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Impact of periodontal preventive programmes on the data from epidemiologic studies

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Abstract

This report provides only circumstantial evidence for the impact of programmes on periodontal epidemiology. The prerequisites for programmes and campaigns are described, and epidemiologic data on periodontal disease are compared with known changes in factors that may be affected by such activities. Unfortunately, parameters for periodontal disease as a process are not available. Only variables indicating irreversible effects on the periodontal status can be obtained. A lack of appropriate studies creates additional problems. This review indicates that preventive programmes and campaigns to improve oral hygiene have affected periodontal epidemiologic data concerning gingivitis and mild/moderate periodontitis favourably. Severe periodontitis seems not to have been influenced by such activities. Smoking is strongly associated with the severity of periodontitis. Therefore, a positive effect may be anticipated following the smoking cessation campaigns currently introduced worldwide. However, because of the irreversible nature of our epidemiologic parameters, it will take decades before any effect may be evident. It is recommended that periodontal epidemiology should be revitalized by introducing a nominalistic categorization instead of the changing essentialistic approaches used so far in order to facilitate the interpretation of data.

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Epidemiology is concerned with the prevalence, severity and distribution of a disease on the population level as well as associations with putative causal or other affecting factors (MacMahon et al. 1960, Last 2001).

Population surveys are rarely carried out to evaluate a preventive programme, but when the goals of a programme are described in terms of health or disease, or severity of disease, epidemiologic methods are often used in the evaluation. It is believed that results from preventive programmes implemented in a population might eventually affect the outcome of descriptive epidemiologic surveys. In the context of this paper, epidemiologic data will be compared with information of the status of changeable aetiological or modifying factors from the same country/area and in this way discuss the title of this presentation

with a more philosophic approach. This is in concord with a position paper by the American Academy of Periodontology that described attempts to interpret changes in incidence and prevalence of periodontitis as an exercise in philosophy (American Academy of Periodontology 1996). Also, trends in development of the disease over time as evidenced in repeated cross-sectional studies, cohort studies or longitudinal studies, when available from the same target population, will be evaluated against changes in the society to evaluate interactions that might explain the trend in disease.

A recent global evaluation of periodontal epidemiology concludes that representative population surveys are scarce, particularly in developing countries. However, a profile emerges indicating that the majority of the world's population suffer from gingivitis or mild-to-moderate forms of periodontitis, while a fraction (5–15%) suffer from advanced disease (Albandar & Rams 2002a).

During the last decade, a series of reports suggesting associations between periodontal diseases and serious systemic diseases such as cardio-vascular diseases and pre-term/low weight births have been published (Offebacher et al. 1998, Genco et al. 2002). If these prove to be causal, another dimension is introduced to the prevention of periodontal diseases.

An aspect that creates problems with the interpretation of epidemiologic data concerning periodontal diseases is that the parameters used for assessing the health and severity of disease vary greatly among surveys (Albandar & Rams 2002b) and that their validity has been questioned (Papapanou 1994, Gjermo 1998, Hansen 2004). However, recent epidemiologic surveys have made efforts to distinguish between severe disease (which may lead to loss of teeth) and moderate disease (commensurable with retaining a functioning dentition) (American Academy of Periodontology 1996, Gjermo 1998, Baelum & Scheutz 2002, Gjermo et al. 2002, Sheiham & Netuveli 2002). In spite of varying cut-off levels among different surveys, this has probably made it somewhat easier to interpret the findings in a longitudinal perspective and also to compare studies. Baelum & Lopez (2003) have advocated a change in the categorization of periodontal diseases from an essentialistic approach to a nominalistic principle in order to facilitate interpretation of periodontal epidemiology in general and when comparing studies in particular.

