The Estimation of the Needs for Periodontal Treatment in Adult Hong Kong Chinese using the Community Periodontal Index of Treatment Needs (CPITN) and an Evaluation of a Minimal Periodontal Treatment Programme

Thesis presented for the degree of

Doctor of Philosophy

by

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1997

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ABSTRACT

The Estimation of the Needs for Periodontal Treatment in Adult Hong Kong Chinese using the Community Periodontal Index of Treatment Needs (CPITN) and an Evaluation of a Minimal Periodontal Treatment Programme.

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The Community Periodontal Index of Treatment Needs (CPITN) was designed primarily to assess periodontal treatment needs in populations but has been applied to individuals with some modifications (Ainamo et al., 1982; Cutress et al., 1987). Although the CPITN is widely used, many of the assumptions upon which the index is based have been questioned in view of an improved understanding of the periodontal disease process and of responses to different treatment approaches.

The purpose of this investigation was to: (1) assess the time required to provide periodontal treatment in a group of adult Hong Kong Chinese; (2) examine if a relationship exists between CPITN scores and treatment times; and (3) evaluate the effects of oral hygiene instruction in the absence of scaling.

Based upon CPITN treatment need indications, a sub-sample of the 668 subjects aged 35-44 years examined during the 1984 Hong Kong Survey of Adult Oral Health (Lind et al., 1986) was defined comprising all 104 Treatment Need (TN) "3" subjects and 100 randomly selected (TN) "2" subjects. 43 subjects (21%) of this sample eventually participated in this study, the clinical part of which was conducted between 1987 and 1989.

During the first six months of the study, a split-mouth approach was used to assess the outcome of oral hygiene alone as against oral hygiene and scaling. Thereafter, routine periodontal treatment was undertaken and monitored for a total period of 15 months. Treatment times were assessed using the methods of time study and activity sampling while clinical outcomes were assessed on probing depth, calculus, and bleeding on probing.

The mean initial oral hygiene time for this sample was 39 minutes, while for the 6- and 12-month maintenance appointments, this reduced to a mean of 15 and 11 minutes respectively. The mean initial scaling time for sextants was 23 minutes, however for those sextants where scaling had been deferred until six-months after the provision of oral hygiene instruction, the mean scaling time was reduced by one-half. Significantly less time was required for scaling at subsequent maintenance appointments. Rather few sextants eventually received complex periodontal treatment thereby making meaningful comparisons difficult. The highest subject CPITN score was not useful as an indicator
of oral hygiene instruction time during any phase of the study, while the highest sextants CPITN score was only useful as an indicator of treatment time for initial scaling. Activity sampling revealed that 61% of hygienist time was unproductive (patient late, cancelled, failed or not booked), and that only 29% of total time was devoted to primary activities (examination, instrumentation and other preventive activities). Over two-thirds of primary activity time was spent on scaling.

Statistically significant reductions in CPITN scores, probing depths and bleeding after probing were observed over the first six months of treatment both in sextants which received conventional periodontal treatment and those which received only oral hygiene, however the reductions were less in the latter. The hierarchical design of the CPITN did however obscure the detection of some of the improvements in non-instrumented sextants since calculus (CPITN code 2) was not removed. Scaling provided at the six-month recall in sextants which had previously only received oral hygiene, resulted in further improvements in all clinical parameters.

In summary, the principal findings of this study are that:

- For adult Hong Kong Chinese treated under the conditions of this study, the mean initial oral hygiene time was somewhat less than the time estimates provided in TRS 621 (WHO, 1978);
- The mean time for initial scaling of sextants at baseline was within the range suggested by TRS 621;
- For subsequent maintenance phases, the mean oral hygiene time per subject and the mean scaling time per sextant were greater than the TRS 621 estimates;
- Deferment of initial scaling for a period of six-months after oral hygiene instruction reduced scaling time by one-half thereby providing a basis for the development of more time efficient methods for the provision of periodontal treatment;
- The CPITN score was not useful as an indicator of the time required for individual components of treatment except for initial scaling time at baseline;
- Activity sampling revealed that over half of hygienist time was unproductive;
- Improvements in periodontal health can take place following oral hygiene instruction in the absence of scaling;
- Scaling enhances the improvements in periodontal health achieved by oral hygiene alone;
- The CPITN has deficiencies due to its hierarchical nature when used for the monitoring periodontal treatment outcomes;
- The CPITN as modified by Takahashi et al., (1988) confers no advantage in monitoring the outcomes of a minimal periodontal treatment programme involving oral hygiene in the absence of scaling.
ACKNOWLEDGEMENTS

In a study of this magnitude and duration, many individuals deserve thanks for without their assistance this work would not have come to fruition. Of the many who have contributed either directly or indirectly to this study special acknowledgement must be given to the following:

Professor Aubrey Sheiham, Professor of Dental Public Health, University College London Medical School, who as a undergraduate student awakened me to the importance of the community perspective and as a postgraduate student served as an advisor to this thesis.

Professor Ian Davies, Pro Vice Chancellor, the University of Hong Kong and formerly Head of the Department of Periodontology and Public Health, Faculty of Dentistry, for his considerable support and assistance throughout the period of the study both in the establishment of this study and in the subsequent reading of numerous drafts of the thesis.

Professor Taco Pilot, WHO Collaborating Centre for Oral Health Services Research, University of Groningen, the Netherlands for his considerable and continued assistance both initially with the calibration exercises as the WHO ‘gold-standard’, subsequently through inviting me to join the Joint WHO/FDI Working Group 10 on Periodontal Health Services Research, and the valuable experience gained through the collaboration of members of this Working Group.

Ms. Jennifer Sardo-lnfirri, Scientist, Oral Health Program, World Health Organization, Geneva for her assistance in arranging the original calibration sessions with the WHO roving consultant and for being a continual source of relevant WHO documents on the CPITN.

Drs. Ian Fowler and Felix Yeung who acted as the study periodontists.

Last but certainly not least I must thank my ever suffering family for their support during the years this work has taken to complete. To my dear wife Louise who has made the most sacrifices and who has shared my frustrations and to my two children Imogen and Tamlyn who have never known a time when their father was not working on his thesis. Special mention must be given to Imogen whose caesarian delivery was delayed a day in order that the calibration sessions for the study could go ahead as planned.
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1.1 Background to the study

Prior to the 1984 Hong Kong Survey of Adult Oral Health conducted by the Department of Periodontology and Public Health of the University of Hong Kong there was a paucity of data describing the oral health status and treatment needs of Hong Kong adults (Lind, Holmgren et al., 1987a). The first oral health survey of Hong Kong adults had been conducted fifteen years previously by the World Health Organization [WHO] and the Hong Kong Government Dental Service (Wong, 1968). The main focus of the 1968 survey was on dental caries, however, one of the findings of this survey was that 47% of adults aged 20-54 years had pockets >3mm whilst 6% had pockets >6mm. No recommendations were however made with respect to periodontal treatment needs. At that time the population of Hong Kong was approximately 3.9 million people. This rapidly grew over the forthcoming years primarily through a huge influx of immigrants from mainland China.

By the 1980’s, the population of Hong Kong was approaching 5.5 million. Considerable demographic, social and economic changes had taken place over the previous decade which meant that the data from the 1968 survey (Wong, 1968) was not only out-of-date but possibly unreliable. In 1982, the Government conducted an oral health survey of government officers and their dependents, however, such a sample could not be considered representative of the Hong Kong population as a whole (Wong, 1983). The Department of Periodontology and Public Health of the University of Hong Kong therefore took upon itself the task of performing a survey to collect and analyze epidemiological data that would describe the existing oral health status, the oral disease situation, and the treatment needs of adult Hong Kong Chinese [Hong Kong Survey of Adult Oral Health-HKSAOH] (Lind, Holmgren et al., 1987a).

Two age cohorts were surveyed according to WHO standard age groupings, namely 15-19 and 35-44 year-olds (WHO, 1977). The design of the clinical examination was based upon WHO guidelines as found in "Oral Health Surveys - Basic Methods" 2nd. edition (WHO, 1977) except that the Community Periodontal Index of Treatment Needs [CPITN](Ainamo et al., 1982) was used to assess periodontal conditions and treatment needs. The survey results have since been published (Lind et al., 1986; Lind, Holmgren et al., 1987a; Lind et al., 1987b; Corbet, Holmgren et al., 1989). In summary, the
periodontal findings showed that negligible proportions in each age group had healthy gingiva, but that calculus and gingival inflammation, as evidenced by bleeding on gentle probing, were detected in almost every individual in virtually every sextant scored. Despite this, deep pockets of 6mm or greater were found in only 1% of 15-19 year-olds and 16% of 35-44 year-olds (Appendix I, Tables 1.1 & 1.2).

The periodontal treatment needs for the sample (Appendix I, Table 1.3), when extrapolated to the overall Hong Kong population using treatment guidelines as recommended by the CPITN, would indicate that almost every adult in the population within these age cohorts would require not only a considerable improvement in oral hygiene but also removal of calculus by scaling. Only a small proportion would require "complex" periodontal treatment in the form of root planing and/or periodontal surgery.

It is possible to make estimates of the manpower requirements for delivery of periodontal treatment according to the CPITN as shown by Manji & Sheiham (1986). A simple translation of the CPITN derived treatment needs into treatment time estimates for periodontal procedures as laid down in the WHO's Technical Report Series 621 [TRS 621] (WHO, 1978) would, as found by Manji & Sheiham in Kenya (1986), indicate a potential commitment in terms of both manpower and resources that would be prohibitive in cost. Furthermore, in a population with large deposits of calculus, such as in Hong Kong, it would be expected that a substantial proportion of time and resources would be used to remove calculus, since surveys have shown this to be omnipresent.

The time estimates provided in TRS 621 (WHO, 1978) were largely based on times for treatment in Western countries. At the time of the 1984 HKSAOH there was a scarcity of data relating to the time required for the provision of periodontal treatment in different countries with different modes of delivery, with none available for Chinese populations. Furthermore, any relationship between CPITN scores and treatment times had yet to be ascertained to determine the validity of the CPITN for determining resource and manpower requirements. These fundamental deficiencies in our knowledge therefore formed the basis for one part of this study.

In the early 1980's traditional periodontal doctrine which evolved largely out of clinical practice and experience was being challenged (Shanley, 1980). Hitherto, it was generally acknowledged that periodontal treatment must involve oral hygiene instruction, removal of calculus, other plaque retentive factors, and in some instances of more
severe disease, might include more complex procedures such as root planing and surgery (Lindhe, 1989). This treatment approach was based on the concept of a single periodontal disease continuum where, marginal gingival inflammation, if not eliminated, would inexorably progress to loss of attachment with eventual loss of teeth.

This traditional concept has recently been questioned as there is now substantial evidence to show that, despite a high prevalence of marginal gingival inflammation in most populations, only a minority of individuals or groups experience severe progressive periodontal disease. In this respect it has been suggested that it is no longer valid to consider periodontal disease as a single entity but rather as a number of different diseases, each with a different clinical presentation and rate of progression (Listgarten, 1986; Johnson et al., 1988).

An apparent paradox has thus emerged in the practice of periodontology, between the traditional approach to treatment based on one concept of the disease process progressing continuously in all affected individuals, and evidence from recent research which inevitably questions the validity of this concept. It therefore seems somewhat incongruous that an index primarily designed to estimate the periodontal treatment needs of a community, namely the CPITN, appears to recommend a single treatment strategy for the prevention and treatment of all periodontal diseases (see Chapter 3). Such a strategy, by its very nature, generally necessitates an individual operator to patient approach with the implications that while well developed countries have difficulty in providing such a strategy to communities, in developing countries with limited resources it would be impossible to provide (Horowitz, 1979).

This realisation that the traditional periodontal treatment strategy is both unrealistic at a community level and is based on outdated concepts of disease behaviour, implies a need to explore alternative strategies which might require fewer resources. The goals of periodontal treatment should also be redefined so they are more realistic and achievable. For instance, Pilot (1980) suggests that periodontal care should maintain 'a healthy natural functioning dentition throughout life, including all the social and biological functions as aesthetics, chewing, taste, speech, no discomfort, in the light of personal well-being of the individual'. Sheiham (1984) suggests that a comprehensive plan for the prevention and treatment of periodontal disease should include a population, a high-risk, and a secondary prevention strategy.
A population strategy aims at a reduction in plaque levels within a population, thereby reducing the overall rate of progression of periodontal disease and therefore the numbers of teeth lost. This can be achieved through "altering life-style and environmental characteristics, and their social and economic determinants" (Sheiham, 1984). There is sound epidemiological evidence to show that severe loss of attachment is less prevalent in populations with better oral hygiene (Burt, 1988) and that, over time, improvements within populations can be achieved with this strategy. For example, Douglass et al., (1983) over a 12 year period in the United States, and Sheiham et al., (1986) over 14 years in the United Kingdom have both shown improvements in oral cleanliness and marginal gingival inflammation attributable in part to this strategy, however only the latter study has shown a decrease in the proportions of pockets as assessed using the Periodontal Index (Russell, 1956).

A high-risk strategy involves screening on a community basis to identify those at high-risk making use of prognostic indicators of progressive periodontal disease combined with the delivery of efficacious treatment. Unfortunately, adoption of a high-risk strategy at a community level is currently not viable as reliable markers of disease susceptibility and activity have yet to be developed and screening at a community level to identify such high-risk individuals is unlikely to be practical or cost-effective (Sheiham, 1978; Johnson, 1989). As discussed in section 3.5.1, screening could to a limited extent be performed at an individual or 'captive' group level based on the criteria of 'severe disease for age', possibly using CPITN methodology (Johnson, 1989). Still, even having recognised such high-risk individuals, a further dilemma is that currently available treatment approaches may fail to be totally effective (Badersten et al., 1985a,b,c; Lindhe & Nyman, 1984).

While Sheiham (1984) maintains that the concentration of effort should be on the population and high-risk strategies, a secondary preventive approach involving treatment of the early signs and symptoms of diseases of the periodontium in order to prevent their progression [TRS, 621](WHO, 1978) continues to form the basis for the clinical management of periodontal disease (Theilade, 1986). This approach, necessarily involving the life-long, 'non-specific', professional removal of plaque on a regular basis and of factors which hinder its removal, is considered to be both 'non-biological' (Johnson et al., 1988) and 'cumbersome and inefficient' (Burt, 1988) and will almost certainly result in over-treatment of many individuals who are at little or no risk of severe progressive periodontal disease and tooth loss as a possible sequela. In spite of these
problems, secondary prevention as currently practised remains the most widespread strategy (Arnljot et al. 1985) and will no doubt continue to be so until effective disease markers are developed facilitating the concentration of effort on certain high-risk groups and individuals.

The potential problems associated with the delivery of secondary prevention of periodontal disease to communities emphasises the need to explore alternative approaches which could minimize manpower and resource requirements by using simpler, less time consuming and less costly treatment methods, thereby maximizing the scope and effect of such treatment. One avenue which was considered worth exploring was to evaluate whether an improvement of plaque control through self-performed oral hygiene without instrumentation would result in discernable improvements in periodontal health. The logic of such an approach is based on the finding that calculus was not always associated with gingival inflammation as shown from the findings from the 1984 Survey of Adult Oral Health (Holmgren & Corbet, 1990). At the time of the commencement of this study further support for this finding came from Cercek et al., (1983).

Despite a rapidly growing bank of data being collected around the world utilizing CPITN criteria, only a limited number of studies have specifically investigated the validity of the index for determining periodontal treatment needs, and the appropriateness of treatment strategies once the periodontal treatment needs have been assessed. The meeting of the Oral Research and Advisory Group (ORAG) of the Federation Dentaire Internationale in Tokyo, Japan in 1983 noted that the "evaluation of the CPITN should be concomitant with its future use" and that particular emphasis should be placed on "the appropriateness of different preventive and treatment needs approaches in different populations" and "the appropriateness of the index in monitoring responses to oral hygiene programmes and to therapeutic measures in periodontal treatment".

Indeed, many of the assumptions upon which the CPITN has been based could be questioned in light of recent developments relating to both the understanding of the nature of the disease process and of responses to different approaches to treatment. It is therefore essential that the tenets upon which the CPITN is based be critically reappraised and an investigation of the validity of this index for assessing periodontal treatment needs, as well as the resources required for the provision of the treatment indicated be carried out.
1.2 Purpose of the study

The main purposes of this study were:

- To estimate the needs for periodontal treatment in adult Hong Kong Chinese using the Community Periodontal Index of Treatment Needs (CPITN);
- To evaluate a minimal periodontal treatment programme.

1.3 Principal objectives of the study

The principal objectives of the study were:

- To assess the time required to provide periodontal treatment in a group of adult Hong Kong Chinese;
- To examine if a relationship exists between CPITN scores and treatment times;
- To evaluate the effects of oral hygiene in the absence of instrumentation.

The objectives of this study fulfil two of the recommendations for research in periodontal health care detailed in the working paper for the WHO - FDI Joint Working Group 10 on Periodontal Health Services prepared at the pre-congress meeting of JWG1 held in Prague in September 1985. Suggestions were made at this meeting that research examining the delivery of (oral) health care should assess "whether indices - such as the CPITN - result in realistic and adequate manpower planning" and secondly that research in the effectiveness and efficiency of treatment regimes should include as a first priority "the effect of scaling versus not scaling".
CHAPTER 2 - THE ASSESSMENT OF PERIODONTAL TREATMENT NEEDS

2.1 Introduction

Last's Dictionary of Epidemiology (1988) states that the term 'need' has a precise and an all-but-indefinable meaning in the context of public health. It is therefore inevitable that there is no single definition of the term 'need'. Traditionally, dental need has referred to "a state of oral health deemed as in 'need' of intervention by a dental practitioner" (Cooper, 1979). Only recently has it become realised that "a more realistic assessment of treatment needs should include the functional and social dimensions of dental disease and an assessment of the social and motivational factors which predispose people towards dental ill health and influence the effectiveness of treatment and health education" (Sheiham et al., 1982).

A generally recognised taxonomy which takes into account this wider interpretation of the term 'need' and which includes some sociological factors has been proposed by Bradshaw (1972) based on four discriminators:

- **Normative need** "that which the expert or professional, administrator or social scientist defines as need in any given situation. A 'desirable' standard is laid down and is compared with the standard that actually exists";

- **Felt or perceived need** "here need is equated with want. When assessing need for a service, the population is asked whether they feel they need it";

- **Expressed need or demand** "is felt need turned into action. Expressed need is commonly used in the health service where long waiting-lists are taken as a measure of unmet need. Waiting-lists are generally accepted as a poor definition of 'real need' especially for the pre-symptomatic cases";

- **Comparative need** "obtained by studying the characteristics of the population in receipt of a service. If there are people with similar characteristics not in receipt of a service, then they are in need".

Cooper (1979) has simplified this taxonomy into oral health needs, wants and demands. An aspect of 'expressed need or demand' which takes into account some of the barriers to dental care is the actual attendance of members of the public at health care facilities
to receive care; this is termed 'utilization' (Spencer, 1980). Furthermore, any differences that may exist between the services judged necessary to deal appropriately with defined health problems and those services actually being received is termed 'unmet need' (Carr & Wolfe, 1976).

Burt (1975) has subdivided need into different categories of service, namely 'diagnostic needs', 'preventive needs', and 'disease, disability, or dysfunction-orientated needs'. In this respect, both Spencer (1980) and Striffler (1983) consider that a critical approach to the estimation of diagnostic and preventive needs is presently lacking, as estimation of such needs tends to reflect a philosophy of care held by the provider, rather than the characteristics of any given population. A similar supposition could however be advanced for the estimation of all categories of need for dental care. For needs arising out of disease, disability, or dysfunction, Burt (1975) subdivides these into three additional categories, namely:

- **Initial needs** which refer to the requirements for care to achieve dental health for the first time;

- **Backlog needs** which refer to the requirements of entrants or re-entrants to a program where there has been some dental neglect prior to entry and a considerable amount of care may be required to achieve dental health;

- **Incremental (or maintenance) needs** which refers to provision of care at specific intervals of time to achieve dental health in those who have already received care and therefore only need an increment of care.

More complex interpretations of the term 'need' to take additional factors such as overtreatment, under-treatment and appropriate treatment into account have been described by Striffler (1983), and are depicted in the Venn diagram overleaf:

Thus, the term 'need' can be interpreted in many different ways and failure to take into account all the dimensions of need, particularly in terms of social and psychological aspects, must lead to shortcomings.
2.2 Methods of determining dental care needs

In the estimation of need for dental care, Spencer (1980) has suggested four approaches, distinguished by their source of data. These are:

- surveys of dental status;
- surveys of need for dental care;
- analysis of service or treatment records;
- the best judgement of dental practitioners.

The epidemiological assessment of dental care needs by the application of indices of dental status or by the use of specific 'treatment' need indices are covered in sections 2.5 to 2.7. The assessment of treatment needs by the retrospective analysis of existing service or treatment records from dental health programmes, third-party health insurance schemes, or from individual practitioners has not been widely used. Spencer (1980) suggests that this is because such data can sometimes be difficult and costly to obtain, can be difficult to collate, and may only give information on attendance frequencies and the number of treatment items provided. Even if these problems are taken into account,
it must also be recognised that needs derived from such data can only be relevant to
those subjects who utilise dental services and cannot be extrapolated to larger groups
or other populations (Striffler, 1983).

While the four methods of assessing dental treatment needs might be considered to be
mutually exclusive, some benefit might be gained from a combination of approaches,
although considerably more research is needed in this area (Spencer, 1980). Indeed
Barmes (1976) suggests that the possibility of combining data on treatment received and
its consequences, with clinical data, should receive attention. Furthermore, the
considerable differences between normative, perceived and expressed periodontal needs
(see section 2.3) emphasises the need to include sociological and psychological data in
need assessments (Sheiham et al., 1982; Cushing et al., 1986; Selikowitz, 1987), while
Technical Report Series 472 [TRS 421] (WHO, 1971) stresses the need for subjective
measures of perceived needs and health status of the consumers of health care as these
data may be better predictors of need and utilization than mortality statistics. However,
as Cushing et al. (1986) point out, "treatment needs have been defined in clinical
terms...designed for community assessment by dental epidemiologists and represent
provider assessments only". Such assessments of normative need by epidemiological
means within populations require both a quantitative and qualitative approach and rely
almost entirely upon the use of indices. The requirements of such indices are reviewed
in section 2.4.

2.3 Periodontal treatment needs

The concept of oral health need has been reviewed in its widest context in section 2.1.
Periodontal needs are but one component of oral health care needs, which in turn forms
part of overall health needs of individuals and communities.

In an American Academy of Periodontology workshop organised to consider the
periodontal needs of the United States population (O'Leary, 1967a), Ramfjord stated that
there were "no established standards for what constitutes periodontal needs".
Furthermore, he added that periodontal needs "have never been assessed in a scientific
manner and so far no ways have been generally accepted to assess these needs". The
intervening years have witnessed the introduction of numerous methods to assess
periodontal needs ranging from conversion factors to be used with pre-existing
periodontal indices (Ramfjord, 1967; Russell, 1967a; Sheiham, 1967, 71; Davies et al.,
Chapter 2 - The assessment of periodontal treatment needs

1961; Scheinin et al., 1970; Ekanayaka, 1976)(see section 2.5), to the development of completely new indices specifically designed with the purpose of assessing periodontal needs (Cross, 1952; MacPhee, 1967; Bowden et al., 1973; Johansen et al., 1973; Ainamo et al., 1982)(see section 2.6). Without exception these methods have been based solely on normative assessments of periodontal needs.

2.3.1 Normative periodontal needs

The definition of normative periodontal needs might appear to be as straightforward as those proposed by Ramfjord (1967a) which were:

- The number of people needing periodontal treatment and the extent of treatment;
- The number of people needing preventive procedures or periodontal health care; and,
- The number and educational qualifications of personnel needed to perform the services that would be required to treat periodontal disease and maintain periodontal health.

Unfortunately, the issue as to what exactly constitutes 'periodontal treatment need' and 'good periodontal health' is largely dependent upon the goals of the provider. As Sheiham (1981) points out, "there is no consensus among dentists of what constitutes good health, and which methods are the most effective at achieving that state. Neither is there a consensus on what constitutes need for treatment". Traditionally, normative periodontal needs have been based upon a perception of a disease process behaving as an inexorable, slow and continuous progression from marginal gingival inflammation to advanced periodontal destruction which, left untreated, would inevitably lead to tooth loss. In concordance with this perception, treatment has been directed towards the elimination of all signs of periodontal inflammation in all individuals with the objective of preventing or halting loss of periodontal attachment. During the 1980's, however, new concepts began to emerge from clinical and epidemiological studies to challenge traditional beliefs concerning the behaviour of the disease process. These were that:
Relatively few individuals experience severe periodontal disease in terms of loss of attachment, and in these, most have only a few sites or teeth so involved (Hugoson & Jordan, 1982; Bælum et al., 1986,88; Löe et al., 1986; Miller et al., 1987; Pilot et al., 1986,87; Pilot & Barnes, 1987; Okamoto et al., 1988; Papapanou et al., 1988; Yoneyama et al., 1988; Hugoson et al., 1992).

Longitudinal studies suggest that periodontal disease is, for the most part, non-progressive or progresses slowly in most individuals (Hugoson & Rylander, 1982; Lindhe et al., 1983; Buckley & Crowley, 1984; Sheiham et al., 1986; Albandar et al., 1986,90; Löe et al., 1986).

Loss of periodontal attachment probably occurs in bursts of activity at individual sites for short periods of time (Goodson et al., 1982; Haffajee et al., 1983a; Lindhe et al., 1983a; Socransky et al., 1984).

Inevitably, such dramatic changes in our understanding of the behaviour of periodontal disease have huge implications in terms of defining exactly what constitutes periodontal treatment need and periodontal health. If the objective of periodontal treatment remains the prevention or halting of loss of attachment, then the elimination of all disease in all individuals could be considered to be gross over-treatment. Pilot (1980) considers that complete elimination of periodontal disease is neither realistic nor necessary, this concept being implicit in the goal for periodontal health proposed by Gjermo (1984) "that periodontal disease should not limit the social function of the dentition throughout life". This lends credence to Waerhaug's suggestion that in an academic sense, periodontal health may be defined as the absence of gingivitis and loss of attachment around any of the teeth, while in public health terms some gingival inflammation and loss of attachment may be acceptable (Waerhaug, 1980). Age does however need to be taken into account, for example, Lennon & Davies (1975) submit that while gingivitis, in a teenage population, cannot necessarily be indicative of a treatment need in the context of a public dental service with scarce resources, early signs of loss of attachment may be more relevant. This is because in the absence of reliable prognostic indicators, 'severe disease for age' might be indicative of individuals considered to be at greater risk of further periodontal breakdown (Johnson, 1989). The CPITN defined periodontal health goals for the year 2000, which have been adopted by a number of countries, take into account a certain amount of 'acceptable' periodontal disease and it is interesting to
speculate whether this is because of the realisation of the practical impossibility of eliminating periodontal disease or whether it is because of the acceptance of the new concepts of periodontal disease whereby marginal gingival inflammation could be considered a normal, possibly healthy, response to plaque.

The need to agree upon defined periodontal treatment procedures related to the periodontal diagnosis has been stressed by Bellini (1974). Unfortunately, the effectiveness of traditional periodontal treatment procedures has only been evaluated in carefully controlled clinical studies, with experienced operators working in optimal conditions on small numbers of patients (for review, see Lindhe, 1989). Few studies have evaluated the effectiveness and efficiency of periodontal treatment regimes in the community setting. In this respect, Plasschaert et al., (1978) suggest that before translating periodontal disease levels into estimates of needs for treatment, the effectiveness of current methods of treating periodontal disease should be evaluated. In addition, they propose a number of further conditions which should also be fulfilled, namely:

- The likelihood of affected persons complying with the therapeutic regimen must be assessed.
- The availability of suitably trained dental health personnel should be assessed;
- The skills required and the time needed to treat different levels of periodontal disease in persons of different ages and educational level should be quantified, so that clinical and behavioral assessments can be converted into estimates of personnel, facilities and finance required to treat affected persons.

While it is generally assumed that normative assessments of periodontal disease and treatment needs are objective, this might not be the case (Nikias et al., 1979; Bulman et al., 1968a,b; Smith & Sheiham, 1980; Cushing et al., 1986). In addition there is no guarantee that the treatment needs assessed in an epidemiological survey will be the same as those determined by practising dental personnel (Bowden et al., 1973).
2.3.2 Perceived and expressed periodontal needs

Expressed need is perceived need turned into action. Selikowitz (1987) points out that as periodontal disease has both biological and socio-cultural determinants, it is necessary to consider a person's perception and interpretation of periodontal symptoms, which is termed 'periodontal illness'.

Perceived need is dependent upon the awareness by an individual or community that periodontal disease is present with symptoms being interpreted as a problem. While the awareness of tooth decay within populations is generally good, awareness of periodontal conditions tends to be poor (Bulman et al., 1968a,b; Ainamo, 1972). Many studies have shown large discrepancies between self-assessments of periodontal conditions (awareness) and normative assessments (Bulman et al., 1968a,b; Ainamo, 1972; Murtomaa & Ainamo, 1977; Brady, 1984; Srikandi et al., 1983; Davies et al., 1985; Cushing et al., 1986; Lie & Mellingen, 1987). Studies carried out in the 1960's and 70's, for example in Scandinavia (Heloe, 1972; Ainamo, 1972; Murtomaa & Ainamo, 1977) and in the United Kingdom (Richards et al., 1965), showed awareness of periodontal disease to be virtually non-existent. In more recent years however general awareness of periodontal disease may have shown some improvement as suggested by the results of the study by Lie & Mellingen (1987), although even in this study, 68% of participants were unaware of existing marginal gingival inflammation. In terms of expressed need, Davies et al., (1985) suggest that misconceptions of (self-assessed) need for care may explain at least in part why people do not use dental services. An additional factor might be the failure to believe in one's own disease susceptibility (Kirscht et al., 1966). While this lack of awareness may to some extent be understandable in lay-people considering the insidious nature of periodontal disease and that symptoms of the disease might be accepted as the norm, it is surprising that awareness among dental professionals is also poor (Wade, 1972; Chattopadhyay, 1990).

The obvious discrepancies between perceived, expressed and normative need, particularly significant in terms of periodontal disease further underlines the necessity for a combined approach to data collection when these are to be used for planning of manpower and resources.
2.4 The requirements of indices used to assess periodontal treatment needs

An index has been defined by Russell (1960) as "a number describing the relative status of a population on a graduated scale with definite upper and lower limits, designed to facilitate comparisons with other populations classified by the same criteria and methods". In the context of periodontal disease, an index is an attempt to describe aspects of a biological process in numerical terms.

A perusal of the dental literature reveals that numerous periodontal indices have been described, often because the different types of epidemiological study require different type of indices (for reviews see Stratford, 1975; Barnes et al., 1986). Gjermo (1974) has classified epidemiological studies into four categories, namely:

- Epidemiological studies on prevalence and incidence;
- Longitudinal experimental studies to evaluate prophylactic and/or therapeutic measures in population groups;
- Clinical trials in small, well controlled, experimental groups;
- Periodontal treatment need evaluation.

As Oliver et al. (1989) point out, there is no universally accepted method for estimating periodontal treatment need, however the two main approaches which have been used are the conversion of existing prevalence data collected with traditional indices into periodontal treatment need, or the direct measurement of periodontal treatment need (Ekanayaka, 1976).

Irrespective of the purpose to which they are applied, periodontal indices have a number of general requirements, which include:

- Simplicity (Davies, 1968; Davies et al., 1974; Johansen et al., 1973; Gjermo, 1974; Hazen, 1974; Horowitz, 1979);
- Clarity of criteria (Davies, 1968; Davies et al., 1974; Hazen, 1974; Horowitz, 1979);
Quick to apply (Davies, 1968; Davies et al., 1974; Johansen et al., 1973; Gjermo, 1974; Hazen, 1974; Oliver, 1976; Horowitz, 1979);

Validation i.e., the index must measure what it is intended to measure (Burt, 1983);

Sensitivity i.e., the probability of detecting a condition correctly (Hazen, 1974; Lennon & Davies, 1975; Horowitz, 1979);

Specificity i.e., the probability of correctly excluding a person without a condition (Lennon & Davies, 1975);

Reproducibility (Davies, 1968; Hazen, 1974; Oliver, 1976; Horowitz, 1979);

Quantifiable i.e., amenable to statistical analysis (Davies, 1968; Davies et al., 1974; Hazen, 1974; Gjermo, 1974);

Acceptable and comfortable to examinees (Horowitz, 1979).

Periodontal treatment need indices have certain specific requirements. They should be able to measure levels of periodontal disease in terms of preventive or curative action (Johansen et al., 1973; Davies, 1974; Gjermo, 1974; Oliver, 1976; Barmes, 1976); the therapeutic procedures indicated by the index should be classified and related to treatment time (Johansen et al., 1973; Bellini, 1974); and thus the data derived should provide a basis for manpower calculation and cost (Johansen et al., 1973; Barmes, 1976). Gjermo (1974) is alone in suggesting that a periodontal treatment need index should include an assessment of loss of attachment and possibly an indication of where in the dentition this has occurred. In addition, Barmes (1976) in describing what a public health planner requires from an index includes an indication of the amount of treatment met, to show how much need is being serviced by existing services, and an indication of treatment failed as a quality assessment.

The recognition that treatment need indices should include both clinical and sociological components has been recognised by a number of authors (Barmes, 1976; Plasschaert et al., 1978; Sheiham et al., 1982; Cushing et al., 1986). In spite of this, almost all
dental treatment need indices and all periodontal treatment need indices, the CPITN included, are based on an assessment of normative treatment needs only. The total reliance on such normative data for planning purposes without due consideration to perceived and expressed need will inevitably lead to gross over-estimations in terms of requirements for manpower and resources.

It is perhaps because of the widespread reliance on normative treatment need data that Horowitz (1979) questioned the need for a treatment need index as "...the probability that treatment needs could not be fully met even in developed countries". He added that "unless there is a reasonable expectation that treatment will follow the determination of treatment needs, what point is there to prove there is a need?" These sentiments are reflected by Lennon & Davies (1975) who, whilst recognising that the measurement of treatment needs is an important stage in the planning of a dental service, warn that "the actual criterion for a treatment need in an ongoing service must bear some relationship to the likelihood of that need being met". Despite these somewhat despondent views, Horowitz (1979) states that "the availability of a valid index for measuring the need for periodontal treatment may ultimately prove to be a valuable asset for persons responsible for delivering oral health care services to various population groups or for countries about to develop oral health care delivery systems".

The majority of treatment need indices have as their ultimate objective the elimination of all signs of periodontal disease, therefore by definition, there will inevitably be a treatment need in the absence of health. The dilemma brought about by changing concepts of the behaviour of periodontal disease (see section 2.3.1) combined with the realisation that elimination of periodontal disease in a public health context is unachievable, imply that the requirements of periodontal treatment need indices must be redefined. Thus, new methods of assessing treatment needs will need to be developed to identify individuals or groups at-risk of periodontal breakdown so that treatment priorities can be established. Such methods should exhibit both high sensitivity and specificity (Lennon & Davis, 1975). Moreover, sociological indicators which enable an assessment of expected demand must be defined.
2.5 The use of conversion factors in the assessment of periodontal treatment needs

In reviewing possible methods for the determination of periodontal treatment needs, Ramfjord (1967a, 1969) suggested that a correlation or 'conversion' factor could exist between periodontal treatment need expressed in terms of treatment time and periodontal status scores as determined by the application of conventional periodontal indices. He proposed that there may exist:

- a relation between plaque score and time required for oral hygiene instruction;

- a relation between calculus score and time required for calculus removal, where indices which assign higher scores for subgingival calculus, such as the Calculus Index component of the PDI (Ramfjord, 1967) or the OHI-S (Green & Vermillion, 1964), may be more appropriate as subgingival calculus would be the most time consuming to remove;

- a relation between a high calculus score based on subgingival calculus and the time required for root planing;

- a relation between loss of attachment or pocket depth and time required for root planing and different methods of surgery.

The possibility of using conversion factors to enable an assessment of periodontal treatment need has obvious attractions, for instance, such conversions would negate the necessity for specialized indices of treatment need as conventional epidemiological indices could be used. In this context, Russell (1967 a,b) proposed that mean Periodontal Index [PI] scores (Russell, 1956) could be used to give an indication of periodontal treatment need, as he considered there to be a reasonably constant correlation between group PI scores and the average state of periodontal disease in a group. The schema outlined overleaf showing the relationship between ranges of PI, the periodontal condition and the indicated treatment was based upon the assessment of patients by clinicians from the National Institute of Health, USA (Table 2.1).
Chapter 2 - The assessment of periodontal treatment needs

<table>
<thead>
<tr>
<th>Periodontal Index</th>
<th>Periodontal Condition</th>
<th>Treatment Indicated</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 0.1 or 0.2</td>
<td>Clinically normal supportive tissues</td>
<td>No treatment indicated</td>
</tr>
<tr>
<td>0.1 - 1.0</td>
<td>Simple gingivitis</td>
<td>Simple prophylaxis required</td>
</tr>
<tr>
<td>0.5 - 1.9</td>
<td>Incipient destructive disease</td>
<td>Minimal periodontal treatment</td>
</tr>
<tr>
<td>1.5 - 5.0</td>
<td>Established destructive disease</td>
<td>Elaborate and perhaps protracted treatment</td>
</tr>
<tr>
<td>4.0 - 8.0</td>
<td>Disease in terminal stages</td>
<td>Full mouth extraction because of loss of supportive tissue</td>
</tr>
</tbody>
</table>

Table 2.1 Treatment need indications based on the Periodontal Index [PI]. (Russell 1967a,b)

The reliance on mean figures with this system of treatment need estimation has potential problems (Davies et al., 1974; Oliver et al., 1989)(see section 2.7.1). Furthermore, Schonfeld (1981) considers that although the extent of the treatment will depend upon the severity of the disease, a wide range of treatments is possible even for disease characterised by a small range in mean PI. Another problem inherent in the conversion of PI scores for treatment needs estimations is the lack of routine probing in the PI system (Ramfjord, 1967a; Oliver et al., 1989) thereby failing to distinguish between shallow and deep pockets, which might require quite different approaches to their treatment. In spite of this problem, the Dental Manpower Study Committee of North Carolina (Schonfeld, 1981) proposed the following conversions:

<table>
<thead>
<tr>
<th>Periodontal Index</th>
<th>Periodontal Condition</th>
<th>Treatment Indicated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 - 1.9</td>
<td>Incipient periodontitis</td>
<td>Minimal treatment by a general dentist or hygienist required</td>
</tr>
<tr>
<td>2.0 - 4.9</td>
<td>Moderate periodontitis</td>
<td>Some treatment from a periodontist required</td>
</tr>
<tr>
<td>5.0 and above</td>
<td>Advanced periodontitis</td>
<td>Extensive periodontal treatment, or extractions, or both required</td>
</tr>
</tbody>
</table>

Table 2.2 Treatment need indications based on the Periodontal Index [PI]. (Schonfeld, 1981)

Ramfjord (1959,67a) describes one of the objectives of the Periodontal Disease Index [PDI] as providing a meaningful basis for the estimation of need for periodontal therapy in individuals and population groups. This rather detailed index, assesses marginal gingival inflammation, probing depth and recession at six index teeth. An assessment of plaque and calculus was often included in the total assessment of periodontal status. The criteria for the index do not specify how PDI scores might be interpreted in terms of periodontal treatment needs, however as mentioned earlier, Ramfjord (1967a,69)
considered that conversion factors might be used for this purpose.

The Plaque Index [PII] (Silness & Löe, 1964) has been used to determine the need for periodontal treatment and respective treatment times for Finnish university students (Scheinin et al., 1970), as follows:

<table>
<thead>
<tr>
<th>Plaque Index</th>
<th>Treatment Indicated and time allotted</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00 - 0.19</td>
<td>20 minutes for brushing instruction and motivation</td>
</tr>
<tr>
<td>0.20 - 0.99</td>
<td>60 minutes for instruction, motivation and removal of plaque and calculus</td>
</tr>
<tr>
<td>≥1.00</td>
<td>80 minutes for instruction, motivation and removal of plaque and calculus</td>
</tr>
</tbody>
</table>

| Table 2.3 Treatment need indications based on the Plaque Index [PII]. (Scheinin et al., 1970) |

The reliance on the PI alone as the basis for indication for treatment and time allocation is surprising considering that both the Gingival Index [GI] (Loe & Silness, 1963) and radiographic loss of bone were also part of the overall clinical assessment. In addition, the poor correlation reported by the authors between the PI and calculus \((r=0.28)\), would invariably affect both the indication for scaling and the respective treatment time. This brings into question the validity of assessing plaque, rather than its consequences, in the assessment of periodontal treatment needs.

Despite the suggestion by Ramfjord (1967a) that conversion factors should be established between conventional indices, recorded periodontal health status and treatment need, it was not until 1974 that Bellini reported results of a pilot study correlating the measurement of plaque, calculus, probing depth and the number of teeth with treatment need expressed as the time required for certain periodontal treatment procedures. In Bellini's study, timings were based on three treatment procedures, namely individual motivation and oral hygiene (OH), scaling and elimination of overhangs (Sc), and, periodontal surgery (Su). Periodontal status was assessed using the Plaque Index [PII] (Silness & Löe, 1964), Calculus Index [CI] (Greene & Vermillion, 1964) and probing depth. No relationship was found between the time required for oral hygiene (OH) and any of the periodontal parameters with the exception of a weak correlation with the number of teeth \((r=0.32)\). The time for scaling and elimination of overhangs (Sc) was significantly correlated with the number of teeth \((r=0.57)\) when the mouth was the unit under consideration, and with the CI \((r=0.55)\) when quadrants were considered. The
time for surgery (Su) was only correlated with the number of teeth ($r=0.66$) when considering the mouth as a unit, and with the mean probing depth ($0.48$) when quadrants were considered. Bellini concluded that there was no reliable association between treatment time and the numerical epidemiological parameters used. Some of the findings were however subsequently used in the development of the Periodontal Treatment Need System [PTNS] (Johansen et al, 1973) (see section 2.6.4).

In Bellini’s (1974) study, only two periodontal indices were used. However in 1978, Ekanayaka & Sheiham examined the relationship between treatment time and a far more comprehensive list of periodontal indices. These included the PII (Silness & Løe, 1964); the Simplified Oral Hygiene Index [OHI], Debris Index [DI], Calculus Index [CI](Green & Vermillion, 1964); the GI (Løe & Silness, 1963); the Periodontal Index [PI](Russell, 1956); the Gingival Periodontal Index [GPI] [Ging][Perio][Comp](O’Leary, 1967); Gingival Recession (Stahl & Morris, 1955); and the Retention Index [RI](modified from Bjorby & Løe, 1967). Modification was made to the Debris Index [DI] to distinguish between the presence of supra- and subgingival calculus by means of a Calculus Index Supragingival [Supra Cl], a Calculus Index Subgingival [Sub Cl] which together made up a Composite Calculus Index [Comp Cl]. Lastly, a periodontist categorized the severity of disease for each patient on a six point scale. Treatment times were assessed for examination, oral hygiene instruction, scaling and polishing and periodontal surgery.

With respect to the mean examination time, a significant correlation was found with only the PI ($r=0.37$), age ($r=0.30$), and clinical categorization ($r=0.27$). The mean oral hygiene time correlated significantly with only the GPI[Ging] ($r=0.41$), and the GPI[Comp] ($r=0.21$). For mean scaling time, the highest correlations were with PI ($r=0.60$) and Supra Cl($r=0.63$). Statistically significant correlations were however also found with DI ($r=0.24$), GPI[Ging] ($r=0.27$), Recession Score ($r=0.47$), and with Sub. CI, Comp. CI, OHI and GPI[Perio] ($r=0.53$). Lastly, the mean surgery time was highly significantly correlated with PI ($r=0.46$), GPI[Perio] ($r=0.39$), and GPI[Comp] ($r=0.43$).

Comparisons between the studies of Bellini (1973) and Ekanayaka & Sheiham (1978) show some similarities in the relation between periodontal indices and treatment time despite differences in treatment philosophy and techniques, operators and method of assessment of treatment time. Both studies show a lack of correlation between oral hygiene instruction time and the DI. Likewise, the significant correlation between CI and scaling time is common to both studies. There would also appear to be a relationship
between the amount of loss of attachment and surgery time. The mean probing depth used by Bellini (1973), the GPI[Perio] based on loss of attachment, and the PI which is weighted for attachment loss, (these latter two being used by Ekanayaka & Sheiham, 1979), all show a strong correlation with surgery time. These findings largely support the assertions of Ramfjord (1967a, 1969) that there exists a correlation between treatment time and certain periodontal status scores. Ekanayaka & Sheiham (1978) therefore concluded that "by converting periodontal indices into treatment times, planners can estimate with a fair degree of accuracy the time and resources required to carry out periodontal treatment for a population".

