. gingivalis* (odds ratio 7.0), suggesting that *P. gingivalis* is a factor in atherosclerosis [43].

One way in which dentists can determine whether their patients have evidence of carotid calcification as a sign of cardiovascular disease is to learn how to use panoramic radiography for the identification of this problem [44]. A significant association between radiographic signs of carotid calcification and a gold standard (duplex sonography) establishes the accuracy of this method [45]. Furthermore, studies of older subjects have shown associations between radiographic evidence of carotid calcification, a history of cardiovascular disease, and periodontitis [46].

# Diabetes mellitus

The incidence of type II diabetes mellitus is increasing, perhaps as a result of changes in life-style and dietary habits leading to obesity. Recent data suggest that the prevalence of diagnosed and undiagnosed diabetes mellitus in older subjects approaches 20% [47]. Patients with diabetes mellitus are likely to develop long-term complications as a consequence of the disease. The major complications resulting from hyperglycemia include retinopathy, nephropathy, neuropathy, and circulatory abnormalities. Hyperinsulinemia in elderly type II diabetes mellitus patients has also been associated with cardiovascular disease. An elevated mortality has been reported for middleaged patients with a combination of obesity, hypertension, and diabetes [48]. A unique cluster of metabolic abnormalities in subjects with diabetes, including dyslipidemia, hypertension, insulin resistance, and hyperglycemia, may be linked to their increased risk for other diseases, such as cardiovascular disease and chronic periodontitis [49].

Subjects with diabetes mellitus are at greater risk for destructive periodontal disease [50]. However, most studies on the relationship between periodontitis and diabetes mellitus have been performed in subjects with type I diabetes mellitus. Older subjects are predominantly at risk for type II diabetes mellitus. Few studies have reported on the relationship between periodontal disease and type II diabetes. Several of these studies reported specifically on the Pima Indians of the Gila River Indian Community in Arizona. Studies of older subjects with diabetes mellitus are limited. In a 5-year study of subjects older than 60 years, those with diabetes mellitus appeared to experience more clinical attachment loss. In this study of older subjects, smoking was not a confounding factor, supporting the aforementioned observation that older smokers may not be at greater risk for progressive periodontitis [7]. In another study of older subjects that included type II diabetes mellitus, no differences in periodontal health in relation to controls were reported [51]. The role of poor oral hygiene in subjects with diabetes mellitus might outweigh the impact of both diabetes mellitus and other factors, such as smoking [52].

## Osteoporosis

Changes in alveolar bone height have been associated with systemic changes in bone tissues and osteoporosis in postmenopausal women [53]. Systemic osteopenia or osteoporosis is a degenerative disease that primarily affects postmenopausal women but also can affect older men. The disease is characterized by a loss of bone mineral density, resulting in a hip fracture. The diagnosis of osteopenia or osteoporosis is often made using bone density measurements. Approximately 20 million people in the United States have osteoporosis, with 2 million fractures each year. Several factors have been associated with osteoporosis, including female gender, age, ethnicity, diet, and life-style [54]. A diagnosis of osteoporosis is often difficult to verify, and many older people may have osteoporosis without knowing it. Subjects with a self-reported history of osteoporotic fractures also tend to have increased resorption and thinning of the mandibular lower cortex [55], and this is correlated with bone mass changes [56]. Oral osteopenia (bone loss of the jaws) may therefore be a component of systemic osteopenia and osteoporosis.

An index has been developed to assess osteoporosis using panoramic radiographs [57]. Recent studies have suggested an association between

osteoporosis and periodontitis [38]. Assessment of the mandibular cortex by panoramic radiographs might be a feasible clinical method for identifying subjects who have osteopenia or osteoporosis. Paired with dental evidence of tooth loss and alveolar bone loss, such findings should justify a referral of older subjects to a clinic for further evaluation of osteoporosis.

## **Risk profile**

The susceptibility to periodontitis and to other systemic diseases varies with a large number of factors. It has been suggested that genetic factors explain 50% of cases of periodontitis. Although it might be possible to assess genetic factors in younger subjects by studying periodontitis severity in their parents, it would, of course, be difficult to obtain valid information about periodontitis in the parents of currently old patients. The risk for periodontitis and the impact of disease susceptibility in currently older subjects are obvious, whereas future periodontitis risk may depend on other factors than those applying to younger patients. Therefore, dentists should develop skills to identify older subjects who may be at risk for an unsuccessful aging process.

This review of factors associated with periodontitis makes it clear that a periodontal risk profile for older subjects can be established:

Poor oral hygiene remains a significant determinant independent of age. Low socioeconomic status is an important factor.

- Older African Americans are more likely to have an elevated risk for periodontitis than other ethnic groups.
- Older men appear to be at greater risk than older women.
- In combination with poor oral hygiene, a smoking habit is probably detrimental.
- Older subjects with a history of cardiovascular disease, diabetes mellitus, or osteoporosis probably have an elevated risk.
- Subjects with negative self-perception and self-efficacy are at greater risk.

Dentists can only have an impact on three of these factors: poor oral hygiene, smoking habits, and systemic conditions. It therefore seems reasonable to direct the major efforts to reduce the risks of periodontitis toward improvement of oral hygiene, while also working with older patients on smoking cessation. Dentists can improve older patients' self-perception of oral health and self-efficacy by providing information and support. Referral of older patients with established periodontitis and risk profiles for systemic diseases should be a routine procedure for dentists. Coordinated medical and dental care would increase the quality of life for such older patients consider alternative options for dental treatment. Dental care should probably be focused on control of the oral infectious burden as a primary

goal and reconstruction as a secondary one. Improvement of periodontal status improves quality of life [58].

#### Summary

The increasing population of older subjects with dental care needs will become a major challenge to our society and its care providers. To manage the health care needs of the elderly, a coordination between medical and dental care providers will become necessary. From the dental perspective, it is important to develop skills in the risk assessment of older patients. Such risk assessment of older subjects should take an approach that is holistic and focused on the reduction of the infectious burden and the improvement of self-efficacy.

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