The prevailing essentialistic disease concept is based on various opinions of the aetiology, the course of the disease and treatment and is reflected in the way epidemiologic studies are conducted. This has consequently led to different studies using different definitions of the disease, obscuring all attempts to compare studies from different countries and different research groups (Lopez & Baelum 2003). A nominalistic disease definition, on the other hand, is based on observable and measurable phenomena independent of current understanding of the aetiology and pathogenesis of the disease facilitating the construction of mutually exclusive categories of the disease (Baelum & Lopez 2003). An example of a nominalistic disease classification has been suggested by van der Velden (2000).

Preventive Programmes

Preventive programmes related to periodontal diseases may be defined as "regimented undertakings of *indefinite* duration which aim at bringing about change in some characteristic(s) of a whole population or a pre-defined subgroup(s) of a population" (Hausen 1987) (Fig. 1). It may be added that this should be regimented by a public authority or an institution. The target group is often a specified subgroup limited to people with certain characteristics (age, gender, physical abilities, recruits, patients, residence, etc.). Programmes targeting a whole population



Fig. 1. Different structures of a programme and a campaign.

are rare, and special groups like illegal immigrants may easily fall out of "representative" studies.

A prerequisite for a preventive programme is that there is a scientific rationale indicating the effectiveness of the measures included in the programme to promote the intended changes of the particular characteristic(s) of the target population. This ought to be demonstrated in for example randomized clinical trials or field experiments before a preventive programme is launched (Hausen 1987). Thus, the conceptual distinction between a research project and a programme is essential in the present context. In essence, a scientific study is undertaken to learn the premises of a future programme. Programmes are supposed to be planned, carried out, evaluated and continuously improved according to an established goal (Striffler 1983). Furthermore, the disease status of the target population should be well documented, for instance, in epidemiologic surveys.

Another prerequisite in order to properly implement a preventive programme aiming at periodontal diseases seems to be a well-organized public (oral) healthcare system responsible for the administration, budgeting and performance of the programme, and preferably a possibility of utilizing mass media when appropriate (Gjermo 1987). This will be the case in most developed countries, while countries with less developed public services and a high rate of illiteracy may face obstacles (Albandar 1989).

Campaigns

Health promotion campaigns are usually implemented by public health authorities, but may also be initiated and conducted by commercial or other parties, for example producers and distributors of oral hygiene aids or dental organizations. A campaign, as opposed to a programme, usually has a definite nature, i.e. its duration is specified to last for a certain time period and is often aimed at a broader public than a programme (Fig. 1) (Hausen 1987). With respect to the dissemination of the content of programmes and campaigns, they are often acting in a similar way through mass media or from person to person as a secondary event (Schaub 1987). In the context of the present paper, programmes and campaigns will be regarded as synonymous.

Factors Affecting Aetiology and Pathogenesis of Periodontal Diseases

The causal relationship between gingivitis and dental plaque is well established (Löe et al. 1965). Antigens produced in the biofilm are regarded as the aetiologic factor inducing a host response called gingivitis. Gingivitis per se could be regarded a priori as a normal physiologic response to noxious agents normally found in the dental biofilm and not a disease. It may be regarded as pathological only when clinical symptoms like pain, redness, swelling or bleeding are present (Gjermo 1984, Prayitno et al. 1993). Epidemiologic research indicates a strong relationship between oral hygiene and gingivitis and mild periodontitis. The relationship with severe periodontitis is less evident (Albandar & Rams 2002b). Clinical trials and field studies more than 40 years ago have shown that treatment of periodontitis aiming at reducing plaque and calculus over time improves the periodontal disease parameters (Schei et al. 1959, Lövdal et al. 1961). A secondary prevention effort could be recommendations of regular dental visits, information about signs and symptoms of disease, etc., in order to treat incipient disease (Glavind & Attström 1979, Gjermo 1980, 1984).

Since gingivitis is regarded as a prerequisite for periodontitis to develop (Page & Schröder 1982), primary prevention of gingivitis focusing on information of oral hygiene measures to reduce/eliminate dental plaque, if successful, will probably prevent periodontitis. This notion is supported by two recent reports (Schätzle et al. 2003, 2004). In these studies, very few teeth scoring low on gingivitis were lost, while those constantly over 26 years appearing with high gingivitis scores yielded a 46 times higher risk of being lost. However, comprehensive programmes/campaigns to prevent gingivitis might prove inefficient in preventing the severe forms of periodontitis.