Despite these findings, conversion factors to determine periodontal treatment needs have never been widely used. However, in countries where large scale national surveys have been conducted without the use of specific periodontal treatment indices, some form of conversion of prevalence and severity data must be performed in order to obtain an estimate of treatment needs. Recently, for example, Oliver et al. (1989) estimated periodontal treatment needs in the United States from epidemiological data using conversion factors. Aware of the problems of using mean values for the conversion, only the presence of marginal gingival inflammation and severity of periodontal pockets were used as indicators of treatment need, as shown overleaf (Table 2.4). In making these recommendations for treatment, the authors acknowledged that concepts have changed, thus scaling and root planing were recommended for moderate pockets while surgery was only recommended for pockets ≥6 mm. Additionally, treatment indications were linked to estimated treatment times which in turn were linked to treatment costs. In this respect, the system differentiates between the initial and maintenance treatment needs, a consideration which is usually overlooked with other systems designed for the assessment of treatment needs.
Chapter 2 - The assessment of periodontal treatment needs

<table>
<thead>
<tr>
<th>Epidemiological Finding</th>
<th>Treatment Indicated</th>
<th>Time Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Treatment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gingival Inflammation</td>
<td>Prophylaxis</td>
<td>45 min.</td>
</tr>
<tr>
<td>Pockets 4-6 mm</td>
<td>Scaling and root planing</td>
<td>&lt;3 sites = 20 minutes/quadrant, ≥3 sites = 30 minutes/quadrant</td>
</tr>
<tr>
<td></td>
<td>Prophylaxis</td>
<td></td>
</tr>
<tr>
<td>Pockets &gt; 6 mm</td>
<td>Surgery</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scaling Prophylaxis</td>
<td>≥3 sites = 45 minutes/quadrant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>45 minutes</td>
</tr>
<tr>
<td><strong>Prevention and Maintenance</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pockets &lt; 4 mm</td>
<td>Prophylaxis (every 12 months)</td>
<td>45 minutes</td>
</tr>
<tr>
<td>Pockets ≥ 4 mm</td>
<td>Scaling (every 24 months)</td>
<td>&lt;3 sites = 20 minutes/quadrant, ≥ 3 sites = 30 minutes/quadrant</td>
</tr>
</tbody>
</table>

Table 2.4 Treatment need indications and time allocation according to epidemiological findings (Oliver et al., 1989)

Thus, conversion factors might have their uses, but there has been an ever increasing trend for treatment needs to be assessed by direct measurement as described in the following section.

2.6 The measurement of periodontal treatment need by direct assessment

While the findings of Bellini (1974) and Ekanayaka & Sheiham (1978) suggested that conventional periodontal indices may be used to give some indication of periodontal treatment needs, Gjermo (1974) still considered that "information about the sort of treatment needed or the time, money and manpower requirements for treatment delivery is hardly offered by any of the traditional index systems". Similar views were expressed by Ramfjord (1969) Bowden et al. (1973), and Newcomb (1975). Barmes (1976) pointed out that indices such as the Periodontal Index [PI] (Russell, 1956), the PDI (Ramfjord, 1967b) and the PMA (Schour & Massler, 1948) have mainly been devised for the assessment of oral disease status and "even for that factor there are considerable deficiencies". Moreover, he considered that none of these indices "have provided the public health planner with anything but the most peripheral information about treatment needs and nothing about treatment achievements or failure".

The apparent deficiencies with conventional periodontal indices suggest the need for
indices which directly express the need for periodontal treatment according to the type of therapy required, the time required to perform such therapy and the manpower required. Many of the indices developed for the purposes of assessing periodontal treatment needs only partially meet these objectives.

2.6.1 Early periodontal treatment need indices

One of the first attempts to assess periodontal treatment need by direct measurement was described by Cross (1952). In reporting on the dental treatment needs of United States Naval personnel, he categorized individuals into three types as shown below:

<table>
<thead>
<tr>
<th>Type</th>
<th>Clinical Findings</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tooth surfaces free from food film. Gingival crevices and interproximal areas free of debris with no signs of food irritation. Soft tissues firm and of good colour. No acute or chronic infection present.</td>
<td>No treatment required.</td>
</tr>
<tr>
<td>3</td>
<td>Acute soft tissue condition of extreme bone loss.</td>
<td>Immediate treatment from a dentist required.</td>
</tr>
</tbody>
</table>

While being somewhat elementary in design, this schema divided individuals into those who needed oral hygiene instruction and those who needed more complex care. Application of these criteria to a sample of 1570 persons found only 3.8% were in need of immediate treatment (Type 3), while between 15 and 26% needed oral hygiene instruction (Type 2). This latter figure appears remarkably low but probably reflects the level of diagnosis of marginal gingival inflammation current at that time.

A more complex system for the classification of periodontal treatment needs was described by Davies et al. (1961), also for United States naval personnel. In addition to relating the degree of periodontal disease to the type of treatment required, the system also indicated the nature of personnel required to provide it, as shown overleaf:
A good correlation was found between treatment needs assessed using this system and a description of periodontal conditions using the Ray Index (Davies et al., 1961), based upon the sum of mesial and distal probing depths and a radiographic assessment of interdental alveolar bone resorption, for all teeth. Precise recommendations about whether the Ray Index should be used to determine periodontal treatment needs were not however made.

The United States Indian Health Service (Indian Health Manual, 1966) also adopted a method by which periodontal treatment needs could be directly estimated. Patients were classified into three categories of treatment need on the basis of a clinical examination, as shown below:
The Periodontal Screening Examination [PSE] of O'Leary (1967b) comprises two components, namely: i. the Gingival Periodontal Index [GPI], scoring the severity of marginal gingival inflammation and probing depth, and ii. the Irritant Index [II] scoring plaque, calculus and overhanging or deficient restorations. O'Leary suggests that the PSE applied to individual patients could determine urgency of treatment needs, while GPI and II mean scores derived from surveys could be of value in determining personnel, facility and equipment needs. The precise manner as to how such scores could be used for this purpose has not been described. Some of the features of the PSE, such as the scoring by segments (sexants) of the highest finding have been incorporated into a number of treatment need indices including the CPITN.

The system described by MacPhee (1967) for the assessment of treatment needs of individual patients used severity scorings based on the PI (Russell, 1956), with each score corresponding to a specified range of therapy. However, unlike other PI related treatment need systems which were reliant on mean values, this system scored each tooth separately, thereby avoiding the inherent problems with mean values. Moreover, in addition to the use of visual criteria and percussive tests, MacPhee suggested that periodontal probing could be used to provide additional diagnostic information. The clinical criteria and the indicated therapy relative to the numerical scoring system are detailed below:

<table>
<thead>
<tr>
<th>Code</th>
<th>Stage in progression of periodontitis</th>
<th>Type of pocket</th>
<th>Range of therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Limited oedematous gingivitis</td>
<td>Simple false</td>
<td>Oral hygiene instruction, scaling and polishing</td>
</tr>
<tr>
<td>2</td>
<td>Limited fibrous gingivitis</td>
<td>Simple false</td>
<td>Oral hygiene instruction, scaling and polishing, curettage without a flap or gingivectomy</td>
</tr>
<tr>
<td>4</td>
<td>The initial stage of established periodontitis</td>
<td>Simple true</td>
<td>Oral hygiene instruction, scaling and polishing, gingivectomy in relation to simple pockets.</td>
</tr>
<tr>
<td>6</td>
<td>Loss of supporting tissue in excess of Code 4, but less than half the length of the root of the tooth</td>
<td>Simple, true, and compound</td>
<td>Oral hygiene instruction, scaling and polishing, gingivectomy in relation to compound pockets.</td>
</tr>
<tr>
<td>8</td>
<td>Loss of supporting tissues in excess of half the length of the root of the tooth</td>
<td>Simple, true, and compound</td>
<td>Flap surgery in relation to compound pockets.</td>
</tr>
</tbody>
</table>

Table 2.8 Treatment need indications according to the Periodontal Index [PI]. (MacPhee, 1967)
While the system made use of five codes to describe the periodontal status, these were condensed into only three combinations of treatment. Despite this, the system made clear indications of the treatment required, a criticism of other treatment need systems of the period.

Broadly based on the system devised by MacPhee (1967), the Periodontal Treatment Requirement Index (PTR) of Newcomb (1975) was devised to assess periodontal treatment needs of Australian defense personnel. Following a detailed examination which included periapical and bitewing radiographs, the highest (worst) finding in each sextant was scored. This approach closely parallels the modifications being made during this period to WHO periodontal treatment need indices to permit greater quantification of needs (Barmes, 1976). Furthermore, it is interesting to note that in Newcomb's study, individual treatment needs were reported in a manner akin to standard CPITN reporting (see section 3.2.9) whereby both the highest (worst) PTR score (PTR-W) and the mean number of sextants, in this case requiring periodontal surgery, were reported.

The treatment indicated by the PTR is very dependent on different surgical approaches combined in certain instances with occlusal equilibration which is perhaps a reflection of periodontal treatment philosophies current at that time. Furthermore, the recommendations concerning the subdivision of tasks into those performed by specific dental personnel such as therapy performed by hygienists or specialists would not be compatible with delivery systems in many countries where these personnel may not exist. The scoring criteria for the (PTR) are detailed overleaf (Table 2.9).

Application of the PTR to a group aged 18-54 years revealed all to be in need of periodontal treatment with 60% requiring periodontal surgery in one or more sextants which is unremarkable considering the index's strong emphasis on surgical treatment. Comparison between the mean PI (Russell, 1956) and the PTR-W showed that as the PI increases, there is a greater need for more complex treatment which is to be expected as the PTR follows much the same schema as the PI. Unfortunately, Newcomb's subgrouping of individuals according to mean PI does not follow that proposed by Russell (1967) relating to conversion factors (see section 2.5), preventing direct comparisons.
Neither the index of MacPhee (1967), nor the PTR make specific recommendations concerning either treatment time or personnel requirements. Newcomb points out however that as 54% of sextants only required improved oral hygiene and scaling that this emphasises the value of hygienists in the provision of treatment.

<table>
<thead>
<tr>
<th>Code</th>
<th>Clinical findings</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Healthy gingivae with no calculus</td>
<td>None</td>
</tr>
<tr>
<td>1</td>
<td>Oedematous gingivitis and/or calculus. Calculus present and/or enlarged oedematous gingivae, false pockets, changes in colour and consistency, and bleeding on blunt probing. Normal radiological appearance.</td>
<td>Scale and polish Oral hygiene instruction Subgingival curettage if necessary</td>
</tr>
<tr>
<td>2</td>
<td>Fibrous gingivitis. Fibrous hyperplasia, false pockets, changes in colour and consistency, and bleeding on blunt probing. Normal radiological appearance.</td>
<td>Scale and polish Oral hygiene instruction Gingivoplasty</td>
</tr>
<tr>
<td>3</td>
<td>Early periodontitis. Slight loss of attachment with shallow pockets not extending to the mucogingival junction; gingival changes as above. Radiographs show some bone resorption of the alveolar crest.</td>
<td>Scale and polish Oral hygiene instruction Occlusal equilibration, if necessary Mucogingival surgery, osseous surgery, or subgingival curettage.</td>
</tr>
<tr>
<td>4</td>
<td>Established gingivitis. Periodontal pockets which may or may not extend beyond the mucogingival junction; teeth may appear slightly loose. Radiographs show bone resorption which does not exceed half the length of the root; vertical bone defects may be visible.</td>
<td>Scale and polish Oral hygiene instruction Gingivectomy, minimal flap surgery or subgingival curettage.</td>
</tr>
<tr>
<td>5</td>
<td>Severe established periodontitis. Deep pockets usually beyond the mucogingival junction; the teeth may be loose but there is no loss of function. Radiographs show bone resorption which exceeds half the length of the root and involves the furcation of multirooted teeth; vertical bone defects may be visible.</td>
<td>Scale and polish Oral hygiene instruction Occlusal equilibration, if necessary Mucogingival surgery, osseous surgery including bone grafting if necessary or subgingival curettage.</td>
</tr>
<tr>
<td></td>
<td>Terminal periodontitis. Deep pockets approaching the root apex; very loose teeth causing loss of function. Radiographs show extreme horizontal and vertical bone loss indicating that the prognosis is hopeless.</td>
<td>Extraction.</td>
</tr>
</tbody>
</table>

Table 2.9 The Periodontal Treatment Requirement Index [PTR]. (Newcomb, 1975)
Chapter 2 - The assessment of periodontal treatment needs

In assessing the treatment needs of 15-year-olds, Bowden et al., (1973) defined needs according to three categories of increasingly complex treatment based upon the existing structure of dental care providers in the United Kingdom National Health Service system. In addition, as the treatment of individuals with evidence of periodontal destruction was considered to be a priority, the part-mouth clinical examination involved the probing of sites most likely to show loss of attachment in such an age group, namely the mesio-buccal of first molars and disto-buccal of all incisors. Treatment need was based upon the presence of marginal gingival inflammation as evidenced by gingival bleeding on gentle probing (Gingival Index scores 2 or 3), or periodontitis (loss of attachment of 1 mm or more on at least one tooth). Because supragingival calculus was almost always found in association with subgingival calculus in the sites examined, subgingival calculus alone was used as the indicator for scaling (Group 2). Excluding those individuals where no periodontal treatment was considered necessary, individuals were categorized into three groups, as follows:

<table>
<thead>
<tr>
<th>Group</th>
<th>Clinical findings</th>
<th>Treatment Indicated</th>
<th>Personnel required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Periodontal disease associated with oral debris</td>
<td>Oral hygiene instruction</td>
<td>Hygienist</td>
</tr>
<tr>
<td>2</td>
<td>Periodontal disease associated with subgingival calculus</td>
<td>Oral hygiene instruction and scaling</td>
<td>Hygienist</td>
</tr>
<tr>
<td>3</td>
<td>Considerable degree of periodontal destruction (i.e. loss of attachment of at least 2 mm on at least one tooth)</td>
<td>Oral hygiene instruction, scaling and review</td>
<td>Hygienist and review by dentist</td>
</tr>
</tbody>
</table>

Table 2.10 Treatment need indications according to clinical findings. (Bowden et al., 1973)

In the context of identifying teenagers with loss of attachment (bone loss) as a treatment priority, members of the same group tested the sensitivity and specificity of gingival bleeding, plaque and calculus as predictors of loss of attachment (Lennon & Davies, 1975). They found that with an increase in the number of teeth scored positively for each predictor (the screening level), the specificity increased but the sensitivity decreased. Subgingival calculus was found to have the highest specificity and lowest sensitivity while conversely, the presence of plaque had the lowest specificity. As none of the criteria had both high sensitivity and specificity, the authors suggested that the choice of predictor/s depend upon "the public's and profession's attitudes to the disease, the effectiveness of available treatments and the resources available". Downer et al., (1979) were later to define a need for periodontal treatment in 11-14 year olds as:
supragingival accretions (plaque or supragingival calculus) on at least 11 sites, five or more sites with gingivitis (bleeding) or two or more sites with subgingival calculus, scored according to Lennon & Davies (1975). The periodontal treatment needs so derived, were expressed as a mean Resource Related Index [RRI](Hill, 1974) an index designed to produce objective estimates of the comparative amount of finance needed to provide dental care for populations.

2.6.2 The Periodontal Treatment Need System (PTNS)

In 1973, Johansen et al., published details of the Periodontal Treatment Need System (PTNS). This system could be considered a landmark in the development of periodontal treatment need indices as it represented the first real attempt to design an index which would give a direct indication of treatment requirements, these being both quantifiable and time related. A thorough review of the PTNS is warranted as many of the concepts of the system were later to be incorporated into the CPITN.

In designing the PTNS, the authors considered that the following requirements must be fulfilled:

- The method should be useful for evaluating the need for periodontal treatment;
- The therapeutic procedures should be classified and related to time;
- A basis for calculation of manpower and costs in delivering the necessary treatment should be provided;
- The method should be simple and quick in field studies.

i. The PTNS, method of use

The PTNS relies upon defined diagnostic criteria to determine treatment needs based on three standardised therapeutic procedures, namely: motivation and oral hygiene instruction (OH); scaling and/or elimination of overhangs (Sc); and, periodontal surgery (Su). The clinical criteria used are: (i) the presence of supragingival plaque and gingivitis; (ii) calculus and/or overhangs; and (iii) pathological pockets. The diagnostic criteria for the PTNS and related treatment time estimates are summarized in Table 2.11.
Chapter 2 - The assessment of periodontal treatment needs

The scoring system adopts the mouth as the unit for oral hygiene instruction and motivation (OH), which can be given alone or together with other classes of treatment. The unit for scaling/removal of overhangs (Sc), and surgery (Su) is the quadrant, defined as a segment containing 4 - 8 teeth. The presence of periodontal pockets is determined by probing all surfaces of all teeth in a quadrant. The highest (worst) score for a quadrant is recorded, so that irrespective of the location of the gingival margin, if a probing depth greater than 5 mm is detected, the quadrant is assigned a score C. In the absence of such probing depths, a score of B is assigned when calculus and/or overhangs are present, and a score of A if only plaque and gingivitis are detected. The system assumes that any quadrant scoring 'C' will also require Class A and B treatment, similarly, a quadrant scoring 'B' will require Class A treatment.

<table>
<thead>
<tr>
<th>PTNS Classification</th>
<th>Unit</th>
<th>Plaque</th>
<th>Calculus and/or overhang</th>
<th>Inflammation</th>
<th>Probing depth</th>
<th>Treatment indicated</th>
<th>Treatment time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 0</td>
<td>Mouth</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Not considered</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Class A</td>
<td>Mouth</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>≤5 mm</td>
<td>Motivation &amp; oral hygiene (OH)</td>
<td>60 mins.</td>
</tr>
<tr>
<td>Class B</td>
<td>Quadrant</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>≤5 mm</td>
<td>Scaling &amp; removal of overhangs (Sc)</td>
<td>30 mins/quadrant + OH time.</td>
</tr>
<tr>
<td>Class C</td>
<td>Quadrant</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>&gt;5 mm</td>
<td>Periodontal surgery (Su)</td>
<td>60 mins/quadrant + OH, scaling &amp; overhang removal time</td>
</tr>
</tbody>
</table>

In order to prevent an over-estimation of treatment needs: less than 8 teeth in a jaw are scored as only one quadrant; four or less teeth in a mouth are scored as only one quadrant; only 'true' pockets due to loss of attachment on the distal surfaces of last molars are scored 'C' for that quadrant; and, a pocket deeper than 5 mm detected mesial to the central incisors is not scored 'C' when it is the only such pocket found in that quadrant, provided the adjacent quadrant has been scored as 'C'.

The treatment time guidelines were derived from timings for periodontal treatment delivered by a single periodontist with chairside assistance to a group of 42 adult
patients attending the Dental Faculty, University of Oslo (Johansen et al., 1973), where, according to the PTNS, all patients required motivation and oral hygiene (OH), 41 patients required scaling (Sc) in 158 quadrants, while 31 patients required surgery (Su) in 74 quadrants. The guidelines suggest that dependant upon the extent and complexity of treatment, the total treatment time per patient could range from 1 to 7 hours.

ii. Modifications to the PTNS

While adopting the broad tenets of the PTNS, a number of studies have modified either the clinical criteria or treatment indications of the system. For example, Heløe (1973), in a survey investigating the oral health status of a group of disadvantaged, rural dwellers in Norway, was able to derive PTNS scores from the scoring of the Oral Hygiene Index [OHI] (Greene & Vermillion, 1964), the Gingival Index [GI] (Loe & Silness, 1963) and the probing depth. In addition, both the treatment need indications and the treatment time guidelines were modified, these being appropriately based upon data from dentists working in both the public health and private sector in Sweden and Norway, as detailed below:

<table>
<thead>
<tr>
<th>Classification</th>
<th>Unit</th>
<th>Clinical Criteria</th>
<th>Treatment Indicated</th>
<th>Treatment Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 0</td>
<td>Mouth</td>
<td>OHI, GI &amp; CI = 0, probing depth &lt;4 mm.</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Class 1</td>
<td>Mouth</td>
<td>OHI &gt;0</td>
<td>Motivation &amp; oral hygiene instruction</td>
<td>30 mins.</td>
</tr>
<tr>
<td>Class 2a</td>
<td>Mouth</td>
<td>CI or GI &gt;0</td>
<td>Supragingival scaling</td>
<td>60 mins*</td>
</tr>
<tr>
<td>Class 2b</td>
<td>Quadrant</td>
<td>One or more pockets ≥4 mm.</td>
<td>Subgingival scaling and removal of overhangs</td>
<td>60 mins.</td>
</tr>
<tr>
<td>Class 3</td>
<td>Quadrant</td>
<td>One or more pockets &gt;5 mm.</td>
<td>Periodontal surgery</td>
<td>60 mins.</td>
</tr>
</tbody>
</table>

* The treatment time for supragingival scaling was not added when subgingival scaling was needed in two or more quadrants.

Table 2.12 Modified criteria for the PTNS (Heløe, 1973)

No reasons were however given by the author for making these modifications, however the subdivision of scaling (PTNS Class B) according to its extent and complexity, class 2a and 2b, might have allowed a more precise estimation of treatment time than that provided by the original PTNS.
Chapter 2 - The assessment of periodontal treatment needs

In evaluating the periodontal status and needs of a Finnish industrial population, Markkanen (1978, 79) modified both the clinical criteria and the treatment time guidelines of the PTNS so that the premises of the system reflected Finnish periodontal practice, as detailed below:

<table>
<thead>
<tr>
<th>Classification</th>
<th>Unit</th>
<th>Clinical Criteria</th>
<th>Treatment Indicated</th>
<th>Treatment Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 0</td>
<td>Mouth</td>
<td>GI = 0, no probing depths &gt;4 mm.</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Class 1</td>
<td>Mouth</td>
<td>GI ≥ 1, no probing depths &gt;4 mm.</td>
<td>Motivation &amp; oral hygiene instruction</td>
<td>30 mins.</td>
</tr>
<tr>
<td>Class 2</td>
<td>Quadrant</td>
<td>Plaque retentions (supra and/or subgingival calculus, overhangs), no probing depths &gt;4 mm.</td>
<td>Scaling and removal of overhangs + Class A treatment</td>
<td>30 mins.</td>
</tr>
<tr>
<td>Class 3</td>
<td>Quadrant</td>
<td>Probing depths &gt;4 mm.</td>
<td>Periodontal surgery + Class A &amp; B treatment</td>
<td>60 mins.</td>
</tr>
</tbody>
</table>

Table 2.13 Modified criteria for the PTNS (Markkanen et al., 1978, 79)

Unlike the original PTNS (Johansen et al., 1973), the need for motivation and oral hygiene instruction with this modified system was based solely on the presence of gingival inflammation as assessed by the Gingival Index (Löe & Silness, 1963), irrespective of the presence of plaque. Furthermore, the need for periodontal surgery, was based on probing depths >4 mm instead of >5 mm, with the possible implication of a greater proportion of a population being indicated for surgery. Appropriately, treatment time guidelines were based on data from Finnish periodontists collected by means of a questionnaire.

For the Mini-Finland Health Survey, Markkanen et al. (1983) made further revisions to the original PTNS in terms of both clinical criteria and treatment need indications. The clinical scoring of each quadrant was modified such that the indicator for periodontal surgery was increased from probing depths >5 mm (Johansen et al., 1973) to >6 mm, possibly to make the criteria more compatible with recommendations in WHO Technical Report Series 621 [TRS 621] (WHO, 1978) (see section 2.7.4). In addition, plaque retentive factors were scored separately and classified according to whether they comprised either supra- or sub-gingival calculus or overhanging restorations. This method of data collection permitted estimations of treatment needs and times to be made, based: a) solely on clinical status; or, b) on clinical status, but taking into account plaque retentive factors; or c) according to recommendations in TRS 621 (WHO, 1978).
The details of these modifications are summarized in the following table:

<table>
<thead>
<tr>
<th>Periodontal condition</th>
<th>Plaque retention</th>
<th>Alternative 1 Rx. need based only on clinical status *</th>
<th>Alternative 2 Rx. need based also on retentive factors *</th>
<th>Alternative 3 Rx. need based on WHO TRS621 **</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No inflammation</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>Nil</td>
<td>Sc</td>
<td>OHE + Sc</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inflammation</td>
<td>No</td>
<td>OHE</td>
<td>OHE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>OHE + Sc</td>
<td>OHE + Sc</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pockets 4-6 mm</td>
<td>No</td>
<td>OHE + Sc</td>
<td>OHE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>OHE + Sc</td>
<td>OHE + Sc</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pockets &gt;6 mm</td>
<td>No</td>
<td>OHE + Sc + Su</td>
<td>OHE + Su</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>OHE + Deep Sc + Su</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Where:  
OHE = Oral hygiene instruction,  
Sc = Scaling & removal of overhangs,  
DeepSc = Deep scaling & removal of overhangs,  
Su = Periodontal surgery.  
* = Time estimates based upon Markkanen (1978)(see above)  
** = Time estimates based upon WHO TRS 621 (see Chapter 5)

Table 2.14 Modified criteria for the PTNS (Markkanen et al., 1983).

Mean overall treatment times derived from the three methods given above showed considerable differences ranging from 112 min/person for Alternative 1, to 195 min/person for Alternative 3. Naturally such large differences could have considerable implications were these time estimates used for resource and manpower planning and it is regrettable that further studies were not performed to establish which alternative, if any, served as the best predictor of treatment time.

Minor modifications to the PTNS have also been reported by Christensen et al., (1984), who used the index to study the periodontal treatment needs of 35-44 years olds in Copenhagen, Denmark. In order to provide data for a longitudinal study, all teeth were scored separately, the highest score for a quadrant being computer derived. An additional score, the score D, was used for teeth with advanced destruction of the supporting tissues and loss of masticatory function, however the treatment implication of such a score was not defined.

iii. Surveys using the PTNS

While being innovative in its design as a periodontal treatment need index, the PTNS failed to gain widespread adoption and with few exceptions has been used principally for surveys in Scandinavia, often in a modified form as outlined above. These modifications
cause problems when comparing between different studies; which are further compounded because of non-standardized methods of reporting and differences in age ranges. Table 2.15 summarizes studies where the percentage of persons requiring different levels of treatment according to the PTNS have been reported.

The studies of Hansen & Johansen (1977) and Christensen et al., (1984) serve as examples of the application of the PTNS to population groups of a similar age. Certain trends can be observed, the most notable being that only negligible proportions of persons were assessed as healthy. Moreover, over one-half of persons were indicated as requiring scaling with an additional one-third to one-half also requiring surgery.

<table>
<thead>
<tr>
<th>Author</th>
<th>Country</th>
<th>Age</th>
<th>N</th>
<th>O</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hansen &amp; Johansen</td>
<td>Norway</td>
<td>35</td>
<td>116</td>
<td>2%</td>
<td>8%</td>
<td>52%</td>
<td>38%</td>
<td>Caucasians only</td>
</tr>
<tr>
<td>Hansen et al.</td>
<td>Norway</td>
<td>35</td>
<td>144</td>
<td>&lt;12%</td>
<td>---</td>
<td>65%</td>
<td>23%</td>
<td>Caucasians only</td>
</tr>
<tr>
<td>Christensen et al.</td>
<td>Denmark</td>
<td>35-44</td>
<td>294</td>
<td>1%</td>
<td>0%</td>
<td>58%</td>
<td>49%</td>
<td>Modified PTNS</td>
</tr>
<tr>
<td>Mann et al.</td>
<td>Israel</td>
<td>18-25</td>
<td>830</td>
<td>3%</td>
<td>17%</td>
<td>66%</td>
<td>14%</td>
<td>Institutionised handicapped.</td>
</tr>
<tr>
<td>Mann et al.</td>
<td>Israel</td>
<td>3-22</td>
<td>45</td>
<td>4%</td>
<td>31%</td>
<td>47%</td>
<td>18%</td>
<td>Modified PTNS</td>
</tr>
<tr>
<td>Maseman et al.</td>
<td>USA</td>
<td>21-91</td>
<td>102</td>
<td>0%</td>
<td>3%</td>
<td>22%</td>
<td>75%</td>
<td></td>
</tr>
<tr>
<td>Markkanen et al.</td>
<td>Finland</td>
<td>18-62</td>
<td>254</td>
<td>3%</td>
<td>19%</td>
<td>71%</td>
<td>7%</td>
<td>Modified PTNS</td>
</tr>
</tbody>
</table>

Table 2.15 Percentage of persons needing different types of treatment according to the PTNS

While not being totally comparable, Markkanen et al. (1983), using a modified PTNS, reported that less than 5% of 30-39 year olds were healthy, however a smaller proportion (15%) required surgery possibly because the indicator for surgery was increased from pockets >5 mm to those >6 mm. Overall, the general trends seen in these studies appear to be almost universal when the PTNS has been used in population surveys, irrespective of country or age group. The scoring of the PTNS on a quadrant basis permits further quantification of the amount of treatment required and corroborates the findings detailed above in terms of a considerable indicated treatment need. Table 2.16 summarizes studies where the percentage of quadrants requiring different levels of treatment according to the PTNS have been reported.
Table 2.16 Percentage of quadrants needing different types of treatment according to the PTNS

<table>
<thead>
<tr>
<th>Author</th>
<th>Country</th>
<th>Age</th>
<th>N</th>
<th>O</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bellini &amp; Gjermo (1973)</td>
<td>Norway</td>
<td>36-45</td>
<td>36</td>
<td>-</td>
<td>4%</td>
<td>54%</td>
<td>39%</td>
<td>Industrial employees</td>
</tr>
<tr>
<td>Johansen et al. (1975)</td>
<td>Norway</td>
<td>36-45</td>
<td>-</td>
<td>-8%</td>
<td>12%</td>
<td>65%</td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>Christensen et al. (1984)</td>
<td>Denmark</td>
<td>35-44</td>
<td>294</td>
<td>1%</td>
<td>1%</td>
<td>71%</td>
<td>27%</td>
<td></td>
</tr>
</tbody>
</table>

The PTNS would appear to be sensitive enough to monitor longitudinal changes in periodontal treatment needs. Markkanen et al., (1980b) over a one-year period, reported an overall reduction in periodontal treatment needs which were largely unrelated to socio-economic factors, dietary habits, dental health behaviour, dental visits or periodontal treatment received. Over a longer 11 year period, Hansen et al., (1990) reported a reduction in periodontal treatment needs due mainly to a decrease in the proportion of persons with deep pockets (PTNS Score C), and a coincident increase in the proportion of persons scoring A and B (see Table 2.15).

The relationship between the need for periodontal treatment, as determined by the PTNS, and other factors has also been investigated. Periodontal treatment need has been found to increase with age (Bellini & Gjermo, 1973; Johansen et al., 1975; Markkanen et al., 1980,83; Mann et al., 1984; Maseman et al., 1988), however Markkanen et al., (1983) in the Mini-Finland Health Survey reported that periodontal treatment need decreased after the age of 60 years, presumably due to loss of teeth. There is also a trend for periodontal treatment needs to be sex dependent with a higher proportion of males requiring surgical treatment (Mann et al., 1980; Markkanen et al., 1983; Christensen et al., 1984), in more quadrants (Bellini & Gjermo, 1973; Johansen et al., 1975; Christensen et al., 1984); conversely a higher proportion of females are assessed as healthy (Mann et al., 1980; Markkanen et al., 1983; Christensen et al., 1984). In contradistinction, Markkanen (1978) and Hansen & Johansen (1977), failed to identify any sex related differences in treatment need; similarly, the follow-up to the latter study (Hansen et al., 1990) found the prevalence of persons with a score C to be unaffected by gender.

In addition to age and sex influencing treatment needs as assessed by the PTNS, other factors may also be important including: the number of teeth (Markkanen et al.,
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1980a,83), the caries and filling score (Markkanen et al., 1983) and educational level (Markkanen et al., 1980,83). Toothbrushing frequency appears to have minimal or no effect on treatment needs (Markkanen et al., 1978,80a,83; Hansen et al., 1990), however a lower mean number of quadrants scoring C in persons with low OHI-S scores has been reported (Hansen et al., 1990). No clear differences in treatment need have been reported according to income (Bellini & Gjermo, 1973; Markkanen et al., 1978,83), occupation (Markkanen et al., 1978; Christensen et al., 1984) and diet (Markkanen et al., 1983). Furthermore, Hansen et al., (1990) found that educational level, dental health behaviour, self-expressed need for treatment, health attitude and smoking habits had no influence on the mean number of quadrants scoring C. Similarly, Markkanen et al., (1985) found smoking had only a minor effect on treatment needs.

It might be expected that previous dental treatment would influence periodontal treatment needs and both Christensen et al., (1984) and Hansen et al., (1990) have reported the number of quadrants with a score C to be lower amongst those who visited the dentist regularly. Conversely, Markkanen et al., (1980a, 83) reported that dental visit frequency had a negligible effect on periodontal treatment need. Unlike Hansen & Johansen (1990), Christensen et al., (1984) found a higher prevalence of both persons and quadrants with a score C for those persons who had received periodontal treatment. These findings taken aside, it is of particular note that despite regular dental visits and/or receipt of periodontal treatment, the PTNS still indicates a considerable periodontal treatment need, for example, 99% of the sample in Christensen's study had gingivitis and calculus or pocket formation regardless of frequency of dental visits.

iv. Appraisal of the PTNS

The PTNS (Johansen et al., 1973) was designed to be a simple, reproducible, and rapid means of estimating periodontal treatment needs and the associated time and resources required for the provision of that treatment.

The application of the PTNS in surveys has proven the system to be simple, quick to apply and to require little equipment (Bellini & Gjermo, 1973; Johansen et al., 1975; Markkanen et al., 1985 [modified PTNS]). In addition, both inter- and intra-examiner reproducibility of the system expressed as either percentage agreement, Cohen's kappa or weighted kappa (Fleiss et al., 1969) appears to be high (Johansen et al., 1973; Christensen et al., 1984; Markkanen et al., 1979,85) (see Table 2.17). Reproducibility does decrease when repeat examinations are delayed for 2 to 6 months (Markkanen et
possibly attributable to actual changes in periodontal status.

<table>
<thead>
<tr>
<th>Author</th>
<th>Type</th>
<th>Time Interval</th>
<th>Agreement</th>
<th>Kappa</th>
<th>Weighted Kappa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johansen et al. (1973)</td>
<td>Interexaminer</td>
<td>Not specified</td>
<td>97%</td>
<td>Not specified</td>
<td>Not specified</td>
</tr>
<tr>
<td>Christensen et al. (1984)</td>
<td>Intraexaminer</td>
<td>Not specified</td>
<td>= 90%</td>
<td>Not specified</td>
<td>Not specified</td>
</tr>
<tr>
<td>Markkanen et al. (1979)</td>
<td>Intraexaminer</td>
<td>2 weeks</td>
<td>84%</td>
<td>0.76 ± 0.18</td>
<td>0.80 ± 0.18°</td>
</tr>
<tr>
<td>Markkanen et al. (1985)</td>
<td>Intraexaminer</td>
<td>2-6 month interval</td>
<td>71%</td>
<td>0.56 ± 0.07</td>
<td>0.67 ± 0.05&quot;</td>
</tr>
<tr>
<td></td>
<td>Interexaminer</td>
<td>2-6 month interval</td>
<td>80%</td>
<td>0.69 ± 0.06</td>
<td>0.77 ± 0.05&quot;</td>
</tr>
</tbody>
</table>

* Inconsistencies weighted as follows:
  Healthy = 0
  Plaque retentions = 3
  Inflammation = 1
  Pockets >4 mm = 7

** Inconsistencies weighted as follows:
  Healthy = 0
  Pockets 4-6 mm = 3
  Pockets >6 mm = 7

Table 2.17 The reproducibility of the PTNS (original and modified systems).

In assessing the applicability of the PTNS, Johansen et al., (1973), in a hospital environment, and Bellini & Gjermo (1973), in an industrial population, considered the system provided an estimate of the type(s) of periodontal treatment required and thus the time required to perform it, thereby permitting manpower and costs to be calculated.

The PTNS has however been considered to be deficient in a number of respects. With respect to treatment needs, the system assesses these as being required on a once only basis with no provision being made for maintenance after preliminary treatment or for recurrent disease (Bellini & Gjermo, 1973; O'Leary, 1976; Markkanen et al., 1983 [modified PTNS]), an obvious limitation when the system is used longitudinally in a population group (Gjermo, 1976). In addition, the system does not make any allowance for detailed examination of the individual patient, including the time, equipment and personnel for radiographs (Gjermo, 1976), nor the need for extraction for periodontal disease, occlusal therapy or prosthetic treatment for periodontal health (Markkanen et al., 1973 [modified PTNS]).
Chapter 2 - The assessment of periodontal treatment needs

In reviewing the PTNS, Gjermo (1976) commented that the treatment classes, criteria and definitions of the PTNS were based upon Norwegian conditions, however Ekanayaka & Sheiham, (1978) have pointed out that other countries have different treatment philosophies, and different ranges of patients. In this context, O'Leary (1976) questioned the use of probing depths alone in determining surgical treatment need, while Ekanayaka & Sheiham (1978) expressed concern about the use of probing depths greater than 5 mm as an indicator for surgery. In addition, it is interesting to note that Heløe (1973), Christensen et al., (1984) and Markkanen et al., (1983), all made modifications to the treatment need indications of the PTNS, although they were all working in Scandinavian countries with fairly similar dental care provision systems.

Concern has also been shown over the treatment time guidelines recommended by the PTNS. These were based on times for a single periodontist working in a University clinic, however when they were compared with the average time per quadrant required for scaling and for surgery performed by six different dentists working under the same standardized conditions (Bellini & Johansen et al., 1973), the treatment times were found to be significantly less. Thus, application of the PTNS under these conditions might result in some overestimation of treatment time requirements. In spite of this finding, Bellini & Gjermo (1973) considered it possible to calculate good treatment time estimates for a group of Norwegian industrial employees although this assumption was never evaluated. Ainamo (1984) supported the system as permitting a fair estimate of the treatment time needed per adult patient, perhaps because of the similarities in working conditions found in Scandinavian countries, but considered that the PTNS might overestimate treatment time in children and young age groups with only minimal calculus. Nevertheless, both Heløe (1973) and Markkanen et al., (1978,79,83), working in Norway and Finland respectively, in addition to modifying treatment need indications of the PTNS, also modified the treatment time guidelines. Reservations concerning the applicability of PTNS treatment time guidelines for populations other than in Scandinavia have been expressed by O'Leary (1976) and Ekanayaka & Sheiham (1978). In this respect, Gjermo et al. (1983) developed a system of 'time units' for use with the PTNS instead of specific treatment times as it was considered that these would vary with local conditions. Thus, by deriving the proportion of time required for different components of periodontal treatment from data collected when developing the PTNS (Johansen et al. 1973) it was possible to determine the number of 'time units' required to provide treatment.
Johansen et al., (1973) and Gjermo (1976) suggest that as the PTNS treatment classifications are estimated separately, optimal blends of different categories of dental health personnel can be made according to the regional availability of personnel, salaries and the calculation of costs according to different alternatives. Such estimations made by applying the system to an industrial population demonstrated the advantages of using auxiliary personnel in the delivery of periodontal treatment (Bellini & Gjermo, 1973). However, when a modified PTNS was used to predict treatment services and cost of a subsidized dental programme for disadvantaged individuals in Norway, Heløe (1974) reported a considerable over-estimation of cost, possibly due to an over-estimation of treatment times, failure of dentists to claim fees for some periodontal treatment or the failure to deliver adequate treatment. He suggested that the PTNS was "...more suitable for obtaining idealistic rather than realistic estimates" and that "the system should undergo further testing and modification before it can be used as a guideline for stipulating time and cost of treatment provided in general practice".

Despite the potential inadequacies of the PTNS, in a working paper reviewing indices used for assessing treatment needs, prepared for the 1977 Moscow meeting of the WHO Scientific Group on Epidemiology, Aetiology and Prevention of Periodontal Diseases, Horowitz (1979) considered that the PTNS, at that time, was the only periodontal treatment need index which dealt with the problems of time requirement and the types of treatment required. The system was no doubt considered to be an important development however, because the clinical criteria, the examination procedure and the method of calculating the treatment time requirements from the PTNS were included in the WHO manual entitled "A Guide to Oral Health Investigations" (WHO, 1979).

Lastly, Hansen et al., (1990) while using the PTNS to evaluate changes in periodontal disease indicators in 35-year-old Oslo citizens over an 11 year period accepts that "new concepts of the aetiology and pathogenesis of periodontal diseases question the validity of the PTNS for assessing treatment need on a population level".
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2.6.3 The Periodontal Profile Score (PPS)

The Periodontal Profile Score (PPS) was developed by Spolsky et al., (1974) as a simple method for estimating the periodontal treatment needs of participants in the Rand Health Insurance Experiment. The need for professional treatment was assumed only when calculus and pockets were present according to the following scores:

<table>
<thead>
<tr>
<th>Code</th>
<th>Clinical findings</th>
<th>Treatment</th>
<th>Time estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Only isolated gingivitis and no calculus</td>
<td>No professional intervention needed</td>
<td>35 - 45 min. by dental hygienist or dentist</td>
</tr>
<tr>
<td>1</td>
<td>Gingivitis and overt calculus</td>
<td>Thorough teeth cleaning needed</td>
<td>No more than 2 appointments</td>
</tr>
<tr>
<td>2</td>
<td>Periodontal pockets</td>
<td>Prophylaxis, gingival curettage</td>
<td>At least three appointments</td>
</tr>
<tr>
<td>3</td>
<td>Numerous periodontal pockets, calculus, gingivitis</td>
<td>Prophylaxis, curettage, and probably some surgery</td>
<td></td>
</tr>
</tbody>
</table>

Table 2.18 The Periodontal Profile Score [PPS]. (Spolsky et al., 1974)

Irrespective of the treatment indicated, needs were assessed for the whole mouth and thus the index lacked the quantification of the PTNS. While there were indications of the amount of time which should be allocated for each treatment need code, these were poorly defined. Furthermore, the index lacked objective definitions of what constituted 'gingivitis' or a 'periodontal pocket'. The authors of this index did however caution that the PPS was still in the development stage and had not been subjected to any reliability or validity testing.

2.6.4 The Periodontal Screening Index (PSI)

One of the criticisms levied against the PTNS by Ekanayaka (1976) was the lack of simple, straightforward and easily applied criteria to screen patients rapidly into treatment categories. The PSI (Ekanayaka, 1976) was an attempt to correct these deficiencies by combining the treatment categories of the PTNS with components of the Gingival Periodontal Index (O'Leary, 1967b) and its modification by Davies et al. (1974)(see section 2.7.1). The need for oral hygiene instruction was based solely on the objective sign of bleeding after probing, thus dispensing with plaque assessments. Compared to the PTNS, the need for scaling and surgery was assessed by sextants thereby conferring a greater degree of quantification. Calculus was assessed dichotomously in each
sex tant scoring buccal and lingual aspects separately. Unlike the PTNS which used a probing depth of 5 mm as a determinant for periodontal surgery, the PSI deliberately avoided such rigid criteria to enable retrospective decisions to be made concerning the need for surgery according to treatment philosophy. The criteria for the PSI are detailed below:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Unit</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient motivation</td>
<td>Mouth</td>
<td>The presence of one or more BLEEDING POINTS when the entrance to the gingival crevice is probed with a blunt periodontal probe. All 4 sides of each tooth are probed until bleeding is observed from any one margin. Even a single bleeding point will cause the mouth to be classified as positive for this criterion</td>
</tr>
<tr>
<td>Scaling</td>
<td>The mouth is divided into sextants each divided into buccal and lingual aspects to give a total of 12 units</td>
<td>Each unit is scored for the presence of one or more deposits of visible supragingival or subgingival calculus that can be detected with a calculus probe</td>
</tr>
<tr>
<td>Surgery</td>
<td>The 6 segments described above without division into buccal and lingual aspects</td>
<td>The mesiobuccal line angle of each tooth is probed. The deepest pocket is recorded for each segment. Probing is carried out in the long axis of the tooth and measurements made to the nearest mm from the gingival margin to the bottom of the pocket</td>
</tr>
</tbody>
</table>

Table 2.19  The Periodontal Screening Index [PSI]. (Ekanayaka, 1976)

Inter-examiner reproducibility was assessed as being high (97%) for patient motivation, however percentage agreement fell to 79% for calculus scores. Probing depth measurements coincided in only 52% of sextants, however 79% were within 1 mm and 94% within 2 mm of each other which emphasises a potential problem with predefined 'cut-off' points for periodontal surgery. The author suggested that further studies were required to validate the screening levels of the index and that these should be related to treatment time averages. This was however preempted by the TRS 621 method, proposed by WHO two years later (see section 2.7.4) which bears a degree of similarity to the PSI.

2.6.5 The Periodontal Screening Examination (PSE)

An index which gained relatively wide use amongst practising dentists, particularly in the United States, was the Periodontal Screening Examination (PSE), described by Oliver (1976,77) as "a rapid, simple periodontal screening examination with distinct treatment guidelines". This index was similar to the PSI (Ekanayaka, 1976) in the use of bleeding
and probing depths to determine treatment needs, but the PSE also included an assessment of furcation involvement and mobility. Moreover, instead of sextant scoring, each tooth was scored separately after probing at mesio-buccal and disto-buccal line angles, a mode of scoring selected over a 'more reliable' part mouth scoring at six sites of all posterior teeth on the grounds of being faster, more accurate and acceptable to all dental personnel (see section 3.2.5). In spite of the finding that different dentists using the PSE correctly classified patients between 72-95% of the time, Ainamo (1984) considered the PTNS to be more reliable as it examines all surfaces of all teeth. Furthermore, the PSE gave clear guidelines on the types of treatment needed but unlike the PTNS also included information on the nature of personnel required. Patients were classified into four distinct categories, as follows:

<table>
<thead>
<tr>
<th>Classification</th>
<th>Clinical Criteria</th>
<th>Treatment and Personnel Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>No bleeding after probing, no sulcus over 3 mm in depth, bucco-lingual mobility of 0.5 mm or less, no furcation involvement.</td>
<td>No treatment required.</td>
</tr>
<tr>
<td>Gingivitis</td>
<td>Bleeding on probing, with the other characteristics of normal.</td>
<td>Oral hygiene instruction and prophylaxis (if calculus or stain present) (Hygienist)</td>
</tr>
<tr>
<td>Moderate periodontitis</td>
<td>Pocket depth of 3 - 5 mm, mobility of 1.0 mm or less, incipient furcation involvement.</td>
<td>Oral hygiene instruction, scaling, root planing, curettage and may include occlusal adjustment. This is followed by re-evaluation for further treatment, referral or recall.</td>
</tr>
<tr>
<td>Advanced periodontitis</td>
<td>Pocket depth of over 5 mm, mobility of over 1 mm, and furcation involvement at least halfway through.</td>
<td>Immediate referral to a specialist or a more comprehensive examination and treatment.</td>
</tr>
</tbody>
</table>

Table 2.20 The Periodontal Screening Examination [PSE]. (Oliver, 1976,77)

A probing depth of 5 mm was selected as the criterion for specialist referral on the premise that pockets up to this depth could be maintained by plaque control combined with scaling and root planing. Surgery per se was not indicated by the criteria, and was mainly to be considered in sites failing to respond to non-surgical therapy, i.e. sites with persistent increased probing depth and bleeding. While primarily designed for individual patient evaluation, Oliver (1976) considered a form of PSE could be used in the community context.
2.6.6 Treatment need index of Gordon et al. (1986)

While treatment need indices such as the PSI (Ekanayaka, 1976) and the CPITN (Ainamo, 1982)(see Chapter 3) attempted to improve on examiner reliability by using objective signs such as bleeding after probing, it is somewhat surprising that Gordon et al., (1986) reverted to such clinical signs as gingival appearance, mobility and assessment of plaque in their estimation of the dental treatment needs of an Israeli military population. In addition to these clinical signs, panoramic radiographs were assessed for bone loss. Probing depth measurements were made only for patients with alterations in gingival appearance, mobility, or bone loss. Patients were classified into one of five treatment need categories as shown below:

<table>
<thead>
<tr>
<th>Code</th>
<th>Signs and symptoms</th>
<th>Treatment</th>
<th>Time estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No visible plaque, no gingivitis, and no bone loss.</td>
<td>No treatment indicated.</td>
<td>15 min.</td>
</tr>
<tr>
<td>2</td>
<td>Demonstrable plaque present and/or gingivitis, but no apparent bone loss.</td>
<td>Only oral hygiene required (Hygienist).</td>
<td>45-75 min.</td>
</tr>
<tr>
<td>3</td>
<td>Presence of plaque, gingivitis, and supra- and/or subgingival calculus seen clinically or in radiographs.</td>
<td>Oral hygiene instruction, scaling and root planing of deep pockets required (Hygienist).</td>
<td>75-105 min. (OH + S &amp; RP under LA); 75 min. (quadrant surgery).</td>
</tr>
<tr>
<td>4</td>
<td>Presence of plaque, gingivitis, and supra- and/or subgingival calculus seen clinically or in radiographs, plus bone loss involving half the root length and periodontal pockets greater than 5 mm on at least three surfaces of a tooth.</td>
<td>Oral hygiene instruction, scaling and root planing and localised surgery required.</td>
<td>75-105 min. (OH + S &amp; RP under LA); 75 min. (quadrant surgery).</td>
</tr>
<tr>
<td>5</td>
<td>Presence of plaque, gingivitis, and supra- and/or subgingival calculus seen clinically or in radiographs, plus bone loss involving half the root length and periodontal pockets greater than 5 mm on at least three surfaces of a tooth.</td>
<td>Oral hygiene instruction, scaling and root planing and multiple quadrant surgery required.</td>
<td>75-105 min. (OH + S &amp; RP under LA); 75 min. (quadrant surgery).</td>
</tr>
</tbody>
</table>

Table 2.21 The Treatment Need Index of Gordon et. al., (1986)

Oral hygiene scaling and root planing were indicated to be performed by hygienists however there was no indication as to whether periodontal surgery would be carried out by dentists or specialist periodontists. In common with the PTNS (Johansen et al., 1973), estimated treatment times were linked to each category of treatment thereby enabling the costs and personnel required to treat this population to be calculated. While standard WHO age groups were not used, it is noteworthy that application of this index in a group aged 20-46 years, 74% required solely oral hygiene scaling and root planing
while only 23% required periodontal surgery, the majority in only localized areas. These findings concur with other recent epidemiological findings that relatively few individuals experience severe periodontal disease.

Thus, since the first attempt to assess periodontal treatment needs by Cross (1952), there have been a number of treatment need indices which have been developed. None have gained widespread acceptance, with the possible exception of the PTNS (Johansen et al., 1973) and its modifications which have been used relatively widely in Scandinavian countries.

Paralleling the previously described methods used to measure periodontal treatment need by direct assessment has been the development of periodontal treatment need indices by the World Health Organization.

2.7 Periodontal treatment need indices developed by the World Health Organization (WHO)

In 1965, a WHO Scientific Group on Research in Dental Health recommended that WHO should give priority to the development of international epidemiology in dental health which would include both a uniform classification of dental and oral diseases and standardized methods for epidemiological studies. The former was achieved in part with the publication of the International Classification of Diseases - application to dentistry and stomatology [ICD-DA] (Munksgaard, Copenhagen, 1969), but it was not until 1971 that WHO published the first edition of Oral Health Surveys - Basic Methods which described how such surveys should be designed, conducted and reported (Barmes & Sardo Infirri, 1977).

2.7.1 The periodontal assessment in the WHO manual Oral Health Surveys - Basic Methods (WHO, Geneva, 1971)

One of the aims of the Oral Health Surveys - Basic Methods [OHS-BM1] manual, was to provide a method for collecting and reporting the basic oral health data needed for planning the nature and extent of services that would meet the dental health care needs of a local or national population. In the context of periodontal disease, a simple 'basic' method of assessment was described to provide this information, with an additional 'elective' assessment using the Periodontal Index [PI] (Russell, 1956) and the Simplified Oral Hygiene Index [OHI-S] (Greene & Vermillion, 1964) for those circumstances where
more detailed epidemiological information was required.

The 'basic' periodontal examination comprised a rapid assessment of the full mouth, using only a mouth mirror, measuring periodontal status in terms of (a) the condition of the periodontal tissues, (b) the need for extraction and loss of teeth due to the disease, and, (c) the presence of calculus. The former was scored as follows:

0 = The absence of intense gingivitis and destructive periodontal disease;
1 = The presence of intense gingivitis only;
2 = The presence of destructive periodontal disease.

As the 'basic' examination did not include periodontal probing, all assessments were based on visual criteria. Distinction between a score of 0 and 1 was made on the basis of colour changes and/or bleeding on digital palpation, while a score of 2 was assigned if there was periodontal pocketing as evidenced by loss of tone of the free gingiva, loss of stippling, alteration of gingival form or recession when accompanied by marked gingivitis. Teeth were indicated for extraction if, in the examiner's opinion, there was loss of function for which only extraction was possible, with a separate assessment being made for teeth assumed lost due to periodontal disease. Calculus was assessed on a simple dichotomous scoring system.

With the exception of teeth indicated for extraction, no specific details of how these data could be used to determine periodontal treatment needs was given in the manual. Barmes (1976) later pointed out that data from this 'basic' examination could be used to classify individuals into broad treatment categories for "it was reasoned that if a particular condition was present, even if it affected the periodontal tissues around only one tooth, the relevant treatment, either prophylaxis or periodontal therapy, was required for that patient". Furthermore, he suggested the separate scoring of calculus made it possible to "subdivide the prophylaxis treatment needs into those with and without a major scaling component".

In order to test the practicability and usefulness of the procedures recommended in this OHS-BM1 manual (WHO, 1971), Davies et al. (1974) conducted oral health surveys in several countries applying the criteria. Problems encountered with inter-examiner variability in the 'basic' examination led the investigators to conclude that this method was unreliable. Furthermore, while inter-examiner variability was better with the 'elective'...
assessment, neither the OHI-S or the PI were considered to be satisfactory for the assessment of treatment needs on the basis that: i. Calculus was underscored by the OHI-S due to the exclusion of the lingual surfaces of the lower teeth; and ii. There were problems in the interpretation of the mean PI scores as "a mean score of 2.0 may be obtained by patients with clinical conditions as widely different as 20 teeth with circumscribed gingivitis (score of 2) or 5 out of 20 teeth with advanced destructive periodontal disease (score of 8)".

In addition, Barmes (1976), in reviewing the periodontal assessment in OHS-BM1 manual (WHO, 1971), considered that the data obtained in terms of percentages of samples with gingivitis or periodontitis was an inadequate statement of disease and that inferences concerning treatment needs were too crude for the needs of administrators. Moreover, he reiterated the concern over the method's reliability.

In view of these problems, Davies et al. (1974) suggested there was a need to distinguish degrees of periodontal disease in terms of preventive or curative action required for the problem; to define succinctly, clearly and unequivocally the clinical signs of periodontal disease of diagnostic importance; and, to develop a simple system of recording which could be easily converted into treatment needs. They subsequently proposed that for public health planners, periodontal treatment needs should be classified into four categories, as follows:

i. Nil;
ii. Gingivitis that requires early treatment of an interceptive or preventive character;
iii. Intense gingivitis or pocket formation that requires periodontal treatment;
iv. Advanced destructive periodontal disease for which extraction is the only possible treatment.

Davies et al. (1974) field-tested a modified form of the Periodontal Screening Examination [PSE] (O'Leary, 1967) where quantification of disease parameters within subjects was achieved by subdividing the mouth into six segments (sextants) comprising one anterior and two posterior sextants in each arch. Unlike the WHO (1971) method which used a probe solely to confirm the presence of calculus, a periodontal probe was used in all the assessments including the identification of periodontal pockets. The potential problem of underscoring calculus was rectified by assessing calculus and
plaque (oral debris) separately in each sextant on both buccal and lingual aspects. Calculus was scored dichotomously and plaque on a three-point scale. If on visual inspection, changes in colour, form or consistency of the periodontal tissues were identified, a sextant would be examined for bleeding following the application of external pressure from a periodontal probe and the presence and extent of periodontal pocketing assessed on the mesio-buccal line angle of each tooth. Both gingivitis and probing depth were scored on a three-point scale, for the former according to bleeding response, and the latter according to depth range. The system showed closely comparable results between two examiners in their assessment of calculus, gingivitis and periodontal pockets. Application of this system, with only very minor modifications, in an epidemiological survey of periodontal disease in Dutch adults, confirmed the high degree of examiner reproducibility achievable with this system (Plasschaert et al., 1978). The authors did however consider that a limitation of the system was that no reasonable assessment of treatment needs could be made. This is understandable as Davies et al. (1974) failed to describe in any detail how the clinical scoring system could be interpreted in terms of the four suggested categories of periodontal treatment need.

Davies & Barmes (1976) evaluated proposed revisions to OHS-BM1 manual (WHO, 1971) by conducting an extensive field trial at the First WHO Western Pacific Regional Course in Public Health Dentistry held in Singapore and Malaysia in May-June, 1975 where a total of 22 participants with a wide variety of qualifications and training from 16 countries took part. As a part of the clinical examination, periodontal status was assessed using a sextant based system similar to that proposed by Davies et al. (1974) except that dichotomous scoring was substituted for all clinical criteria for simplification. In addition, each subject was classified separately according to whether they needed: no periodontal care (Score 0), oral hygiene only (Score 1), prophylaxis and oral hygiene (Score 2), periodontal therapy (Score 3), or full extraction because of untreatable periodontal disease (Score 4). Results from the calibration trials suggested that the methods and criteria recommended were generally satisfactory, however, gross underestimations of the prevalence of intense gingivitis and advanced periodontal involvement were considered to be a major deficiency.

To improve reliability in the recognition of these two conditions, the possibility was discussed of using a method based on the Gingival Bleeding Index (GBI) (Ainamo & Bay, 1975) where presence of inflammation is determined by the bleeding response after gentle probing of the orifice of the gingival sulcus. Objections to the use of periodontal
probing in public health surveys on the grounds of possible examiner variability and because of the problem of sterilisation under field conditions led to adoption, in the 2nd edition of *Oral Health Surveys - Basic Methods* [OHS-BM2] (WHO, 1977), of compromise clinical criteria for the assessment of intense gingivitis and advanced periodontal involvement.

2.7.2 The periodontal treatment need component of the International Collaborative Study of Oral Health Care Systems (ICS-1)

The International Collaborative Study of Oral Health Care Systems (Arnijot et al., 1985), jointly sponsored by WHO and the United States Public Health Services [USPHS], was organised during 1970 to 1972 and based its oral examination on those recommended in the OHS-BM1 manual (WHO, 1971). Additional criteria were however included to enable an assessment of treatment need.

The periodontal assessment comprised the scoring of both the Debris Index and Calculus Index components of the OHI-S (Greene & Vermillion, 1964) and a modified form of PI (Russell, 1956). This modification included the use of a periodontal probe to confirm pocket formation, thereby subdividing the finding of 'gingivitis with pocket formation' (original PI score 6), into a score of '3' for probing depths >3 and ≤6 mm, and a score of '6' for probing depths >6 mm. The periodontal treatment needs were recorded for each person examined using a simple dichotomous code indicating the need for different types of periodontal treatment but relied largely upon the clinical judgement of the examiner (Oral Data Collection Instrument and Examination Criteria, WHO/DNH/DD/74.2). However, to assist examiners general guidelines were provided as follows:

i. **Extraction(s):** recorded when periodontal disease had advanced so far that the tooth was loose or functionless and in the clinical judgement of the examiner could not be restored to a firm and functional state. Teeth scoring '8' (with the PI) would normally require this score for treatment;

ii. **Periodontal surgery:** intended to include the removal of diseased soft and hard tissues, the recontouring of bone, the re-establishment of gingival form, or flap operations;
iii. **Replacement and recontouring restorations:** intended to refer to such treatment needs as they affect periodontal disease—in particular overhanging margins, any unrestored marginal ridges and missing contact points;

iv. **Major scaling:** scored when there were gross deposits of calculus either for the whole mouth or for more than one tooth, necessitating the meticulous removal of subgingival deposits;

v. **Plaque removal including minor scaling and individual instruction:** scored only when there is a clear diagnosis of persistent and adherent plaque in any part of the mouth, and there are minor deposits of calculus, almost exclusively supragingival; or for individual instruction where there is clear failure in the present system of oral hygiene.

Despite the considerable efforts taken to ensure reproducibility, including the use of two 'roving' epidemiologists, comparisons between periodontal treatment need and the OHI-S or the mean number of teeth with gingival inflammation showed little relationship, and thus the former were not reported (Arnljot et al., 1985). In this respect, it is somewhat surprising that treatment needs were not directly derived from the scoring of the DI and CI components of the OHI-S and the modified Periodontal Index, all of which gave more objective clinical criteria than those provided above. An additional criticism of the ICS-1 method was that no attempt was made to quantify the extent of each treatment needed or to translate the needs into time requirements for treatment (Horowitz, 1979).

### 2.7.3 The Periodontal Status Index [PSI](WHO, 1977)

The 2nd. edition of *Oral Health Surveys - Basic Methods* manual [OHS-BM2] (WHO, 1977) describes a method enabling both the assessment of periodontal status and treatment needs to be made. This was subsequently termed the Periodontal Status Index [PSI](Cutress et al, 1978).

The periodontal assessment was based on modifications to the method proposed by Davies et al. (1974) whereby each sextant was scored separately for plaque (soft deposits), calculus, intense gingivitis and advanced periodontal involvement using a simple dichotomous scoring system. Buccal and lingual aspects of each sextant were examined, and when a particular condition was detected on any aspect of any tooth
within a sextant, the assessment for that condition in that particular sextant ceased. Plaque (soft deposits) was scored on a visual basis as was calculus, except that a probe could be used to confirm calcification of a deposit. Intense gingivitis was scored on the basis of colour changes of the gingiva or if firm digital palpation caused bleeding. Examiners were cautioned not to palpate in instances where the intensity of inflammation would undoubtedly cause bleeding. Advanced periodontal involvement was recorded if there was either definite tooth mobility or a periodontal pocket greater than 3 mm in depth accompanied by either intense gingivitis, marked change in gingival contour, suppuration or advanced gingival recession with exposure of cementum. Probing was only performed if one or more of these signs were present but mobility was absent. Multiple probings were discouraged and all measurements in a sextant ceased as soon as a probing depth greater than 3 mm was detected. The treatment needs component of the PSI were based on the findings from the periodontal examination, whereby irrespective of whether different types of treatment were required in separate parts of the mouth, only the most advanced form of treatment was scored, as shown overleaf:
<table>
<thead>
<tr>
<th>Classification</th>
<th>Clinical Criteria</th>
<th>Treatment Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code 0</td>
<td>There are no obvious signs of soft deposits, calculus, intense gingivitis, or advanced periodontal involvement.</td>
<td>No treatment necessary</td>
</tr>
<tr>
<td>Code 1</td>
<td>Soft deposits are present in one or more segments but there are no obvious signs of either intense gingivitis or advanced periodontal involvement (this category is intended only for those needing special instruction).</td>
<td>Oral hygiene instruction</td>
</tr>
<tr>
<td>Code 2</td>
<td>Soft deposits and calculus are present. Intense gingivitis may be recorded in one or more segments but there are no obvious signs of advanced periodontal involvement.</td>
<td>Prophylaxis and oral hygiene instruction.</td>
</tr>
<tr>
<td>Code 3</td>
<td>There are obvious signs of advanced periodontal involvement in one or more segments but the teeth are functionally satisfactory.</td>
<td>Periodontal therapy without the extraction of any teeth for periodontal reasons.</td>
</tr>
<tr>
<td>Code 4</td>
<td>There are obvious signs of advanced periodontal involvement in one or more segments and in one or more teeth the disease has proceeded to the terminal stage where these teeth are so loose and/or non-functional that conservative therapy is neither warranted nor possible.</td>
<td>Treatment which includes the extraction of one or more, but not all, teeth for periodontal reasons.</td>
</tr>
<tr>
<td>Code 5</td>
<td>Advanced periodontal involvement has proceeded to a stage where all teeth (or all but a few teeth) are so loose and/or non-functional that conservative therapy is neither warranted nor possible.</td>
<td>Full extraction.</td>
</tr>
</tbody>
</table>

Table 2.22  The Periodontal Status Index [PSI]. (WHO, 1977)

This coding system differs from that described by Davies & Barmes (1976) in the incorporation of an additional code for 'Treatment which includes the extraction of one or more, but not all, teeth for periodontal reasons'. The reasons for including this additional code were not given.

As Horowitz (1979) points out, the manual contains an apologia on compromises made in the criteria used (pp 36-37). The emphasis however appeared to concentrate on reduction of examiner variability as is evident in the following statement from the manual: "... diagnostic variations in individual examiners and between examiners must be maintained within acceptable limits and that findings should be suitable for the planning
of public health programmes. Inevitably, these requirements can be met only by accepting certain compromises and restricting the diagnostic signs to those that can be determined simply without stress to the subjects and that can be recognised easily and interpreted uniformly by examiners with varying levels of training and experience". Furthermore, the manual acknowledges that periodontal treatment need criteria were not entirely satisfactory and that examiners should not waste time on exceptional cases but should exercise their clinical judgement.

Even Barmes (1976) expressed concern over the method of periodontal assessment detailed in the OHS-BM2 manual (WHO, 1977) even as it went to press declaring that "there is still need for epidemiologists to further refine the criteria of periodontal disease and to identify the significance of the various signs of gingival and periodontal pathology" and that a "concentrated endeavour is needed to establish optimally reliable and useful methods for the assessment of periodontal status and treatment needs". Furthermore, although Horowitz (1979) acknowledged that the assessment of periodontal disease and treatment needs in OHS-BM2 (WHO, 1977) was an improvement on OHS-BM1 (WHO, 1971) in terms of sensitivity and precision, he still considered it less than perfect. He cited potential problems as being: i. the inability to obtain estimates of care requirements; ii. the potential problems of using a periodontal probe under field conditions; and, iii. the definition of advanced periodontal involvement on a gingival sulcus of 3 mm was too shallow. With respect to the latter problem, he suggested that additional non-invasive signs would be preferable but that if probing was to be used, then advanced periodontal involvement should be defined by probing depths greater than 5 mm as used by the PTNS (Johansen et al., 1973).

From data collected from a survey of the adult oral health of the New Zealand population, Cutress et al. (1978) made comparisons between the PSI, the Periodontal Index [PI] (Russell, 1956) and the Simplified Oral Hygiene Index [OHI-S] (Greene & Vermillion, 1964). The investigators found the advantages of the PSI were the ease of scoring and the ability to assess treatment needs, in terms of time, at the public health level. Disadvantages included the lack of quantification, and even though the PSI had relatively simple criteria, there were difficulties of diagnosis of intense gingivitis, and localised and generalised conditions. Conversely, the PI and the OHI-S were considered to be more objective, quantitative and sensitive than the PSI; for example, the distribution of the different PI score categories (0,1,2,6 or 8) gave information on severity of periodontal disease. The advocacy by WHO of the PSI in preference to the PI and the
OHI-S at this point in its development may well have been premature, for as Cutress et al. (1978) point out, the PSI as well as a similar index by Davies et al. (1974), described earlier, had only been field tested to a very limited extent.

Despite the apparent inadequacies of the PSI, it is noteworthy that OHS-BM2 (WHO, 1977) recommended a method of tabulating data which was very similar to current recommendations for CPITN based data. Thus periodontal status was reported according to: i. the number and percentage of subjects; and ii. the mean number of sextants with soft deposits (plaque), calculus, intense gingivitis, and advanced periodontal involvement. Treatment needs were tabulated according to the number and percentage of persons requiring: i. no treatment; ii. oral hygiene instruction; iii. prophylaxis and oral hygiene instruction; iv. periodontal therapy with no extractions; v. periodontal therapy and extractions; vi. a full extraction (clearance).

2.7.4 The periodontal assessment and treatment needs system of WHO Technical Report Series 621 (WHO, 1978)

Aware of dissatisfaction with basic methods for the measurement of periodontal disease and treatment needs in populations, the WHO Scientific Group on Epidemiology, Etiology, and Prevention of Periodontal Diseases met in Moscow in 1977; one of their objectives was to make specific recommendations on epidemiological methods for the assessment of periodontal diseases and treatment needs.

The Group proposed an entirely new approach for such assessments with the emphasis on practicality and reliability aimed at satisfying the needs of three types of study, these being:

i. Field trials, where the objective is to demonstrate the feasibility, acceptability, and effectiveness of preventive methods or curative programmes in a defined community;

ii. Population studies of periodontal disease status, where the objective is to collect descriptive data on the prevalence and distribution of the disease in various populations or subgroups and to evaluate preventive programmes; and,

iii. The determination of periodontal treatment needs and the evaluation of existing services, which are made for planning purposes.
The method, subsequently described in WHO Technical Report Series 621 (WHO, 1978), incorporated elements of the periodontal assessment from OHS-BM2 (WHO, 1977), but introduced a more rational approach with respect to clinical criteria based on part-mouth scoring of calculus, probing depth and the bleeding response after gentle probing. Fundamental to the method was the introduction of a specially designed ball-ended colour coded periodontal probe, the 'WHO probe' (Emslie, 1980) which resolved the previous dilemma over the use of periodontal probing in field surveys. The scoring of plaque was rejected in favour of scoring the consequences i.e. the disease, which was considered more important for population studies. The problems encountered with examiner reliability when using largely visual criteria for scoring gingival inflammation was resolved by the reliance on the presence of gingival bleeding alone. Furthermore, this objective sign was considered to be practical as the gingival sulcus/pocket needed to be probed to assess its depth and the presence of subgingival calculus. The measurement of recession was not considered essential, however provision was made in the method for scoring it as an indication of past disease or of treatment already provided. The method is described below:

i. **Age-groups**
The method recommended that periodontal assessment should be reported for four separate age-groups namely: 15-19, 20-29, 30-44, and 45-64; these age groups being compatible with standard WHO age-groups while also providing information on age related variations in periodontal disease.

ii. **Part-mouth scoring**
While being cognisant of potential under- or overestimation by the use of part-mouth scoring, the Group recommended the use of index teeth for simplicity and in order to restrict periodontal probing to a minimum. The teeth selected were 16, 21 and 24 (buccal and mesial aspects), and teeth 36, 41 and 44 (lingual and mesial aspects). Missing index teeth were substituted with the distal neighbour.

iii. **Scoring of calculus**
A tooth was assigned a score of 1 if calculus was visible or if, after gentle probing of the subgingival tooth surface, calculus was detected. If, multiple probings failed to detect either supra- or subgingival calculus, the tooth was assigned a score of 0.
iv. **Measurement of probing depth**

The probing depth was measured from the gingival margin, the deepest site on a tooth being scored according to the following criteria:

- **0** = Clinical gingival sulcus ≤3.5 mm
- **1** = Pockets >3.5 mm and ≤5.5 mm
- **2** = Pockets >5.5 mm

The logic behind this scoring system was that teeth scored 0 would be considered free of periodontitis, while teeth with shallow pockets (score 1) could be maintained free of gingivitis and attachment loss by plaque and calculus control. Deep pockets (score 2) would require complex periodontal treatment.

v. **Assessment of gingivitis**

When obvious bleeding from the gingival sulcus or pocket has resulted from the periodontal probing, the tooth was assigned a score of 1; in the absence of bleeding, a score of 0 was assigned.

vi. **Assessment of gingival recession**

The criteria for gingival recession was included in the method should a measure of past disease or of treatment already provided be required. Recession, measured from the cemento-enamel junction to the gingival margin, was scored as follows:

- **1** = root exposure ≤3.5 mm
- **2** = root exposure >3.5 mm but ≤5.5 mm
- **3** = root exposure >5.5 mm

vii. **Requirements for prevention and treatment**

With the exception of recession, the clinical criteria detailed above were considered to be those relevant for the determination of requirements for prevention and treatment. Thus:

a. gingivitis would indicate the need for oral hygiene instruction;

b. calculus or shallow pocketing would indicate the need for scaling in the affected quadrant(s) and oral hygiene instruction;
c. deep pocketing scores would indicate the need for complex care, which may comprise deep scaling and/or surgery, and for oral hygiene instruction.

The report gave estimates for periodontal treatment times, according to age-group, in order for "the administrator to work out the total time to be allowed for initial and follow up treatment of each subject and to decide on the period necessary between treatment and follow up". These time estimates are discussed in more detail in Chapter 5.

Sheiham et al., (1979) evaluated whether TRS 621 criteria (WHO, 1978) detected more periodontal disease than the criteria described in OHS-BM2 (WHO, 1977). Surprisingly, an age group outwith those recommended by WHO TRS 621 criteria was used, namely children aged 6 and 12 years. The OHS-BM2 method was found to detect fewer cases of gingival inflammation but in those cases so identified, the extent of involvement was greater. No cases of pocketing were detected using OHS-BM2 while 15% had pocketing using TRS 621 criteria. While these findings were to be expected considering the design of the two methods, this study can be criticised on the grounds that differences in detection levels might be due to interexaminer variability.

The Group recommended that testing should be undertaken to assess the reliability and validity of the proposed survey methodology for population and field studies and for treatment needs with emphasis on:

- the validity of using the specified index teeth and assigned surfaces as indicators of the whole mouth's periodontal status;
- the value of assessing gingival recession;
- the value of recording calculus, and the correlation that exists between subgingival and supragingival calculus.

Field testing of the TRS 621 method was subsequently performed in 12 countries on a total of 2212 subjects ranging in age from 15-55 years. Through multifactorial analysis, a strong relationship was found between buccal and lingual tooth surfaces, and between similar types of teeth suggesting that index teeth might be applicable for epidemiological surveys on periodontal status and treatment needs (WHO, 1984) (see section 3.2.4).
In addition, a significant relationship was found between bleeding and supragingival calculus and between subgingival calculus and pocketing. No results were however reported on the scoring of gingival recession, this component of the TRS 621 method subsequently being excluded from what was to become the Community Periodontal Index of Treatment Needs [CPITN] (see Chapter 3).

2.8 Periodontal treatment needs determined from decision making models

The realisation that assessments of treatment need based upon elimination of periodontal disease are both unrealistic in terms of delivery of the treatment to populations and inconsistent in terms of new concepts concerning the behaviour of the disease process (see section 2.3.1), lends credence to the exploration of alternative definitions of preventive and treatment needs.

Consistent with the now extensive evidence that only 7-15% of the adult dentate population experience severe periodontal breakdown, would be the specific targeting of preventive and treatment resources towards those individuals and groups who are 'susceptible' or who have already experienced such breakdown, a 'high-risk' strategy (Johnson, 1989). This strategy would thus be both scientifically valid, as well being more cost-effective than traditional approaches, but would be provisory upon the identification of such individuals or groups. Unfortunately, a predictive test to identify susceptible individuals remains to be developed and at present, identification relies upon the criteria of 'severe disease for age'.

An attempt to define treatment needs according to 'severe disease for age' has been advanced in a model devised by Wennström et al., (1990). This model considers an acceptable periodontal goal to be an alveolar bone height of at least one-third of the root length, assessed on intraoral radiographs, at the age of 75 years. A 'rate factor' of bone loss for individual interdental sites derived from a 10-year retrospective radiographic study (Papapanou et al., 1988, 89a,b; Papapanou & Wennström, 1990) enabled 'critical' limits of approximal bone loss to be calculated for 5-year intervals between 25 and 75 years. Periodontal intervention required to maintain teeth functional throughout life was considered as being required if an interproximal tooth site had bone loss exceeding the 'critical' limit for the age of the subject, persistent bleeding on probing and/or a probing depth of ≥6 mm. Other goals could however be defined at either an individual or
Chapter 2 - The assessment of periodontal treatment needs

Treatment needs according to this proposed model were evaluated in a random sample of 192 subjects (Papapanou et al., 1990). Whereas 100% of the subjects and 70% of interproximal tooth sites had treatment indicated based on bleeding on probing, when radiographic bone loss limits were included in the criteria, the proportions were reduced to 40% and 2.5% respectively.

While this decision-making model appears to provide a more rational approach to the determination of periodontal treatment needs, it is not without its flaws. The authors drew attention to: the possible underestimation of sites undergoing progression as only interproximal sites are assessed radiographically; that tooth loss might have underestimated the rate of periodontal breakdown; and that the 'critical' limits of approximal bone loss were calculated in-part from cross-sectional data expressed as mean values (see section 2.7.1). The possible underestimations might have been overshadowed by the reliance on mean values in the calculation of rate factor, as the 40% of persons identified by this model by Papapanou et al., (1990) to be in need of treatment is much higher than the 7-15% of the adult dentate population who experience periodontal breakdown. Perhaps of greater importance is that the model assumes that periodontal breakdown progresses continuously at an even rate; however there remains controversy as to the exact nature of disease progression and a number of different patterns have been proposed including the 'random/episodic burst' and the 'asynchronous multiple/simultaneous burst' (Socransky et al., 1984; Zimmerman, 1986). However, irrespective of the pattern of breakdown, there is evidence which is supportive of the Wennström model of treatment needs, namely the higher risk of progressive disease found in sites with previous severe disease (Albander et al., 1986,90; Lindhe et al., 1989a,b; Halazonetis et al., 1989), and in those with higher initial mean bone loss (Bolin et al., 1986; Lavstedt et al., 1986; Papapanou et al., 1989a,b).

On a purely practical level, the use of full-mouth radiographic surveys combined with the need to make radiographic measurements to assess an individual's need for periodontal treatment might be unrealistic at the community level on the grounds of time and expense. Until simple and inexpensive laboratory markers of disease susceptibility and activity are developed, an alternative, conceivably less time consuming method of decision making with respect to determining periodontal treatment needs might be the development of 'critical levels' for probing attachment loss which could be established...
for specific populations using a method similar to that of Wennström et al., (1990).
CHAPTER 3 - THE COMMUNITY PERIODONTAL INDEX OF TREATMENT NEEDS (CPITN)

3.1 Introduction

The CPITN evolved from the survey method proposed by the WHO Scientific Group on Epidemiology, Etiology and Prevention of Periodontal Diseases in Technical Report Series 621 [TRS 621] (WHO, 1978) for the measurement of periodontal disease and treatment requirements in populations (see Chapter 2). Under the auspices of Joint FDI/WHO Working Group 1 on 'Planning of Oral Health Services with Special Attention to Periodontal Disease', the method underwent a field trial in 2212 subjects from 12 countries testing for validation of the clinical criteria and the part-mouth recording method. The results of this trial were reported in the WHO document Community Periodontal Index of Treatment Need: Development, Field Testing and Statistical Evaluation (WHO, 1984). Meanwhile the final recommendations for scoring the CPITN were published (Ainamo et al., 1982). Two further sets of recommendations have since been published, the first following a review of the CPITN by Joint FDI/WHO Working Group 1 in 1985 (Cutress et al., 1987) and the most recent following a working group meeting in 1994 that reviewed 15 years use of the CPITN (Page & Morrison, 1994).

3.2 A review of the principal features of the CPITN

The following sections will review the principal features of the CPITN and, where available, provide scientific justification for the methods and criteria used by the index.

3.2.1 The CPITN periodontal probe and probing procedure

Central to the CPITN method is the purpose-designed CPITN periodontal probe (Figure 3.1). This probe was first described in TRS 621 (WHO, 1978) and was designed to facilitate the measurement of pockets, the detection of subgingival calculus and to elicit the bleeding response after probing, these being the principal criteria originally proposed by CPITN. While TRS 621 gave only the briefest description of the probe, a subsequent publication by Emslie (1980) provided more details of its specifications as follows:
1. It should be constructed in metal with a knurled handle of diameter 3.5 mm and have a maximum weight of 4.5 g.

2. It should have at the working tip a sphere 0.5 mm in diameter, a minimum diameter of 0.25 mm at the neck where the sphere is attached, and an appropriate taper from the handle.

3. It should have a black band between 3.5 and 5.5 mm from the end of the probe.

Figure 3.1 The CPITN periodontal probe

While the diagram of the probe in TRS 621 shows additional graduations at 8.5 and 11.5 mm from the working tip, Emslie (1980) states that these were abandoned and thus did not feature in the first description of the CPITN method (Ainamo et al., 1982). They were later resurrected with the CPITN-C (clinical) probe for use in detailed assessments of individuals with deep pockets and for treatment planning of complex treatment (Cutress et al., 1987). Grace & Smales (1989) however failed to find these markings useful in clinical practice. The probe with only two graduations is now identified as CPITN-E (epidemiological). Recently, the WHO Expert Group on Equipment and Materials for Oral Care (EGEMOC) has published formal recommended specifications for the design of the CPITN probe which includes performance parameters (WHO, 1990).

The lightness of the probe and the unique spherical tip were features claimed to assist...
in the detection of subgingival calculus and other roughness on the tooth surface, and
to minimize trauma in assessing probing depth, thereby reducing the risk of over-
measurement (see section 3.2.4). To this end, the knurled shaft permitted a gentle grip
of the probe and the contra-angle reduced the need to twist the probe (Emslie, 1980).

Meitner et al., (1979) caution about the use of non-standardised probing forces and
technique, as these may vary widely (Gabathuler & Hassell, 1971; Hassell et al., 1973)
thus influencing both bleeding response and probing depth. It is therefore not surprising
that the CPITN criteria (Ainamo et al., 1982; Cutress et al., 1987) described the probing
method in detail in order to standardize this procedure as far as possible. The insertion
of the probe should be in the long axis of the tooth sensing for subgingival calculus. A
'sensing' force of not more than 25 g [0.25 N] was originally recommended (Ainamo et
al., 1982) however 20 g or less is now suggested (Cutress et al., 1987). For calibration
purposes, in the absence of a force sensitive probe, it is recommended that the probing
force should be consistent with the gentle insertion of the probe under the examiner's
fingernail or into the gingival sulcus of the front teeth without causing pain or discomfort.
The criteria also advise that pain experienced by the patient is indicative of too much
force being used.

While the TRS 621 method (WHO, 1978) recommended probing on buccal and mesial
sites in the maxilla, with lingual and mesial sites for the mandible, the 1982 CPITN
recommendations failed to specify either the number or position of sites, save to
comment that it would be rare to exceed four probings per sextant. Sivaneswaran
(1985) compared two and four site probing and found the former underestimated the
proportion of individuals with pockets ≥6 mm by between 17-24%. Kingman et al.,
(1988) have also shown that the sensitivity of detection of pockets >6 mm is substantially
reduced by limiting the number of tooth sites probed. The 1987 recommendations
(Cutress et al., 1987) were more explicit, advocating the probing of mesial (M), mid-line,
and distal (D) on both buccal (B) and lingual/palatal (L) aspects, this being achieved
either by withdrawing the probe between each probing or by 'walking' the probe around
the tooth. Comparison between four (DB, MB, DL, ML) and six site assessments
showed the former to overestimate the proportion of sites involved for all CPITN
indicators, particularly pockets (Aucott & Ashley, 1986). However the effect of six-site
probing on detecting conditions within sextants or individuals remains unclear.
3.2.2 Bleeding on probing

The CPITN relies upon bleeding after probing the pocket or sulcus (BOP) as an indicator of gingival inflammation and is based upon the Gingival Bleeding Index [GBI] developed by Ainamo & Bay (1975). If calculus, other plaque retentive factors, and/or probing depths over 3.5 mm are detected, the presence of BOP is assumed.

In the assessment of periodontal inflammation, bleeding has been used in a number of clinical indices either alone (Carter & Barnes, 1974; Ainamo & Bay, 1975; Saxer & Mühlemann, 1975, Mühlemann, 1977; van der Velden, 1979; Nowicki et al., 1981; Caton & Polson, 1985), or in combination with visual changes of the gingiva (Schour & Massler, 1948; Mühlemann & Mazor, 1958; Ramfjord, 1959; Løe & Silness, 1963; O'Leary, 1967b; Suomi & Barbano, 1968; Suomi, 1969; Mühlemann & Son, 1971). It should be noted however that the methods used to determine the bleeding response of the periodontal tissues in the various indices differ in terms of the sites from where the bleeding is elicited, the instrument used, and the method of scoring. Thus, as the CPITN relies upon bleeding on probing the depths of the pocket, only this will be reviewed.

The use of BOP in the CPITN criteria stems from problems experienced with the lack of examiner reproducibility when other indicators of periodontal inflammation, such as oedema and colour changes, were used in surveys (Davies et al., 1974; Benamghar et al., 1982; Himmiche et al., 1984). Greenstein (1984) considers that BOP provides an objective sign of periodontal inflammation which can easily be assessed, as BOP can only be absent or present, unlike colour changes and other signs of inflammation which require subjective estimations by the examiner.

The validity of using BOP as an indicator of periodontal inflammation has been shown by histopathological, bacterial and clinical studies. Histopathologically, periodontal inflammation is characterised by increased numbers of inflammatory cells of varying proportions, loss of collagen and changes in the sulcular epithelium. Most studies, with the exception of that of Harper & Robinson (1987), find that sites which exhibit BOP show a significantly greater proportion of the connective tissue subjacent to the junctional epithelium to be replaced by inflammatory infiltrate than non-bleeding sites (Greenstein et al., 1981; Polson et al., 1981; Davenport et al., 1982; Cooper et al., 1983), a finding corroborated by Engelberger et al., (1983) using the Papillary Bleeding Index [PBI]. The predominant cellular infiltrate in deep sites (mean probing depth [PD] 5.2 mm) with BOP
has been reported to be plasma cells (Davenport et al., 1982; Harper & Robinson, 1987). However, Cooper et al., (1983) found shallow sites (PD 1-3 mm) to be dominated by lymphocytes. The differences are possibly attributable to differences in activity of the lesions. Furthermore, sites with BOP show thinned or ulcerated areas of epithelium with long, tortuous strands of rete pegs extending deep into infiltrated connective tissue (Davenport et al., 1982). Thus, while there are some differences between these studies, all show that sites which exhibit BOP have histopathological changes associated with gingival inflammation.

Both Armitage et al., (1982) and Harper & Robinson (1987) showed BOP to be correlated with increased proportions of spirochaetes and motile bacteria, compared to non-bleeding sites. This is consistent with the findings for periodontally diseased sites (Listgarten & Helldén, 1978; Listgarten & Levin, 1981; Evian et al., 1982). More recently, however, Baab & Opsvig (1986) failed to find significant differences in bacterial morphotypes between bleeding and non-bleeding sites.

Clinically, BOP has been shown generally to precede visual changes associated with the development of marginal gingival inflammation (Mühlemann & Son, 1971; Meitner et al., 1979; Hirsch et al., 1981), however, Greenstein (1984) points out that "clinicians do see visually inflamed sites which do not bleed on probing". This might in part be attributable to differences in probing forces where increased probing forces result in a concomitant increase in bleeding response (van der Velden, 1980a; Proye et al., 1982; Caton et al., 1982). Moreover, this phenomenon even occurs in clinically healthy sites, possibly due to traumatization of clinically healthy gingiva, when probing forces over 0.25 N are exceeded (Lang et al., 1991). These findings call for standardized probing forces at or below this probing force for the assessment of bleeding response. This is particularly important when evaluating the healing response to therapy as van der Velden (1982) has shown that bleeding tendency assessed before treatment with 0.15 N was comparable to that assessed after treatment with 0.75 N, a finding supported by Caton et al., (1982).

The standardization of probing force in respect to bleeding tendency might also be important in terms of examiner reproducibility. Saxton et al., (1976) reported a proportion agreement between examiners for BOP of 0.76 using routine probing, however, van der Velden (1980b) found a reproducibility as low as 0.40. By using a pressure probe at 0.75 N, inter-examiner reproducibility increased to 0.71 with intra-examiner reproducibility at 0.75 (van der Velden, 1980b). Similarly, Janssen et al., (1986) using a pressure probe reported 78% agreement for non-bleeding pockets and 64% for bleeding pockets.
Interestingly, they also reported that reproducibility was dependent on probing depth with agreement on bleeding in shallow sites being low (0.36) but which increased significantly in deep sites. Thus, pressure-probes increase the reproducibility of BOP, however the use of such instruments outside clinical studies is probably impractical although Cutress et al., (1987) suggest one could be used for CPITN calibration purposes. Recently, however, a number of plastic CPITN pressure probes have been introduced with claimed improvements in reproducibility (Hunter, 1994).

Gingival bleeding may occur either immediately after eliciting the bleeding response of the periodontal tissues or may occur some time thereafter. In view of this, the amount of time which is allowed to elapse before bleeding tendency is assessed should also be standardized as far as possible within the constraints of practicability. An attempt has been made to do so in the Final Recommendations for Scoring the CPITN, which state "the gingivae of the designated tooth or teeth should be inspected for the presence or absence of bleeding before the examinee is allowed to swallow or close his mouth. At times bleeding may be delayed for 10-30 seconds after probing". Unfortunately, substantiation of this time period before judging the bleeding tendency suggested by Emslie (1980) has not as yet been provided and therefore does not have any scientific basis. The range of time suggested in the CPITN Final Recommendations does however fall between the 10 seconds used by Ainamo & Bay (1975) with the Gingival Bleeding Index (GBI) and the 30 seconds allowed by Lenox & Kopczyk (1973). Most other studies which have used gingival bleeding as a clinical parameter allow time periods within this range as longer time periods would be impracticable.

The CPITN uses the absence of BOP as an indication of gingival health. Longitudinally, in patients receiving maintenance care the bleeding response at sites has been shown to fluctuate (Lang et al., 1986, 90; Kalkwalf et al., 1989; Grbic et al., 1991), however the absence of BOP on successive maintenance examinations appears to be a good indicator of periodontal stability (Lang et al., 1990). This later finding supports the CPITN's assumption that treatment is not required in the absence of BOP.

### 3.2.3 Calculus and other plaque retentive factors

Calculus was the only plaque retentive factor recommended for scoring in both the TRS 621 method (WHO, 1978) and by the CPITN method described by Ainamo et al., (1982). Cutress et al., (1987) later included ill-fitting crowns or poorly adapted edges of
restorations in the criteria, acknowledging that calculus and plaque retentive factors, while not being pathological in themselves, 'favour plaque retention and inflammation' and thus must be removed by professional care.

The role of calculus in the pathogenesis of periodontal disease has been extensively reviewed by Mandel & Gaffar (1986) who contend that it remains unclear as to what extent the presence of calculus enhances gingival inflammation. However, on conjectural grounds, they consider that supragingival calculus limits natural self-cleansing mechanisms, impedes oral hygiene and restricts drainage of sulcular fluid. Furthermore, there is some evidence that the rate of plaque growth is hastened in the presence of calculus (Sharaway et al., 1966, Ainamo, 1970) and that plaque in the presence of calculus has a greater pathogenic potential than plaque alone (Schwartz et al., 1971). Subgingival calculus is now generally regarded to be the result of periodontal disease rather than the cause, but that its presence most probably contributes to the chronicity of the disease (Mandel & Gaffer, 1986). Ånerud et al. (1991) reported that teeth with subgingival calculus lose more periodontal attachment than teeth without calculus but this does not necessarily demonstrate cause and effect. To add further to the uncertain role calculus plays in the pathogenesis of periodontal disease there are reports that under some circumstances calculus would appear to be compatible with health, from an epidemiological standpoint (Markkanen et al., 1983; Burt et al., 1985; Takahashi et al., 1988; Grytten et al., 1989; Holmgren & Corbet, 1990; Baelum et al., 1993; Lewis et al., 1994), a clinical standpoint (Fujikawa et al., 1988; Sherman et al., 1990a,b), and from a histological one (Listgarten & Ellegaard, 1973; Fujikawa et al., 1988).

Irrespective of the dilemma concerning the role of calculus, clinical studies which have included the removal of calculus as part of a comprehensive periodontal treatment programme have shown reductions in gingival inflammation, probing depth and a gain in clinical attachment (for review see Kakehashi & Parakkal, 1982; Pihlstrom et al., 1983; and Mandel & Gaffar, 1986). Whether these improvements come about due to a reduction of calculus or due to removal of plaque both at the gingival margin by personal plaque control and subgingivally by the removal of the calculus remains largely unanswered, but the finding that healing can take place in the presence of retained calculus lends credence to the argument that plaque removal is the principal factor determining the improvement (for review see Robertson, 1990).