Although gingivitis is necessary for destructive periodontitis to develop, such a development is rare (Page & Schroeder 1982) and is probably dependent on other factors in addition to plaque. There are several medical conditions and drugs that may modify the host responses to bacterial antigens (diabetes, HIV infection, anti-hypertension drugs, anti-epileptic drugs, immunemodulating drugs, etc.). Also, genetic factors, depression and certain types of stress and smoking are determinants for periodontitis (Bergström 1989, 2005, Breivik et al. 1996, Bergström et al. 2000, Tomar & Asma 2000, Hugoson et al. 2002, Kinane & Lindhe 2003), probably by modifying the host response in several ways (Breivik et al. 1996, Palmer & Soory 2003). There is also evidence that tobacco use may be a direct aetiologic factor in the transition of a stable gingivitis lesion into a tissuedestructive lesion (Gelskey 1999. Hujoel et al. 2003, Bergström 2005).

A general principle in preventive efforts towards chronic diseases is to focus on changeable causal or modifying factors. Regarding periodontal diseases, such factors are those related to life style such as oral hygiene, regularity of dental visits (Sheiham et al. 1986) and tobacco use (Amarasena et al. 2002). Factors related to genetics, medical disorders or medication are of minor interest in this context.

A major problem in periodontal epidemiology is that periodontal disease

cannot be assessed as an active process, but only as a present status by historic evidence by means of surrogate parameters (Armitage et al. 1977, Baelum 1998, Baelum & Lopez 2003, Aleksejuniene & Holst 2004, Hansen 2004), with rather poor correlation with a tangible effect for the subjects (such as tooth retention or no discomfort). Sheiham et al. (1986) performed a longitudinal study in British workers indicating that improved oral hygiene and improved periodontal status had occurred between 1970 and 1985, and that this group lost very few teeth. However, the effects of treatment and prevention of recurrence after treatment are difficult to assess using only surrogate parameters. Also, more teeth retained and increased life expectancy may cause an increase in disease parameters (Papapanou & Lindhe 2003). Likewise, the increasing migration of people from developing countries to the more developed Western industrialized societies may dilute the effect of prevention as assessed in epidemiologic studies.

Recently, the global epidemiology of periodontal diseases has been reviewed in an issue of Periodontology 2000 (Albandar & Rams 2002a). The various reviewers all make a comment on the difficulty in comparing results from different studies with different designs, different surrogate parameters for assessing the disease prevalence and severity using different investigators. and Another complicating factor for the contributing authors was the general scarcity of representative data. Also, studies allowing cohort analyses or longitudinal studies that may be used for assessing the cause of trends or changes are very few. Some such studies may be found in well-developed industrial countries like the US, UK and the Scandinavian countries, but are non-existent in developing countries. However, the recent review of the global epidemiology of periodontal diseases reveals that a limited fraction of the world population exhibits severe forms that may cause extensive tooth loss during life (Baelum 1998, Albandar & Rams 2002b).

Risk Factor Changes and Trends in Disease

It seems that mainly the mild and moderate forms of periodontitis are influenced by preventive actions as they have been performed to date (Albandar &

Rams 2002a). These include plaque control, utilization of dental services and an improvement of the general health attitudes of the societies in question. A variation in the prevalence of disease among countries could mostly be detected among subjects with mildto-moderate disease, a periodontal status that is probably influenced by oral hygiene (Albandar & Rams 2002b). Thus, the majority of the world's population suffers from a periodontitis that should be affected by preventive programmes aiming at improved oral hygiene. Minor variations in the proportion experiencing mild/moderate disease could be distinguished among populations in North America, Central and South America and Europe (Albandar 2002, Gjermo et al. 2002, Sheiham & Netuveli 2002). Such variations were less evident or non-existent in Africa and Asia and Oceania (Baelum & Scheutz 2002, Corbet et al. 2002).