In the field testing of the CPITN (WHO, 1984), supra- and subgingival calculus were
scored separately and it is interesting to note that one-third of subjects with calculus had only supragingival calculus (Himmiche et al., 1984). Although the CPITN fails to make a distinction between the supra- and subgingival calculus, Songpaisan & Davies (1989) considered it worthwhile to discriminate between the two forms of calculus, whereby removal of the potentially more deleterious subgingival calculus would have a priority over supragingival calculus. Moreover, Takahashi et al., (1988) reasoned that as subgingival calculus is more time consuming to remove, distinction between the supra- and subgingival calculus might achieve a more realistic assessment for planning purposes of the time required for scaling.

Ainamo (1984) recommended that defective margins of crowns and fillings should also be included into CPITN Code 2 for populations with a history of high caries experience and extensive restorative treatment. In such populations between 32 and 90% of subjects and from 25 to 76% of restorations or surfaces have overhangs (for review see Brunsvold & Lane, 1990). The relative influence of calculus and overhanging restorations was examined in Finnish adults by Tervonen & Ainamo (1986) who found that overhangs made a significant contribution to Code 2 particularly amongst younger age groups. Ainamo’s modification was thus incorporated into the 1987 description of the CPITN (Cutress et al., 1987).

Overhanging restorations have been shown to have a deleterious effect on the periodontium most probably mediated through a hindering of plaque control and a change in the adjacent subgingival microflora (Lang et al., 1983) in a manner akin to experimental ligature placement (Slots et al., 1979; Kornman et al., 1981). This generally leads to more severe periodontal conditions in terms of bleeding on probing (Gorzo et al., 1979; Pack et al., 1990), greater probing depth (Gorzo et al., 1979; Clamen et al., 1986; Pack et al., 1990), attachment loss (Than et al., 1982; Keszthelyi & Szebo, 1984; Chen et al., 1987) and bone loss (Björn et al., 1969; Gilmore & Sheiham, 1971; Hakkarainen & Ainamo, 1980; Jeffcoat & Howell, 1980; Eid, 1987). However, the extent of the effect is dependent upon the size of the overhang (Björn et al., 1969; Jeffcoat & Howell, 1980) and whether the overhang is supra- or subgingival in location (Leon, 1976; Gorzo et al., 1979). Removal of the overhang brings about an improvement in gingival health in terms of decrease in BOP, probing depths and some infill of alveolar bone, while most subgingival overhangs become equi- or supragingival, the extent of this response is largely dependent upon the level of plaque control achieved after removal (Highfield & Powell, 1978; Gorzo et al., 1979; Rodrigues-Ferrer et al., 1980; Laurell et
The high prevalence of overhangs in certain populations and the available evidence concerning their contributory role in CIPD, appear to provide justification for their removal.

The scoring of overhangs within the CPITN's treatment need hierarchy would thus be consistent with the treatment philosophies adopted by the CPITN. However for planning purposes, there may be advantages in distinguishing between the types of plaque retentive factor, as many overhangs are inaccessible and therefore difficult and time consuming to remove (Brunsvold & Lane, 1990). Furthermore, in some instances, overhangs can only be managed by replacement of the restoration thereby implying a restorative rather than a periodontal treatment need. These issues should be clarified by future studies.

3.2.4 Probing depth

Probing depth has traditionally been used as one of the indicators of the past history of periodontal disease, as an indicator for the level of periodontal therapy required and as a means of evaluating therapeutic outcomes. Until the last decade, probing depth was considered an absolute measurement of pocket depth, that is the distance from the gingival margin to the apical extent of the sulcus or pocket. It is however now recognised that this is rarely the case as probing depth can be influenced by a number of factors including: the degree of periodontal inflammation (Armitage et al., 1977; Robinson & Vitek, 1979; Garnick, 1980; van der Velden, 1982; Anderson et al., 1991), variation in examiner technique and clinical ability (Gabathuler & Hassell, 1971; Hassell et al., 1973; Chester et al., 1987), probing force (van der Velden, 1980a; Caton et al., 1982), probe dimension (Atassi et al., 1992), the presence of subgingival calculus and overcontoured restorations (Listgarten, 1980)(for review see Listgarten, 1980; Anderson & Smith, 1988). Only Wilson et al., (1988) have assessed the validity of probing depths determined with the CPITN probe. Clinical and laboratory measurements concurred in 92-97% of probing depths <3.5 mm, in 62-70% of probing depths ≥6 mm but in only 33-52% of probing depths 3.5-5.5 mm. Discrepancies were largely due to overestimations of clinical probing depth which in screening surveys would lead to an overestimation of sextants/persons indicated for 'complex' treatment. In this context, it is interesting to note that Chamberlain et al., (1985) considered that a probing force of 25 g might be too small for the consistent measurement of deep pockets as they found that standard deviations of mean pre-operative probing depths were greater at 25 g than at higher
probing forces. Probing depth variation can to some extent be reduced by the use of acrylic stents (Badersten et al., 1984; Isidor et al., 1984) and by the use of pressure sensitive/constant force probes (Poison et al., 1980; Caton et al., 1982; Walsh & Saxby, 1989), however such refinements are more appropriate for clinical trials than for surveys or for routine use in patients.

The markings on both the CPITN-E and CPITN-C probes are designed solely for the identification of ranges of probing depths as 'it was realised that the use of any pocket probe does not provide the clinician with accurate measurements of pockets in millimetres which, even if feasible, are of doubtful value.' (Ainamo et al., 1982). In the case of the CPITN-E probe, the differentiation between probing depths of 4 or 5 mm and 6 mm or greater was because of "currently accepted differences in the approach to their treatment" (Cutress et al., 1987)(see section 3.2.8).

Following successful treatment there is usually a reduction of probing depth brought about by recession and gain in clinical attachment. Ainamo et al., (1982) claim that in the assessment of the response to treatment, the 20-25 g used with the CPITN probe is light enough to be resisted by a healthy junctional epithelium. Histological studies in healthy gingiva show that with this probing force, the probe tip is found to remain in the junctional epithelium while higher forces possibly penetrate the junctional epithelium (Armitage et al., 1977; Robinson & Vitek, 1979; Poison et al., 1980). Listgarten (1980) however points out potential problems of achieving minimal probing depths as healing mediated through a long junctional epithelium (Listgarten & Rosenberg, 1979) could result in probing depths of 4 mm accompanied by only minimal inflammation. The implications of these findings on treatment need indications have been discussed by Holmgren (1994).

3.2.5 The use of index teeth and scoring by sextants

For epidemiological purposes in adults the CPITN relies upon a tooth subset (index teeth) which reduces examination time (Downer, 1972) thereby permitting sample size to be increased per unit of examination time (Gettinger et al., 1983). Tooth subsets have been used with a number of different indices including the PMA (Massler et al., 1950); the Periodontal Disease Index [PDI](Ramfjord, 1959); the Simplified Oral Hygiene Index [OHI-S](Green & Vermillion, 1964); the Gingival Index [GI](Löe & Silness, 1963); and the Extent and Severity Index [ESI](Carlos et al., 1986). The most widely used tooth subset,
that proposed by Ramfjord (1959) namely teeth 16, 21, 24, 36, 41, 44, the 'Ramfjord teeth', have been shown generally to give good correlations with whole mouth mean scores for plaque (Shick & Ash, 1961; Alexander, 1970; Mills et al., 1975; Gettinger et al., 1983; Goldberg et al., 1985; and, Silness & Roynstrand, 1988), calculus (Alexander, 1970; Gettinger et al., 1983), and various assessments of periodontal disease including the PMA index, the GI, the PDI, the Periodontal Index of Russell (1956), probing depth and attachment loss (Alexander, 1970; Jamison, 1963; Lilienthal et al., 1964; Mills et al., 1975; Downer, 1972; Kjome, 1975; Chilton et al., 1978; Gettinger et al., 1983; Berg et al., 1984; Goldberg et al., 1985; Fleiss et al., 1987; and Silness & Roynstrand, 1988). Good correlations for mean values for periodontal parameters have also been reported for other tooth subsets (Alexander, 1970; Downer, 1972; Mills et al., 1975; Goldberg et al., 1985). The use of mean values in clinical studies has been criticised by Lindhe & Nyman (1984); in addition their use may cause potential problems for treatment need estimation (Davies et al., 1974; Oliver et al., 1989). For surveys aimed primarily at the assessment of periodontal treatment needs, the prevalence and extent of conditions within populations are more important. In this respect, Downer (1972) found that none of a number of tooth subsets, the 'Ramfjord teeth' included, were adequate to describe the prevalence of gingivitis and periodontitis, a finding reiterated by Ainamo & Ainamo (1985) and Fleiss et al., (1987) who found a systematic underestimation in the proportion of persons with deep pockets by use of the 'Ramfjord teeth'.

In determining the periodontal treatment needs of populations, it is clearly important to be able correctly to identify those individuals with particular conditions requiring treatment. The TRS 621 method recommended the use of the 'Ramfjord teeth' subset, however after the FDI/WHO Joint Working Group 1 had considered a number of different tooth subsets pertinent to the classification of subjects into treatment need categories a subset of ten index teeth was finally recommended for use with the CPITN (Ainamo et al., 1982; WHO, 1984) as follows:

```
17 16 11 26 27
47 46 31 36 37
```

Although in adults ten index teeth are examined, for recording purposes only six recordings are made, each one relating to a sextant (O'Leary, 1967b). The sextants and their associated index teeth (shown in bold) are defined below and exclude the third molars except when they are functioning in place of missing second molars:
Scoring by sextants still permits some quantification of the extent of periodontal conditions (Davies & Barmes, 1976) and is purported to save time. In posterior sextants when one or both of the index teeth are present, the highest finding derived from these teeth is recorded for the sextant. The original recommendations for the scoring of the CPITN (Ainamo et al., 1982) state that if the index teeth in a particular sextant are missing, all remaining teeth in that sextant are examined. This recommendation has since been modified so that for anterior maxillary sextants, tooth 21 is examined if tooth 11 is missing, but if both these teeth are missing all remaining teeth in that sextant are examined (Cutress et al., 1987). The same applies for the anterior mandibular sextant where a missing 31 is substituted by tooth 41. Furthermore, when only one tooth remains in a sextant, it is included in the adjacent sextant, presumably to prevent overestimation of treatment needs. A number of studies have looked at the reliability of the CPITN tooth subset and these have been reviewed by Holmgren (1994).

### 3.2.6 Modifications to the CPITN according to age

The original recommendations for the scoring of the CPITN (Ainamo et al., 1982) made no particular reference to the use of the CPITN in groups under the age of 20 save to state that full sextant recordings had little advantage over partial recordings. Ainamo et al., (1984b) however expressed concern that CPITN assessments in children and adolescents might overestimate probing depths due to the recording of false pockets around erupting teeth. They therefore recommended that, for populations under the age of 20, the CPITN tooth subset should include only teeth 16, 11, 26, 36, 31, 46. Furthermore, for children of age 7-11 years, index teeth should be probed to detect calculus (and/or overhangs) and bleeding, but pockets should not be recorded, as pathological pockets are rare in this age group. The final criteria for the use of the CPITN (Cutress et al., 1987) adopted these recommendations with the additional modification that pockets are only recorded above the age of 15 years, presumably because Ainamo et al., (1984b), failed to detect true pockets exceeding 3 mm in depth in a group of 13-15 year olds. Additional details of these modifications have been reviewed by Holmgren (1994).
Figure 3.2   Examples of CPITN codes 0 to 4
3.2.7 Recording of sextant findings

The clinical indicators used by the CPITN have been described in sections 3.2.2 to 3.2.4, and a summary of CPITN codes derived from these indicators is given below:

- **CODE X**: when only one tooth or no teeth are present in a sextant;
- **CODE 4**: presence of a pathological pocket of 6 mm or more;
- **CODE 3**: presence of a pathological pocket of 4 or 5 mm (Code 4 indicators absent);
- **CODE 2**: presence of calculus or other plaque retentive factors (Code 3 indicators absent);
- **CODE 1**: presence of bleeding observed during or after probing (Code 2 indicators absent);
- **CODE 0**: presence of healthy tissue (Code 1 indicators absent).

Examples of these codes are depicted in Figure 3.2.

A hierarchical method of scoring is adopted whereby the highest (worst) finding in a sextant is recorded, a method of simplification introduced by O'Leary (1967b) with the Periodontal Screening Index. Thus, if a pathological pocket of 6 mm or more (Code 4) is detected on specified teeth in a sextant, this code is recorded and no further examination of the sextant is required; it is assumed that calculus and bleeding will also be present. Similarly, if the deepest pathological pocket is found to be 4 or 5 mm, a code 3 is assigned irrespective of the presence of other indicators. In the absence of pockets in a sextant, if calculus or other plaque retentive factors are detected, a code 2 is assigned, the assumption being that this indicator is always associated with bleeding on probing (BOP). If bleeding after probing occurs in the absence of pockets or plaque retentive factors, the sextant is assigned a code 1, while in the absence of any of the indicators, a sextant is scored 0. When only one tooth remains in a sextant, it is included in the adjacent sextant, thereby preventing an overestimation of treatment needs. For a review of studies which have examined the validity of the CPITN's hierarchical method of scoring, see Holmgren (1994).
3.2.8 Treatment needs indicated by the CPITN

The Treatment Needs (TN) of groups or individuals are determined from the CPITN sextant scores (Cutress et al., 1987)(section 3.2.6) and assume a hierarchical structure of complexity as follows:

**TN 0:** A recording of Code 0 (health) or X (missing) for all six sextants indicates there is no need for treatment.

**TN 1:** A code of 1 or higher indicates a need for improving the personal oral hygiene of that individual.

**TN 2:** (a) A code of 2 or higher indicates a need for professional cleaning of the teeth and removal of plaque retentive factors. In addition, the patient requires oral hygiene instruction;

(b) Shallow or moderate pocketing (4 or 5 mm, Code 3). Oral hygiene and scaling will usually reduce inflammation and bring 4 or 5 mm pockets to values of or below 3 mm. Thus sextants with these pockets are placed in the same treatment category as scaling and root planing, i.e. Treatment Need 2 (TN 2).

**TN 3:** A sextant scoring Code 4 (6 mm or deeper pockets) may or may not be treated by means of deep scaling and efficient personal oral hygiene measures. Code 4 is therefore assigned as 'complex treatment' which can involve deep scaling, root planing, and more complex surgical procedures.

In common with other treatment need indices, the CPITN only assesses normative need and therefore does not take into account either the 'wants' or the 'demands' of patients or populations (Gjermo, 1991). To some extent however, these can be taken into account when CPITN data is used in the WHO oral health care planning model and are considered under modifying factors (see section 3.8). The specific limitations of the CPITN's treatment need indications have been discussed by Holmgren (1994).
3.2.9 Reporting of findings

To ensure comparability between epidemiological and other surveys when reporting CPITN results, four 'standard tables' have been recommended (Cutress et al., 1987). These are: the prevalence of persons affected according to their highest CPITN score (known as Table 1); the severity, in terms of the mean number of sextants involved (Table 2); the treatment needs according to the proportion of persons in each treatment need category and the mean number of sextants involved (Table 3); and, a cross-tabulation for each age group indicating the number and percentage of individuals scoring CPITN Codes 0-4, or X (missing sextant), in 0-6 sextants (Table 4). There are two options for reporting Table 2, the WHO preferred method shows the mean number of sextants scoring 0,1,2,3 or 4 on a cumulative basis (Table 2a), while the alternative shows the mean number of sextants considered separately, the total therefore adding up to six (Table 2b). Edentulous individuals are excluded from all tables except for an indication of the proportion so affected in Table 1; this serves to prevent underestimation of the periodontal treatment needs in the dentate (Ainamo et al., 1986). The algorithms use to generate these tables from raw survey data have been described by Cutress et al., (1987).

The third edition of Oral Health Surveys-Basic Methods [OHS-BM3] (WHO, 1987) has recommended that CPITN results be reported using only tables 1, 2a, and 3, and data in this format has now been collected in the WHO Global Oral Data Bank (Pilot et al., 1987a,b; Miyazaki et al., 1991 a,b; Pilot & Miyazaki, 1991,94). It has been suggested by Ainamo et al., (1987) that Table 4 cross-tabulations could be sensitive enough for the evaluation of preventive or therapeutic programmes in populations. This application is discussed in more detail by Holmgren (1994). Table 4 can however be used to evaluate population goals (see section 3.9) when these are CPITN sextant defined, e.g. three or more healthy (Code 0) sextants at a specified age. Moreover, Table 4 facilitates the identification of low or high risk groups and therefore might be used to define priorities for treatment (Ainamo et al., 1982); for instance, those with a certain number of Code 4 sextants at a certain age could be considered to be at high risk.

In addition to the above mentioned 'standard' tables, the original description of the CPITN suggested that CPITN results could be reported in the form of the average time required to perform the CPITN indicated treatment procedures (Ainamo et al., 1982). Gjermo et al., (1983) however proposed a system of CPITN based time unit estimates
(TU) for sextants derived from the relationship between treatment times for periodontal procedures reported by Bellini (1974) (Table 3.1 below).

<table>
<thead>
<tr>
<th>CPITN</th>
<th>Type of care</th>
<th>TU</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>Oral hygiene instruction</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>OHI + scaling</td>
<td>3 (1+2)</td>
</tr>
<tr>
<td>3</td>
<td>OHI + scaling + root planing</td>
<td>3 (1+2)</td>
</tr>
<tr>
<td>4</td>
<td>OHI + scaling + 'complex'</td>
<td>7 (1+2+4)</td>
</tr>
</tbody>
</table>

Table 3.1 CPITN based time unit estimates [TU] (Gjermo et al., 1983)

The mean number of time units per person or the total for a group can thus be calculated using this data (Srivastava et al., 1986) which can then be used for planning purposes. Time units were used rather than accurate time estimates, because of concern over the variability of treatment times in different working situations. Ironically, the relationship between treatment times for periodontal procedures upon which the TU weightings are based could themselves be vulnerable to variability.

3.3 The validity of the CPITN

The concurrent validity (Last, 1988) of the CPITN has been tested in terms of its use both as a screening tool and for the determination of treatment needs in individual patients.

Sivaneswaran (1985) compared periodontal assessments made by dental officers at a dental school with CPITN based assessments. Surprisingly, 94% of patients assessed as having no periodontal disease, and, 87% assessed as having only mild disease, had probing depths 4-5 mm. Moreover, there were cases with deep probing depths which went undiagnosed by the dental officers. The apparent underestimation of the prevalence and severity of disease was ascribed largely to the dental officers' subjective evaluations without the use of a periodontal probe. The author considered the CPITN index to be sufficiently refined and sensitive to be used for routine periodontal screening at the dental school.

Periodontists have however criticised the CPITN as being too crude to diagnose individual patients' treatment need in the clinical practice setting (Chesters et al., 1987). Schaub (1984), in a limited study involving only 12 patients, compared the diagnosis
determined by four periodontists using full clinical records with sextant CPITN scores and individual treatment needs. The agreement was generally high, however there was a trend to overestimate treatment needs with the CPITN method (see section 3.5.3).

In another study (Chesters et al., 1987), five periodontists were asked to derive CPITN categorized treatment requirements for 50 patients based upon detailed records including radiographs, study casts, and full mouth clinical charting of supra- and subgingival calculus, overhanging restorations, recession and probing depths. Independently, CPITN treatment needs were determined with a CPITN-C probe. Inter-examiner agreement for treatment requirements ranged between 49-82% while agreement between periodontists and CPITN derived treatment needs was from 62-82%. As the agreement was comparable between the two methods, the authors considered the CPITN was applicable for the determination of treatment plans for individual patients.

In a retrospective study using CPITN derived sextant scores, Persson et al., (1989) reported that all sextants with CPITN codes 3 or 4 received more extensive treatment than oral hygiene and prophylaxis but this was only qualified in terms of sextants which received surgical treatment. Almost all anterior sextants were treated by non-surgical means while 62% of posterior sextants initially scoring Code 4 and 24% scoring code 3 received surgery. The authors concluded that CPITN sextant codes 3 and 4 had limited value in distinguishing the level of therapeutic intervention and that many sextants scoring Code 0 to 2 often had more treatment provided than indicated by the CPITN.

Mubarak & Gjermo (1990) similarly assessed the validity of the CPITN as a screening procedure by comparing initial CPITN assessments with the treatment eventually received. For 'complex' treatment, there was a strong correlation between the initial CPITN examination and the amount of treatment eventually received (R=0.78) however the CPITN tended to over-estimate the proportion requiring this treatment.

The above mentioned studies were all conducted in dental schools, therefore the results obtained may not truly reflect the general dental practice environment. If the CPITN is to be advocated for use by general practitioners as is the FDI's intent, the validity of the method must be assessed in a similar environment. In this respect, it is interesting to observe that even regular dental attenders have needs for all the CPITN categories of treatment (Bader et al., 1988).
3.4 Comparisons between the CPITN and other indices

Few comparisons have been made between CPITN findings and those obtained with other indices. This is not surprising considering that most other indices were designed for purposes other than for the assessment of periodontal treatment needs. Of particular relevance to the use of the CPITN as a treatment need indicator was the study of Mubarak & Gjermo, (1990), described in the previous section, which compared the validity of the CPITN with the PTNS as a screening test for eventual treatment. Both indices were able to distinguish reasonably well those requiring 'complex' treatment, however the correlation coefficients were higher for the CPITN.

The CPITN has been advocated for estimations of the prevalence and extent of periodontal conditions (Barmes & Leous, 1986), and in this capacity has been compared with the Periodontal Index [PI] (Russell, 1956) in a survey of New Zealand adults (Cutress et al., 1986). The CPITN was found to identify a greater proportion of healthy individuals than the PI either because of an overestimation of gingivitis by the PI, or an underestimation due to the CPITN's use of index teeth. Conversely, the CPITN identified a greater proportion of individuals with periodontitis (probing depths ≥3.5 mm) than the PI, presumably because the CPITN method, unlike the PI, makes use of a periodontal probe, thereby supporting the use of a periodontal probe for epidemiological surveys.

Reich et al., (1986) compared subject mean CPITN scores categorized into three groups of ascending severity, the Periodontal Disease Index [PDI] (Ramfjord, 1959) and the Periodontal Index [PI] (Russell, 1956) for correlation with the Gingival Index [GI] (Löe & Silness, 1963), mean probing depth and attachment loss. The CPITN and the PDI both showed significant correlations with the other indices while the PI failed to correlate significantly with the GI. Almas et al., (1991) however found no relation between the CPITN sextant code and the GI, the Plaque Index [PII] (Silness & Löe, 1964), or the number of sites affected per sextant. Some relationship was however found between the CPITN, the Papilla Bleeding Index [PBI] (Mühlemann, 1977), and probing depth. Similarly, Watenabe et al., (1984) reported significant correlations between CPITN sextant scores and the Gingival Bleeding Index [GBI] (Ainamo & Bay, 1975), probing depth and furcation involvement.
Chapter 3 - The Community Periodontal Index of Treatment Needs

3.5 Modifications of the CPITN

Since the original description of the CPITN was published (Ainamo et al., 1982), a number of modifications have been proposed. These are described below:

3.5.1 Modifications of the CPITN for use in clinical practice.

The CPITN was originally developed as a screening tool for epidemiological purposes; however, the method has also been recommended for the initial screening of individual patients in clinical practice, to determine treatment needs (Ainamo et al., 1982). The main modification of the epidemiological method was for individuals over 20 years old, where, to prevent under-estimation of probing depths, sextants scores would be derived from the examination of all teeth. The CPITN recordings were considered sufficient for the treatment planning of patients requiring just oral hygiene and scaling, but for individuals with deep probing depths, it was suggested that affected tooth sites be identified before the instigation of treatment. Furthermore, the method was suggested as being appropriate for the assessment of recall patients since the 25 g probing force, while being resisted by a healthy epithelial attachment, would be sufficient to detect a re-infected long epithelial attachment.

Croxson (1984) later described 'A Simplified Periodontal Screening Examination' for use in general practice based on the CPITN and incorporating most of Ainamo's modifications. At this juncture the Fédération Dentaire Internationale seized upon this method, considered by Ahlberg (1984) to be "a periodontal breakthrough", and started actively to promote it worldwide with commercial sponsorship. A two-page pamphlet describing 'A Simplified Periodontal Examination' was prepared (FDI, 1985) and translated into 6 languages for distribution to dentists in member countries. Some National Dental Associations including Finland, New Zealand, Australia, Japan, South Africa, readily accepted the method (Cutress et al., 1987). However, in the United Kingdom, the Dental Health and Science Committee of the British Dental Association, while considering the CPITN probe and CPITN useful for screening purposes, initially expressed reservations about any index which combines bleeding with the presence of calculus and pockets (BDJ, 1985). However, the Dental Estimates Board of the British National Health Service eventually accepted the method for reporting of periodontal conditions (FDI, 1986).

In 1986, the British Society of Periodontology promoted the CPITN as a system of
periodontal screening in clinical practice (BSP, 1986) with the addition of the extra code [*] which was assigned to a sextant whenever there was a furcation involvement or loss of attachment in the form of recession plus probing depths totalling 7 mm or more. The criteria were more specific than those of Ainamo (1982) for cases detected with a code 4 (or *), recommending that a full charting, recording probing depth, recession and furcation involvement, be performed together with radiographs of any teeth with furcation involvement or loss of attachment of 7 mm or more.

The 1987 description of the CPITN method (Cutress et al., 1987) did not include the additions suggested by the British Society of Periodontology and followed the recommendations for the Simplified Periodontal Examination (Croxson, 1984). A review of the method by FDI/WHO Joint Working Group 10 in 1988 suggested the name be changed to 'Basic Periodontal Examination' [BPE] in order to indicate this to be the first step in the diagnostic sequence. In the United States, the American Academy of Periodontology, accepted this 'basic' method, the sole modification being that implants were scored as teeth in the clinical examination. The Academy decided however for medico-legal reasons to re-name the method the 'Periodontal Screening and Recording Examination' [PSR] (FDI, 1991). The FDI considers the BPE and the PSR to provide:
1. Clear warning if any changes occur with time; 2. Feedback and motivation for the patient; 3. Information for third parties before advanced treatment is sanctioned; and, 4. Medico-legal protection in the event of malpractice claims.

The CPITN in its various guises continues to be promulgated although Page & Morrison (1994) recommend that the development for common methodology between CPITN, BPE and PSR should be pursued.

3.5.2 The GPM/T Index (Gaengler, 1984)

A method of describing periodontal epidemiological data using the same probe and clinical indicators as the CPITN has been proposed by Gaengler (1984) whereby periodontal conditions were characterised by the ratio Gingivitis: Periodontitis: Missing/Teeth (GPM/T). The index relies on full mouth examinations, probing at six sites per tooth, scoring for bleeding after probing (no pockets), pockets (shallow and deep), and missing teeth. The mean number of teeth with each of these indicators for a population are then expressed as the GPM/T index in a manner analogous to the DMFT e.g. GPM/T = 15.4:0.6:0.8. The author claimed that the method makes it possible to
present data of the progression rate of periodontal disease by the increment of P/T and M/T, however this assumes that all missing teeth are lost due to periodontal disease. The GPM/T has not gained widespread acceptance.

3.5.3 The R [Revised] - CPITN (Schaub, 1984)

In studying the validity of the CPITN, Schaub (1984) expressed concern over the index's treatment needs indications whereby the most serious condition in a sextant determines the sextant's treatment need, while the sextant with the highest treatment needs determines the subject's treatment need. He considered that in the public health context this might lead to an overestimation of treatment needs as a subject might be allocated into a treatment category on the basis of only one index tooth scoring calculus or pockets while remaining teeth might be affected by less serious problems. He reported that, in a sample of 440 subjects assigned a TN of 1 to 3, 24% had been so assigned on the basis of one tooth scoring a higher score. In addition, of 1635 sextants with a CPITN score of 1 to 4, 50% were assigned a higher score on the same grounds.

Modified rules were therefore devised whereby in the determination of treatment needs, "at least two teeth with a periodontal problem (calculus or pockets) should be present in a sextant; the second most serious problem determines the treatment need category of the sextant unless at least two teeth have the most serious problem in the sextant, which then determines the treatment need". The application of these modified rules in Schaub's study resulted in a considerable reduction in indicated treatment needs (Table 3.2 below).

<table>
<thead>
<tr>
<th>CPITN score</th>
<th>Mean CPITN sextant score</th>
<th>Mean R-CPITN sextant score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2.42</td>
<td>3.32</td>
</tr>
<tr>
<td>1</td>
<td>0.51</td>
<td>0.52</td>
</tr>
<tr>
<td>2</td>
<td>1.69</td>
<td>1.60</td>
</tr>
<tr>
<td>3</td>
<td>1.30</td>
<td>0.53</td>
</tr>
<tr>
<td>4</td>
<td>0.09</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Table 3.2 Mean sextant scores obtained with the CPITN and with the CPITN revised by Schaub (1984)

One of the potential problems in applying these modified criteria is that full mouth recording is required, as the original CPITN criteria dictate that only one index tooth is
assessed in anterior sextants. Furthermore, while two index teeth are usually assessed in posterior sextants, one tooth might be missing. Full mouth recordings in surveys could also defeat the objective of the CPITN as being quick and simple to perform. It might also be argued that R-CPITN is an unnecessary complication because if a sextant or a subject has a particular periodontal condition e.g. a deep pocket, treatment will still be indicated if it is for one tooth or for many. The CPITN does allow for an assessment of the extent of treatment by quantifying treatment on a sextant basis. These considerations taken into account, it is not surprising that the R-CPITN has not been featured in any other studies.

3.5.4 The CPITN modified by Takahashi et al., (1988)

In a study on Japanese company employees Takahashi et al., (1988) modified the CPITN so that sextants without pockets but with calculus were scored code 2+ if bleeding after probing was found and code 2- if bleeding was absent. The authors reasoned that scaling for all those with a CPITN indicated need would be unfeasible in the community perspective, and it would therefore be logical for subjects or sextants with calculus and associated bleeding to be accorded a higher priority for treatment than those without bleeding.

Such a subdivision was used by Addo-Yobo et al., (1991) and is indeed rational as further epidemiological and clinical evidence becomes available, questioning the need to remove calculus from all sites in all persons (Holmgren & Corbet, 1990). With the widespread adoption of the CPITN, these simple modifications could improve the value of the CPITN both for the assessment of periodontal status and for manpower planning but this in turn would require further evaluation.

3.5.5 The Periodontal Index for Treatment [PIT](Eaton & Woodman, 1989)

The Periodontal Index for Treatment [PIT] was developed by Eaton & Woodman (1989) in order to prioritise resources for periodontal care within the UK Armed Forces. The PIT, developed between 1981 and 1985, can be considered to be a modification to the CPITN as the two indices show many similarities.

The PIT uses a ball ended periodontal probe virtually indistinguishable from the CPITN-C periodontal probe (Cutress et al., 1987) except that markings appear at 4, 6, 8, and 11
mm from the probe tip as against the 3.5, 5.5, 8.5, 11.5 mm markings on the CPITN-C probe. These differences are inconsequential clinically as the same ranges of probing depths are used by the two indices. The purpose of the 8 and 11 mm markings on the PIT probe was not however explained. A probing force of 0.25 N is recommended which corresponds with the probing force recommended by the CPITN. Part-mouth scoring using the same index teeth are used by both indices except that the PIT excludes the second molars to save time. For the same reason, probing is restricted to maxillary palatal and mandibular buccal sites unlike the 6 sites now recommended for the CPITN (Cutress et al., 1987). The PIT uses a hierarchical scoring system analogous to the CPITN except that CPITN Code 2 (calculus) is excluded in order to stress the presence of disease. In common with the CPITN, the highest finding is assigned, in this case to the index tooth, and the overall patient score (PIT score) is recorded as the highest score of the six index teeth. No instructions are given concerning substitution for missing index teeth.

<table>
<thead>
<tr>
<th>PIT Score</th>
<th>Clinical Observation</th>
<th>Diagnostic Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No pocketing of more than 4 mm or gingival bleeding</td>
<td>Health</td>
</tr>
<tr>
<td>1</td>
<td>No pocketing of more than 4 mm but gingival bleeding within 20 seconds of probing</td>
<td>Gingivitis</td>
</tr>
<tr>
<td>2</td>
<td>Pockets of 4 - 5 mm present</td>
<td>Possible early periodontitis'</td>
</tr>
<tr>
<td>3</td>
<td>Pockets of 6 mm or more present</td>
<td>Established periodontitis'</td>
</tr>
</tbody>
</table>

*Indicates a full pocket depth chart to be necessary

Table 3.3 The Periodontal Index for Treatment [PIT] (Eaton & Woodman, 1989)

The PIT differs from the CPITN in that bitewing radiographs are used as an adjunct to the probing procedure so that if posterior teeth exhibit radiographic bone loss, then the PIT scores are modified accordingly. In an evaluation of the PIT screening performed by general dental practitioners compared with a full-mouth examination performed by periodontists, the use of radiographs substantially improved the sensitivity of the PIT in the detection of pockets and/or bone loss thereby achieving both high levels of sensitivity and specificity. Such a modification might be useful for CPITN based surveys should radiographs be available.

Somewhat surprisingly, considering the name of the index, the PIT fails to classify
subjects into treatment categories. In addition, the omission of the scoring of calculus in the criteria causes difficulties in determining whether subjects with, for instance, a PIT score of 1, require scaling or only oral hygiene instruction. Such omissions defeat the objective of such an index particularly when applied to an organisation such as the UK Armed Forces which has a well developed dental care system making use of ancillary dental personnel.

3.5.6 Periodontal Control System (Grace & Smales, 1989)

Grace & Smales (1989) considered the CPITN to be useful as a rapid, reproducible method of assessing the periodontal condition at the initial visit but proposed an extension of the system very similar to that proposed by the BSP system where the initial CPITN scores were used to categorize patients according to their requirement for additional records as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>CPITN scores</th>
<th>Suggested additional indices</th>
<th>Radiographs indicated</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Mainly 0 &amp; 1, or possibly 2 in lower anterior &amp; upper molar regions</td>
<td>Debris Index (D.I.) (based on Greene &amp; Vermillion, 1974) and Bleeding Index (B.I.) (Cowell et al., 1975)</td>
<td>Bitewing or panoramic radiographs in case of bone loss</td>
</tr>
<tr>
<td>B</td>
<td>2 in upper anterior and lower posterior regions</td>
<td>D.I. and B.I.</td>
<td>Intraoral radiographs for teeth showing furcation involvement or total loss of attachment &gt;7 mm</td>
</tr>
<tr>
<td>C</td>
<td>3 anywhere in the mouth</td>
<td>D.I., B.I., bleeding points and probing depths chart</td>
<td></td>
</tr>
<tr>
<td>D or E</td>
<td>4 or * anywhere in the mouth</td>
<td>D.I., B.I., bleeding points and probing depths chart, mobility index and Periodontal Index.</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.4 The Periodontal Control System (Grace & Smales, 1989)

These supplementary records form the basis of the Periodontal Control System, proposed by the same authors. This rather comprehensive recording system, which is claimed to be effective in dental practice, attempts to simplify treatment planning and monitoring of individual patients but is probably quite time consuming to undertake. The use of index teeth for the scoring of Dl & Bl possibly reduces examination time, yet it might be questioned whether it is necessary to assess both indices.
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3.5.7 CPITN modified by Lennon et al., (1992)

Lennon et al., (1992) proposed a simplification to the reporting of CPITN results whereby the data for each subject would be summarized by just two digits, the first digit representing the highest CPITN for a subject with the second digit representing the number of sextants so affected. For example, a score 3,4 would indicate a subject with CPITN score 3 as the highest score and with 4 sextants so affected.

In the monitoring of patient treatment responses, this system would appear to have some virtue as demonstrated by Lennon et al., (1992) where six-months after the institution of treatment, 83% of cases had shown reductions in either the first or the second digit. While the authors suggest this system incorporates sensitivity, in certain cases it would be insensitive to deteriorations in periodontal conditions in those sextants which have a score that is lower than the subject’s highest CPITN score. For example, a score of 4,1 which changes after treatment to 3,6 would only indicate an improvement in the one sextant which was previously scored CPITN 4. The system would not detect whether periodontal deterioration had taken place in the other five sextants.

3.5.8 Modifications proposed by the workshop on 15 years of CPITN
(Page & Morrison, 1994)

Numerous suggestions for modification of the CPITN were made at this workshop both in the form of general recommendations and recommendations for use of the CPITN for specific purposes (detailed in sections 3.6, 3.7 and 3.8). Under the former, the major modifications proposed were:

- The treatment need codes be deleted from the index and code 0-4 be used for recording both findings and treatment needs;
- Bleeding, calculus and pockets should be recorded separately;
- The term 'shallow pocket' should be discontinued and only probing depth range reported;
- Screening using the CPITN should begin at an age earlier than 15 years, i.e. when the permanent teeth erupt, however only codes 0-2 should be used.

A number of areas for future research were also proposed by Page & Morrison (1994) which, if carried out, might point to additional modifications being required for the CPITN.
3.6 The application of the CPITN in epidemiological studies

"The CPITN is recommended for epidemiological surveys of periodontal health" (Cutress et al., 1987). As such, the CPITN method forms part of the basic oral health and treatment need assessment in the manual Oral Health Surveys - Basic Methods, Third Edition' (WHO, 1987).

For epidemiological studies the CPITN-E probe is recommended, with index teeth or their substitutes being assessed (see sections 3.2.1 & 3.2.5). Cutress et al., (1987) recommend that for planning and monitoring oral health and care, a basic sampling unit comprising a minimum of 25 to 30 person should be examined at any examination site for each age cohort; the number of sampling units being dependent upon the expected variation in the disease in the population. For planning and monitoring in large populations, a sample size of between 200 and 250 subjects per age group is recommended. The authors acknowledge that such sample sizes are unlikely to provide statistically meaningful results for the rarer conditions such as juvenile periodontitis. Furthermore, while WHO standard age groups should be used, the age cohorts 15-19 (or 15 years), 35-44 years and 65-74 years are the prime recommendations as these permit international comparisons and are useful for planning and monitoring (Cutress et al., 1987).

Since its development, the CPITN has been extensively used in epidemiological studies worldwide. Pilot & Miyazaki (1994) reported that in 1993 the Global Oral Data Bank (GODB) at WHO, Geneva held CPITN data from over 300 surveys and from over 100 countries. This CPITN data in the WHO GODB have been reviewed for the 15-19 year-old cohort (Pilot et al., 1987b; Miyazaki et al., 1990,91; Pilot & Miyazaki, 1991); the 35-44 year-old cohort (Pilot et al., 1987a; Miyazaki et al., 1990,91; Pilot & Miyazaki, 1991); and for older age cohorts including the 65-74 year-old cohort (Pilot et al., 1992).

Holmgren (1994) points to deficiencies in the CPITN as there is a poor correlation between probing depths and attachment loss in older adults. Morrison & Page (1994) recommended that when using the CPITN for descriptive and analytical epidemiology, that measures of tissue destruction in terms of attachment loss and recession be included. In this context it is interesting to note that the Second International Collaborative Study of Oral Health Outcomes (ICS2) and the draft for the 4th edition of
the WHO manual 'Oral Health Surveys - Basic Methods' both include the CPITN and an assessment of attachment loss. Morrison & Page (1994) also recommend that all teeth be examined when using the CPITN to prevent underestimations that might occur due to the use of index teeth.

3.7 The use of CPITN for the monitoring longitudinal changes in periodontal conditions

The CPITN has been recommended for the monitoring of treatment outcomes both for individual patients (Croxson, 1984; Cutress et al., 1987) and for populations (Ainamo et al., 1987). In addition, the use of CPITN related goals (Barmes & Leous, 1986) implies the system can be used to assess longitudinal changes within a population. For a review of the use of the CPITN for these purposes see Holmgren (1994) and Lennon (1994).

More recently, Wright et al., (1994), in a five-year longitudinal study of Australian adults using CPITN derived data reported an overall increase in the proportion of subjects with CPITN code 0 and a sharp decrease in the proportion of subjects with CPITN code 4. This study supports the suggestion that the CPITN is sensitive enough to detect some changes in a community perspective. Page & Morrison (1994) suggest however that further research in this area is required and that the inclusion of additional measurements might be warranted.

3.8 The use of the CPITN for health personnel planning (manpower planning)

Health personnel planning (manpower planning) is the process whereby a determination is made regarding the appropriate numbers, types and distribution of individuals capable of providing health services to achieve a desired goal or health outcome (Arnljot et al., 1985). Goodman & Weyant (1990), in their review of dental health personnel planning, report that the three most common models for such purposes are: dentist-population ratios, demand-based models, and need-based models. Each of these models has its advantages and disadvantages which are discussed in the above-mentioned review. Other models include functional analysis models, target setting approach models, and system dynamics models (Sheiham, 1981; Bronkhorst et al., 1991).

The CPITN has most commonly been used to identify the prevalence and severity of
periodontal conditions in populations. Such data may then be used to determine the
treatment needs and personnel required Cutress et al., (1987). A model for personnel
planning developed by WHO/FDI Working Group 6 which makes use of CPITN data has
been described in a manual "Health Through Oral Health; Guidelines for Planning And
Monitoring Oral Health Care" (WHO, 1989). The WHO model is based on the "health
needs approach" which involves four steps (Schoenfeld, 1981). These are:

- assessment of the dental health status of a population;
- translation of dental conditions into need for service;
- estimation of the time required to provide the services needed;
- conversion of the required time into estimates of personnel needed.

In the calculation of oral care needs, the WHO model makes estimations of the services
needed per person, per year, expressed in minutes. A computer spreadsheet program
is available from WHO to facilitate the calculation. One component of the WHO model
is estimation of the services required for periodontal care which requires the following
data for each age cohort considered:

- The mean number of sextants indicated for scaling;
- The percentage of individuals indicated for complex treatment (P);
- Time estimates for scaling per sextant in minutes (TS);
- Time estimates for 'complex' treatment per person in minutes (TC).

The time for scaling per person per year is calculated for each of the age cohorts 0-14,
15-29, 30-64 and 65-79 years, using the mean number of sextants indicated for this
treatment i.e. Treatment Need 2 (TN 2). The equation used for this calculation is shown
below:

\[
\frac{NxT(S) x P(S)}{Cohort-span}
\]

Where

- \(N\) = number of sextants indicated as requiring scaling
- \(T(S)\) = treatment time in minutes for scaling per person
- \(P(S)\) = number of sessions (periodicity) for scaling
- Cohort-span = 15 or 35 years

The time for 'complex' periodontal treatment per person per year is calculated for each
of the age cohorts 15-29, 30-64, and 65-79 years, using the percentage of the population
indicated for this treatment i.e. TN 3, as follows:
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\[
\frac{P \times T(CS) \times P(CS)}{\text{cohort-span}}
\]

Where

- \( P \) = percentage indicated as requiring 'complex' treatment
- \( T(CS) \) = treatment time in minutes for 'complex' treatment per person
- \( P(CS) \) = number of sessions (periodicity) for 'complex' treatment
- \( \text{Cohort span} = 15 \) or \( 35 \) years

The need for oral hygiene instruction (TN 1) is considered separately in the manual under the heading of 'Preventive Care' which also includes group health education and other preventive exercises. The estimate \( T(\text{Prev}) \) is expressed in minutes required per person per year. Provision is made in the WHO model, after the age 15-29, for the option either to continue to include 'T(Prev)' in the WHO model or for special health education time to be included under the estimates for specific items of care e.g. periodontal care.

The WHO model makes an allowance for examination time as this is included in the time estimates for each category of care. An alternative method is to allow specific periodicity and time for examinations with a consequent reduction in the estimates of treatment time.

The data from the above calculations can then be used to indicate the quantity of services indicated corresponding to the needs of the current and predicted population and the number of personnel, expressed as FTEs (Full Time Equivalents), required to provide them. Furthermore, the data can give an indication of the quantity of services which could actually be delivered. Estimates based on normative need will not necessary reflect demand for care and the WHO model therefore suggests that these estimates are adjusted to take into consideration modifying factors which include:

- Social and political factors and economic policies affecting health and oral health care;
- Capacity of existing care facilities and personnel;
- The practice profile of the country or district;
- Training facilities for oral care personnel;
- Actual and projected demand for oral care;
- Research advances affecting oral health and care.
Adjustment of the estimates considering these modifying factors must be based upon a number of assumptions however the manual fails to give clear guidelines except to state that both the data and assumptions will be highly specific to a particular population.

A number of studies have examined the WHO model for planning and monitoring for oral health care (WHO/FDI, 1989) and these have been reviewed by Holmgren (1994).

### 3.9 CPITN related goals

An integral component of the health care planning process is the formulation of defined goals (WHO, 1980). With the widespread use of the CPITN for epidemiological purposes and its claimed ability to monitor the effectiveness of periodontal care programmes, it is not surprising that periodontal health goals have been expressed in CPITN compatible terms.

Cooperation between the World Health Organisation (WHO) and the Federation Dentaire Internationale (FDI) has resulted in the proposition of goals for oral health in the year 2000 (Aggeryd, 1983). Barmes & Leous (1986), in reviewing CPITN data in the WHO Global Oral Data Bank, have suggested a number of tentative CPITN defined global goals for the year 2000, as shown overleaf:

- **12 years**  - not less than 3 healthy sextants (CPITN = 0) per child
- **15 years**  - zero sextants with periodontal pockets (CPITN ≥3)

The authors did not however feel confident enough to formulate similar goals for adults but suggested that an appropriate measurement could be the percentage affected or average number of periodontal pockets at age 35-44, and the average number of retained functional teeth per person at age 65 and over. In this respect, recently CPITN defined global goals for the year 2010 which include older age cohorts have been proposed by WHO as follows:

- **15 years**  - at least 5 healthy sextants, the remainder scoring CPITN 1 or 2
- **35-44 years**  - no more than 0.1 sextants scoring CPITN 4
- **65-74 years**  - no more than 0.5 sextants scoring CPITN 4

For European populations, periodontal goals for health by the year 2000 have been formulated which include goals for older age groups (Frandsen, 1984), as follows:

- **18 years**  - 90% with at least three healthy sextants (CPITN = 0)
- **35-44 years**  - 75% with at least three healthy sextants (CPITN = 0)
- **65+ years**  - no more than 10% with one or more sextants with CPITN = 4
In the Western Pacific Region, Songpaisan & Davies (1989) state the Thai national goals for periodontal health by the year 2000 to be:

- 12 years - not less than 3 healthy sextants (CPITN = 0) per child
- 18 years - not less than 2 healthy sextants (CPITN = 0) per person

Numerous other CPITN related goals by the year 2000 have been proposed within the region, however Lind, Holmgren et al., (1986) proposed the following tentative goals for the year 2000 for Hong Kong:

- 18 years - 60% should have at least 3 non-bleeding sextants while 90% should not have periodontal pockets (CPITN 3 or 4);
- 35-44 years - 30% should have at least 3 non-bleeding sextants and 80% should not have periodontal pockets (CPITN 3 or 4).

In the goals defined above, the term 'non-bleeding sextants' were used in lieu of CPITN 0 as it was recognised that a goal specifying an improvement for this age group in the latter terms would be dependent upon the removal of much calculus which was considered unrealistic. As calculus can be present in the absence of gingival bleeding (Holmgren & Corbet, 1990), the former definition was deemed more appropriate and achievable.

It is interesting to note that Holmgren et al., (1994) failed to detect any significant changes in the CPITN of 35-44 year-olds between the 1994 and the 1991 Hong Kong Adult Oral Health Survey (Lind, Holmgren et al., 1986). It seems unlikely therefore that the CPITN related goals proposed for Hong Kong will be achieved by the year 2000.
4.1 Introduction

In planning health services, an estimation of the time required to perform specific treatment procedures is necessary in order to determine personnel and resource requirements (Ekanayaka & Sheiham, 1978). The use of such data for this purpose has been demonstrated by Douglass et al., (1984) and more recently in a publication prepared by Joint WHO/FDI Working Group 6 entitled *Health Through Oral Health: Guidelines for Planning and Monitoring for Oral Health Care* (1989) where treatment time estimates combined with CPITN data are the foundation for planning periodontal health services.

While such information is essential at the planning stage, treatment time data is also an integral component in determining the cost of provision of treatment. For example, Holst & Brembo (1980) have used average treatment times to estimate treatment costs of a public dental service, relating to different treatment profiles. In this respect, a number of dental health schemes have based the scale of fees to be charged for various items of treatment on treatment times. In the British National Health Service (NHS), the fee for each item of treatment determined by the Dental Rates Study Group has been based upon a combination of the treatment time required, administrative costs and laboratory fees (Hill, 1974; Downer et al., 1979). Similarly, the times taken to perform dental procedures have been used as the basis for the Swedish dental care fee schedule (Håkansson & Eriksen, 1982).

Treatment times can also be used in the measurement of productivity. Baird et al., (1967) used 'Time Points' which are weighted values for dental operations based on the average time required to complete various operations, as a measure of productivity. They also used a 'Relative Value Unit' of dental treatment (RVU) which is a statistical expression of treatment time, cost and responsibility factors involved with any given dental procedure, relative to other dental procedures, which they considered to be the most accurate method for analysing dental productivity. RVUs were subsequently used by Hobdell et al., (1975) to plan a dental treatment program for an institutionalized population. More recently, Kaplan et al., (1983), in examining the relations between potential delegation of tasks and their execution, introduced the 'Standard Production
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Minute' which weighs each procedure performed by the treatment time required in the production of the procedure. Productivity can also be computed on the basis of benefits and costs of a specific procedure. In this context, Hendricks et al., (1985), performing cost benefit analysis of direct posterior restorations, point out that the cost factor is mainly determined by the treatment time spent by the dentist, as material costs are of minor importance.

The treatment needs of a group or population can be expressed as the time required to provide the treatment indicated (Markkanen et al., 1983). In relation to this, Ainamo et al., (1982) have suggested that periodontal treatment needs as defined by the CPITN could be reported in terms of the average time required to carry out the procedures in the various treatment categories.

In addition to the planning and evaluation of health services for communities, Mundel (1958) has suggested that treatment time data from dental practice, makes it possible to:

- decide what effect additional assistance would have;
- decide what tasks are most time consuming;
- relate time expenditure to charges;
- find what time is really spent; and,
- provide a basis for evaluating the desirability of different equipment.

Furthermore, information derived from treatment times can be used to improve efficiency and productivity (Graning et al., 1951) and help determine which activities could be assigned to ancillary personnel (Parrish et al., 1967; Kaplan et al., 1983).

Thus, treatment time data have many uses and are an essential component in the planning and evaluation of health services and for the improvement in efficiency and productivity of dental practice.
4.2 Definition of treatment time

Treatment time has rarely been precisely defined and could conceivably be reported in terms of:

- The total amount of time required to perform all dental care during a course of treatment;
- The time taken for each visit, regardless of the procedure being carried out;
- The total amount of time required to perform one component of treatment within the overall treatment e.g. the periodontal treatment;
- The time required to perform a single procedure, or item of treatment, e.g. scaling, or oral hygiene instruction;
- The time required to perform a portion or element of a single procedure, e.g. instruction on interdental cleaning as part of oral hygiene instruction.

Naturally, none of these categories is mutually exclusive. In addition, there would appear to be a lack of consistency within each of these categories. For example, Ekanayaka (1976) recorded treatment time for clinical procedures as being "from the moment the operator began working intra-orally until he put down the instrument at the completion of treatment", while Johansen et al., (1973) recorded treatment time, for example for scaling, from "when the dentist started to wash his hands until a particular treatment procedure was completed". Ekanayaka (1976) claimed that inclusion of other activities in the treatment time would increase overall variability of the measurements, therefore, exclusion would permit better standardisation, as the start and finish of treatment was more clearly defined. Furthermore, he considered that as one of the objectives of his study was to study treatment needs, it was reasonable to quantify only the actual procedures. It was however noted that to do so would underestimate the total treatment time, and that this factor would need to be taken into account when used for planning purposes. These comments aside, unfortunately the treatment time has not been defined as precisely as in these two studies.

Complications also arise because of differences in the way that activities (procedures) are defined and grouped within clinical disciplines (Bader & Kaplan, 1983; Spencer & Lewis, 1989). Another consideration when defining treatment time, particularly with respect to periodontal treatment, is whether it relates to initial care, where treatment is being provided for the first time, or whether it relates to subsequent incremental or
maintenance care (Ast et al., 1970). Initial care is usually much more time consuming than incremental care and therefore distinction should be made between the two (Striffler et al., 1983; Helöe, 1973).

There is therefore no single definition of treatment time. However, ideally, when reporting such data, the activity should be defined as precisely as possible with respect to what it involves, and whether the time relates to initial or to incremental care. Unfortunately, the dilemma posed by the previous lack of standardisation inevitably leads to problems when attempting to interpret results or make comparisons between different studies.

4.3 Methods used to determine treatment times

A standardised method for the determination of treatment times does not exist largely due to practical considerations and because the type of data collected varies according to the purpose for which it is to be used. With respect to the determination of average times for different treatment categories recommended by the CPITN, Ainamo et al., (1982) state that "suitable procedures are presently being tested and more detailed recommendations will be developed"; however these remain to be published.

The majority of existing methods used in the medical and dental fields to determine treatment times have their foundations in techniques used in industry for improving productivity. These come under the general heading of 'Work Study, Organisation and Method', defined by the British Standards Institute Glossary BS 3138:1979 as "The systematic investigation of activities in order to improve the effective use of human and other resources".

A component of Work Study, Organisation and Method is 'Work Measurement' which is "the application of techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance" (BS 3138:1979). According to this definition, the assessment of treatment time can clearly be classified under this heading.

In the industrial setting there are numerous methods by which work measurement can be accomplished (see Currie, 1977), however when applying these methods to the medical and dental environment, it must be borne in mind that there are fundamental
differences between the industrial situation and the clinical setting. With the former, the task/procedure is usually standardized and repeated e.g. in an industrial press; in contrast clinical conditions vary from practice to practice, between patients and between the same procedures performed on different patients (Byrne et al., 1973). Because of these differences, the methods of work measurement which are most applicable to and therefore most commonly used in the clinical setting are based on 'Time-study' and 'Activity Sampling' (see sections 4.3.1 & 4.3.3).

Data collection for work measurement can be either 'Self generated' or 'Observer generated'. With the former, "data is recorded by either the individual providing the dental service or some other member of the dental team at the site, such as a dental assistant or receptionist," whilst for the latter, "data is recorded by an individual and/or instrument independent of, and detached from, any of the inputs (team members) to the dental production process at the site being studied" (Byrne et al., 1973). Both methods of data collection have inherent advantages and disadvantages. Self generated data collection is the only practical method of obtaining data from a large number of operators working in geographically distinct locations. This method can however be both difficult and time consuming to perform (Parrish et al., 1967); it may also be less accurate as it may introduce a distorting effect of the time including that required to make and record the data (Buchan & Richardson, 1973), which may in turn increase bias and disrupt the routine of the operator (Parrish et al., 1967). It is therefore important that the collection system must be relatively error free, require little operator sophistication and require a relatively small amount of time to perform (Byrne et al., 1973). Furthermore, the quality of the data depends upon the training, motivation, knowledgeability of the recorder and quality control is more difficult where multiple recorders are employed (Byrne et al., 1973). Observer generated data collection does alleviate many of these problems but does require trained observers. Hobdell & Evans (1977) considered that such observers should have some knowledge of dentistry and therefore, in their study, largely used dental auxiliaries and dental surgery assistants, while Tan & van Gemert (1977) used dental students. Quality control of data collection is often easier as fewer observers are usually required when compared to recorders for self generated data. Disadvantages of observer generated data include the cost of such personnel and the possibility that the effect on an operator being overseen by an observer may in itself cause anxiety and introduce a distorting effect on the behaviour of the operator and the time used for activities (Buchan & Richardson, 1973).
A further method of data collection used in work study involves the production of a continuous record of the activities either in the form of an audiotape recording or by the use of photographic methods which can subsequently be analyzed (see section 4.3.2). Outwith the standard methods of work measurement per se, the questionnaire tool has also been used in a number of studies to obtain data on treatment time (see section 4.3.4).

Finally, an essential consideration irrespective of the method used to assess treatment times, is that the period of study be representative. Studies of short duration or occurring during atypical periods in a dental practice may lead to bias in the results (Bader & Kaplan, 1983).

4.3.1 Time-study

Time-study, also known as continuous recording, is defined as "a work measurement technique designed to establish the time for a qualified worker to carry out specified elements under specified conditions at a defined rate of working, recorded by direct observation of the times, using a time measuring device and the ratings for individual elements" (BS 3138:1979). The term 'element' used in the above definition refers to "a distinct part of an operation selected for convenience of observation, measurement and analysis" (BS 3138:1979) and could therefore relate to either a dental procedure or part of a procedure.

The basic method of time-study has the advantage that only minimal and inexpensive equipment is required comprising only a stopwatch or clock to monitor time and a data sheet to record results. Data collection can be either self or observer generated, however with this method, a single observer can generally only observe one operator unless complex methods of communication such as intercoms are used (Lotzkar et al., 1971). Two methods of timing can be used: these being either 'flyback timing' where "the hands of the stopwatch are returned to zero at the end of each element and are allowed to restart, the time for each element being obtained directly"; and 'cumulative timing', where "the hands of the stopwatch are allowed to continue to move without returning them to zero at the end of each element, the time for each element being obtained subsequently by subtraction" (BS 3138:1979).

In conducting a time-study, it is essential to specify accurately at which point a procedure
begins and where it ends. These are defined as 'break points' (BS 3138:1979) and must be determined before the start of a study. Both Parrish et al., (1967) and Buchan & Richardson (1973) experienced difficulties in defining break points in general medical practice as often two activities were being performed simultaneously, emphasising the problems of adapting an industrial work measurement method to a clinical setting. Similar problems are likely to be encountered in dental practice.

Despite these potential difficulties, the broad principle encompassed with time-study has been widely used in both the medical and dental fields. In the former, the method has been used to determine the amount of time spent on different activities by rural health officers (Dean 1935), by general medical practitioners during consultations (Buchan & Richardson, 1973; Haring & Eckert, 1979), and by consultant psychiatrists (Dun & Attwood, 1978). In the dental field, time-study has been used to assess treatment times in a number of studies (Altman, 1946; Klein et al., 1947; Stewart et al., 1967; Ast et al., 1970; Lotzkar et al., 1971a; Johansen et al., 1973; Bellini & Johansen, 1973; Ekanayaka, 1976; Solovan et al., 1984).

In one of the first studies to use time-study to determine the average treatment times for dental procedures, Klein et al., (1947) used the self-generated data collection method to acquire data from a large sample of dentists in the United States. Participants were requested to record on a treatment log, the exact start and completion time for all items of treatment performed for the first five patient visits on a specified date, whereupon treatment times could be easily calculated. A similar approach has been widely used in many studies as it permits data collection from a large number of persons in geographically distinct locations. For example, it has been used to determine treatment times for general dental practitioners in the United Kingdom (Penman Report, 1949), for Norwegian district dental officers (Holst & Brembo, 1980), and for dentists in Australia (Spencer & Lewis, 1989). Many dental procedures however require more than one visit to complete and it is therefore necessary that the basic data collection method be modified appropriately. Klein et al., (1947) only modified the data collection method for prosthetic treatment, accomplishing this by requesting participants to record, for the first three patients starting such treatment, the time for each visit until treatment was completed. Similar modifications are nonetheless equally relevant to other treatment procedures including the assessment of periodontal treatment times, where oral hygiene instruction, scaling or more complex treatment may extend over a number of patient visits.
The basic method of time-study has been modified in a number of studies in order to simplify data collection in the clinical setting, thereby making the data more reliable. This has been achieved by using specially designed daily report forms on which participants record the nature and duration of each predefined activity to the nearest five-minutes. This modification has been used by Ferguson et al., (1952) to investigate the range and frequency of activities of health officers and medical administrators within the United States, by Cohart & Willard (1955) and by Milne et al., (1958) to record the activities of public health workers, and by Parrish et al., (1967) to record those of general medical practitioners. More recently, the WHO/FDI Joint Working Group 9 has recommended a similar modified method of time-study in the protocol for Practice Profile Time Studies (Amerongen BM van, 1989). Once again, use has been made of a self completion daily report form provided with a set of boxes for recording the nature and duration of predefined activities undertaken during the working day, the major difference being that the duration of each activity is recorded to the nearest fifteen minutes. This difference may to some extent be beneficial as the normal routine of the operator is less disrupted by data recording, however, the chance of two activities being performed in the same time period is increased. To compensate for this, the protocol advises that, in such instances, both activities are recorded for that time period. Such data allows the percentage of time spent by general dental practitioners on different practice activities to be determined. This provides both dental associations and individual practitioners with information on workload and the use of time in practice including some assessment of the proportion of unproductive time caused by cancelled and failed appointments. Unfortunately, in its present format, the protocol does not permit the exact time for specific activities to be determined for two reasons. Firstly, the duration of any single activity can only be accurate to the nearest 7½ minutes and secondly, because there is no allowance for activities which may take more than one visit.

Thus the advantages of time-study are:

- The method is relatively simple to perform;
- The basic equipment required is both minimal and inexpensive;
- Data collection can be both 'self generated' or 'observer generated';
- Self generated data can be collected from a large number of persons in geographically distinct locations;
- The method can be more accurate than others (see section 4.3.3).
The disadvantages of time-study are:

- When the data is observer generated, a single observer can generally only observe one operator unless complex methods of communication are used;
- It is unsuitable for studying activities of long duration as it would become too costly to use (Peer & Kennedy, 1973).

4.3.2 Photographic and other methods

Another modification to the conventional time-study method makes use of a continuous record of the activities either in the form of an audiotape recording or by the use of photographic methods. These records can subsequently be analyzed using a stop-watch to measure the time spent on various activities. Audiotape recordings have been used to study the content of doctor-patient contacts (Jeans, 1963), and to analyze the content and duration of oral hygiene instruction given by dental therapists (Milgröm et al., 1989). In circumstances where the activity cannot be accurately deduced from the audiotape recording, the operator can verbally record its nature. Timing accuracy can be improved by use of an electronic pulse recorded on the tape at fixed time intervals (Byrne et al., 1973).

The use of photographic techniques for work study were introduced by Gilbreth (1916) primarily for method study where a systematic recording and critical examination of ways of doing things is undertaken in order to make improvements in the method. Since then still, cine and video photography has been widely used in industry for this purpose. Photographic techniques make use of a camera to replace the direct, ‘real time’ observation, analysis and recording of activities usually performed by an observer. The analysis of activities can then take place at any subsequent time either by the operator or by any number of independent people. The availability of a permanent record enables an experienced observer to refine his analysis system to suit the current experimental objectives within minutes of starting the study, and to continue to refine it as the study proceeds (Peer & Kennedy, 1973). The data obtained from photographic techniques offer higher accuracy in the assessment of timings over conventional stopwatch timings made from the actual performance of the operator and can be checked by replaying the recording (Peer & Kennedy, 1973; Mundel & Margolin, 1948).

Photographic techniques enable the recording of both the activities and the coordination
of a whole team of individuals simultaneously. Without this technique, several observers would probably have to be employed to record the activities. Providing the design of the clinical area permits, only one camera need be used.

The high cost of cine film led to the development of a specific photographic technique known as 'Memomotion photography' defined as "a form of time lapse photography which records an activity by using a cine camera with longer than normal intervals between frames" where "the resultant display shows a speeding up of the activity" (BS3138:1979). This technique has been used for time and motion study both in industry (Currie, 1977), and in dentistry (Mundel, 1958). Mundel (1958) describes how a cine camera running at only one frame per second instead of the customary 16 frames per second, can be used to record activities. Then, with a projector running at normal speed, it is possible to rapidly analyze the activities of a long period of time. One of the advantages of using memomotion photography is that it is more economical in film consumption. Despite this, compared to other work study methods, Hobdell & Evans (1977) still consider the costs for time-lapse cine films, their subsequent analysis and data processing to be relatively high. Furthermore, a special driving device is required for camera and projector to maintain accurate recording and projection speeds.

An alternative to cine photography is videotape recording (VTR) which has been used for productivity studies in the construction industry (Peer & Kennedy, 1973) and for other industrial situations (Sakuma, 1973). The main differences between VTR and cine photography lie with the equipment used and the recording medium. Sakuma (1973) considers some of the advantages of VTR over the use of cine film to be:

- the tape recording is available for analysis immediately after recording as no special processing is required;
- it is more economical as the tape can be repeatedly erased and reused;
- recording and reproducing speeds are accurate;
- the VTR can still be used in relatively low light areas;
- both sound and picture are recorded on the same tape;
- the video camera is silent and does not disturb workers;
- the videotape can run for long periods of time without change.

The disadvantages of VTR methods largely relate to relatively high initial cost of the video camera and recorder which is compensated in the long term by the inexpensive video tapes. Over recent years, the cost of VTR equipment has reduced considerably
and it is foreseen that this method will become more widespread in the future.

Lastly, a combination of basic time-study and elaborate photographic techniques used by the Westchester-Fairfield Work Simplification Group for time and motion study in general dental practice has been described by Kilpatrick et al., (1972) where use was made of a combination of still cameras, cine cameras and direct observers. Such combinations are however more relevant to method study.

In summary, the advantages of using photographic techniques for work measurement are:

- A permanent record is obtained of the work being studied;
- The activities and coordination of a whole team of operators can be recorded simultaneously if the work area permits;
- The record can be referred to at any time, in any place, and by any number of people and can be analyzed in many different ways according to the objective of the study;
- The technique is more accurate than conventional time-study.

Disadvantages of photographic methods centre around the cost of photographic equipment and materials.

4.3.3 Activity sampling

Activity sampling is a method of work study first introduced by Tippett in 1935, under the heading of 'snap reading' for use in the textile industry. This method is also known in the U.S.A. as 'ratio delay' and 'work sampling' (Barnes, 1980). Activity sampling is defined as "a technique in which a number of successive observations are made over a period of time of one or a group of machine(s), process(es) or worker(s)" and where "each observation records what is happening at that instant and the percentage of observations recorded for a particular activity or delay is a measure of the percentage of time during which that activity or delay occurs" (BS 3138:1979). The method is based upon the laws of probability in that a sample taken at random from a large group will have the same pattern of distribution as the large group. Thus, by making a record at pre-specified time intervals of the nature of activity being performed by an operator or operators, it is possible to calculate the proportion of time devoted to a certain activity. Moreover, the ratio of productive to unproductive activities can be estimated as can the
average time required to complete a specified activity providing the number of completed activities is simultaneously recorded for the period of activity sampling.

Prior to conducting a work measurement study using activity sampling, it is necessary to:

- Compile a list of activities to be sampled;
- Determine the required accuracy and thus the number of observations needed; and,
- Determine the time intervals between observations during a specified period.

The list of activities used for sampling should be pertinent to the objective of the study (Mundel, 1958). Hobdell & Evans (1977), initially identified a total of 150 activities for study, however, these were subsequently reduced to 98 activities as the larger number was found to be unwieldy. These activities were subdivided into three broad categories namely:

- **Primary activities** - defined as those activities which were "ends in themselves and would normally be entered by a clinician in a patient's record e.g. cavity preparation for a Class 1 lesion";
- **Secondary activities** - defined as those activities "which are not ends in themselves but which are nevertheless essential, e.g. instrument passing"; and,
- **Unproductive activities** - defined as those activities "which do not contribute to fulfilling primary activities, e.g. waiting for the patient".

The advantage of such categorisation of activities is that it is possible subsequently to report treatment time as either the **Primary Activity Time**, "the time spent in primary activities, disregarding time spent in secondary or unproductive activities", or as the **Overall Activity Time**, "the time spent in primary activities, including time spent in secondary and unproductive activities".

Other studies have used different numbers and classification of activities. For example Hoffman (1972) defined 38 activities for activity sampling of dentists in general practice subdivided into 'productive', 'non-productive or delegable', and 'idle in dentistry during office hours' categories. Tan & van Gemert (1977) however defined only 27 activities when using this method to compare the time utilization, productivity and cost between
solo and extended duty auxiliary dental practice.

The required accuracy determines the number of observations needed which in turn effects the duration and cost of the study. For an analysis of dental practice, Mundel (1958) suggests that observations should be made on at least 1000 separate occasions. It is however possible to use the following formula, based on 95% confidence limits, to determine the required number of observations:

\[ L = 1.96 \sqrt{ \frac{P(100-P)}{N}} \]

Where

- \( L \) = limits of permitted variation stated as a percentage of total time (95% confidence intervals)
- \( P \) = proportion of time devoted to activity
- \( N \) = number of random observations for activity (sample size)

Activity sampling routinely uses random time intervals between observations during a specified period, however Peer & Kennedy (1973) consider systematic activity sampling, where there is the same interval between successive observations, to be more useful when activities are stochastic in nature and of long duration. Floyd & Livesey (1975) used systematic activity sampling in general medical practice with their 'bleep method' where a bleep signal was transmitted every minute through the practice premises over a loudspeaker, whereupon the doctor recorded the activity being performed at that instant. Systematic activity sampling has also been used by Buchan & Richardson (1972) where a group of medical practice secretary-receptionists were sampled every minute. The use of longer time intervals may produce problems particularly if they relate to natural time periods such as every hour, as this may lead to only the changeover of patients being observed (Mundel, 1958).

Random time intervals can be derived by a number of different methods. Mundel (1958) suggests marking a large number of cards e.g. 1000, with fixed time intervals within a normal working day; the cards are then shuffled and the number of cards corresponding to the number of observations required per day are selected and sorted. Random number tables can be similarly be used to construct a list of sampling times. Other methods include a random audible signal generator such as the Frekvensor device (Frekvensor International AB, Sweden) which produces an audible sound at random
times, thereby dispensing with the need for both predetermined observation times and a separate timing device. This device has been used for work measurement in a community dental care unit by Hobdell & Evans (1977).

In the industrial setting, a specially printed Activity Sampling Observation Record Form is normally used which permits a large number of operators performing a large number of different activities to be sampled (Currie, 1977). In the clinical setting, the specific activity can be recorded on a similarly designed form (Hobdell & Evans, 1977) or could alternatively be recorded on the card indicating the time of sampling (Mundel 1965).

Activity sampling is extremely flexible in that the method permits data to be both self- or observer generated. Comparisons show results from these two data collection methods to correspond reasonably well, with the slight differences observed probably due to different interpretations of activities (Hobdell & Evans, 1977).

Activity sampling is considered to be an inexpensive method of obtaining data (Buchan & Richardson, 1972; Floyd & Livesey, 1975). Hobdell & Evans (1977) also make this point when comparing the differences between activity sampling and time-study (continuous recording). They consider that an advantage of activity sampling over time-study is that the former "enables a large number of activities being carried out by many individuals during a given period of time to be studied by a single observer" and that "it is therefore considered to be ideally suited to the collection of information about the whole of the dental team".

A possible disadvantage of activity sampling when compared to time-study is that the former may be less accurate (Hobdell & Evans, 1977) but accuracy can be improved by increasing the number of observations. However, because of the fundamental statistical basis of activity sampling, the accuracy is also related to the proportion of the time spent on a particular activity. In the estimation of periodontal treatment times this could pose a problem in that, generally speaking, only a small proportion of time is spent by general dental practitioners on periodontal treatment. Bader & Kaplan (1983) have shown this proportion in the USA to range from 1.1% to 4.9% and in addition Cohen (1983) showed that only 1% of US patients have periodontal disease recognised and treated. In contrast, 10% of dentist time in Australia is spent on removal of calculus and plaque (Spencer & Lewis, 1989). More recent practice profile studies conducted in 9 countries show that the proportion of time spent by general dental practitioners on oral hygiene
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Instruction ranged between 0% [Finland] and 5% [Sweden], on scaling between 1% [Hong Kong] and 11% [Finland], and on root planing and periodontal surgery between 1% [Hong Kong, Denmark, Sweden, New Zealand, Netherlands] and 8% [Finland] (Amerongen BM van, ed. 1989).

A further problem with activity sampling is in relation to the assessment of treatment time for multi-visit procedures. This is a similar problem to that discussed in section 4.3.1, however in the case of activity sampling, there is no simple modification to the data collection method that enables the treatment time for a multi-visit procedure to be determined.

In summary the advantages of activity sampling are:

- Flexibility in the means of data collection;
- Inexpensive;
- A large number of activities being carried out by many individuals can be studied by a single observer.

The main disadvantages of activity sampling are its accuracy and the problems of assessment of treatment time for multi-visit procedures.

4.3.4 Questionnaires

Questionnaires are the most widely used tool in social investigations (Moser & Kalton, 1971), and have been used extensively in the medical and dental fields for many purposes including the estimation of time spent on various activities. The method is particularly useful where data needs to be collected from a large sample of operators.

Several studies have used a questionnaire combined with a daily treatment log or report form for participants to detail the treatment activities and times taken for such activities over a defined period e.g Klein et al., (1947). Such a combined data collection instrument permits the collection of data on operator and practice characteristics while concurrently collecting data on treatment profiles and treatment times. The use of report forms as a means of collecting treatment time data, has already been described in section 3.3.1 under 'Time-study'.

Less sophisticated studies have solely used the questionnaire tool itself to elicit data on
treatment times. In such studies, respondents have simply been asked to make an estimate of the time spent on different activities. The responses to such questions are often categorized according to ranges of time such as in the studies of Miller et al., (1989,90) where questions were structured as follows: "How much time do you usually spend per appointment to motivate your patients in oral hygiene? 1-5 min; 5-10 min; 10-15 min; 15-20 min; 20-30 min; 30-45 min; more than 45 min".

Naturally, data collected with a questionnaire will be less accurate than data collected by work study techniques (Bader & Kaplan, 1983). Despite this, questionnaires have been used by the Dental Rates Study Group of the British National Health Service to determine the scale of fees according to the relative time spent on various dental procedures (Downer et al., 1979).

In relation to the assessment of treatment times for periodontal procedures, Markkanen (1978,83) made use of a questionnaire to obtain data from members of the Periodontology Division of the Finnish Dental Society. In this study, estimates for the mean treatment times for a 'check-up', motivation and oral hygiene instruction, scaling and removal of overhangs, and periodontal surgery were ascertained. These estimates were then used as a basis for the calculation, from modified PTNS data, the periodontal treatment needs expressed as the mean periodontal treatment time in minutes per person for a sample population.

More recently, Miller (1989,90) has made use of a questionnaire in two studies of French dentists to determine treatment times for specific items of periodontal treatment. In one study, the questionnaire was specifically designed to seek responses for treatment procedures according to guidelines specified by the CPITN (Ainamo et al., 1982). Questions were focused on the time for oral hygiene instruction, scaling and root planing per sextant, treatment of pockets 3.5-5.5mm deep and treatment of pockets more than 6mm deep. Supplementary questions enquired about the length and frequency of maintenance appointments. The results of these two studies are given in Table 5.1 (Appendix I).

Thus, the use of the questionnaire tool to obtain data on treatment time has the advantage that it is relatively simple, inexpensive, and allows collection of data from a large number of participants working in geographically distinct locations. The major disadvantage relates to the quality of the data obtained which is dependent upon the
cooperation and assiduity of the participant and the correct interpretation of the information sought. When dentists were asked to estimate the length of time spent on various activities, Byrne et al., (1973) found a pronounced and predictable tendency for participants to report in five-minute intervals when open-ended questions were used. The effect of any bias caused by this depends largely upon the purpose for which the data is to be used. The reliability of the data may also be affected by low response rates such as those reported by Klein et al., (1947), where only 25%, of almost 1500 dentists sampled, responded. In certain circumstances this might pose a problem, however, Milgrom et al., (1988) found no significant differences between respondents and a sample of non-respondents in a questionnaire survey of attitudes and behaviours of dentists in counselling patients about oral self care. Furthermore, the response rates of dentists to questionnaires are generally good with some as high as 82% (Holst & Brembo, 1980).

Questionnaires are thus a time honoured method of data collection being both simple, inexpensive and permit data to be collected with minimal effort from many distinct locations. The disadvantages are their possible lack of accuracy and respondent bias.

4.4 Summary

In the determination of treatment times for dental procedures, there are a number of methods which could be used either alone or in combination. The particular method selected will depend largely on the objectives of the study and the nature of the data required. Irrespective of the method used however, it is essential that the treatment times determined be clearly defined.
5.1 Introduction

The treatment needs component of the CPITN (see section 3.2.8), categorizes subjects according to their preventive and treatment requirements, these being:

- Oral hygiene instruction;
- Scaling, root planing and removal of plaque retentive factors;
- 'Complex' treatment which may involve deep scaling and root planing, or more complex surgical procedures.

It is therefore logical, when reviewing studies which have reported treatment times for periodontal procedures, to subdivide the results where possible into these same broad categories. Furthermore, procedures integral to the delivery of periodontal treatment such as examination, charting and radiographs, should also be included for completeness. Such a review allows comparisons to be made between studies, however difficulties do sometimes arise in terminology as some authors use the same terms to describe different periodontal treatment procedures. For example, the term 'prophylaxis' has been used by some to describe a combination of patient examination, oral hygiene instruction, scaling and root planing and other procedures (Schallhom & Snider, 1981), while others use the term solely to describe polishing the teeth with pumice (Lotzkar et al., 1971a,b). Another difficulty, is the lack of consistency in the method used for the assessment and reporting of treatment times. While most authors report the treatment time according to the total time expended during a course of treatment on a procedure or series of procedures, some report only the treatment time per visit.

Treatment times for most restorative procedures are relatively easy to define as the provision of a restoration is an end to itself. The treatment of periodontal disease is however very different as there is no commonly accepted endpoint at which treatment can be considered completed. If the objective of periodontal treatment is total elimination of periodontal inflammation, then this is rarely, if ever, achieved. Similarly, if the objective is acceptable periodontal health, then the question is, what is acceptable and how much effort should be expended attempting to achieve it? This question is
probably unanswerable as it depends upon numerous factors including definitions of health, availability of resources, operator's demands and expectations, patient's demands, expectations and compliance, etc. Since there appears to be no definable endpoint for periodontal treatment, then it is inevitable that periodontal treatment time is subject to considerable variation. Ideally therefore, periodontal treatment time should be considered from the perspective of the benefit gained relative to the effort expended under the conditions where the treatment is delivered.

Bearing these considerations in mind, the pertinent details of studies which have reported treatment times for periodontal procedures are summarized in Table 5.1 (Appendix II). As might be expected, with few exceptions, considerable variation in treatment times can be discerned across the majority of studies. This variation is caused through the many confounding factors which may, individually or in combination, influence the time required to perform dental procedures. Some factors are common to all dental procedures performed in a particular environment, whilst others may relate specifically to certain items of periodontal treatment.

The WHO technical report on the Epidemiology, Etiology and Prevention of Periodontal Diseases [TRS 621] (WHO, 1978) states that the estimated time required to deliver dental services depend upon a number of factors of which "... the most important are the attitudes and behaviour of the population, the types of manpower, the type of equipment, the approach to oral hygiene education and the actual treatment procedures". Ekanayaka & Sheiham (1978) consider the skill of the operator, the workload, the availability of assistants, the equipment and the treatment philosophy of the operator as important factors, while Ast et al., (1965) include the working speed, habits of the operator and the cooperation of the patient as being critically important. The effect of these factors on the variability in treatment times implies that the results obtained in any one situation may not apply to another (Ast et al., 1965; Ekanayaka & Sheiham, 1978). This is reiterated in TRS 621 (WHO, 1978) which stresses that the time estimates given in this document (see Table 5.2, Appendix III), need to be tested and then adjusted according to local factors. Ainamo et al., (1982) also allude to this problem in relation to treatment times for periodontal procedures recommended by CPITN, and have similarly advised the need for treatment times to be assessed locally.
5.2 Treatment times for specific periodontal procedures

5.2.1 Time required for examination, charting and radiographs

Examination, charting and the taking of radiographs are an integral component of all dental treatment, with the formulation of a treatment plan being in part dependant upon the findings of such activities. With respect to periodontal disease, there is no single method by which these activities are performed although in the context of general dental practice, attempts have been made by certain professional organizations to introduce the CPITN as the standardized method of periodontal screening and examination (see section 3.5.1). If the CPITN is not used then the content of the examination, the parameters which are charted, and the number and type of radiographs taken are undoubtably highly variable which will invariably have a bearing on the time expended.

Published data on the time required for examination, charting and radiographs is summarized in Table 5.1 (Appendix II). Unfortunately, much of the data is not directly comparable between studies because:

- some data relate to general dental practice while other data relate to clinical or epidemiological studies;
- the clinical parameters used often differ;
- some studies report data for the examination, charting and radiographs separately while others report them conjointly;
- some studies report overall time spent during a course of treatment while others report the time per session.

Despite the difficulties experienced in interpreting the data, some clear trends do appear. Examinations which use minimal clinical criteria are generally shorter, for example, the PTNS (Bellini & Gjermo, 1973) takes on average 1.4 minutes, the PSE (Oliver, 1976) <5 minutes, while the CPITN takes between 1 and 2 minutes (Ainamo, 1984). The longest examination times were those reported by Glavind & Løe (1967) at 22.5 minutes, and Hetland et al., (1981) at 30 minutes. It must be noted however that these latter examination times both relate to clinical studies where examination criteria tend to be more complex and detailed and therefore might not directly be relevant to the dental practice setting.
There is also evidence that examination and charting is less time consuming when a chairside assistant is used (Klein et al., 1947; Schallhom & Snider, 1981), and a tendency for charting performed by dentists to be shorter than when performed by dental assistants (Lotzkar et al., 1971a,b). The oral health status of the mouth might also affect charting time, as Lenox & Kopczyk (1973) have reported that the time required for recording of plaque and bleeding reduces as oral hygiene improves.

Few studies have reported the time taken for radiographs, and those that have, have failed to specify the exact nature of the radiographs taken. Rosenberg et al., (1986) reported that a full-mouth radiographic survey took on average between 8.5 and 10 minutes. Lotzkar et al., (1971) reported that the time required for taking radiographs by dentists and dental assistants were a mean of 13.4 and 20.9 minutes respectively. Conversely, Nash et al., (1979) reported that the mean time for radiographs taken by hygienists was less than those taken by dentists.

5.2.2 Time required for oral hygiene instruction

A CPITN treatment code of 1 or higher indicates the need for improving the personal oral hygiene of that individual involving oral hygiene instruction (Cutress et al., 1987).

The American Academy of Periodontology Glossary of Terms (1986) defines oral hygiene as "the removal of bacterial plaque with brushes, dental floss, and other special instruments", and "the maintenance of oral cleanliness". Oral hygiene instruction can be provided in many forms ranging in labour intensity from conventional individual instruction on a one-to-one patient-to-operator basis (Johansen et al., 1973; Soderholm et al., 1982), through group instruction (Elliott & Bowers, 1972), to the use of self-instructional material (Glavind et al., 1981). Despite the potential advantages in terms of time saving of the latter two approaches, individual instruction remains the most common mode of delivery for this procedure.

A summary of studies which have reported on the time required for oral hygiene instruction is given in Table 5.1 (Appendix II). As with other components of periodontal treatment, considerable variation can be seen in the mean time spent on this procedure; the shortest being 4.2 minutes/person (Schallhorn & Snider, 1981) with the longest being 150 minutes/person used in the clinical study of Soderholm et al., (1982). [Note: the study of Godin (1976) reported a mean of 180 minutes/person, however this time also
Excluding those clinical studies which have specifically examined the effects of oral hygiene instruction (Hetland et al., 1981; Söderholm et al., 1982; Söderholm & Egelberg, 1982) there is a tendency for more time to be used on oral hygiene instruction in dental hospitals and teaching institutions than in dental practice. Both Johansen et al., (1973) and Ekanayaka & Sheiham (1978) report mean oral hygiene instruction times in the region of an hour or more for the former environments, while in dental practice the majority of reported times are generally less than 30 minutes. Ekanayaka & Sheiham (1978) note this difference in comparing between a hospital [mean OH time = 56 minutes/person] and an industrial clinic [mean OH time = 8 minutes/person] and suggest dissimilar treatment philosophies and disease states as possible explanations for the differences.

Milgrom et al., (1988) analyzed treatment time data according to whether a fee was charged for oral hygiene instruction or not and found that significantly more time is spent on oral hygiene if remuneration is received for the procedure. They also reported a trend for initial oral hygiene instruction to take longer than during maintenance care and it is interesting to note that the shortest reported mean time for oral hygiene instruction was for patients receiving maintenance treatment (Schallhorn & Snider, 1981). Milgrom et al., (1988,89) also reported that the content of the oral hygiene instruction delivered varies between operators, for instance in the use of disclosing agents, interdental cleaning aids, demonstrations of toothbrushing technique, etc., which could affect treatment time. In this context, the mean time expended by dentists on oral hygiene instruction would appear to be shorter than that used by auxiliaries or hygienists (Lotzkar et al., 1971a,b; Nash, 1979).

The studies of Söderholm et al.(1982) and Söderholm & Egelberg (1982) examining the effect of varying the length, number and spacing of oral hygiene instruction appointments show no advantage of increasing the duration of oral hygiene instruction beyond 45 minutes/person. These studies beg the question as to whether similar clinical results could be achieved if less than 45 minutes were used for oral hygiene instruction.

The treatment time estimates for oral hygiene instruction published in TRS 621 (WHO, 1978) (see Table 5.2, Appendix III) range from 50-60 minutes/person for initial treatment down to 10 minutes/person for maintenance. The document *A Simplified Periodontal*
Examination for Dental Practices (FDI, 1985) gives a time estimate for oral hygiene instruction ranging from 10 to 30 minutes/person. These estimates largely concur with the majority of times given for oral hygiene instruction in dental practice.

5.2.3 Time required for scaling, root planing and correction/removal of plaque retentive factors

A CPITN treatment code of 2 or higher indicates the need for professional cleaning of the teeth and removal of plaque retentive factors. This implies scaling, root planing and the correction/removal of other plaque retentive factors such as ill fitting crowns or poorly adapted edges of restorations (Cutress et al., 1987).

The definition of scaling given in the American Academy of Periodontology Glossary of Terms (1986) is "instrumentation of the crown and root surfaces of the teeth to remove plaque, calculus and stains from these surfaces", while root planing is defined as "a definitive treatment procedure designed to remove cementum or surface dentine that is rough, impregnated with calculus, or contaminated with toxins or microorganisms". While conceptually scaling and root planing might differ, it is difficult clinically to distinguish between the two. Perhaps it is due to this problem that some studies have failed to distinguish between the two procedures (Torfason et al., 1979; Schallhorn & Snider, 1981; Ciancio et al., 1982; Greenwell, 1985; Lavanchy et al., 1987; Brayer et al., 1989).

Studies which have reported on the time required for scaling, root planing and/or correction/removal of plaque retentive factors are summarized in Table 5.1 (Appendix II). As previously noted, there is a lack of consistency in the reporting of data with respect to the terminology used, the precise form of treatment, the unit under consideration, and the time to which it relates. In order to compare between studies it is useful to convert the data to a standard unit of consideration, and a sextant has been used in Table 5.3 (Appendix IV) in order to be consistent with CPITN recommendations. This has been achieved in the case of time estimates per tooth by multiplying by a factor of 6. This conversion factor assumes that in a sextant all teeth are present and are similar in terms of periodontal involvement and severity of plaque retentive factors. While posterior sextants have fewer than 6 teeth, they are generally more difficult to instrument and therefore potential potentially more time consuming to treat. In the case of time estimates given originally for quadrants, a sextant time has been derived by dividing by a factor of 1.5; time estimates for half arches and for both arches have been divided by
a factor of 3 and 6 respectively. It must be borne in mind that the use of such conversion factors to derive data is bound to lead to some inaccuracies as seen with the study of Johansen et al., (1973) where treatment time derived from data per tooth was 50% greater than treatment time derived from a quadrant for the same subjects.

In spite of converting the data so that a sextant is the standard unit under consideration, direct comparison between the studies outlined in Table 5.3 (Appendix IV) is difficult because some of the treatment times reported relate solely to scaling, others relate to scaling in combination with either polishing, root planing, or, removal of overhangs. Of particular note is the tendency for studies from Scandinavian countries to include the latter procedure (Heløe, 1973; Johansen et al., 1973; Bellini & Gjermo, 1973; Hetland et al., 1981; Soderholm et al., 1982). This could be in part due to differences in treatment philosophy (Ekanayaka & Sheiham, 1978), but could also be due to variations in the nature of plaque retentive factors found in different populations. For example, Ånerud et al., (1983) in making comparisons of periodontal disease between young adult males in the U.S.A., Norway and Sri Lanka showed that calculus scores were highest in Sri Lankans and lowest in Norwegians, however restorations with defective margins were more common in this latter group. Thus it could be envisaged that scaling would take longer in Sri Lankans compared to Americans or Norwegians, while in Norway, a higher proportion of overall treatment time might be spent correcting defective margins of restorations. This is corroborated by Ainamo et al., (1986) who showed that in young adult Finns, a substantial number of sextants scored a CPITN Code 2 by virtue of the presence of overhanging margins of restorations alone.

In addition to the variations in the nature of plaque retentive factors found in different populations, there are a number of other factors which could affect treatment time. The most pertinent example in relation to the time used for scaling (and root planing) is the choice of instruments used. Since the introduction of ultrasonic scalers by Zinner in 1955, numerous studies have compared both the effectiveness and the efficiency of these in relation to scaling with hand instruments. Most studies have reported a time saving of between 20 and 50% by the use of ultrasonic over hand instrumentation (Johnson & Wilson, 1957; Lemoine, 1958; Tascher, 1959; McCall & Szmyd, 1960; Jarabak, 1961; Moskow & Bressman, 1964; Sorin & Ewen, 1965; Forrest, 1967; Bhaskar et al., 1972; Donzé et al., 1973; Torfason et al., 1979; Badersten et al., 1981). Stewart et al., (1967), however, found a reduction in scaling time with ultrasonics in mandibular quadrants but not in maxillary quadrants for scaling performed by
inexperienced dental students. Only Burman et al., (1958) failed to find any saving in time by the use of ultrasonic scalers, but this finding must be viewed with caution being based on comparisons of scaling time for only 3 teeth in 2 patients.

More recently, airturbines scalers have been introduced as an alternative to ultrasonic scalers. Lie & Leknes (1985) in comparing between the effectiveness of the two types of scalers on extracted teeth failed to find statistically significant differences in scaling time, however Loos et al., (1987) found slighter longer time was required with the airturbine scaler, attributed to lack of operator experience with this instrument. A comparison between airturbine and hand scalers found instrumentation time to be shorter with the former (Laurell & Pettersson, 1988).

The method of instrumentation would also appear to have an effect on the time required for removal of overhanging restorations as shown by Spinks et al., (1986), albeit on extracted teeth, where reciprocating diamond tips were the fastest followed by sonic scalers, while curettes were the slowest.

Treatment time may also be affected by operator experience and skill in terms of a proficiency that comes from training and practice. Evidence that this may have an affect on treatment time is seen the study of Brayer et al., (1989) where experienced periodontists with, on average, 12 years of periodontal experience used less time for scaling and root planing than trainee periodontists with 2 years post-graduate experience. This might be due to a better knowledge of root surface morphology, manual dexterity, proper instrument selection and application. In support of this, Forrest (1967) found that the time taken by trainee hygienists to remove artificial calculus from phantom heads reduced over a training period of one year. In contrast, Frisch et al., (1970) found no significant correlation between the efficiency of removing calculus in relation to the number of years since qualification in either dentists or periodontists.