Observations similar to those of Sheiham & Netuveli (2002) were made by Giermo (1998) in Europe, where the socioeconomically less-developed Eastern European countries displayed a higher fraction with mild-to-moderate disease than did the Western and Northern well-developed societies. Particularly, the Scandinavian countries where a comprehensive public dental healthcare system with emphasis on prevention and regular dental visits has existed for more than 100 years (Helöe 1982. Gjermo 1984), displayed high proportions of healthy subjects and even a low prevalence of severe disease (Löe et al. 1978, Papapanou et al. 1988, Hugoson et al. 1998a).

Differences among the populations of the world in terms of periodontal status, oral cleanliness and oral health behaviour probably reflect the social and economic development of the various regions (Albandar 1989, Morris et al. 2001). Also, cultural differences may affect the attitudes towards dental health and dental care in populations.

In the US, Douglass et al. (1983) could demonstrate an improvement in oral hygiene from the mid-1960s to the mid-1970s. Parallel to this, a reduction in gingivitis was evident, and also a reduction of the prevalence of periodontitis in the youngest age group. The data indicated that fewer persons under the age of 35 years developed pocketing during this decade than would be expected if the trend had been unchanged. In the older part of the



Fig. 2. Percentage of persons with pockets (Russell's score 6) in the US population at two time points according to age (data derived from Douglass et al. 1983).

population, no such effect could be observed (Fig. 2). Later studies in the US (Albandar 2002) indicate similar trends up to 1994, when the latest comprehensive survey was performed. In the same time period, the economic development has progressed in the US, and so have insurance coverage, frequency of dental visits and the proportion of the population seeking regular dental care (Robertson et al. 2002). The same authors showed that the treatment profile among US citizens indicated that patients displayed less severe periodontitis and consequently received simpler and cheaper treatment.

Exact information on the sales of dental-care products could be used as a proxy for assessing oral hygiene habits, but such data appear difficult to obtain on a global basis. However, there is no doubt that the sales of dental-care products for home use have increased steadily from the 1960s, particularly in the industrialized world (A. S. Jordan, personal communication). Local data from South America lend support to the notion that this is a global trend (Gjermo et al. 2002).

A representative study of 35-year-old citizens of Oslo, Norway has been repeated with intervals of 10 years. The results display similar features from the early 1970s as the US studies (Hansen et al. 1990). An improvement in oral hygiene and a reduction in the need for complex treatment (as assessed by the periodontal treatment need system (PTNS); (Johansen et al. 1973) were evident. A similar study from Tröndelag, Norway covering the same 10-year period indicated comparable improvements in both oral hygiene and the proportion of subjects with deepened pockets (Baerum et al. 1985).

Hugoson et al. (1998a, b) showed that both oral hygiene and gingivitis had improved in a representative population in Jönköping, Sweden. In this population, the prevalence and severity of periodontitis were very low and comparable with that of Norwegian academicians (Löe et al. 1978)

In UK, a group of British workers were followed for 14 years and showed a substantial improvement in both oral hygiene and periodontal condition with no particular action or treatment implemented (Sheiham et al. 1986).

All these studies, considering the evidence for plaque as an aetiologic factor for gingivitis, would indicate that preventive programmes focusing on oral hygiene may have had an impact on the epidemiology of periodontal diseases on a population level. However, any single programme or campaign cannot be identified as the one affecting the outcome of periodontal epidemiologic studies. In a living and changing society, a variety of events may influence behaviour. Thus, there are indications that general health knowledge and attitudes, the influence of peers, the social demands of a society, the material wealth and prosperity play important roles (Gjermo 1987). In fact, a study from Brazil evaluating the effect of a comprehensive 3-year programme in 13-16 year olds from a prosperous community yielded an impressive effect as compared with a control group (Buischi et al. 1994). However, in a follow-up study 5 years later (when the participants had reached 21 years of age), the subjects from the control group displayed the same level concerning oral hygiene habits as did the experimental group immediately after the termination of the programme (Mayer et al. 2003). This is reflected in a statement by Wiio (1987) that "man is a social animal who constantly monitors his environment to find dominant modes of behavior in order to be accepted", and is in concord with the observation of peer influence.