As was reported for oral hygiene instruction, there is a tendency for dentists to expend less time than hygienists on scaling [root planing] (Nash et al., 1979). Surprisingly this tendency is also found in relation to dental students and trainee hygienists (Sisty et al., 1978). It will also be noted that the longest mean time for scaling in Table 5.3 (Appendix IV) is the 72 minutes/sextant quoted by Laurell & Pettersson (1988) for student hygienists. Similarly, there is a trend for more time to be spent on these procedures in dental hospitals and teaching institutions than in dental practice (Ekanayaka & Sheiham,
Another factor which appears to influence instrumentation time is the area of the mouth which is being treated. There is a trend for mandibular teeth to take longer than maxillary teeth to instrument irrespective of whether hand or ultrasonic scalers are used (Stewart et al., 1967; Donzé et al., 1973). Stewart et al., (1967) postulates that this might be due to greater deposits of calculus in the mandibular arch. Furthermore, Nordland et al., (1987) has shown that molar teeth take over twice as much time to instrument when compared to non-molar teeth. This can be attributable in part to the position, the access and complex root morphology found with molar teeth.

Recent standards for the control of transmissible diseases in the dental workplace (Sandler et al., 1989) advocate the wearing of surgical gloves when treating patients to prevent the risk of transmitting hepatitis B, HIV and other blood borne viruses. The wearing of gloves might affect manual skill and efficiency thereby treatment times, however Solovan et al., (1984) found the average time for scaling performed by 20 hygienist students was not significantly different irrespective of whether gloves were worn or not. This agrees with similar studies investigating the effect of wearing gloves for other operative procedures (Brantley et al., 1986; Hardison et al., 1988).

Both Bellini (1974) and Ekanayaka & Sheiham (1978) have reported that subjects with greater deposits of calculus require longer to scale. In addition, both studies reported that the treatment time for scaling is longer for subjects with more severe periodontal disease (see section 2.5). Frisch et al., (1970) have similarly reported that dentists need longer to scale when pockets are 4-7 mm deep as against those that are ≤5 mm deep. The extrapolation of these findings possibly explain why there is a trend for initial scaling to be more time consuming than scaling during maintenance care as is reflected in the treatment time estimates for scaling published in TRS 621 (WHO, 1978) [see Table 5.2, Appendix III], which range from 20 minutes/sextant, for initial scaling in adults aged 30 year and above, down to 3 minutes/sextant for maintenance scaling in young adults aged 15-19 years. Comparable times ranging from 5 to 20 minutes/sextant for scaling and polishing are given by the FDI in A Simplified Periodontal Examination for Dental Practices (FDI, 1985).

The considerable variation in treatment time estimates seen both in these two documents and in Table 5.3 (Appendix IV) highlight the dilemma posed to health care planners in
estimating manpower requirements for this component of periodontal treatment.

5.2.4 Time required for 'Complex' periodontal treatment

Complex treatment, as defined by the CPITN for sextants with pathological pockets of 6 mm or deeper, may involve deep scaling and root planing under local anaesthesia, or surgical exposure of the root surface in order to gain access to clean it. These treatment need indications embody the differences in treatment philosophy, notably the 'surgical' and 'non-surgical' philosophies, which exist for the treatment of advanced periodontal disease. Reviews of therapeutic outcomes show no clear advantages between the two modes (Pihlstrom et al., 1983; Garrett, 1983) and thus the treatment approach used on individual patients, which might in certain instances include a combination of the two modes, is largely determined by operator and/or patient preferences.

It is inevitable that the choice of treatment approach is likely to have an effect on treatment time. In this respect, Lindhe et al., (1982) reported that the non-surgical mode "is a difficult treatment procedure which requires not only a skilful operator but in addition, an extended treatment period", and that "scaling and root planing (No surgery group) required more than twice the number of hours of active treatment than scaling and root planing in conjunction with surgery (Surgery group)". Conversely, Morrison et al., (1980) in comparing clinical results between: i. surgical pocket elimination and reduction, ii. modified Widman flap surgery, iii. subgingival curettage, and, iv. scaling and root planing only, reported that "the length of time spent on treating the patients were very similar for all the methods". Unfortunately, the method by which the treatment times were assessed and specific content of treatment in relation to these times in these two studies has not been reported.

It is also necessary to note that treatment philosophies alter with the passage of time. This might not only affect the type of treatment delivered such as the choice between surgical and non-surgical approaches but might also affect the level of disease where a specific intervention might be considered. Such factors must have an affect on periodontal treatment time and thus surgical and non-surgical complex periodontal treatment will be discussed separately.
Chapter 5 - Treatment times for periodontal procedures

i. Complex treatment (Non-Surgical).

A number of studies which have reported the time used for scaling and root planing, have included data for sites with PPDs $\geq$ 6 mm (Frisch et al., 1970; Nordland et al., 1987; Loos et al., 1987; Lavanchy, 1987; Laurell et al., 1988; Brayer et al., 1989). Unfortunately, since the treatment times reported in these studies do not relate exclusively to teeth or portions of the mouth with deep pockets, they have not been included in this section. In contrast, the studies of Torfason et al., (1979), Ciancio et al., (1982), Badersten et al., (1981,84a,84b,85), and Thornton & Garnick (1982) have restricted analysis solely to the time required for instrumentation of deep pockets, but have used selection criteria which are only slightly different from the $\geq$ 6 mm PPD stipulated by the CPITN to indicate the need for complex treatment. Torfason et al., (1979), Badersten et al., (1981) and Thornton & Garnick (1982) have reported treatment times for individual non-molar teeth with PPDs $\geq$ 5 mm deep, while Ciancio et al., (1982) selected subjects on the basis that their Ramfjord reference teeth (Ramfjord, 1959) had PPDs $\geq$ 5 mm.

Since advanced periodontal disease is often localised, complex periodontal treatment would normally only be performed on those teeth so affected. The conversion of reported treatment times to a single unit under consideration such as a sextant, as in section 5.2.3, could therefore probably lead to either under- or overestimations. Fortunately, with the exception of one study (Ciancio et al., 1982), all other studies which have reported on the time required for complex non-surgical treatment have done so at the tooth level (see Table 5.1, Appendix II). Thus, comparisons between studies is possible which shows that such treatment is subject to similar variations as was found with the time for scaling (see section 5.2.3). Bearing in mind that no prior scaling had been performed in any of these studies, the shortest reported time was 3 minutes/tooth (Thornton & Garnick, 1982), while the longest time was the 39 minutes/tooth reported by Stambaugh et al., (1981). The results from the latter study must be viewed with caution as the sample size was small, involving only 7 teeth.

As with routine scaling, there is a trend for ultrasonic instrumentation to be less time consuming than hand instrumentation for complex non-surgical treatment (Torfason et al., 1979; Badersten et al., 1981,84a). For instrumentation performed with similar types of instruments, some variation in the mean treatment time can be discerned between operators (Torfason et al., 1979; Badersten et al., 1981,84a,85d). This variation may be
due to true differences in the operators' working speed but might also be due in part to differences in the clinical status of the subjects treated. Evidence of this last factor affecting treatment time is that the mean instrumentation time was less for teeth with 4-7 mm PPDs (Badersten et al., 1981) than for teeth with 4-12 mm PPDs (Badersten et al., 1984a).

The treatment times given in Table 5.1 (Appendix II) for the studies of Torfason et al., (1979) and Badersten et al., (1981, 84a) relate to multiple instrumentations of teeth over a period as short as one month in the case of the former and over nine months in the case of the latter study. In comparing treatment responses following a single instrumentation or following repeated instrumentation on teeth with periodontal pockets up to 11 mm deep, Badersten et al., (1984b) detected no differences in clinical results between the two modes of treatment, although a 38 percent saving in time was achieved with the former. While the authors caution that the results relate to only one operator and thus a single instrumentation may not be recommended for general clinical use, a later study (Badersten et al., 1985a) using six different operators showed similar clinical results following a single instrumentation. Surprisingly, in this study, the operators spent twice as long on this single instrumentation than the operator [Periodontist # 1] (Badersten et al., 1984b) used for repeated instrumentation over several months. Further investigation is therefore required to assess whether similar clinical responses could be achieved if the time for instrumentation was shortened.

The treatment time estimation for initial deep scaling published in TRS 621 (WHO, 1978) is 45 minutes/quadrant which is consistent with the 30-40 minutes/sextant given in the document A Simplified Periodontal Examination for Dental Practices (FDI, 1985) for complex treatment. For the reasons stated above, it is difficult to compare these time estimates with those in Table 5.1 (Appendix II).

ii Complex treatment (Surgical).

The different approaches to complex periodontal treatment in terms of either surgical and non-surgical methods have already been mentioned. In addition, numerous surgical approaches have been described (Lindhe, 1989). For those studies which have reported on treatment times for surgery, some have reported on the time for gingivectomy, others for flap procedures while others have failed to specify the surgical procedures to which the times relate. Furthermore, the unit of consideration for the time estimates has
differed, this being either the patient, the quadrant, the sextant or the tooth. For the reasons given in section 5.2.4.i, conversion to the sextant level for comparisons between studies has not been done. An example of the problems of using such a conversion is demonstrated by the study of Ekanayaka & Sheiham (1978) where a mean of 51 minutes were required per surgical procedure while a mean of 78 minutes were required per patient.

As might be expected, there is some evidence that flap operations take slightly longer than gingivectomy as shown by Bellini & Johansen (1973) where the former took a mean of 58 minutes/quadrant as against 45 minutes/quadrant for the gingivectomy procedure. In addition, the same study showed that prescaling marginally reduced the time during surgery. In common with the findings for non-surgical complex treatment, Miller *et al.*, (1990) reported that periodontal surgery performed in sextants with maximum PPDs of 3.5-5.5 mm took less time than in sextants with PPDs ≥6 mm; it might however be questioned why surgery was being performed in sextants with shallow PPDs. Lastly, Brayer *et al.*, (1989) reported that student periodontists took slightly longer to perform flap surgery than experienced periodontists.

In spite of the differences in treatment times mentioned above, it is surprising that many studies report the time for periodontal surgery to be in the region of 60 minutes/quadrant (Edwardsson & Mobius, 1966; Helöe, 1973; Johansen *et al.*, 1973; Bellini & Johansen, 1973; Markkanen *et al.*, 1978; Nash *et al.*, 1979). The treatment time estimates given in TRS 621 (WHO, 1978), is 60 minutes/quadrant for periodontal surgery which is consistent with the treatment time estimates given above. The estimate given in TRS 621 is the same for all age groupings and also estimates a further 30 minutes of post-operative care.

5.2.5 Time required for periodontal maintenance treatment

Mention has already been made (see section 5.2.3) that the time required for initial periodontal treatment is generally longer than for maintenance care. This is reflected in TRS 621 (WHO, 1978) where the times estimates for "follow-up" treatment is considerably less for both oral hygiene instruction and scaling. For example, while 50 minutes is estimated for initial oral hygiene instruction, only 10 minutes is estimated for oral hygiene during maintenance care. Similarly, for subjects of 30 years and over but without deep pockets, initial scaling is estimated to take 30 minutes/quadrant while
maintenance scaling is estimated to take 5 minutes/quadrant.

Pihlstrom et al., (1981,84) reported that initial treatment involving oral hygiene instruction, scaling and root planing, recontouring of overhangs and occlusal adjustment took from 300-480 minutes/person while only 60 minutes was assigned for maintenance treatment. Other studies have reported overall treatment times in the range of 30-60 minutes/person for maintenance care which is consistent with this (Miller et al., 1989,90; Nordland et al., 1987; Pfeifer & Pfeifer, 1988; Kaldahl et al., 1988).

5.2.6 Total time required for periodontal treatment

Of those studies which have reported on the total time required for periodontal treatment, one of the most relevant is that of Butterworth & Sheihm (1991) where treatment times of patients with different CPITN scores were assessed. Treatment was provided under the British National Health Service in general practice. The average treatment time was 14.7 minutes/patient however this varied according to the patient's highest CPITN score. Patients scoring CPITN of 0 received on average 6.8 minutes of periodontal treatment while those with CPITN scores of 1, 2, 3, and 4 received 9.0, 13.5, 18.0 and 18.0 minutes of treatment respectively. The authors point out that these times are much less than the estimates given in TRS 621 (WHO, 1978).

5.3 Summary

In summary, there is evidence from the studies reviewed that the variations seen in the treatment times reported for periodontal procedures can be accounted for in part by a number of factors. These can largely be divided into three components, namely patient, operator and clinical environment factors.

Patient factors include: periodontal disease levels, levels of plaque retention factors, location within the mouth of these problems, and whether the treatment provided relates to initial or maintenance care. Operator factors include: type of operator, experience, treatment philosophy, procedures used and renumeration. Clinical environment factors include the working location e.g. dental school or hospital or general dental practice, and the equipment available.

These findings therefore emphasizes the need for treatment times to be determined in the same environment and under the same conditions as that where the data will
ultimately be used.
CHAPTER 6 - TOWARDS A MINIMAL PERIODONTAL TREATMENT PROGRAMME

6.1 Introduction

The problems associated with the provision of effective periodontal health care to communities centre largely on the resource implications of providing treatment according to traditional strategies such as those indicated by the CPITN (see Chapter 3). These problems emphasize the need to explore alternative approaches which could minimize manpower and resource requirements by using simpler, less time consuming and less costly treatment, while maximising the scope and effect of such treatment. Such approaches are generally termed minimal periodontal treatment programmes, and are, as far as possible, based on self-reliance rather than what is normally almost total reliance on dental professionals. One example of a minimal periodontal treatment programme is the use of self-assessment and instructional material to replace time consuming oral hygiene instruction delivered on a one-to-one basis (Glavind et al., 1979, 81, 84, 85). This approach has shown promising results and is worthy of further investigation at the community level. Another minimal approach is to eliminate or restrict the delivery of certain components of traditional periodontal treatment such as instrumentation in the form of scaling and root planing, a procedure which realistically can only be delivered on a one-to-one basis. Studies which have examined these more minimal approaches to periodontal treatment are reviewed in the following sections.

6.2 Effects of supragingival plaque control performed in the absence of instrumentation

A considerable body of research has shown the importance of maintaining effective supragingival plaque control as part of the management of periodontal disease irrespective of concurrent treatment modes (for review see Glavind & Nyvad, 1986). This can be achieved through a number of methods including professional prophylaxis (Axelsson & Lindhe, 1978, 1981a, b, c), chemical means (Westfelt et al., 1983), and by self-performed oral hygiene (Glavind & Nyvad, 1986), although in the community setting only the latter method is likely however to be cost-effective. The effects of supragingival plaque control performed in the absence of instrumentation has rarely been specifically studied and information on the effectiveness of this approach must largely be gleaned from studies where this has not been the principal objective e.g. where non-instrumented
teeth have served as a control in the evaluation of other treatment procedures or therapeutic agents. Problems do however exist in the interpretation of the results of these studies because of differences in study design and the frequent reliance on mean values which may obscure true changes (Lindhe et al., 1986). In addition, the methods of achieving improved supragingival plaque control and the level of control realized is obviously not consistent between the studies.

The response to periodontal treatment may be assessed using clinical, microbiological or histological periodontal parameters (Chilton, 1986). The effects of supragingival plaque control alone on each of these separate parameters are detailed below:

6.2.1 Effects on clinical periodontal parameters

(i) Gingival inflammation

Bleeding on probing the sulcus or pocket (BOP) as an indicator of the presence of gingival inflammation is employed in a number of periodontal indices including the CPITN (for review see Greenstein, 1984; Anderson & Smith, 1988). Studies evaluating the effects of supragingival plaque control alone on this parameter have reported somewhat conflicting results; while some show a reduction in proportion of sites with BOP in response to this measure, others show little or no change. These apparent discrepancies may to some extent be explained by variations in the initial pocket probing depths (PPD) of the sites and the effectiveness of the plaque control achieved.

The effects that PPD might have on treatment responses has been demonstrated by Cercek et al., (1983) in a longitudinal study where the healing responses for non-molar teeth were monitored in 7 patients with PPDs ≥5 mm, over three consecutive phases of treatment which involved: a. tooth brushing and flossing only; b. subgingival use of a Perio-Aid (Marquis Dental Mfg. Co., Aurora, CO, U.S.A.); and c. supra- and subgingival instrumentation. Each phase of treatment was continued until the maximum effects were achieved before the subsequent phase was started. An overall reduction in sites with BOP from 72% to 41% over a five month period of supragingival plaque control alone was reported, representing a 43% reduction. The reduction was influenced by the initial PPD as sites ≤3.5 mm demonstrated a 50% reduction of bleeding sites, whereas deeper PPDs showed much smaller reductions. These findings are consistent with those of Turner et al., (1994), where over a six-week period of substantially improved oral hygiene, the mean proportion of sites with BOP had fallen from 59% to 34%, a 43%
reduction overall. It is interesting to note that shallow sites showed a 64% reduction over this period whereas sites ≥ 6 mm showed a smaller 30% reduction. No statistically significant reductions in BOP were observed over a further six-week monitoring period.

These findings of Cercek et al., (1983) and Turner et al., (1994) concur with those of Kho et al., (1985), using the bleeding index of Cowell et al., (1975), who likewise found smaller reductions in bleeding scores, one week after oral hygiene instruction, for sites with PPDs ≥7 mm compared to ‘whole mouth’ bleeding scores with a shallower mean PPD. Whole mouth bleeding score means were reduced from 1.2 to 0.7, while sites with PPDs ≥7 mm were reduced from 1.2 to 0.9.

Those studies which have found that supragingival plaque control has minimal or no effect on BOP are largely those involving sites with deep PPDs. For example, Lindhe et al., (1983c) used non-instrumented, non-molar teeth with PPDs ≥6 mm, in 7 subjects receiving a placebo medication as controls in a study on the effect of long-term tetracycline therapy on periodontal disease. Despite excellent self-performed supragingival plaque control, no decrease in the proportion of sites with BOP was reported, even after 50 weeks. Similarly, Badersten et al., (1984a), reported minimal effects on BOP after three months of substantially improved plaque control, in non-molar teeth with PPDs from 5-12 mm and with calculus. Furthermore, Siegrist & Kornman (1982) albeit in a monkey model with ligature induced periodontitis where the majority of sites displayed PPDs ≥4 mm, failed to find a decrease in BOP over a six-week period of supragingival plaque control using rubber cup prophylaxis and flossing.

The combined influences of PPD and quality of supragingival plaque control on treatment responses have been shown by Loos et al., (1988). In 15 subjects, after 6 weeks of self applied supragingival plaque control alone, the proportion of sites with BOP reduced by 43% for PPDs ≤3.5 mm in those subjects who complied with oral hygiene recommendations, while those assessed as having poor oral hygiene showed only a 24% reduction of sites with BOP. Minimal improvement in BOP was however observed in PPDs ≥7 mm irrespective of the standard of plaque control, a finding consistent with those of Lindhe et al., (1983c) and Badersten et al., (1984a).

Apart from BOP, many other indices have been developed to assess the presence and severity of gingival inflammation (for review see Hazen, 1974; Ciancio, 1986). The Gingival Index (GI) (Løe & Silness, 1963) has been used extensively in clinical studies.
The design of this index primarily assesses qualitative changes of the marginal gingiva, the region of the periodontium most accessible to supragingival plaque control. It is therefore not surprising that a number of studies investigating the effects of supragingival plaque control alone on gingival inflammation, as assessed by this index, have reported improvements both in sites with shallow or deep PPDs and during short or long periods of review.

Tabita et al., (1981) reported that in the absence of scaling both daily supragingival polishing or self performed oral hygiene after instruction in brushing and flossing resulted in a decrease in mean GI over a two-week period in quadrants with PPDs of 4-6 mm. In a study evaluating the effectiveness of Keyes’ method of oral hygiene which includes brushing with a hydrogen peroxide - sodium bicarbonate paste, Greenwell et al., (1985) found over a two month period significant improvements from baseline in mean GI, both for patients who initially had moderate to severe periodontitis with PPDs ≥5 mm and for those who had received periodontal surgery in the previous 4 years with average PPDs <5 mm. Lyne et al., (1986), in a similar study, reported a reduction in mean GI from 1.48 to 0.97 for non-instrumented sites in response to brushing alone over the same period.

Following detailed oral hygiene instruction only, Hetland et al., (1981) observed a significant reduction in GI after 4 weeks which continued to reduce over a 24-week monitoring period. Helldén et al., (1979) also reported a significant decrease in the GI over a similar long-term period of improved supragingival plaque control in non-instrumented sites. Furthermore, the proportion of sites exhibiting a GI = 0 (clinically healthy) increased significantly from 8.5% at baseline to 42.5% over this period. Analysis of data from the same study (Listgarten et al., 1978) for teeth with initial PPD of 7.0 mm, showed a small but non-significant change in the GI for non-instrumented sites with a reduction in median GI from 2 to 1.5.

In a study where metronidazole was used to determine the relative importance of subgingival anaerobic organisms in periodontal disease, Lindhe et al., (1983b) used non-instrumented teeth with PPDs ≥6 mm in subjects receiving a placebo medication as controls. At baseline 100% of sites scored a GI ≥2, however fifty weeks after detailed oral hygiene instruction only 20% scored GI = 2, 60% scored GI = 1 while the remaining 20% scored GI = 0. Similar results have been reported by Lindhe et al., (1983c), in a study of similar design but using non-molar teeth. At baseline, 100% of control sites in
teeth with PPDs $\geq 6$ mm scored GI $\geq 2$. After 50 weeks only 27% scored GI = 2, 56% scored GI = 1 and 17% scored GI = 0.

Only Siegrist & Komman (1982) in an above-mentioned study on monkeys, failed to discern a decrease in GI in response to rubber cup prophylaxis and flossing over a six-week period which is in common with the finding with respect to BOP. The reason for this is unclear but might be due to differences in the model used and the plaque control achieved.

Evaluation of the response to supragingival plaque control in the absence of instrumentation has also been made using other indices. For example, Tagge et al., (1975), using an index based on gingival fluid, bleeding and oedema, found that sites with an initial PPD of 3 mm, treated solely by self performed oral hygiene for eight weeks showed a reduction in clinical mean gingival inflammation scores. Bouwsma et al., (1988) and Caton et al., (1989) using the Eastman Interdental Bleeding Index (EIBI)(Caton & Polson, 1985) have demonstrated that interdental areas with PPD and probing attachment loss (PAL) $\leq 4$ mm, can be converted from bleeding to non-bleeding sites, solely by an oral hygiene programme alone consisting of conventional toothbrushing combined with interdental cleaners used over a period of four weeks. Lastly, Carter & Barnes (1974), using the Gingival Bleeding Index, where gingival inflammation was assessed by bleeding after flossing, found after 2 months of improved oral hygiene only, a mean reduction of scorable sites of 79%.

The improvements seen in clinical studies following supragingival plaque control are also reflected in community studies. In a group of rural Indian children and young adults, Chawla et al., (1975) showed a small but significant improvement in gingival inflammation as assessed by the Gingival Index of Ramfjord (1959) when toothbrushing instructions was given only twice a year in the absence of prophylaxis and scaling. Of particular interest is a more recent study by Gaare et al., (1990) in a group of Indonesian soldiers with a high degree of supragingival calculus with PPDs $< 3$ mm where, over a two month period of improved self-performed plaque control, there was a 41% reduction in sites with BOP.

Generally, but with a few exceptions, both the clinical and community studies described above show that some improvement in gingival inflammation can be expected in response to improved supragingival plaque control in the absence of instrumentation.
The responses are generally greater in sites with shallow PPDs and in those where high levels of supragingival plaque control can be achieved. The response in sites with deep PPDs assessed by BOP is limited even over extended periods, however inflammation assessed by the GI show improvements can be achieved. This apparent discrepancy is probably because the GI assesses inflammation largely at the marginal gingiva while BOP has the capability of detecting inflammation also at the depths of pockets.

(ii) Pocket probing depth (PPD) and probing attachment level (PAL)

Histologically, the response to routine non-surgical periodontal treatment is a decrease in the inflammatory infiltrate with a concomitant deposition of new collagen which provides the tissues with greater resistance to penetration by a periodontal probe. This event, combined with some shrinkage of the marginal tissues is evidenced by a decrease in probing depth and gain in clinical attachment level (for review see Listgarten, 1980; Anderson & Smith, 1988). Thus, changes in these two parameters have been often used in the evaluation of treatment responses.

Most studies have shown a reduction in PPD in response to improved supragingival plaque control alone. The amount of reduction, should it occur, appears to be dependent upon the initial PPD and the effectiveness of plaque control. For example, Cercek et al. (1983) found that the greatest reduction in PPDs in response to improved oral hygiene occurred in sites initially \( \geq 6 \) mm deep while sites with PPDs \( \leq 3.5 \) mm displayed the least reduction. Taken overall, initial mean PPDs were reduced by approximately 0.5 mm, mainly over the first month, however minimal changes were observed in attachment levels. These findings were corroborated by Lyne et al., (1986), who showed that after eight weeks of improved oral hygiene alone, non-instrumented sites with initial PPDs of between 4 and 7 mm reduced by a mean of 0.9 mm whereas sites initially of between 1 and 3 mm were reduced by a mean of 0.3 mm. Similarly, Turner et al., (1994) found and overall reduction in mean PPD over a six-week period of improved oral hygiene alone but that this was only statistically significant for PPDs initially \( \geq 6 \) mm. No further improvements took place over a further six-week monitoring period.

Reductions of PPD in response to improved supragingival plaque control have been detected in as short a period as one week by Kho et al., (1985) where mean PPD decreased from 4.0 to 3.6 mm in response to improved oral hygiene. Over a longer period of two months of oral hygiene alone, Tagge et al., (1975) found PPDs were
reduced from a mean of 2.9 to 2.3 mm, while PALs remained unchanged. Badersten et al., (1984a) found mean PPDs were reduced from 5.5-5.8 mm to 5.1-5.3 mm largely as a result of recession over a three-month period, however only limited changes in PAL were observed. Over a period of 4 weeks, Hetland et al., (1981) found significant reductions in the proportion of teeth with PPDs ≥4 mm following improved plaque control, with further reductions taking place over a 24-week monitoring period. Over a similar period, Helldén et al., (1979) reported a reduction in mean PPD of 0.8 mm in response to oral hygiene alone, however when the analysis was restricted to deep PPDs with an initial PPD ≥5 mm, there was a small but statistically insignificant decrease in mean PPD from 7.0 to 6.5 mm (Listgarten et al., 1978). Lindhe et al., (1983b,c) similarly failed to find a marked change in PPD or PAL in non-scaled sites over a 50-week period of improved plaque control although in the latter study a mean decrease in PPD of 0.9 mm was observed. Finally, no decrease in probing depth in response to supragingival plaque control was observed by Greenwell et al., (1985) for previously untreated subjects with a mean probing depth of 7.0 mm and for previously surgically treated subjects with a mean probing depth of 3.5 mm; and by Siegrist & Kornman (1982) in monkeys.

The quality of supragingival plaque control appears to affect the reduction in probing depths as shown by Loos et al., (1988) who observed that over a six-week period, in subjects who complied with oral hygiene instructions, sites with initial PPDs ≥7.0 mm showed a mean reduction in PPD of 1.4 - 1.6 mm as against a reduction of only 0.2 - 0.4 mm for sites in the less compliant subjects. Shallow and moderately deep sites up to 6.5 mm showed only minor decreases in mean PPD, however greater changes were noted in compliant subjects. Unlike other studies which have shown little or no change in the PAL in response to improved plaque control, Loos et al., (1988) found that deep sites in compliant subjects displayed a 0.7 mm gain in PAL although shallow to moderately deep sites showed little change.

6.2.2 Effects on subgingival microflora

The monitoring of the composition of subgingival microflora to assess treatment responses is based on findings that indicate that significant differences may be detected in subgingival microflora between periodontally diseased sites and those considered to be healthy. There is a tendency for motile rods, curved rods and spirochaetes to predominate at diseased sites whereas coccoid cells predominate at healthy sites (Listgarten & Helldén, 1978; Slots, 1979).
It is generally accepted that supragingival plaque is necessary for the establishment of a subgingival microflora, however its role in the perpetuation of the subgingival microflora remains unclear (for review see Corbet & Davies, 1993). Smulow et al., (1983) have hypothesised that supragingival plaque might be necessary to sustain the subgingival microflora and therefore control of supragingival plaque could possibly influence the quantity and composition of subgingival microflora. In addition, although toothbrushing and other self performed plaque control methods are principally targeted at the removal of supragingival plaque, some direct effect on subgingival plaque might take place since Waerhaug (1976, 1981) has shown that toothbrush bristles, using the Bass technique of brushing, are capable of entering the sulcus or pocket to a depth of 0.9 mm below the gingival margin. Moreover, interdental brushes are capable of removing plaque from as far as 2.5 mm below the gingival margin and dental floss can be introduced up to 3.5 mm below the gingival margin. As might be envisaged, the direct mechanical effects are however limited in deep PPDs as persistence of subgingival plaque has been shown in such sites despite effective supragingival plaque control using interdental brushes (Waerhaug, 1976).

In monkeys, where sites were cleaned three time a week over six weeks with a rubber cup and dental floss, Siegrist & Kornman (1982) found a significant decrease in the total cultivable subgingival microflora combined with a significant decrease in the proportion of Bacteroides species. In contrast, human studies have found no effect on microbiological parameters following improved supragingival plaque control. For example, Loos et al., (1988) could not detect any significant changes over a six-week period of improved supragingival plaque control alone, in PPDs initially >6 mm, irrespective of subject compliance with oral hygiene recommendations. Similarly, no significant differences in the subgingival microflora over a 25-week period of oral hygiene alone were found by Listgarten et al., (1978). These findings concur with those of Lindhe et al., (1983b,c) who over a 50-week period, failed to detect significant changes in the proportions of coccoid cells, motile rods and spirochaetes in response to improved plaque control.

It has been suggested (Beltrami et al., 1987) that the discrepancies in the above studies may be explained by differences in the initial probing depth, as in the monkey study of Siegrist where changes in subgingival microflora were detected, the mean PPDs was 4.6 mm compared to the human studies of Loos, Listgarten, Lindhe and Kho where PPDs were somewhat deeper.
Chapter 6 - Towards a Minimal Periodontal Treatment Programme

6.2.3 Effects on histological parameters

In addition to clinical and microbiological means, it is possible to assess changes in inflammation in response to treatment using histological techniques. This is not routinely performed as a biopsy is required for the histological specimen.

In shallow PPDs with initial mean probing depth of 3.0 mm, Tagge et al., (1975) showed that after eight weeks of oral hygiene alone, there was a statistically significant reduction in histological mean gingival inflammation scores when compared to mean pretreatment scores. Likewise, Bouwsma et al., (1988) and Caton et al., (1989) showed that conversion of bleeding to non-bleeding interdental gingiva by oral hygiene alone resulted in a significant reduction in the inflamed connective tissue component for sites with probing depths and attachment loss ≤4 mm.

These histological changes in shallow PPDs were not however observed in deep PPDs, as shown by Lindhe et al., (1983b) who found that biopsies taken at 2, 20 and 50 weeks after institution of excellent oral hygiene alone all showed a comparatively dense infiltrate in the apical portions of the gingival tissues in sites with initial probing depths ≥6 mm. Likewise, in PPDs of similar initial probing depth, Listgarten et al., (1978) reported that biopsies taken at 8 and 25 weeks after the introduction of improved oral hygiene "were essentially indistinguishable from the diseased biopsies obtained at baseline".

The available evidence therefore suggests that histological changes in response to supragingival plaque control alone only takes place in shallow PPDs, or only in the more coronal portions of deeper sites.
6.3 Effects of supragingival and subgingival plaque control performed in the absence of instrumentation

As mentioned in section 6.2.2, toothbrushing and interdental cleaning may have some direct mechanical effect on the subgingival plaque (Waerhaug, 1976, 81). Attempts to augment this subgingival plaque removal by the inserting the tip of a Perio-Aid below the gingival margin have been evaluated over a period of three months by Cercek et al., (1983) who reported no additional improvement in plaque score, BOP, PPD and PAL by its use over that brought about by conventional oral hygiene measures. Similarly, Loos et al., (1988) found no significant changes in BOP, PPD or PAL and no measurable effect on the subgingival microflora over a shorter six-week period of Perio-Aid use.

The failure of the Perio-Aid to bring about any additional clinical benefit over and above routine oral hygiene measures might be because the Perio-Aid did not reach further subgingivally than routine oral hygiene aids or that the subgingival use of the Perio-Aid might have been too demanding for the subjects. Irrespective of the reasons, the subgingival use of the Perio-Aid cannot be advocated based on the above findings.

6.4 Effects of supragingival plaque control and supragingival instrumentation performed in the absence of subgingival instrumentation

An alternative minimal periodontal treatment programme which could be considered where more resources are available is a combination of supragingival plaque control and supragingival scaling. As supragingival plaque control alone can result in improvements in clinical and histological parameters (see section 6.2), it is possible that these improvements might be enhanced by the additional removal of supragingival calculus, because its presence probably hinders effective removal of supragingival plaque, thereby potentially limiting periodontal responses. Moreover, in terms of delivery of treatment, because supragingival calculus is visible and relatively accessible, its removal is probably easier and less time consuming than the removal of calculus supra- and subgingival calculus.
6.4.1 Effects on clinical periodontal parameters

The results of short term studies examining responses to supragingival scaling and plaque control are equivocal. For example, over a three-week period where supragingival scaling was combined with professional prophylaxis delivered three times per week in PPDs >6.5 mm, no reduction in PPD, GI, PBI were observed (Beltrami et al., 1987). These findings were corroborated by Uraguchi et al., (1988) who found no changes in GI, BOP, PPD, PAL in PPDs 4-5 mm and >7 mm over a 5-week period of supragingival plaque control including professional prophylaxis twice a week, and also by Katsanoulas et al., (1992), in PPDs 4-5 mm (mean 4.6 mm) over a three-week period in response to professional supragingival plaque removal three times a week. Even when supragingival scaling and plaque control for sites with PPDs ≥6 mm was supplemented with chlorhexidine rinsing, no improvements in either PPD or BOP was reported over 62 days although a reduction in GI occurred (Heijl et al., 1991). In contrast, when professional removal of supragingival deposits was performed daily over a period of three weeks in teeth with PPDs mostly ≥5 mm (mean 6.6 mm), this resulted in reductions in probing depths of between 1 to 3 mm in 79% of sites, and a reduction in GI (Smulow et al., 1983). Recently, Al-Yahfoufi et al., (1995) reported that over a 37 day period where effective oral hygiene was combined with supragingival calculus removal in subjects with minimal periodontal disease but with a high prevalence of putative periodontal pathogens, the percentage of PPDs >3 mm were reduced from 13% to 3% whilst the percentage of sites with BOP decreased from 68% to 20%.

McNabb et al., (1992) found that in response to supragingival calculus removal and professional prophylaxis three times a week in PPDs 4-6 mm, there was a 50% reduction in the proportion of sites with 4-6 mm PPDs after 3 months. It is interesting to note that only after 6 weeks of supragingival plaque control were significant changes seen in GI, BOP and PPD suggesting that the failure in most short term studies to show clinical change was due to an insufficient period of monitoring. These findings are supported by Müller et al., (1986) who reported a continuous decrease in GI, PPD, BOP and gingival fluid flow, with a concomitant increase in PAL, over a longer six-month period of improved personal oral hygiene, removal of supragingival deposits and professional prophylaxis every 1-4 weeks. Understandably, PPDs ≥7 mm however responded less favourably clinically than those 5-6 mm deep.

Over a longer period of one year, Rosling et al. (1983) reported that supragingival
scaling, comprehensive oral hygiene instruction and professional prophylaxis every two
weeks for the first three months resulted in a two-fold reduction in sites with gingival
bleeding (GI 2 or 3) combined with a small but statistically significant decrease in the
proportions of PPDs 4-6 mm and ≥7 mm. Interestingly, while sites with a PPD of 1-3
mm and 4-6 mm exhibited a small net loss of PAL over the one year, sites with a PPD
≥7 mm did not.

Kaldahl et al. (1988) monitored the responses to oral hygiene and supragingival scaling
over a two-year period of maintenance therapy involving three monthly professional
prophylaxes. Significant and sustained decreases in mean probing depths were
observed for sites with initial probing depths ≥5 mm, however those ≥7 mm showed not
only the greatest decrease overall but also a continued decrease over the maintenance
period, emphasising the need for prolonged periods of monitoring to observe maximal
treatment responses in deep sites. Significant gains in mean PAL levels were reported
in sites ≥5 mm and an increase in mean recession was observed for all categories of
initial probing depth. The improvements with respect to mean PPD and PAL were
similarly found when the analysis was restricted to molar furcation sites however there
was a deterioration in horizontal attachment level over the two year maintenance period
(Kalkwalf et al., 1988). More recently Kaldahl et al., (1990) have shown that the therapy
resulted in a markedly reduced prevalence of gingival suppuration sustained over the
monitoring period. The substantial improvements seen in this last study can be
attributable in part to the selection criteria for the study where patients with poor plaque
control were excluded from the study. In addition, teeth which showed additional
periodontal breakdown were excluded from data analysis as these received additional
treatment.

More recently, Dahlén et al., (1992) reported on a plaque control programme which
involved meticulous oral hygiene instruction, initial supragingival scaling and professional
monitoring over a two year period. Clinically, there was a substantial reduction in the
mean proportion of sites with BOP from between 35-45% down to 5%. Furthermore,
there was a marked increase in the number of sites with PPD ≤3 mm combined with a
reduction in number of sites 4 and 5 mm deep, although the mean PPD and PAL
remained unchanged. The number of sites with PPDs ≥6 mm however remained largely
unchanged. When the self-performed plaque control was extended for an additional
year, there was a continued improvement of periodontal conditions at sites which were
<5 mm deep at the 2-year examination but no change in greater PPDs (Sato et al.,
This latter finding suggests that maximal responses in deep PPDs are achieved after 3 years of improved supragingival scaling and plaque control.

It is therefore apparent from the studies detailed above that the clinical responses to supragingival scaling and plaque control seem to be dependent upon the initial probing depth of the sites under consideration, the period during which the responses were monitored and the levels of plaque control achieved. The long term study of Dahlén et al., (1992) where substantial improvements in clinical parameters were achieved by self-performed plaque control following removal of supragingival calculus is encouraging as the major emphasis was on self care.

6.4.2 Effects on subgingival microflora

The short term effects of supragingival plaque control and supragingival scaling on subgingival microflora are also equivocal. For instance, Beltrami et al., (1987), Uraguchi et al., (1988) and Hiejl et al., (1991) found no changes in the subgingival microflora, while Smulow et al., (1983) found a decrease in the proportion of spirochaetes and motile rods over a similar period of treatment.

In shallow PPDs, Al-Yahfoufi et al., (1995) reported both decreases in the number of subjects and number of counts for P. gingivalis, P. intermedia and A. actinomycetemcomitans over a 37 day period following oral hygiene instruction and supragingival instrumentation in subjects with shallow PPDs. In deeper PPDs, the study of Katsanoulas et al., (1992), showed a continued decrease in putative microbial pathogens over time which suggests that further improvements might take place should the monitoring period be extended. This potentiality is substantiated by the studies of Müller et al., (1986) and McNabb et al., (1992) where over a six-month period, supragingival calculus removal and improved plaque control did result in a steady increase in subgingival cocci and a decrease in putative periodontal pathogens. However, in the latter study, PPDs ≥7 mm responded less favourably microbiologically than those 5-6 mm deep. Over a longer period of one year, Rosling et al., (1983) found a decrease in total bacterial counts combined with small reductions in the proportion of motile rods, however unlike the findings of Müller et al., (1986) and McNabb et al., (1992), proportions of spirochaetes remained largely unchanged. Lastly, Dahlén et al., (1992) reported that over a two year period of improved plaque control there was a marked reduction in the total number of bacteria harvested and a reduction of subjects.
and sites with putative pathogens such as *P. gingivalis*, *P. intermedia* and *A. actinomycetemcomitans*. When the study was extended for a further year, additional improvements in the subgingival microflora were found (Sato et al., 1993).

### 6.5 Comparison of the relative effects of supragingival plaque control alone or in combination with supra- and subgingival instrumentation

The effects of traditional periodontal treatment involving a combination of supragingival plaque control, scaling and root planing have been extensively studied (for review see O'Leary, 1986). The difficulties alluded to in section 6.2 in the interpretation of the findings from studies also arise when comparing the effects of minimal periodontal treatment against traditional treatment. Furthermore, these difficulties are compounded as different study designs have been used including split-mouth, parallel groups, and longitudinal designs where there is an incremental introduction of instrumentation after a period of improved plaque control.

#### 6.5.1 Effects on clinical periodontal parameters

**(i) Gingival inflammation**

The majority of clinical studies comparing the relative effects of supragingival plaque control alone or when combined with supra- and subgingival instrumentation have found that the latter has an adjunctive effect resulting in a greater reduction of BOP (Cercek et al., 1983; Lindhe et al., 1983b,c; Badersten et al., 1984a; Turner et al., 1994). This difference between treatments is particularly marked in deep PPDs (Cercek et al., 1983; Lindhe et al., 1983b,c; Badersten et al., 1984a) but is less so in shallow PPDs (Cercek et al., 1983). In contrast, Greenwell et al., (1985) could not detect differences in BOP between treatments for sites with PPDs ≥5 mm. Moreover, of particular relevance is the study of Gaare et al., (1990) where no obvious benefits from scaling over and above that achieved from oral hygiene instruction alone was found with respect to BOP for young Indonesian soldiers with large amounts of calculus but with PPDs <4 mm.

Tagge et al., (1975) in a split-mouth study of 8 weeks duration where responses were assessed by an index which included an assessment of BOP, oedema and gingival fluid, showed that oral hygiene and instrumentation resulted in a greater reduction in inflammation than oral hygiene alone. Moreover, Kho et al., (1985) in a longitudinal
study where the bleeding index of Cowell et al., (1975) was used to assess gingival response found the improvements seen in bleeding scores after 1 week of improved plaque control were further enhanced by scaling. It is however questionable in this study whether maximal responses were achieved after only 1 week of plaque control before the scaling was performed, as Cercek et al., (1983) have shown improvements continuing over several months of improved plaque control alone. A finding of note in the study of Kho et al., (1985) was that, following a scaling 1 week after the first visit, there was an substantial increase in bleeding scores in sites with PPDs ≥7 mm over the remaining 16 weeks of the study. While the studies are not directly comparable, this finding differs from the findings of Cercek et al., (1983); Lindhe et al., (1983b,c); and Badersten et al., (1984a) who showed sustained improvements after supra- and subgingival scaling with respect to BOP over much longer monitoring periods in deep PPDs.

When the relative effects of supragingival plaque control alone or when combined with supra- and subgingival instrumentation are compared using the GI the results also appear to be dependent upon PPD. In deep PPDs the latter treatment resulted in a greater reduction of GI than plaque control alone (Listgarten et al., 1978; Helldén et al., 1979; Lindhe et al., 1983b,c; Lyne et al., 1986) while in shallow PPDs no difference between treatments could be detected (Hetland et al., 1981; Tabita et al., 1981; Lyne et al., 1986). Lastly, using the Gingival Index of Ramfjord (1959), Chawla et al., (1975) in a community study found greater improvements in gingivitis in response to oral hygiene and scaling than to oral hygiene alone over a 2 year period.

(ii) Probing pocket depth (PPD) and probing attachment level (PAL)

Supragingival plaque control, when combined with supra- and subgingival instrumentation has generally been found to produce greater improvements in PPD and PAL than plaque control alone in both split-mouth (Tagge et al., 1975; Listgarten et al., 1978; Helldén et al., 1979; Lindhe et al., 1983b,c; Turner et al., 1994) and in longitudinal studies (Cercek et al. 1983; Badersten et al., 1984a; Kho et al., 1985). Hetland et al., (1981) in a parallel group study failed however to find differences between the two treatments over 24 weeks in the reductions of PPDs ≥4 mm. When differences have been observed, they tend to be more pronounced in sites with deeper initial PPDs as is clearly demonstrated in the study of Cercek et al., (1983) where reductions in PPD and increases in PAL were greatest in sites with PPDs ≥6 mm.
6.5.2 Effects on subgingival microflora

The effects on subgingival microflora of supragingival plaque control alone compared to supragingival plaque control in combination with supra- and subgingival instrumentation have only been studied in moderate to deep PPDs.

In a longitudinal study, Loos et al., (1988) reported little change in subgingival microbiological parameters over a 12-week period of improved plaque control in sites with an initial mean PPD >7 mm. However, 1-week after instrumentation, significant reductions in microbial parameters were observed. In split-mouth studies, Tabita et al., (1981) showed no difference in the quantity of subgingival plaque between the two modes of treatment over a short 2-week period in PPDs of 4-6 mm. Greenwell et al., (1985) found that while oral hygiene had only minimal effects on subgingival microbial proportions over 8 weeks, oral hygiene and instrumentation produced pronounced changes in microflora over the first 4-weeks but these were not sustained over the following 4-weeks. Over longer periods, of 25 weeks in PPDs ≥5 mm (Listgarten et al., 1978) and 50 weeks in PPDs ≥6 mm (Lindhe et al., 1983b,c) improved plaque control alone failed to produce significant changes in subgingival microflora but when combined with instrumentation, produced significant and sustained reductions in motile rods and spirochaetes with a concomitant increase in coccoid cells.

6.5.3 Effects on histological parameters

The relative effects of supragingival plaque control alone or when combined with supra- and subgingival instrumentation on histological parameters has been studied by Tagge et al., (1975), Listgarten et al., (1978), Lindhe et al., (1983b) and Caton et al., (1989). All four studies have shown that instrumented sites show less signs of inflammation histologically than non-instrumented sites.

6.6 Comparison of supragingival plaque control with supragingival instrumentation alone or in combination with subgingival instrumentation

No studies have specifically examined whether differences exist between responses achieved by supragingival plaque control alone as against supragingival plaque control combined with supragingival instrumentation in the absence of subgingival instrumentation (see section 6.4). There are however studies which permit the effects
of supragingival plaque control in combination with supragingival instrumentation to be compared to traditional treatment involving supragingival plaque control with supra- and subgingival instrumentation. These are described below:

6.6.1 Effects on clinical periodontal parameters

(i) Gingival inflammation

In terms of gingival inflammation assessed by BOP, all studies which have assessed differences in response between supragingival instrumentation and plaque control as against this combined with subgingival instrumentation have shown the latter to produce a more pronounced effect (Rosling et al., 1983; Müller et al., 1986; Heijl et al., 1991; Sato et al., 1993). The magnitude of the difference appears to influenced by the PPD as shown in the latter study where, 2 years after following a supervised plaque control programme during which supragingival scaling was performed, 2 quadrants in each subject received subgingival instrumentation while the remaining two served as controls. In the control quadrants small reductions in BOP were seen only in PPDs <5 mm with no improvements in deeper sites. Conversely, quadrants which received subgingival instrumentation showed substantially greater reductions in BOP which were largely independent of PPD.

When gingival inflammation has been assessed by use of the GI, the differences between supragingival instrumentation and plaque control as against this combined with subgingival instrumentation are equivocal. Both Rosling et al., (1983) and Heijl et al., (1991) have shown the latter form of treatment results in greater reductions in GI than supragingival instrumentation and plaque control alone. Conversely, Smulow et al., (1983) and Müller et al., (1986) failed to find any difference in GI between the two treatment modes although Müller et al., (1986) noted a slower response in those teeth which did not receive subgingival instrumentation.

(ii) Probing pocket depth (PPD) and probing attachment level (PAL)

As with BOP, the periodontal responses in PPD and PAL to plaque control combined with supra- and subgingival instrumentation are generally greater than when only supragingival instrumentation and plaque control are performed (Rosling et al., 1983; Müller et al., 1986; Kaldahl et al., 1988; Heijl et al., 1991; Sato et al., 1993). Smulow et al., (1983) however failed to show substantial differences in response between the two treatment methods for reasons which are unclear.
As might be expected, the magnitude of the response is dependent not only on the
treatment but also on the initial PPD. Sites with deep PPDs show greater reductions in
PPD and gains in PAL than shallower PPDs (Rosling et al., 1983; Kaldahl et al., 1988;
Sato et al., 1993). It is interesting to note that while Kaldahl et al., (1988) failed to find
any change in PAL in shallow PPDs over 2 years in response to either treatment,
Rosling et al., (1983) demonstrated that both treatment modes resulted in a slight loss
of PAL. This is consistent with the findings from a number of other studies showing the
potential harm of instrumentation in shallow sites (for review see Lindhe et al., 1982).

6.6.2 Effects on subgingival microflora

The effects on subgingival microflora of plaque control combined with supra- and
subgingival instrumentation are generally greater than when only supragingival
instrumentation and plaque control are preformed (Rosling et al., 1983; Heijl et al., 1991;
Sago et al., 1993). Smulow et al., (1983) however once again failed to find any
difference between the two treatments.

6.7 Summary

The overall findings from this review of some minimal periodontal treatment programmes
are:

- Improvements in supragingival plaque control in the absence of instrumentation
can result in reductions in gingival inflammation, probing depths and in the
histological parameters of inflammation. These changes appear to be dependent
upon initial PPD and level of plaque control achieved. Any changes in PAL and
subgingival microflora are generally small and insignificant;

- The results of supragingival plaque control and instrumentation in the absence
of subgingival instrumentation can also result in reductions in gingival
inflammation, probing depths, microbiological putative pathogens and in the
histological parameters of inflammation. These changes also appear to be
dependent upon PPD and level of plaque control achieved;

- In most circumstances instrumentation has an adjunctive effect on that resulting
from supragingival plaque control alone.
CHAPTER 7 - MATERIALS AND METHODS

7.1 Selection of subjects for the study

The comprehensive sociological and clinical data already available for individuals surveyed during the 1984 Hong Kong Survey of Adult Oral Health [1984 HKSAOH] provided a sound database for the definition of a sub-sample for this subsequent study (Lind et al., 1986). Furthermore, as one of the principal objectives of the study was to determine the time required to provide periodontal treatment according to CPITN criteria, it was considered pertinent to use a sample consisting of those subjects in whom the treatment needs had originally been so determined (see Chapter 1).

The method for the selection of subjects for the 1984 HKSAOH has been described (Lind et al., 1987a). In brief, a cluster sampling method was used whereby living quarters were selected by systematic sampling and all persons aged 15-19 and 35-44 years within each living quarter were eligible for inclusion as potential subjects for examination. A total of 1239 individuals in the selected age groups were subsequently recruited, but because the medical history contraindicated periodontal probing in a small number of individuals, examinations were performed on only 1231 individuals. Of these, 563 were in the 15-19 age cohort and 668 in the 35-44 age cohort.

While the 1984 HKSAOH collected data for both 15-19 and 35-44 year-old Chinese adults, this study restricted itself to the older age cohort as these subjects had more serious and extensive periodontal conditions with over 99% allocated either a CPITN treatment need (TN) category 2 or 3 (see Table 1.3, Appendix I). The 35-44 year-olds were generally homogeneous with respect to periodontal status and treatment needs when considering different income levels, educational status or last visit to the dentist and it was considered unnecessary to stratify the original sample into these separate groupings for the selection of the sub-sample for this study. The 35-44 year age sample was therefore stratified according to their TN category only, from which only TN2 and 3 were selected.

7.2 Sample size

A statistical estimation of sample size is advisable before commencing a study to ensure that a sufficiently large sample is used to make the results meaningful while avoiding the
use of too large a sample which might be wasteful in terms of resources and time. The method of determining sample size is dependant upon the study design and also requires some prior knowledge of the parameter under consideration. With respect to the latter, little was known about periodontal treatment times for this population which could assist in the determination of sample size. A small pilot study was therefore performed in 1985 by the examiner C.J. Holmgren (CJH), which concurrently served to test the methods used for the recording of clinical criteria, the methods for evaluation of treatment times and provided some indication of possible logistical problems which might have been encountered during the study proper. In addition, treatment time data from a second unpublished study undertaken by CJH were used to supplement the data from the pilot study.

The pilot study assessed periodontal treatment times for 12 subjects attending for routine periodontal treatment provided by hygienists working in the Prince Philip Dental Hospital. The age of the subjects ranged from 20 to 53 years with a mean age of 30 years. On the basis of full mouth recording of CPITN, all subjects were classified as TN2. Subjects were given routine oral hygiene instruction and scaling, the scaling being performed with both ultrasonic and hand instruments. The time taken for each treatment procedure was measured using a stopwatch, with the subject being the unit of assessment for oral hygiene instruction and the sextant for scaling.

Results from the treatment times assessed during this pilot study were incorporated into the following statistical algorithm used to calculate sample size for a specified confidence interval (Chilton, 1982) thereby obtaining an approximation of the sample size needed to achieve a level of accuracy required for the treatment times of individual periodontal procedures.

\[
N = \left( \frac{1.96 \times s.d.}{D} \right)^2
\]

where \( N \) = sample size  
\( s.d. \) = standard deviation  
\( D \) = desired level of accuracy (1.96 x standard error)

Note: This formula generally only holds true when computing sample size for a genuine random sample and for a one-sample problem. Its use did however permit an approximation of the sample size required and its application in this study was done
cognizant of its potential limitations.

The approximate sample sizes required to achieve different degrees of accuracy according to different subdivisions of treatment based on the first pilot study are given in Table 7.1 (Appendix V).

The second study differed from the first in that only hand-instruments were used. The subjects comprised 13 35-44 year-olds attending the Prince Philip Dental Hospital for routine periodontal treatment. Estimated sample sizes based on the data collected are provided in Table 7.2 (Appendix V).

These two studies taken together indicated that, assuming a 95% confidence interval, a sample size of 100 TN2 subjects would provide a degree of accuracy for periodontal treatment procedures approximating ± 30 seconds per person for oral hygiene time; ± 30 seconds per sextant and ± 5 minutes per person for scaling time; and ± 5 minutes per person for total treatment time. It was also estimated that this degree of accuracy should be within about 10% of the total time required for each procedure. Furthermore, a sample size of 100 subject would also allow for a drop-out rate in the region of 25% while still maintaining a similar degree of accuracy.

On the basis of this information, 100 of the 559 TN2 subjects were selected by means of a computer program which randomized the sequence of subjects in this subgroup, with the first 100 being chosen (Figure 7.1). Unfortunately, no treatment time data was available for TN3 subjects, however as only 106 subjects in the 35-44 year age-group were so classified in the 1984 HKSAOH, all 106 TN3 subjects were selected to participate in this study. The sampling method therefore consisted of a multistage sampling technique with a randomized block design (Fleiss, 1986).
7.3 Establishing contact with the selected subjects and booking the appointments

Making use of the computerized 1984 HKSAOH database, each of the selected subject's name, age, sex, address, telephone number and CPITN data were printed onto the front of the control card (Appendix VI).

Attempts to contact the subjects were made in the first instance by telephone as telephone numbers were available for the majority of subjects. This telephone contact was made by one of the receptionists in the Department of Periodontology and Public Health who underwent training before the start of the study to familiarize herself with the standardized format of the telephone call and in the use of the control card and questionnaire (Appendix VI). Instructions were also available for the receptionist to refer to when telephoning the subjects (Appendix VII). In those instances when the subject had no telephone number or the telephone number had changed, the subject was contacted by post using a standard format letter (Appendix VIII). The reverse of the
control card served as a record of each attempt to contact the subject.

Once contact had been made, the subject was asked if he or she was prepared to attend the Prince Philip Dental Hospital for periodontal treatment and if so the most convenient time to attend. This information was recorded on the reverse of the control card. As an additional incentive, treatment was offered free of charge. When subjects were unavailable to attend for treatment during the normal working hours of the Department or were unwilling to attend for treatment then this was recorded. In addition, the stated reasons for unavailability or unwillingness to attend was recorded.

The receptionist was also responsible for booking the examination and treatment appointments. A record of the dates of appointments, the reason for the appointment and the operator were recorded on the front of the control card.

7.4 Registration of the subjects and obtaining their consent to participate in the study

All subjects who participated in the study were registered as patients of the Prince Philip Dental Hospital. They were informed that the normal hospital fee for treatment would be waived, unless treatment other than periodontal treatment was provided. The few subjects who had oral pain or large carious lesions were referred to a Junior Hospital Dental Officer for the management of these problems.

To ensure that the subjects' ethical rights were properly observed, the nature of the study was fully explained to each subject by the dental surgery assistant assigned to the examiner. All subjects were then required to sign a consent form which was available in both Chinese and English consenting to their participation in the study (Appendix IX).

7.5 The pre-treatment questionnaire

A pre-treatment questionnaire was completed by each subject before the baseline (pre-treatment) examination. The questionnaire was designed to ascertain the medical history, the length of time since the last dental visit and the nature of treatment received (Appendix X).

The protocol for the study excluded any subjects with a medical history requiring special management e.g. a history of rheumatic fever. No subjects were however excluded on
this basis presumably because those subjects with a contributory medical history had been previously screened out during the 1984 HKSAOH.

7.6 Periodontal examinations for data analysis

To ensure consistency throughout the study, the method of examination, the clinical criteria, the instruments used, and the examination site were standardized as follows:

7.6.1 The examiner

All clinical examinations of subjects involving data collection for the purposes of analysis in this study, were performed by one examiner (CJH) to alleviate potential problems that may arise due to inter-examiner variability. Pre-study training and calibration exercises were undertaken as were calibration exercises during the study proper to determine levels of reproducibility (see section 7.11).

7.6.2 Examination conditions

All examinations carried out by CJH were performed in a single, fully equipped dental operatory, set aside for the purposes of this study. The dental chair allowed the subject to be positioned supine thereby optimizing visibility. Compressed air and water spray, delivered by a 3-in-1 syringe, and high vacuum aspiration were available. Illumination for the examination was provided by a standard dental operatory light (Den-tal-ez, Great Britain, Ltd.), fitted with a 12 volt quartz halogen bulb.

7.6.3 Clinical instruments

(i) Mirrors

New, plane, front surface mirrors, size 2 (American Dental) were used throughout the study. After use, the mirrors were cleaned, sterilized, and examined by the dental surgery assistant to ensure that they were not damaged or scratched. When a mirror was found to be defective, it was immediately replaced.

(ii) Periodontal probes

A set of new CPITN periodontal probes (LM Dental, Finland) was used throughout this study for all clinical examinations. When a probe became bent or otherwise damaged, it was replaced.
7.6.4 Sequence of Examination

Before each examination, the subject was requested to rinse the mouth thoroughly with half a cupful of water for approximately 15 seconds to remove loosely attached material from the mouth. After placing the subject in a supine position, suction was used to remove saliva and any large particles of debris from the mouth taking care not to disturb the marginal gingiva.

7.6.5 Recording of the data from the clinical examination

All the clinical data from the clinical examination were recorded on a specially designed data collection form (Appendix XI) by a dental surgery assistant trained in the use of the form and with previous experience from earlier clinical studies. The design of the data collection form permitted data to be easily and rapidly recorded whilst also being computer compatible.

7.7 Sequence of periodontal examinations and treatment during Phase A of the study

The overall study design and the sequence of periodontal examinations and treatment provided is given in Figure 7.2.

In addition to the assessment of treatment times, a second objective of the study was to evaluate a minimal periodontal treatment program where the effect of oral hygiene instruction alone was compared with traditional periodontal treatment involving oral hygiene instruction, scaling and complex treatment. This was evaluated during phase A of the study which extended over a period of six months.
7.7.1 First appointment

(i) Baseline periodontal examination

The baseline examination was performed after the subject had completed the pretreatment questionnaire and was performed by CJH using the clinical criteria described in Appendix XII.

(ii) Assignment of sextants to different treatment regimens.

In order to evaluate the minimal periodontal treatment program within subjects, a split-mouth design for the assignment of treatment was chosen similar to that used by Glavind (1977). Following this design, contralateral posterior sextants were considered to be one unit, thereby making two posterior units (sextants 03 and 06 comprising one unit and sextants 05 and 08 comprising another), with anterior sextants each making up a unit. Thus, for posterior teeth, one unit served as a control while the other was experimental. In the anterior teeth, one sextant was the control and the other experimental. This method had the advantage that both experimental and control units were within the same subject, therefore eliminating inter-subject variability. In addition, the sextant approach for the assignment of treatment simultaneously permitted treatment times to be determined.

The assignment of sextants to serve as either control or experimental sextants took place after the baseline periodontal examination. The data recorded from this examination was first used to determine the highest CPITN score for each of the subject's sextants (see section 3.2.7). This score was derived from the scoring of all teeth within a sextant, excluding third molars, partially erupted teeth and teeth designated for extraction.

The subject's name, record number and CPITN score for each of the sextants were then entered onto a microcomputer which, by means of a computer program written in Microsoft BASIC, randomly assigned each sextant to either an experimental or control grouping (Appendix XIII). The random number seed used by the program was the record number of the subject. The computer program produced a printout clearly indicating the assignment of the different treatment regimens for each sextant whilst also serving as a data collection sheet for the recording of treatment times - the treatment time control sheet (Appendix XIV).
The control sextants were assigned treatment according to the treatment need indications of the CPITN (see section 3.2.8). Detailed descriptions of the treatment procedures used in the study are provided in Appendix XV. Experimental sextants were assigned to receive only oral hygiene instruction during the first phase of treatment. The possible permutations for assignment of sextants, in terms of control or experimental units are provided in Figure 7.3.
In this section, we discuss the possibility of assigning sextants as either control or experimental units.

Figure 7.3  Possible assignment of sextants as either control of experimental units.

- □ Oral Hygiene
- □ Oral Hygiene, Scaling & "Complex"

Only.
(iii) Clinical examination by the periodontist

Following the baseline periodontal examination, a standard set of radiographs were taken by an Expanded Duty Dental Surgery Assistant for the purposes of periodontal diagnosis and treatment planning. The radiographs comprised five vertical bitewings, two films for each posterior side and one anterior film. These radiographs were supplemented in cases where additional radiographic information was required. The patient was then examined by the periodontist using conventional clinical criteria with a view to provision of comprehensive periodontal care. A manual providing written guidelines was provided for the periodontist detailing the sequence of appointments, the treatment procedures and the recording of treatment time (Appendices XVI & XVII). The sequence and content of the examination and the type of chartings and records taken were entirely at the discretion of the periodontist who did not have access to the results of the baseline periodontal examination. The findings and chartings of the periodontist were recorded in the subject's hospital folder (Appendix XVIII).

The overall time taken by the periodontist for examination, special tests, diagnosis and treatment planning were recorded on the subject's treatment time control sheet. Furthermore, separate timings were made for the time required for the examination of the periodontium and associated factors, as well as the taking of radiographs (Appendix XIV).

(iv) Initial treatment by hygienists

Each hygienist was identified by a two-digit number to facilitate assignment and subsequent data analysis. It had been the intention to have a random assignment of subjects to individual hygienists and a Microsoft BASIC computer program was written for this purpose. In practice however, random assignment proved to be unmanageable due to the hygienists' other patient commitments. A manual providing written guidelines was provided for the hygienist detailing the sequence of appointments, the treatment procedures and the recording of treatment time (Appendix XIX).

The hygienists provided oral hygiene instruction and scaling according to assignments given on the treatment time control sheet described in section 7.7.1(ii). The times required for examination, oral hygiene reinforcement, scaling, and overall treatment time were recorded on the treatment time control sheet.
7.7.2 Subsequent appointments with the hygienist for initial treatment

Subsequent appointments for additional oral hygiene instruction and scaling were scheduled on a weekly basis by the hygienist until he/she considered that optimal improvements had been obtained with the patient's oral hygiene and that scaling had been performed to the best of his/her ability. The hygienist was also instructed to examine and rechart probing depths and bleeding after probing on each subsequent appointment. Treatment times were recorded as in section 7.7.1.

An appointment was scheduled for the subject one month after the last appointment with the hygienist for a review by the periodontist. This period was to allow tissue responses to take place.

7.7.3 Subsequent appointments with the periodontist for initial treatment

The subsequent appointment with the periodontist was intended to review the need for further periodontal treatment prior to its provision.

The periodontist first examined and recharted probing depths and bleeding after probing. The need for oral hygiene reinforcement was at the discretion of the periodontist and when considered necessary was provided by the periodontist assisted by the dental surgery assistant. The periodontist was also instructed to remove any small deposits of calculus remaining in control sextants after the scaling provided by the hygienist.

Based on the charting from the re-examination of the periodontal status, any sites in control sextants which continued to exhibit probing depths of 6mm and above, and which also exhibited bleeding, were indicated for root planing. This was then performed by the periodontist since the regulations governing the utilization of dental hygienists in Hong Kong (Ancillary Dental Workers [Dental Hygienists] Regulations, 1973: Cap 156. Section 29), did not specifically permit hygienists to perform root planing or administer local anaesthetics to facilitate the instrumentation of deep pockets.

On the last appointment with the periodontist, an appointment was made for the subject to be reviewed by the examiner (CJH). This was scheduled to be three months after the baseline examination.
7.7.4 Three-month examination

The first recall examination followed exactly the same format as used for the baseline periodontal examination (see section 7.6) and was conducted by CJH.

7.7.6 Six-month examination

The second recall examination was scheduled for six months after the baseline examination and followed the same format as used for the baseline periodontal examination. The six-month post-treatment examination constituted the end-point of Phase A evaluating the effects of oral hygiene instruction alone against traditional periodontal treatment.

7.8 Sequence of periodontal examinations and treatment during Phase B of the study

7.8.1 Six-month treatment

Phase B of the study served to ascertain the time required for certain aspects of maintenance treatment but also permitted an evaluation of whether deferment of the provision of scaling after a prolonged period of only oral hygiene resulted in a reduction in the time required to provide the scaling.

On the basis of the data recorded from the six-month recall examination, the highest CPITN score for each of the six sextants was computed as in section 7.7.1. Using a computer program written in Microsoft BASIC (Appendix XX), a new treatment time control sheet was printed however unlike phase A of the study, treatment specified on the control sheet was as indicated by CPITN criteria (Appendix XXI).

The arrangements concerning appointments at the six-month recall followed the same outline as for Phase A. After the examination performed by CJH, the subject was examined by the periodontist who reexamined the subject as described in section 7.7.1(iii) except that radiographs were not routinely taken. The subject was then referred to the same hygienist as in Phase A for oral hygiene reinforcement and scaling in all sextants where indicated. Subsequent appointments with the hygienist and the periodontist were made as described in sections 7.7.2 and 7.7.3. Treatment times were recorded for all items of periodontal treatment performed by both the hygienist and
7.8.2 Nine and twelve-month examinations

The nine and twelve-month recall examinations followed the same format as used for the baseline examination (see section 7.6).

7.9 Sequence of periodontal examinations and treatment during Phase C of the study

7.9.1 Twelve-month treatment

The treatment delivered subsequent to the one-year examination followed the same protocol as described in section 7.8.1.

7.9.2 Fifteen-month examination

The fifteen-month recall examination followed the same format as used for the baseline examination (see section 7.6).

7.9.3 Twenty-four-month examination

The twenty-four-month recall examination followed the same format as used for the baseline examination (see section 7.6).
7.10 Assessment of treatment times

A review of the different methods which could be used for the collection of treatment time data has been presented in Chapter 4. For the purposes of this study, it was necessary to use two methods to collect treatment time data, namely 'time study' and 'activity sampling'.

7.10.1 Time study

Time study was used for measuring the time required to perform all the primary activities involved in the treatment of periodontal disease. As seen in the preceding sections, these activities included treatment procedures as specified by the CPITN as well as the time for examination and the taking of radiographs, and the overall treatment time.

In any time study, it is necessary to predefine a number of factors (as modified from Currie & Farraday, 1977), namely:

- To specify accurately the point at which an activity starts and finishes. (A break point);

- To specify the method by which the activity is to be performed, including details of the materials, equipment and conditions;

- To design a system of measuring and recording time taken by the operator to perform the activity.

Criteria for the measurement and recording of treatment times and definition of break points for individual treatment procedures have been provided in Appendix XVII while the predefinition of the method by which the activity was to be performed has been detailed under Appendix XV. The recording of treatment times was delegated to the dental surgery assistant so as not to disturb the operator's work flow. Treatment times so recorded were converted to minutes by a computer program written in Microsoft BASIC (Appendix XXII) and transferred to a treatment time transfer sheet for eventual computer entry (Appendix XXIII).
Activity sampling was used to determine the proportion of time spent on different treatment procedures and to determine the ratio of time used for primary, secondary and unproductive activities (Hobdell & Evans, 1977). A conversion factor could then be applied to treatment times determined by the method of time study thereby making allowances for time spent in secondary and unproductive activities.

An essential component of activity sampling is the breakdown and classification of activities before sampling commences. The three main groupings, namely primary, secondary and unproductive activities, were divided into sub-groupings which were categorized so as to be CPITN related. A two-digit coding system identified each separate activity where the first digit identified the sub-grouping e.g. oral hygiene instruction procedures, whilst the second digit identified the nature of the oral hygiene instruction activity. Thus, for example, the activity '21' indicated 'Oral Hygiene Instruction - toothbrushing and use of interspace brush', where the first digit '2' indicated 'Oral Hygiene Instruction', and the second digit '1' indicated 'toothbrushing and use of interspace brush'. Primary activities included all those defined as separate treatment procedures in the section on time study.

A short pilot study was undertaken over five clinical sessions to ascertain whether the classification of activities selected and the activity sampling recording sheet were practical and manageable. Problems encountered during this pilot study led to modifications being made to both the design of the activity sampling recording sheet (Appendix XXIV) and the categories of activities of which 63 were eventually defined (Appendix XXV). Furthermore, the pilot study revealed that in order for the activity sampling to be manageable, a single observer could sample a maximum of six operators during a clinical session with a sampling rate of ten samplings per hour. To allow adequate time for the observer to record the activities of each of the operators, a minimum time lapse of three minutes between samplings was specified. Dental surgery assistants were used as samplers as they had a knowledge of the clinical procedures involved. Furthermore, prior to the study proper, instructions were issued to the activity samplers to ensure that data collected was correct (Appendix XXVI).

A Microsoft BASIC computer program (Appendix XXVII) produced a printout of randomly chosen sampling times ranked in temporal order for each individual sampling session.
These times were manually transferred to the activity sampling recording sheet (Appendix XXIV). Each sampling session was identified by the date and time while each operator was identified by a unique two-digit coding system which also identified whether the operator was a hygienist or periodontist.

Activity sampling permits a more representative sample of the activities being investigated because the sampling can be performed over much longer periods than would be economical with time study (Currie & Farraday, 1977). It was therefore possible to take into account those periods of the year when productivity could be affected by external factors such as holiday periods when large number of people leave Hong Kong. The activity sampling exercises therefore took place during months of the year when this was less likely to be a problem. The sessions when sampling took place were different from those when sample subjects were receiving treatment and were largely those when the dental surgery assistants were free of other duties.

The number of observations required to calculate the proportion of total time devoted to a certain activity is determined by the degree of accuracy which is considered acceptable. With activity sampling the degree of accuracy is often expressed as a percentage of the total activity time. The following formula, according to Farraday, 1977, can be used to calculate the required number of observations:

\[
L = 1.96 \sqrt{\frac{P(100-P)}{N}}
\]

Where

- \(L\) = degree of accuracy (95% confidence intervals)
- \(P\) = proportion of time devoted to activity
- \(N\) = number of observations for activity

This formula can be rewritten as below:

\[
N = \frac{3.84 \times P(100-P)}{L^2}
\]

Table 7.3 (Appendix XXIX) gives an estimate of the number of observations required according to degree of accuracy required and the expected proportion of time devoted to an activity. Based on these figures, 400 samplings would provide a 5% degree of accuracy if the proportion of time devoted to an activity is 50% or less (95% confidence limits).
7.11 Clinical examiner reproducibility

The need for standardization and calibration on reproducibility of recordings regardless of whether one or more observers are involved has been emphasized by a number of authors (Clemmer & Barbano, 1974; Davies et al., 1967; Ramfjord, 1973; Smith et al., 1970; WHO, 1977; Davies & Emslie, 1977; Shaw & Murray, 1977; Carlos, 1985). The manual Oral Health Surveys, Basic Methods, 3rd. Edition (WHO, 1987) gives the objectives of standardization and calibration exercises as being:

- To ensure uniform interpretation, understanding and application of the criteria for the various diseases and conditions to be observed and recorded;
- To ensure that each examiner can examine to a consistent standard and that variations between different examiners are minimized.

The principal requirements of standardization and calibration exercises as proposed by Davies & Emslie (1977) formed the basis for the design of these exercises for this study. These are as follows:

- The study should not be carried out until there is consistency within an observer or between observers;
- Training should be carried out until adequate levels of reproducibility are reached;
- Retraining should be performed periodically in longer studies to ensure consistency of scoring during the study;
- Calibration and training exercises should be performed on subjects that reflect the scoring problems likely to be encountered in the sample population, and who should exhibit the full range of the index to be used.

In order to achieve the requirements listed above, a sequence of standardization and calibration exercises was undertaken divided into three stages, comprising pre-study training, pre-study calibration, and calibration exercises during the study proper. Furthermore, potential sources of inter-examiner variation were eliminated since all clinical examinations, for which data was collected for analysis, were performed by one examiner (CJH).
7.11.1 The pre-study training sessions

Although the examiner (CJH) was well conversant with the clinical parameters used in the study and with the CPITN, it was considered important before embarking on this study that the interpretation and use of the criteria be consistent with that recommended and used by the World Health Organization (WHO), particularly with respect to the CPITN. Following consultation with the WHO Oral Health Unit, Geneva, arrangements were made for an inter-regional consultant on special assignment with WHO, Professor Taco Pilot, to visit Hong Kong to conduct training exercises. These comprised:

• A seminar focussing on the use of the CPITN, its clinical criteria, and interpretation of data collected using the index;
• A clinical training session where a total of 10 patients, selected so that they represented a range of periodontal disease, were examined by Professor Pilot overseen by CJH. The results were subsequently discussed paying particular attention each of the clinical components of the CPITN namely bleeding on probing, calculus and probing depth range.
• A second clinical training session, where a further 5 patient examinations were performed by both Professor Pilot and CJH. Differences in scoring were discussed and the interpretation of the clinical criteria by CJH were corrected to be consistent with Professor Pilot.

After the visit by Professor Pilot, a series of six additional training sessions were undertaken by CJH in the three months leading up to the commencement of the study proper. The subjects used for these sessions were patients attending the Reception and Primary Care Unit (RPCU) of the Prince Philip Dental Hospital of an age similar to that used in the study proper and representing a range of severity of periodontal disease. The circumstances of these sessions attempted to replicate those used in the main study with respect to equipment, lighting, instruments, clinical criteria and sequence of examination. However, due to temporal restraints, the examination was restricted to the charting of only three sextants per subject predetermined randomly by tossing a coin before the subject entered the operatory. Training in the use of the probing forces recommended for the CPITN probe was achieved by probing sites in the remaining sextants not assigned for examination with a pressure sensitive probe (Vine Valley Research) set to 25 g and fitted with a standard CPITN probe shank and working end.
Duplicate examinations were performed after a time interval of approximately 30 minutes being the time required for the subjects to receive the radiographic examination which forms part of the routine screening of patients attending the RPCU. This time period was adequate to ensure the examiner could not recall the clinical scores originally assigned. Furthermore, the original scores from the first examination were not available to the examiner until the end of the calibration session. Duplicate examinations were performed on a total of 17 subjects during these training sessions.

7.11.2 Pre-study calibration sessions

To ensure examiner consistency before the start of the study proper, two calibration sessions were undertaken immediately prior to the first baseline examinations. A total of 12 subjects were examined during these sessions which followed the same format as described in section 7.11.1.

7.11.3 Calibration exercises during the study proper

Calibration exercises were scheduled during the study proper to ensure long-term examiner consistency. These took place approximately every 6 months over four time periods and followed the previously described format for calibration sessions. A total of 31 subjects were examined during these four time periods.

7.12 Analysis and statistical treatment

7.12.1 Analysis of the calibration data

Data collected during the calibration sessions were input into a dBase III database and contingency tables produced for initial and repeat examinations according to the following parameters: probing depth range, supra- and subgingival calculus, bleeding, highest CPITN tooth score and the CPITN sextant score. Proportion agreement and the kappa statistic ($\kappa$) (Landis & Koch, 1977) was computed from these clinical parameters using a custom written dBase III program.

7.12.2 Analysis of the clinical data

Data from the clinical examination forms were input into a dBase III computer database and the entered database checked manually twice against the original entry on the examination forms and corrections made. In addition, a specially written Turbo-Pascal
(Borland Ltd.) validation program checked the database to ensure that values for each variable were within the range specified in the examination criteria. All other data analysis was performed using SPSS-PC version 4 (Norusis/SPSS Inc., 1990) and Instat (GraphPad Software, 1993).

(i) Data analysis of the conventional clinical criteria.

For each examination phase and for each examinee, the number of sites per sextant affected by each of the clinical criteria was computed and from this data mean proportions for the sample under consideration were derived. The intention to apply the method of doubly multivariate repeated measurements analysis of variance to the resultant data to test hypotheses concerning changes in responses over time and for differences between treatment groups demanded that the data be approximately normally distributed (Fleiss et al., 1990). Thus, in order to test for normality, the values of skewness and kurtosis were determined for both untransformed data and that transformed by logarithmic, square root and arcsine means. In addition, the data were also evaluated using the Komologov goodness-of-fit test (Siegel & Castellan, 1988). Unfortunately, none of the transformations enabled the mean proportions of sites with deep pockets (probing depths >6mm), with shallow pockets (probing depths 4-5mm) in anterior sextants, and with no pockets (probing depths < 4mm) in anterior sextants, to be included in the repeated measurements analysis of variance. All data relating to the mean proportions of sites was transformed using square roots, with the exception of the mean proportion of sites with no pockets (all sextants considered and posterior sextants only) where arcsine transformation was used.

Prior to the application of the repeated measurements analysis of variance (Gunsolley et al., 1989), the sphericity test developed by Mauchly (1940) was used to test whether a univariate or multivariate approach to repeated measures could be used. The multivariate approach was ultimately selected as the p-value of the sphericity test was <0.05 for most of the criteria assessed (see Table 7.4, Appendix XXXI). Hotelling's $T^2$ statistic was thus used to test between examination phases and groups. For individual clinical parameters, the one-sample (paired) $t$ test was used to make comparisons between control and experimental sextants and between different examination phases. Statistical significance was assumed when $p<0.05$.

Where normality was not achieved with the data even with transformation, namely those
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relating to the mean proportions of sites with deep pockets (probing depths ≥6mm), with shallow pockets (probing depths 4-5 mm) in anterior sextants, and with no pockets (probing depths < 4mm) in anterior sextants, analysis was by the non-parametric Wilcoxon signed ranks test (Siegel & Castellan, 1988). Once again, statistical significance was assumed when p<0.05.

(ii) Data analysis of CPITN sextant data

CPITN sextant codes were derived from the scores for bleeding after probing, calculus and probing depth range determined from all functional teeth in each sextant. The ordinal nature of the CPITN data demanded the use of non-parametric statistics. For comparisons between control and experimental sextants at each examination, the Wilcoxon signed ranks test (Siegel & Castellan, 1988) was used. For comparisons between examinations carried out at different time periods, Friedman two-way analysis of variance by ranks was performed followed by Dunn's test for multiple comparisons (Daniel, 1990). Statistical significance was assumed when p<0.05.

7.12.3 Analysis of the treatment time data

(i) Time study

Many items of periodontal treatment extend over a number of treatment sessions and therefore for each phase of treatment a summation of the treatment times for each primary activity and the overall treatment time was computed. Analysis of variance (ANOVA) was used to test the significance of differences between groups. When ANOVA rejected the hypothesis of equal means, multiple comparison test analysis was undertaken using Scheffé's test. ANOVA was used for total oral hygiene time, X-ray time, examination time. Kruskal-Wallis one-way analysis of variance by ranks was used to determine differences in the number of sessions required.

(ii) Activity sampling

By definition, the percentage of observations recorded for a particular activity is a measure of the percentage of time during which that activity occurs (BS 3138:1979). Based on this definition, the proportion of time spent performing an activity was calculated using the simple formula given overleaf:
\[ P = \frac{N}{N'} \times 100 \]

Where:
- \( P \) = proportion of time devoted to activity
- \( N \) = number of observations for activity
- \( N' \) = total number of observations

The degree of accuracy for each activity were calculated at the 95% confidence interval by means of the following formula:

\[ L = 1.96 \sqrt{\frac{P(100-P)}{N}} \]

Where \( L \) = degree of accuracy
8.1 Treatment Time Results

8.1.1 Number of sessions and procedures completed

A session was defined as a single visit for treatment or review irrespective of whether a subject was being seen by either a periodontist, hygienist, or both. The mean number of sessions required during Phase A was 3.8 (SD=0.7; range 3-6; 43 subjects), for Phase B was 2.9 sessions (SD=0.7; range 2-5; 39 subjects), while 2.4 sessions (SD=0.8; range 2-5; 37 subjects) were required for Phase C. These values for the mean number of sessions were comparable to those for the 37 subjects who completed all three phases of treatment (Table 8.1, Appendix XXXII). There was a significant reduction in the number of sessions required by these 37 subjects for each successive phase of treatment \( p < 0.001 \).

During Phase A, subjects with CPITN 4 as their highest score required the most sessions while subjects with score 2 required the fewest \( p < 0.02 \) (Table 8.1, Appendix XXXII). However, during Phases B and C no significant differences were observed in the numbers of sessions required by subjects with different CPITN scores irrespective of whether these were related to the baseline, 6- or 12-month examinations.

A summary of the number of procedures completed at each treatment stage is provided in Table 8.2 (Appendix XXXII). The numbers of examinations during each treatment phase includes examinations performed by both the periodontists and hygienists. There was a decrease in the number of examinations completed at phases subsequent to Phase A due to both sample attrition and reductions in the number of visits. Radiographic examinations were only conducted during the baseline examination except for one subject who required an additional radiograph during Phase C. During Phase A scaling was only performed in the control sextants, however the numbers of completed scalings in control and experimental sextants were comparable during subsequent phases. Overhang removal was rarely performed and was found to be needed only in control sextants. Root planing did not feature prominently in the treatment provided and was largely performed during Phase C and to a lesser extent during Phase B. Almost twice as many experimental sextants received root planing during Phase C when compared to control sextants.
Periodontal surgery was not performed during any of the three phases; however, outwith the study proper, four subjects were assessed to be in need of additional periodontal treatment after the 15-month examination and were provided with scaling, root planing and periodontal surgery (Phase D, Table 8.2, Appendix XXXII).

8.1.2 Total treatment time

The mean total treatment time for the 43 subjects who completed Phase A was 217 mins. (SD=68; range 85-465). During subsequent phases the mean total treatment time was shorter at 124 mins. (SD=54; range 34-293; 39 subjects) for Phase B and 89 mins. (SD=39; range 36-167; 37 subjects) for Phase C.

Although 37 subjects completed all three phases of treatment, data were only available for 36 subjects as data were missing for one subject during Phase B. The mean total treatment times for these subjects at each phase both overall and according to the highest CPITN score per subject are provided in Table 8.1 (Appendix XXXII), while the distribution of the ranges of total treatment time for each phase is given in Figure 8.1. The mean total treatment time reduced with each successive phase of treatment and there were statistically significant differences between all phases [$p < 0.001$].

During Phase A, no significant difference was detected in the total treatment time between subjects who had a CPITN score of either 2 or 3 as their highest score although there was a significant difference between these subjects and those who scored CPITN 4 [$p < 0.05$]. During Phases B and C, no significant differences were observed in the total treatment time according to the highest subject CPITN scores irrespective of whether these were obtained at the baseline or at the 6- and 12-month examinations.

8.1.3 Time for examination

The total time for examination during each phase comprised the time spent by the periodontist on the initial examination and by the periodontist and hygienist on subsequent appointments. The mean total examination time for all the subjects who completed Phase A was 42 mins. (SD=17; range 13-106; 43 subjects). This reduced to a mean of 27 mins. (SD=12; range 11-70; 39 subjects) for Phase B and to 20 mins. (SD=7; range 10-41; 37 subjects) for Phase C.

The mean total examination times relating to Phases A, B and C both overall and
according to the highest CPITN score per subject for the 36 subjects who completed all three phases are given in Table 8.1 (Appendix XXXII), while Figure 8.2 shows the range of examination times for each phase. The mean total examination time reduced significantly between each successive phase \([p < 0.001]\). The mean examination time per visit however for Phases A, B and C were 11, 9 and 8 minutes respectively.

During Phase A, subjects with CPITN code 4 as their highest score required a significantly longer mean examination time than subjects scoring CPITN code 2 or 3 \([p < 0.05]\), but no significant difference was found in the examination time between these latter two groups. During Phase B, no significant differences were detected in total examination time between different CPITN scores irrespective of whether these were obtained at baseline or at the 6-month examination. However, for Phase C, subjects scoring CPITN 4 at baseline had a significantly higher examination time than those scoring CPITN 2.

### 8.1.4 Time for radiographs

Of the 57 subjects who attended the baseline examination, 53 subjects had a standard set of radiographs taken. The mean time required to take these radiographs was 11.1 mins. \((SD=2.8; \text{ range 5-18})\). For the 43 subjects who completed Phase A, the mean time was 11.0 mins. \((SD=2.9; \text{ range 5-18})\) while for the 36 subjects who completed all three phases of treatment, the mean time was 11.2 mins. \((SD=3.1; \text{ range 5-18})\).

The mean times for radiographs according to the highest subject CPITN score at baseline were 11.6 mins. \((SD=3.8)\), 10.8 mins. \((SD=3.0)\), and 12.4 \((SD=3.0)\) for CPITN codes 2, 3 and 4 respectively. No statistically significant difference was found between these groupings.

The single radiograph which was taken during Phase C took a total of 0.6 mins.
Figure 8.1 Distribution of the ranges of total treatment time for subjects completing Phases A, B, & C (N = 36)

Figure 8.2 Distribution of the ranges of total examination time for subjects completing Phases A, B, & C (N = 36)
8.1.5 Time for oral hygiene instruction

At baseline, the mean time required for initial oral hygiene instruction for the 43 subjects who completed this stage of treatment was 39.2 mins. (SD=14.0; range 5-72). For the 39 subjects who completed the 6-month treatment stage, the mean time for oral hygiene reinforcement was 15.0 mins. (SD=9.8; range 3-44). Further oral hygiene reinforcement was given to all 37 subjects who completed the 12-month treatment stage with a mean time of 10.7 mins. (SD=6.8; range 2-32).

The mean times for oral hygiene instruction for the 36 subjects who completed all three phases of treatment were similar to those given above (Table 8.1, Appendix XXXII). The distributions of time spent on oral hygiene instruction for each phase is given in Figure 8.3. The mean oral hygiene instruction time reduced significantly between each successive phase \( p < 0.001 \) between Phase A & B, \( p < 0.05 \) between Phase B & C.

No significant differences were found at any of the three phases with respect to the mean oral hygiene instruction time required by subjects with different maximum CPITN scores irrespective of whether these scores were derived at baseline or at subsequent examinations (Table 8.1, Appendix XXXII).
8.1.6 Time for scaling and correction/removal of plaque retentive factors

Only control sextants received scaling during Phase A. In the 43 subjects who completed this phase, a total of 129 control sextants were scaled and the mean time taken for this procedure was 23.1 mins. per sextant (SD=11.6; range 4-75).

Initial scaling was deferred in experimental sextants until after the 6-month examination, that is until after the sextants had had the opportunity to benefit from the oral hygiene instruction provided during Phase A. The mean time for scaling the 115 experimental sextants in the 39 subjects who completed Phase B was 11.8 mins. (SD=6.6; range 1-31) compared to the 22.9 mins. (SD=11.8; range 4-75) required to scale the 117 control sextants in these subjects at baseline. Thus, deferment of initial scaling in the experimental sextants almost halved the time required for this procedure \(p < 0.001\).

The distribution of the times used during Phase A for scaling control sextants compared to the times used during Phase B for scaling experimental sextants is given in Figure 8.4. The mean time for the 'maintenance' scaling of the control sextants during Phase B was 6.8 mins. (SD=4.6; range 1-24).
For the 36 subjects who completed all three phases of treatment, the mean times for scaling control sextants during Phase A and experimental sextants during Phase B were comparable to the 39 subjects who only completed up to Phase B (Table 8.3, Appendix XXXII). In these 36 subjects, there was a significant decrease in the mean time required for the scaling control sextants between Phases A and B ('initial' & 'maintenance' scaling respectively)\[p < 0.001\] and between Phases B and C \[p < 0.001\]. Similarly, in experimental sextants there was a significant decrease in mean scaling time between Phases B and C ('initial' & 'maintenance' scaling respectively) \[p < 0.001\] (Figure 8.5).

The overall difference between the mean 'initial' scaling time for control sextants during Phase A and for experimental sextants during Phase B was also highly significant \[p < 0.001\]. Likewise, significant differences were found between control and experimental sextants for the first 'maintenance' scaling which took place during Phase B for control sextants and during Phase C for experimental sextants \[p < 0.001\].
Figure 8.4 Distribution of the range of total scaling time for control sextants (Phase A) \([N = 129]\) and experimental sextants (Phase B) \([N = 116]\)

Figure 8.5 Distribution of the range of total scaling time for control sextants (Phases B & C) \([N = 108]\) and experimental sextants (Phase C) \([N = 106]\)
Table 8.3 (Appendix XXXII) provides the mean scaling time for Phases A, B and C according to the highest CPITN score per sextant for the 36 subjects who completed all three treatment phases. During Phase A, control sextants scoring CPITN code 4 took significantly longer to scale than sextants scoring code 2 or 3 \( [p < 0.05] \), while sextants scoring code 3 required a longer scaling time than those with code 2 \( [p < 0.05] \).

During Phase B, no significant differences were observed in the mean scaling time between sextants with different CPITN scores when obtained at baseline in either control or experimental sextants. When the scores were based on the 6-month examination, a significant difference in scaling time was only found in control sextants between sextants with code 1 and 2.

Significant differences in mean scaling time between sextants with different CPITN scores were only found during Phase C with respect to experimental sextants where sextants scoring code 3 at baseline took longer to scale than those with a code 2.

Overhang removal was only required in two control sextants and this was performed during Phase A. The times taken were 6.3 and 10.0 minutes.

8.1.7 Time for complex treatment

According to CPITN criteria, complex treatment encompasses both root planing and periodontal surgery. As indicated in section 8.1.1, root planing was rarely performed during the study proper while periodontal surgery was only performed after the 15-month examination (Phase D). In view of this, treatment time results are only presented here for the sake of completeness.

(i) Root planing

During Phase B the mean time taken for root planing control sextants was 1.4 mins. (SD=0.6; Range=0.7-2.2; N=4) and 1.9 mins. for experimental sextants (SD=1.7; Range=0.5-4.1; N=4). Similar mean times were found for root planing performed during Phase C at 1.7 mins. (SD=0.8; Range=0.7-2.8; N=7) for control and 1.9 mins. (SD=1.7; Range=0.4-6.6; N=13) for experimental sextants.

Four subjects received additional treatment which included root planing at the end of the study (Phase D). The mean time taken for root planing control sextants during this
Phase was 5.0 mins. (SD=2.6; Range=2.6-7.7; N=3) and 4.2 mins. for experimental sextants (SD=2.5; Range=1.5-7.4; N=4). Overall, both control and experimental sextants considered, the mean time for root planing per sextant was 4.5 mins. (SD=2.4; Range=1.5-7.7; N=7).