The general finding across most populations that 5–15% are classified as having severe disease, irrespective of the level of development of the countries (Albandar & Rams 2002b), constitutes a challenge to the profession. This severe disease does not seem to be dependent on the level of oral hygiene, but many studies show a strong association between severe disease and smoking (Bergström & Preber 1994, Hyman & Reid 2003, Susin et al. 2004).

In several Western industrial countries, smoking cessation programmes/ campaigns have been implemented by governments in order to increase the general health of the populations over the last few decades. This is often combined with prohibitory regulations as smoke-free restaurants and bars, buses, trains, air planes, hospitals, etc., and prohibitions against advertising for tobacco. In the Scandinavian countries. campaigns have recently been launched with particular emphasis on oral health benefits (Lahtinen 2004). A substantial reduction in proportions of smokers has been recorded after the initiation of these programmes/campaigns (World Health Organization (WHO) 2003, Statistics Norway 2004). Most favourable results have been obtained in Sweden, where the proportion of daily smokers in 2003 was 18% (Statistics Sweden 2002). However, in Sweden the proportion of "snuff" users has increased. The consequences for oral and periodontal health of this kind of tobacco use are not explored, but supposedly, the effect of nicotine on the immune response (Breivik et al. 1996) would be similar to that of cigarette smoking.

In the Western world, the habit of cigarette smoking has generally been reduced from affecting more than 50% of the adult population to 20-25% over a period of approximately 30 years, whereas very little has occurred in the developing countries and in the "old" Eastern European countries (World Health Organization (WHO) 2003). Using these data to summarize the proportions of adult daily smokers and the epidemiologic data on periodontal diseases described by Gjermo (1998) from countries with a high and low prevalence of severe periodontitis, a significant association between the smoking habits of the population and the proportion suffering from severe periodontitis could be demonstrated (Fig. 3).

Based on studies indicating the increased risk of severe periodontitis among smokers (Bergström & Preber 1994, Grossi et al. 1994, Hyman & Reid 2003, Susin et al. 2004), some researchers have recently estimated that smoking cessation would dramatically reduce the prevalence and severity on a population level (Bergström et al. 2000, Tomar & Asma 2000, Hashim et al. 2001, Susin et al. 2004).



Fig. 3. Percentage of smokers and subjects with severe periodontitis in countries with low (Denmark, UK, the Netherlands, Norway, Portugal, Spain, Sweden) and high (Byelorussia, Germany, Kirghizia, Slovenia) prevalence of severe periodontitis (data from Gjermo 1998, World Health Organization (WHO) 2003).

Tomar & Asma (2002) reported that 27.9% of dentate adults in the US were regular smokers in 2000 and that 23.3% had quit smoking during recent years. They attributed 41.9% of their periodontitis cases to smoking and 10.9% to former smoking. In a recent study from Brazil, the prevalence of subjects exposed to smoking in the adult population was reported to be over 50% and a statistically significant association with prevalence and severity was established. The proportion of subjects with severe periodontitis attributable to smoking (current and former) was estimated to be 12% (Susin et al. 2004), but in this case we lack information concerning the development of the proportion of smokers over time. In both these studies, the odd's ratio (OR) of having periodontitis decreased when the subjects quit smoking. There is reason to believe that tobacco use is the most promising changeable variable to target in future programmes and campaigns.

Discussion

Periodontal diseases are multifactorial in nature. They are affected by genetic, environmental, behavioural, social, educational, economic and political factors. Thus, changes in one or more of these factors may change the prevalence of these diseases. In addition, there is an obvious interaction among these factors that is still not fully understood.

Preventive programmes and campaigns usually target a limited number of the factors constituting the determinants of a disease in a population. As a consequence, changes in the disease levels in a population can never be attributed to a single programme or a campaign, but it cannot be excluded that such activities may trigger several of the other contributing factors and start a cascade of events leading to an improvement in the disease situation.

In order to detect changes in the disease situation over time, repeated representative epidemiologic surveys performed in the same population are necessary. Such studies are very scarce today (Albandar & Rams 2002b). Also, studies using valid variables to describe the diseases in question are a must. This is not the situation for the large part of surrogate parameters used today (Baelum 1998, Gjermo 1998, Hansen 2004). In fact, our ability to assess disease is rather meager, as we, for the most part, record irreversible changes occurring as a consequence of the disease. This irreversible nature of our most widely used parameters makes it impossible to record improvements because of treatment of the disease.

However, there is reason to believe that the increased focus on prevention of oral diseases in the Western industrialized countries during the last 50 years through programmes and campaigns is in part responsible for the improved situation concerning gingivitis and also the mild/moderate forms of periodontitis. This has occurred concomitant with a steadily increasing professional knowledge and a corresponding change in the education of dental personnel (including introduction of specialist programmes in periodontology) and a development both in the amount and quality of the dental services. In many of the Western world countries, the populations have also experienced a dramatic increase in prosperity since World War II, which in turn has increased the demand for a nice-looking and well-functioning dentition, motivating people to take responsibility for their own oral health.

In spite of the improvements in gingivitis and mild/moderate periodontitis

recorded in prosperous countries, there are no clear indications of a reduction in the proportion of the populations suffering from the very severe forms of periodontitis. The idea of a "hidden periodontitis epidemic'' induced by cigarette smoking during the 20th century has been launched (Hujoel et al. 2003), and the association between smoking and the severity of the disease is no longer questioned (Riviera-Hildago 2003). This may provide hope as cigarette smoking is a habit, and habits may be changed (Schaub 1987). In many countries, the dentist is becoming an important person in changing the habit of smoking (Lahtinen 2004), and courses aiming at improving the dentists' counselling ability concerning smoking cessation are emerging.

In a growing number of countries, large successful governmental campaigns against cigarette smoking have been launched based on the general health hazards of tobacco use (World Health Organization (WHO) 2003). Because of the irreversible character of the most valid epidemiologic variables assessing the periodontal disease status on a population level, it will necessarily take several years, probably decades, before any results of these campaigns may be reflected in epidemiological surveys. It is therefore of paramount interest to revitalize epidemiologic research with properly conducted representative studies using a nominalistic approach to the categorization of periodontitis and including relevant patient variables for analyses. Also, surveys repeated at time intervals in a population to monitor possible changes in the disease prevalence with particular emphasis on the severe forms of periodontitis would be most helpful in the future.

Conclusions

Changes in disease levels as assessed epidemiologically cannot be attributed to single programmes or campaigns. However, such activities may trigger a cascade of events leading to improved disease status. An appropriate oral hygiene level is effective in reducing the prevalence and severity of periodontitis on a population level. The most promising means to prevent severe periodontitis in the future appears to be successful smoking cessation programmes.

Periodontal epidemiology would benefit from a nominalistic approach to the categorization of the disease involving a nominalistic disease definition based on observable and measurable phenomena. Lopez (2003) described the essentialistic reasoning as characterized by a sequence where causes lead to diseases that again display certain signs and symptoms. Contrasting this, the nominalistic reasoning is that causes lead to signs and symptoms, which then may lead to disease. While the first will be rather logical for diagnostic or treatment purposes, the other may be more fruitful for epidemiologic research. This is clearly demonstrated by Lopez & Baelum (2003) when describing the chaos encountered when trying to compare the prevalence and severity of periodontal disease from various studies using the current essentialistic approach.

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