(ii) Periodontal surgery
The four subjects who went on to Phase D each had periodontal surgery performed in one sextant. The mean time for surgery in control sextants was 32.1 mins. (SD=10.4; Range=20.5-40.5; N=3) while surgery in the one experimental sextant took 51.3 mins. Overall, both control and experimental sextants considered, the mean time for surgery was 36.9 mins. (SD=12.8; Range=20.5-51.3; N=4).
Chapter 8 - Treatment Time and Activity Sampling Results

8.2 Activity Sampling Results

8.2.1 General description of the activity sampling component of the study

The original intention was to conduct activity sampling on both the staff hygienists and the two periodontists involved in the study. Early on in the study problems were experienced with the activity sampling of the periodontists as neither had treatment sessions of fixed time periods and there was a trend for patients to be booked on irregular sessions due to their other commitments. The activity sampling of the periodontists was therefore abandoned.

8.2.2 Activity sampling of the hygienists

The activities of hygienists were sampled over a 14 month period on 106 days and involved 120 sampling sessions (excluding holiday periods). Of these, 58 were morning and 62 afternoon sessions. In total, 15,465 samplings were made of the activities of 12 hygienists with a mean of 1289 samplings per hygienist [SD=512]. Seven dental surgery assistants were used to perform the activity samplers.

![Figure 8.6 Proportion of overall time spent on primary, secondary and unproductive activities.](image)
Figure 8.6 shows the proportion of time spent on primary, secondary and unproductive activities. Overall, most of the time was unproductive [60.8% ± 0.8] (patient late, cancelled, failed or not booked), while only 29.3% [± 0.7] of the overall time was devoted to primary activities (examination, oral hygiene, instrumentation and other preventive activities). Just under 10% [± 0.5] of time was spent on secondary activities (preparation of the operatory and instruments, administration). Table 8.4 (Appendix XXXII) shows a breakdown of primary, secondary and unproductive activities according to each individual activity.

8.2.3 Primary activity time (hygienists)

Overall, 6.8% [± 0.7] of primary activity time was spent on examination and charting, 20.8% [± 1.2] on oral hygiene instruction, 70.8% [± 1.3] on instrumentation, 0.3% [± 0.2] on root planing, and 1.3% [± 0.3] on other preventive activities (Figure 8.7).

Figure 8.7 Proportion of primary activity time spent on individual procedures.
Figure 8.8 gives the overall time spent on oral hygiene instruction according to different procedures. Most of the overall time spent on oral hygiene was for instruction on toothbrushing (code 11) [52.4% ± 3.2] with only 15.1% [± 2.3] of time being used for instruction on interdental cleaning aids (code 12). Disclosing agents (code 14) were used rarely and accounted for only 1.3% [± 0.7] of overall oral hygiene instruction time.
A subdivision of the overall time spent on instrumentation according to individual procedures is given in Figure 8.9. Sixty-one percent \(\pm 1.7\) of scaling and prophylaxis activity time was devoted to scaling with hand-instruments (code 20) with 32\% \(\pm 1.6\) being used for ultrasonic instrumentation (code 21). Only 4\% \(\pm 0.7\) of time was used for polishing of teeth (code 22) and only 0.1\% \(\pm 0.1\) of time was used for overhang removal (code 24).

The time spent by hygienists on other preventive activities was mainly for topical fluoride application (code 41) and dietary planning and advice (code 40).

Figure 8.9 Proportion of overall time spent on instrumentation according to individual procedures
8.2.4 Secondary activity time (hygienists)

The proportion of secondary activity time according to different procedures is given in Figure 8.10. Most of secondary activity time was spent on preparation (codes 50, 51, 52 & 53) [49.7% ± 2.5], and fetching or dismissing the patient (code 60) [23.6% ± 2.1]. Other activities featured less commonly.

![Pie chart showing secondary activity time distribution]

*Figure 8.10 Proportion of secondary activity time according to individual activities*
8.2.5 Unproductive activity time (hygienists)

The most common cause for hygienists being unproductive was due to patients not being booked (code 83) [62.9% ± 1.0] (Figure 8.11). Patient failure (code 82) [13.3% ± 0.7], appointments finishing early (code 85) [12.5% ± 0.7] and patient being late (code 81) [8.6% ± 0.6] were the principal other reasons for time being unproductive.

Figure 8.11 Proportion of unproductive time according to individual activities
9.1 Clinical examiner reproducibility

The results for the calibration sessions described in sections 7.11.1 to 7.11.3 are given in Tables 9.1 & 9.2 (Appendix XXXII). With few exceptions, the proportion agreement between initial and repeat examinations was greater than 85% for probing depth range, supra- and subgingival calculus, highest CPITN tooth score and CPITN sextant score, however for bleeding on probing, the proportion agreement between examinations was lower, in the region of 70%.

Examiner reproducibility expressed in terms of Kappa values were generally within a range of values considered to represent substantial agreement (Landis & Koch, 1977). The main exception was bleeding on probing where, based on Kappa values, only fair to moderate agreement was found between examinations. Taken overall, the clinical parameters which showed high proportional agreement between examinations also showed high Kappa values.

9.2 Sample characteristics for subjects completing Phase A

Of the 57 subjects who attended for the baseline clinical examination, only 41 subjects completed the Phase A treatment up to the 6-month recall. Three subjects were excluded since they had received recent periodontal treatment and a further 13 subjects dropped out for other reasons. Of those subjects who completed Phase A, 20 were female and 21 were male with an overall mean age of 42 years [range 37-49; SD=3.7]. The numbers of sextants, teeth and sites are given in Table 9.3 (Appendix XXXII).

For subjects who completed Phase A treatment, the mean number of teeth per subject at baseline, all sextants considered, was 26.0 [SD=2.4]. The mean number of teeth for control and experimental sextants were 13.1 teeth [SD=1.0] and 12.9 teeth [SD=1.8] respectively; the difference failing to reach statistical significance. Furthermore, the mean numbers of teeth were comparable between control and experimental sextants in anterior sextants and posterior sextants. One tooth in one subject's posterior control sextant was eventually lost due to caries between the 3- and the 6-month examination.
9.3 CPITN assessed treatment responses for subjects completing Phase A

The clinical findings for control and experimental sextants expressed as CPITN sextant scores derived from all teeth present at different examination periods are shown in Figure 9.1 and Table 9.4 (Appendix XXXII).

At baseline, no sextants scored CPITN code 0 (healthy), and only one anterior experimental sextant scored code 1 (bleeding on probing only). The majority of both control and experimental sextants scored CPITN code 2 (calculus) or code 3 (shallow pockets), amounting to 91.1% in control and 91.7% in experimental sextants. CPITN code 4 (deep pockets) was infrequently scored in either control and experimental sextants. The relative proportions of CPITN codes for control sextants at baseline were comparable to those scored for experimental sextants, all sextants considered. Similarly, when considering either anterior sextants or posterior sextants there were no statistically significant differences between control and experimental sextants. Furthermore, irrespective of whether anterior or posterior sextants were considered, CPITN codes 2 and 3 constituted the majority of scores although posterior sextants had a greater proportion of sextants scoring CPITN code 3.

Figure 9.1  Proportion of CPITN codes for control and experimental sextants at the baseline, 3- and 6-month examinations (Phase A subjects)
In response to oral hygiene and instrumentation, control sextants at the 3-month examination showed a significant improvement in CPITN scores \( p<0.001 \). The majority of control sextants (67.5%) showed a reduction in CPITN codes, while the remainder retained the same CPITN code (28.6%) or scored a higher code (4.1%) (see Table 9.5, Appendix XXXII). Thus, at the 3-month examination, despite the increase in the proportion of sextants which were scored CPITN code 0 or 1 (47.2%), the majority of sextants remained those which scored CPITN code 2 or 3 (52.0%), while one sextant (0.8%) was scored CPITN code 4. The improvements seen, all control sextants considered, were significant in both anterior and posterior sextants \( [p<0.001] \). The baseline trend for posterior sextants to be assigned higher CPITN codes than anterior sextants was again found at the 3-month examination following treatment (Table 9.4, Appendix XXXII).

Experimental sextants at the 3-month examination showed some changes from baseline in response to oral hygiene instruction alone in the absence of instrumentation. A reduction in CPITN codes was found in 24.8% of experimental sextants, 5.8% of sextants were scored with a higher CPITN code, while the majority of sextants (69.4%) retained the same CPITN code (Table 9.5, Appendix XXXII). With the exception of two sextants where the CPITN score changed from code 2 to code 1, most improvements were seen in sextants changing from an initial score of code 3 to code 2. None of these changes achieved statistical significance either overall or for anterior or posterior sextants considered individually. There was however a significant difference in overall CPITN codes between control and experimental sextants at the 3-month examination \( [p<0.001] \).

Control sextants at the 6-month examination showed a small but statistically insignificant deterioration of the CPITN codes scored at the 3-months examination. However, compared to baseline there still remained a 64.2% overall reduction in CPITN scores \( [p<0.001] \). This deterioration from the 3-month examination was brought about largely due to a decrease in the proportion of sextants scoring CPITN code 0 with a concurrent increase in the proportion of sextants scoring CPITN code 1 and 2 (Figure 9.1; Table 9.5, Appendix XXXII). Deteriorations in CPITN scores were evident in both anterior and posterior sextants; however the slight increase in the number of sextants scoring CPITN code 4 occurred in posterior sextants.

There was also a trend for experimental sextants at the 6-month examination to show
some deterioration in the CPITN codes scored at the 3-month examination but this failed to achieve statistical significance. While 8.2% of sextants reduced their CPITN codes between the 3- and 6-month examination, 15.7% increased their CPITN codes during this period (Table 9.5, Appendix XXXII). These changes were largely brought about by changes from code 2 to 3 and vice versa. When compared to baseline, the improvements seen in experimental sextants at the 6-month examination were small and statistically insignificant. However, when compared to the findings for control sextants, experimental sextants consistently scored higher CPITN codes \(p<0.001\). This latter finding held true for both anterior sextants and posterior sextants \(both\ p<0.001\).

9.3.1 Treatment responses for subjects completing Phase A according to the CPITN modified by Takahashi et al., (1988)

In this modification of the CPITN, sextants with calculus but without pockets are scored code 2+ if bleeding after probing is present and code 2- if bleeding is absent. Data was analyzed according to this modification to ascertain whether such a modification might detect additional changes in periodontal status in sextants scoring CPITN code 2 which would otherwise be obscured. Table 9.6 (Appendix XXXII) shows the number and mean proportion of each of these codes for control and experimental sextants at baseline and at the 3- and 6-month examinations.

Based on the examination of all teeth, at baseline a mean proportion only 15% of control and 13% of experimental sextants with CPITN code 2 failed to exhibit bleeding on probing (code 2-). Although the overall number of sextants scoring code 2 changed at the 3-month examination (see previous section) the proportion of code 2- sextants reduced to 6.8% for control sextants and 11.9% in experimental sextants. At the 6-month examination the relative proportions were 11% and 15% for control and experimental sextants respectively.
9.4 Treatment responses assessed by conventional clinical criteria for subjects completing Phase A

A summary of the treatment responses for sites within control and experimental sextants as assessed by conventional clinical criteria at different examination periods for subjects completing Phase A of the study is given in Table 9.7 (Appendix XXXII).

9.4.1 Bleeding on probing (Phase A subjects)

The mean proportions of sites within sextants exhibiting bleeding on probing (BOP) according to treatment mode, examination period and location within the mouth for Phase A subjects are shown in Figure 9.2.

At baseline, a mean proportion of one-third of sites exhibited bleeding; control and experimental sextants being comparable. Anterior sextants had a smaller mean proportion of bleeding sites than posterior sextants, a finding common to both control and experimental sextants. The differences between control and experimental sextants were not statistically significant for either anterior or posterior sextants.

![Figure 9.2 Proportion of sites in control and experimental sextants with BOP at the baseline, 3- and 6-month examinations (Phase A subjects)]
At the 3-month examination, there were significant reductions from baseline in the mean proportions of bleeding sites for both control and experimental sextants \([p<0.001]\). These amounted to a 60.8% reduction for control sextants and a 38.8% reduction for experimental sextants. There was however a significant difference at 3-months in the mean proportion of bleeding sites between control and experimental sextants \([p<0.001]\). A similar pattern of reductions was seen for both anterior and posterior sextants. The mean proportion of bleeding sites in anterior control sextants reduced by 65.3%, while anterior experimental sextants reduced by 45.0%, the differences between control and experimental sextants being statistically significant \([p<0.01]\). The reductions in posterior sextants were smaller than seen in anterior sextants amounting to 58.2% in control sextants and 33.6% in experimental sextants. Once again the differences in response between control and experimental sextants were significant \([both \ p<0.001]\).

The pattern of reductions in the mean proportions of sites exhibiting BOP at the 3-month examination for control and experimental sextants and according to location in the mouth were reflected in the results from the 6-month examination. The reductions from baseline were significant in both control and experimental and anterior and posterior sextants \([p<0.001]\). Some small but statistically insignificant deterioration was however seen from the 3-month to the 6-month examination in both control and experimental sextants as evidenced by an increase in the mean proportion of bleeding sites. This deterioration was most evident in anterior sextants.

### 9.4.2 Calculus (Phase A subjects)

The mean proportions of sites within sextants exhibiting suprag- and/or subgingival calculus according to treatment mode, examination period and location within the mouth for Phase A subjects are shown in Figure 9.3 (overleaf). At baseline, just over one-half of sites exhibited calculus, the mean proportions of sites so affected in control and experimental sextants not being statistically different. There was a trend for a greater mean proportion of sites in posterior sextants to exhibit calculus when compared to anterior sextants, however control and experimental sextants were comparable.

At the 3-month examination, there were reductions from baseline in the mean proportions of sites with calculus for both control and experimental sextants, amounting to 88.1% and 23.3% respectively \([both \ p<0.001]\). In control sextants the reductions were somewhat greater in posterior sextants than in anterior sextants; in experimental sextants however
the reductions were comparable.

![Graph showing percent calculus at baseline, 3-, and 6-month examinations](image)

**Figure 9.3** Proportion of sites in control and experimental sextants with calculus at the baseline, 3-, and 6-month examinations (Phase A subjects)

The 6-month examination findings for calculus reflect those seen at 3-months with the reductions from baseline being statistically significant for both control and experimental and anterior and posterior sextants [both \(p<0.001\)]. Between the 3- and the 6-month examinations there was a trend for a small but statistically insignificant increase in the proportion of sites scored with calculus in both control and experimental sextants, a finding common to both anterior and posterior sextants.

The mean proportions of sites within sextants exhibiting calculus at different examination periods corresponding to whether it was supra- or subgingivally placed are shown in Figures 9.4 and 9.5. At baseline, the most common location for calculus to be detected was subgingivally irrespective of whether anterior or posterior sextants were being considered. In both control and experimental sextants, a mean of just over one-half of sites exhibited subgingival calculus, with the exception of experimental anterior sextants where 47.8% of sites were so affected. Supragingival calculus was detected more frequently in anterior than in posterior sextants. At baseline there were no statistically
significant differences between control and experimental sextants, in respect to the mean proportions of sites with either supra- or subgingival calculus. This was similarly the case irrespective of whether anterior or posterior sextants were considered. At the 3-month examination there was an 82.3% reduction in the mean proportion of sites scoring supragingival calculus in control sextants \( p<0.001 \). This reduction was greater in posterior sextants (95.8%) than for anterior sextants (70.7%) \( p<0.001 \). Marked reductions were also seen in the mean proportions of sites with subgingival calculus with a reduction of 91.1% overall, 89.3% for anterior sextants and 92.1% for posterior sextants [both \( p<0.001 \)]. In experimental sextants there was an increase in the proportion of sites scoring supragingival calculus, amounting to 23.1% overall \( p<0.01 \), 11.1% in anterior sextants and 38.0% in posterior sextants \( p<0.05 \) & <0.01 respectively]. Conversely, there was a 25.3% decrease overall in the proportion of sites scoring subgingival calculus, with decreases of 23.0% and 26.0% in anterior and posterior sextants respectively \( p<0.001 \).

![Figure 9.4 Proportion of sites in control and experimental sextants with supragingival calculus at the baseline, 3- and 6-month examinations (Phase A subjects)](image_url)
Compared to baseline, the reductions in both supra- and subgingival calculus seen in control sextants were largely sustained at the 6-month examination. The slight increase from the 3-month examination in the mean proportion of sites with supragingival calculus was statistically insignificant. There was however a small but significant increase from 3- to 6-months in the mean proportions of sites with subgingival calculus, both overall and in posterior sextants \([p<0.005 \text{ & } <0.001 \text{ respectively}]\).

For experimental sextants, the mean proportions of sites with both supra- and subgingival calculus at the 6-month examination remained virtually identical to that scored at 3-months, with the minor differences being statistically insignificant irrespective of location within the mouth.

In view of the apparent reductions in the mean proportions of experimental sites scored with calculus in the absence of instrumentation, contingency tables were prepared to compare, on a site-by-site basis, the scoring of calculus at baseline and at the 3- and 6-month examinations (Table 9.8, Appendix XXXII).
When considering the relationship between calculus scores at baseline and the 3-month examination for experimental sextants, the majority of sites (72.3%) had coincident scores at the two examinations with respect to the presence or absence of calculus and, if present, its location relative to the gingival margin. The degree of association was moderate \([\text{Cramer's } V = 0.51; \kappa = 0.56]\). 27.2% of sites scored as having calculus present at baseline were subsequently scored as having calculus absent, this being almost entirely due (93%) to the scoring of subgingival calculus at baseline. Conversely, 7.3% of sites scored as having no calculus at baseline were scored with calculus present at the 3-month examination. When those sites which scored subgingival calculus at baseline and no calculus at 3-months were excluded, 29.3% of sites initially scoring only subgingival calculus at baseline scored either supra- and subgingival calculus or just supragingival calculus at the 3-month examination.

The pattern and extent of the changes in calculus scores relative to the baseline examination at the 6-month examination were very similar to those seen at the 3-month examination. Overall, 69.8% of sites scored the same at both examinations. The degree of association was again moderate \([\text{Cramer's } V = 0.48; \kappa = 0.52]\). 27.1% of sites changed from having the presence of calculus scored at baseline to calculus being absent at the 6-month examination, once again due the scoring of subgingival calculus at baseline, while 8.9% of sites with calculus absent at baseline were subsequently scored as having calculus present. 19.1% of sites initially scoring only subgingival calculus at baseline scored either supra- and subgingival calculus or just supragingival calculus at 6-months, When sites which scored subgingival calculus at baseline and no calculus at 6-months were excluded, this amounted to 30.9%.

Seventy-eight percent of sites in experimental sextants had the same calculus scores at the 3-month and 6-month examinations. The degree of association was moderate \([\text{Cramer's } V = 0.56; \kappa = 0.63]\). The main reason for the failure of concurrence between the two examinations was due to subgingival calculus being scored at the 3-month and not at the 6-month examination and vice-versa.
9.4.3 Probing depths (Phase A subjects)

The mean proportions of sites with probing depths <4 mm (P-) and depths of 4-5 mm (P1+) within control and experimental sextants according to treatment mode, examination period and location within the mouth are given in Table 9.7 (Appendix XXXII) and Figures 9.6 and 9.7 respectively.

At baseline and at the 3- and 6-month examinations, over 90% of the sites both in control and experimental sextants and in anterior and posterior sextants had probing depths <4 mm. There were no statistically significant differences between the mean proportion of P- sites in control and experimental sites at baseline either overall or when anterior or posterior sextants were considered. At the 3-month examination, there were small but significant increases in the mean proportion of P- sites in both control and experimental sextants [p<0.001 & <0.005 respectively]. Significant increases were also seen in anterior and posterior control sextants [p<0.01 & <0.001 respectively], in posterior experimental sextants [p<0.01], but not in anterior experimental sextants. The changes seen at 3-months for both control and experimental sextants were sustained at 6-months with no significant changes between these two examinations. Significant differences were however found between control and experimental sextants at the 6-month examination both overall [p<0.01] and for anterior and posterior sextants [both p<0.01].

The mean proportion of P1+ sites in control and experimental sextants were comparable at baseline, both overall and for anterior and posterior sextants. Overall, P1+ sites accounted for only 5% of all sites, with the mean proportion of P1+ sites in posterior sextants being over twice that found for anterior sextants.

At the 3-month examination, there were reductions overall in the mean proportion of P1+ sites in both control and experimental sextants, amounting to 66.1% and 39.6% respectively [p<0.001 & <0.005 respectively]. In posterior sextants there were significant reductions in P1+ sites at 59.4% for control and 45.9% for experimental sextants [p<0.001 & <0.01 respectively] while in anterior sextants, the only significant reductions were in control sextants with an 82.1% reduction [p<0.005]. No statistically significant differences were found between control and experimental sextants at 3-months either overall or for anterior or posterior sextants.
Figure 9.6 Proportion of sites in control and experimental sextants with probing depths < 4 mm (P-) at the baseline, 3- and 6-month examinations (Phase A subjects)

Figure 9.7 Proportion of sites in control and experimental sextants with probing depths 4-5 mm (P1+) at the baseline, 3- and 6-month examinations (Phase A subjects)
At the 6-month examination, the overall reductions in the mean proportions of P1+ sites seen at the 3-month examination were largely sustained although in experimental sextants there was a small but statistically insignificant deterioration from the 3-month examination. Significant differences were however found at the 6-month examination between control and experimental sextants both overall \( p<0.01 \) and for anterior and posterior sextants \( p<0.01 \) & \( <0.05 \) respectively.

The mean proportions of sites with probing depths of 6+ mm (P2+) within control and experimental sextants according to treatment mode, examination period and location within the mouth are shown in Figure 9.8 and Table 9.7 (Appendix XXXII). Taken overall, the mean proportions of P2+ sites were rather small thereby making comparisons difficult (see section 7.12.2). This taken into consideration, at the baseline examination the mean proportions of P2+ sites were comparable both between treatment groups and for anterior and posterior sextants. Overall, P2+ sites accounted for less than 1% of all sites, with a greater proportion of P2+ sites being observed in posterior than in anterior sextants.

![Figure 9.8](image-url)
At the 3-month examination, both control and experimental sextants showed significant reductions in the mean proportions of P2+ sites, both overall and for posterior sextants [all \( p<0.05 \)]. No significant differences were however detected between control or experimental sextants. Furthermore, at the 3-month examination, no statistically significant reductions were found in either control or experimental anterior sextants although virtually all anterior control P2+ sites were reduced to smaller probing depths.

At the 6-month examination, there was some deterioration in the improvements achieved at 3-months with the result that there were no statistically significant differences in the mean proportions of P2+ sites in either control or experimental sextants when compared to the baseline examination. Furthermore, there were no significant differences between control or experimental sextants.

9.5 Treatment responses assessed by combinations of clinical criteria for subjects completing Phase A

The improvements observed over the 6-months following the baseline examination, seen as reductions in the mean proportions of sites with bleeding on probing, calculus, and increased probing depths, particularly in experimental sextants which had not received any instrumentation, demanded a further analysis of the data to elucidate the nature of the changes in terms of combinations of these clinical parameters.

The changes from baseline at the 3- and 6-month examinations for control and experimental and control sextants expressed in terms of mean proportions of different combinations of clinical parameters, are given in Table 9.9 (Appendix XXXII). Summary results are depicted in Figures 9.9 and 9.10 (overleaf).

At baseline, the mean proportions of the different combinations of clinical parameters were comparable between control and experimental sextants. For sites with calculus (C+), bleeding on probing was absent in 52% of control and 50% of experimental sites. Most sites with PPDs \( \geq 4 \) mm (P1+, P2+) concurrently scored calculus present, amounting to 95% of control and 96% of experimental sextants, however bleeding on probing was not always a feature of increased probing depths.

At the 3-month examination, and in response to oral hygiene and instrumentation, a mean of 82% of sites in control sextants scored P-C-B- representing an increase of
123% from baseline \([p<0.001]\), while P-C-B+ sites showed a 74% increase \([p<0.01]\). These changes were largely due to a decrease in sites with calculus. Sites scored P1+C+ reduced by 86% from baseline \([p<0.001]\) and there was a small but statistically insignificant increase in P1+C- sites. In experimental sextants and in the absence of instrumentation, there was a 33% increase from baseline in the mean proportion of sites scoring P-C-B- \([p<0.001]\), with a concurrent 43% reduction in the mean proportion of sites scoring P-C+B+ \([p<0.001]\) combined with a 16% reduction of P-C-B+ sites \([p<0.01]\). The mean proportion of sites scoring P-C+B- however remained unchanged largely because the number of sites which changed from C+B- to C-B- \((N=272)\) masked the number of those sites which changed from C+B+ to C+B- \((N=322)\). Furthermore, there was a 49% reduction in the mean proportion of sites scoring P1+C+ \([p<0.05]\).

Between the 3-month and the 6-month examination the improvements seen in both control and experimental sextants were largely sustained. There were a few reversals in scores assigned to individual sites but none of these changes achieved statistical significance.
Figure 9.9 Proportion of control sites with different combinations of clinical indicators at the baseline, 3- and 6-month examinations (Phase A subjects)

Figure 9.10 Proportion of experimental sites with different combinations of clinical indicators at the baseline, 3- and 6-month examinations (Phase A subjects)
9.6 Sample characteristics for subjects completing Phases A, B and C

During subsequent treatment phases, further dropouts were encountered so that 39 subjects completed the Phase B treatment and 36 the Phase C treatment up to the 15-month examination. One of these subjects was unavailable for the 9-month examination, however this subject was included in the following analyses as the data was complete for all other examinations. Equal number of females and males completed all phases and the mean age was 42.4 years [SD=3.8].

The original research protocol called for the study to be completed after the 15-month examination, however at this stage the periodontists providing the 'complex' care considered that periodontal surgery was indicated in four of the subjects. Thus, for these subjects only, the study was extended in an attempt to provide some information on the treatment times required for this procedure.

The numbers of sextants, teeth and sites within these subjects at baseline is given in Table 9.10 (Appendix XXXII). The sample attrition after Phase A had no effect on the mean number of teeth per subject which remained at 26.0 [SD=2.5] for those subjects who completed all phases. Similarly the mean number of teeth in control or experimental sextants remained the same as for Phase A, 13.1 [SD=1.0] and 12.9 [SD=1.9] respectively. No statistical difference was detected when comparing the mean number of teeth in control and experimental sextants or for when anterior sextants or posterior sextants were considered separately. It should however be noted that in the following description of treatment responses for subjects completing all phases, differentiation will not be made between anterior and posterior sextants as this was only done to describe Phase A treatment responses more thoroughly where the effects of oral hygiene alone was being compared to oral hygiene and instrumentation.

9.7 CPITN assessed treatment responses for subjects completing Phases A, B and C

The clinical findings for control and experimental sextants expressed as CPITN sextant scores derived from scoring all teeth in subjects completing Phases A and B of the study are shown in Figures 9.11 & 9.12 overleaf and Table 9.11 (Appendix XXXII)
Figure 9.11 Proportion of CPITN codes for control sextants at baseline, 3-, 6-, 9-, 12-, and 15-month examinations (Phase C subjects)

Figure 9.12 Proportion of CPITN codes for experimental sextants at baseline, 3-, 6-, 9-, 12-, and 15-month examinations (Phase C subjects)
At baseline, there was no statistical difference between control and experimental sextants in terms of the relative distributions of CPITN sextant codes. The treatment responses up to and including the 6-month examination expressed as CPITN sextant scores for subjects completing all phases were largely consistent with those described for Phase A subjects (see section 9.3) and will therefore not be described further.

Immediately after the 6-month examination, subjects received oral hygiene reinforcement and instrumentation in both control and experimental sextants. Following this treatment, the 9-month examination revealed some reduction in the overall severity of sextant CPITN codes in both control and experimental sextants. In control sextants, the proportion of sextants scoring code 3 or 4 were comparable to the 6-month examination. There was however a 47.5% reduction in the proportion of sextants scoring code 2 (calculus) largely brought about by a corresponding increase in the proportion of sextants scoring code 0 (healthy) and code 1 (bleeding only). None of these changes however achieved statistical significance.

In experimental sextants, the 9-month examination showed substantial changes in the relative proportions of CPITN codes when compared to the baseline, 3- and 6-month examinations \( p<0.001 \). The relative proportions of CPITN codes for control and experimental sextants at the 9-month examination were comparable although there was a trend for higher CPITN scores in the latter. These changes following the 6-month instrumentation did not however entirely parallel those in control sextants at the 3-month examination following the baseline instrumentation \( p<0.05 \) and was particularly evidenced by a smaller reduction in code 3 sextants and a smaller increase in code 0 sextants.

At the 12-month examination, there was a trend for some deterioration in the CPITN codes overall in both control and experimental sextants, however none of the changes were significantly different from the 9-month examination. Furthermore, there was no significant difference between control and experimental sextants.

No significant improvements in CPITN codes was detected at the 15-month examination in either control or experimental sextants when compared to the 12-month examination. The small changes that took place were largely in the form of reductions in the proportions of sextants scoring codes 2, 3, and 4 coincident with an increase in the proportions of sextants scoring 0 and 1.
9.8 Treatment responses assessed by conventional clinical criteria for subjects completing Phases A, B and C

A summary of the clinical findings for sites within control and experimental sextants as assessed by conventional clinical criteria at different examination periods for subjects completing all phases of treatment is provided in Table 9.12 (Appendix XXXII).

As with the CPITN assessed treatment responses, the responses assessed by conventional clinical criteria up to and including the 6-month examination were very similar to those described for Phase A subjects (see section 9.4) and will therefore not be described further.

9.8.1 Bleeding on probing

The mean proportions of sites within sextants exhibiting bleeding on probing (BOP) according to treatment mode and examination period for subjects completing all phases are shown in Figure 9.13 (below).
Chapter 9 - Clinical Results

Following the provision of oral hygiene reinforcement and instrumentation delivered after the 6-month examination, a significant decrease in the mean proportions of bleeding sites was observed in both control and experimental sextants at the 9-month examination \( p < 0.05 \) and \( < 0.001 \) respectively, resulting in just over 10% of sites which exhibited bleeding. The improvements in experimental sextants were analogous to those seen in control sextants at the 3-month examination.

There was a very slight deterioration in the mean proportions of bleeding sites in both control and experimental sextants at the 12-month examination which was not statistically significant. The mean proportions of bleeding sites in both control and experimental sextants remained largely unchanged at the 15-month examination, a mean of just over 10% of sites exhibiting bleeding on probing. No statistically significant differences were detected between control and experimental sextants at either the 9-, 12-, or 15-month examinations.

9.8.2 Calculus

The mean proportions of sites within sextants exhibiting supra- and/or subgingival calculus according to treatment mode and examination period for subjects completing all phases are shown in Figure 9.14 (overleaf).

Reductions in the mean proportion of sites with supra- and/or subgingival calculus was seen at the 9-month examination for both control and experimental sextants \( p < 0.001 \), the latter reduction being the greatest as these sextants had not been instrumented at baseline during the study. Calculus was scored in just over 3% of sites.

At the 12-month examination, a slight increase in the mean proportion of sites with calculus was observed in both control and experimental sextants but this failed to achieve statistical significance. Following further treatment provided after the 12-month examination, the 15-month examination revealed a small but significant decrease in the mean proportion of sites with calculus in both control and experimental sextants \( p < 0.05 \) and \( < 0.01 \) respectively.

The mean proportions of sites within sextants exhibiting calculus corresponding to whether its position was supra- or subgingivally placed are shown in Figures 9.14 and 9.15 overleaf. The instrumentation provided after the 6-month examination resulted in
a negligible number of sites in both control and experimental sextants being scored with either supra- or subgingival calculus at the 9-month examination.

The slight increase in the mean proportion of sites with calculus seen at the 12-month examination could be apportioned to increases in both supra- and subgingival calculus, however the increases were not statistically significant in either control or experimental sextants. Following further treatment provided after the 12-month examination, there was a small decrease in the mean proportion of sites with calculus at the 15-month examination which came about due to decreases in both supra- and subgingival calculus, however, this decrease was only significant for the latter [control \( p=0.01 \); experimental \( p<0.05 \)].

No statistically significant differences were observed between control or experimental sextants at either the 9-, 12- or 15-month examinations with respect to either supra- or subgingival calculus.

*Figure 9.14 Proportion of sites in control and experimental sextants with calculus at the baseline, 3-, 6-, 9-, 12- and 15-month examinations (Phase C subjects)*
Figure 9.15  Proportion of sites in control and experimental sextants with supragingival calculus at the baseline, 3-, 6-, 9-, 12- and 15-month examinations (Phase C subjects)

Figure 9.16  Proportion of sites in control and experimental sextants with subgingival calculus at the baseline, 3-, 6-, 9-, 12- and 15-month examinations (Phase C subjects)
9.8.3 Probing depths

The mean proportions of sites with probing depths (PPDs) of <4 mm (P-) within control and experimental sextants according to treatment mode and examination period are shown in Figure 9.17 and Table 9.12 (Appendix XXXII).

Following the treatment provided after the 6-month examination, the mean proportion of sites with PPDs <4 mm (P-) remained at ≥ 97% for all subsequent examinations with no statistically significant differences detected between examinations. Only at the 15-month examination was a significant difference detected between control and experimental sextants [p<0.05].

The mean proportions of sites with probing depths of 4-5 mm (P1+) within control and experimental sextants according to treatment mode and examination period are shown in Figure 9.18 (overleaf).

At the 9-month examination and at all subsequent examinations, less than 2% of control sites and less than 3% of experimental sites had probing depths of 4-5 mm (P1+). While
small differences were observed in the mean proportion of sites so affected between examinations these failed to achieve statistical significance. Similarly, no statistically significant difference could be discerned between control and experimental sextants at each examination.

The mean proportions of sites with probing depths ≥6 mm (P2+) within control and experimental sextants according to treatment mode and examination period are shown in Figure 9.19 overleaf.

The mean proportions of sites with P2+ sites were small thereby making comparisons difficult (see section 7.12.2 on data analysis).
Figure 9.19 Proportion of sites in control and experimental sextants with probing depths 6 mm + (P2+) at the baseline, 3-, 6-, 9-, 12- and 15-month examinations (Phase C subjects)
9.9 Treatment responses assessed by combinations of clinical criteria for subjects completing Phases A, B and C

The treatment responses for the 36 subjects completing all phases of treatment up to and including the 15-month examination expressed in terms of mean proportions of different combinations of clinical parameters in control and experimental sextants, are given in Table 9.13 (Appendix XXXII). Summary results are depicted in Figures 9.20 and 9.21. The responses to treatment for these subjects up to and including the 6-month examination were largely consistent with those described for Phase A subjects (see section 9.4) and will therefore not be described further.

Following the oral hygiene reinforcement and instrumentation provided after the 6-month examination, the only statistically significant change in control sextants at the 9-month examination was an 8% increase in the mean proportion of sites scored P-C-B- \([p<0.05]\) and a 48% reduction of sites scoring P-C+B- \([p<0.01]\). In experimental sextants which received the "initial" instrumentation only after the 6-month examination a 95% reduction of sites scoring P-C+B+ and an 88% reduction in those scoring P-C+B- was observed at the 9-month examination \([both \ p<0.001]\). Concomitant increases in the proportion of sites scoring P-C-B- and P-C-B+ were also observed \([p<0.001 \ & \ <0.05 \ respectively]\).

No other changes achieved statistical significance.

No statistically significant changes were observed in the mean proportions of the different combinations of clinical parameters between the 9- and 12-month examinations in either control and experimental sextants. Moreover, at the 12-month examination, no statistically significant differences were observed between control and experimental sextants with respect to any of the combinations of clinical criteria.

In response to the maintenance treatment provided after the 12-month examination, no statistically significant changes were observed at the 15-month examination.
Figure 9.20 Proportion of control sextants with different combinations of clinical indicators at the baseline, 3-, 6-, 9-, 12- and 15-month examinations (Phase C subjects)

Figure 9.21 Proportion of experimental sextants with different combinations of clinical indicators at the baseline, 3-, 6-, 9-, 12- and 15-month examinations (Phase C subjects)
CHAPTER 10 - DISCUSSION

10.1 Introduction

This study was conceived of during the 1984 Hong Kong Survey of Adult Oral Health [HKSAOH] (Lind et al., 1987a,b) when it became apparent that the data being collected on periodontal conditions and CPITN assessed treatment needs could not be used effectively for planning purposes since there was no data available on the time required for the provision of periodontal treatment in such a population. Previously, periodontal treatment time estimates had been based on studies performed in Western countries with no data being available for developing countries such as those in South-east Asia. Concurrently, concerns were emerging about the excessive amounts of time and resources which appeared to be required to deliver treatment according to CPITN recommendations particularly considering the public health importance of periodontal disease (Manji & Sheiham, 1986). A logical alternative for a Hong Kong Chinese population where calculus was found to be omnipresent (Lind et al., 1987a) was to design a minimal periodontal treatment programme where the time and resources required might be less than traditionally required. The study of Cercek et al., (1983) suggested that improvements in certain periodontal parameters could be achieved through improved oral hygiene alone and therefore, based on these findings, a treatment programme was devised where the time-consuming removal of calculus was partially omitted.

Thus, this study set out to: 1. assess the time required to provide periodontal treatment in a group of adult Hong Kong Chinese; 2. examine if a relationship exists between CPITN scores and treatment times; and, 3. evaluate the effects of oral hygiene in the absence of instrumentation.

10.2 Discussion of the study design and the statistical analysis

10.2.1 The selection of the sample

Considerable effort had been expended on the selection and recruitment of the sample for the 1984 HKSAOH (Lind et al., 1987a,b) and it was therefore logical to use this sample as a basis for the definition of a sub-sample of subjects for inclusion in this
study. While the sample could not strictly be considered representative of Hong Kong adults of this age cohort, it was by virtue of the selection process more likely to be representative than would be achieved through obtaining a sample of self-selected subjects e.g. patients attending the Prince Philip Dental Hospital.

The small number of subjects eventually recruited into this study was unexpected. An unforeseen event was that half of the subsample had moved address since the 1984 HKSAOH and could not be contacted. Furthermore, although the treatment was offered free of charge, 22 subjects were not willing to attend for treatment while a further 32 subjects were willing to attend but were unable to spare the time. Thus, only 56 subjects enrolled in the study at baseline. Dropouts also occurred as the study proceeded which necessitated the division of the data analysis into two sections, those subjects who completed Phase A and those who had complete data sets for Phases A, B and C.

10.2.2 The use of the split-mouth study design and statistical analysis

The claimed advantages of the split-mouth study design are the economical use of patients combined with the elimination of the subject factor from the experimental error (Hujoul & Moulton, 1988). Prerequisites for such a design are that: (1) the disease to be investigated is relatively stable and evenly distributed; and (2) there should be no 'carry-over' effect of treatment from one part of a mouth to another. To benefit fully from the design however, appropriate statistical analysis should be used such as repeated measures ANOVA or paired t-tests. Surprisingly, many previous studies have failed in this respect (Antczak-Bouckoms et al., 1990).

The appropriateness of the split-mouth study design for clinical trials on periodontal disease has however been questioned by Imrey (1986). He cites the following as possible contraindications to the use of such a design: (1) that treatment altering the microecology of one part of the mouth might inadvertently affect other parts of the mouth; (2) that periodontal lesions are not always balanced in quantity, severity, or location within a single mouth; (3) that total blinding might be difficult; (4) that analysis may be complex and interpretation difficult because of imbalance within the mouth. In addressing some of these concerns, Hujoul & Loeschke (1990) found that the problem of asymmetry of lesions was dependent upon the method of dividing the mouth into experimental units and the disease criteria under consideration. They concluded that the split-mouth design can provide moderate to large gains in relative efficiency over whole-
mouth clinical trials subject to the disease characteristics being symmetrically distributed over the within-patient experimental units and there being a sufficient number of sites being present per experimental unit.

In spite of recent concerns about the use of the split-mouth design, during the planning stage of this study a split-mouth design based on sextants was deemed appropriate since it provided a convenient subdivision of the mouth which was consistent with CPITN recording criteria. Thus, different modes of treatment could be provided and monitored on a sextant basis while concurrently providing for the assessment of treatment times.

Certain problems did however occur because of the adoption of this design. During Phase A, blinding of treatment assignment was problematic because of the nature of the treatment provided. Patient blinding was impossible since they were inevitably cognisant of those sextants which had received instrumentation. Blinding of the examiner was particularly difficult at the 3- and 6-month examinations since in many subjects it was possible to deduce which were the uninstrumented experimental sextants from the large amounts of calculus which remained. This difficulty of blinding of the examiner could have introduced some bias in the recording of the clinical criteria however it is unlikely that any other study design would have reduced the bias; the problem being inherent in a study of this nature performed in a population with large amounts of calculus.

Some problems were also experienced with the statistical analysis of data particularly with respect to the time for scaling. Comparisons between control and experimental sextants were difficult irrespective of whether contra- or ipsilateral sextants were considered since CPITN scores were not always matched. Furthermore, it was not always possible to compare scaling times for different CPITN sextant scores within the same subject. It was therefore not possible to use either the paired t-test or two-way ANOVA and therefore the two-sample t-test and one-way ANOVA was used. The major problems with such an approach is the reduced power of these tests and the possible failure to detect real differences when they occur (Hujoel & Moulton, 1988).

Lastly, in this present study the problem of what are traditionally considered to be 'carry-over' effects are unlikely to apply since no chemotherapeutic agents were used. There is however the possibility that the instrumentation of the control sextants had an indirect synergistic effect on the effects of oral hygiene in experimental sextants through stimulation of the humoral response. In this context, following the work of Chen et al.,
(1991) where serum antibody and antibody avidity for *P. gingivalis* were increased following treatment, Page (1994) has speculated that a substantial amount of the clinical improvement seen in patients after treatment is due to immunisation caused through instrumentation, but that this has yet to be demonstrated. The effects of this possible synergistic effect are discussed later (see section 10.4.4).

10.3 Discussion of the results from the treatment time assessment

10.3.1 The methods used to assess treatment times

Two of the main purposes of this study were to assess the time required to provide periodontal treatment in a group of adult Hong Kong Chinese, and to examine if a relationship exists between CPITN scores and treatment times. Furthermore, since a model of minimal periodontal intervention treatment was concurrently being evaluated, it was considered essential not only to evaluate treatment outcomes, but also to assess the treatment time necessary to arrive at those outcomes.

The assessment of treatment times usually employs methods adapted from industry which come under the general heading of 'work measurement' (see Chapter 4). Methods include time-study, continuous recording using audio or videotape recordings (VTR), activity sampling, and questionnaires. Continuous recording using VTR or audio recording was not used in this study on the grounds of expense of such equipment (at the time of the study) and difficulty in relating the recordings to specific study subjects, while questionnaires were not used since they were inappropriate. It was however necessary to adopt a combined approach to collect the necessary treatment time data making use of both time-study and activity sampling. The former was used to collect treatment time data for specific periodontal treatment procedures so it could eventually be related to assessments made of the clinical conditions. Moreover, as periodontal treatment is often carried out over several sessions it was necessary to summate the treatment times for each of the sessions in order to assess the total treatment time for a procedure. This is most easily undertaken using time-study. Time-study does have its disadvantages particularly with respect to assessing secondary and unproductive activities which might not all take place in the clinic setting. Thus, supplementary data on the proportion of time spent by the operators on all activities was collected using activity sampling.
It should be noted that the assessment of periodontal treatment times is particularly problematic for, as mentioned in Chapter 5, unlike many other dental procedures which are usually ends in themselves, periodontal treatment has no clinically defined end point, and completion of treatment is often decided on purely arbitrary criteria. This problem of endpoints is not uncommon and even exists in randomised clinical trials where surrogate endpoints are used (Hujoul & DeRouen, 1995). In the absence of any recognised and clearly definable treatment endpoints, the end of a phase of treatment was, in this study, determined following an examination of the periodontal status by one of the two supervising periodontists. The endpoint was therefore entirely subjective which highlights one of the problems in a study of this nature.

10.3.2 The times for treatment as assessed using time-study

(i) The number of treatment sessions and total treatment time

The results from the analysis of both the number of sessions and the total treatment time for Phases A and B are somewhat difficult to interpret since the study design resulted in scaling taking place initially in only three sextants. Normally, during an initial course of treatment, scaling would take place in all sextants with calculus. Therefore, under normal circumstances the number of sessions and total treatment time would probably be greater than that reported in this study for Phase A. Conversely, during Phase B, since an 'initial' rather than a 'maintenance' scaling was required in experimental sextants, it could be expected that the number of sessions and the total treatment time would be less than reported in this study. This is a limitation of the study design, but which could not be avoided if all the other data required of the study were to be collected. Should the need arise, e.g. for planning purposes, an estimation of the mean total treatment time could be calculated from the data from each of the times for the treatment components i.e. examination, oral hygiene instruction, scaling and complex treatment.

Notwithstanding these limitations, the results show a decrease in the number of treatment sessions required with each successive treatment phase from a mean of 3.8 sessions/person for Phase A to 2.4 sessions/person for Phase C. In line with this, the total treatment time also reduced from a mean of 217 minutes/person [range 85-465] for Phase A, through 124 minutes/person [range 34-293] for Phase B, to 89 minutes/person [range 36-137] for Phase C. For Phase A, the number of sessions and the total treatment time was less than reported by Hill et al., (1981) where 4-6 sessions were
required with a hygienist, equivalent to 300-480 minutes/person, prior to any treatment being provided by a periodontist. Compared to the treatment time estimates given in TRS 621 (WHO, 1978) where the times for initial treatment for the age cohort 30-44 years range from 185 minutes/person (oral hygiene instruction & scaling in 4 quadrants) to 230 minutes/person (oral hygiene instruction and deep scaling in 4 quadrants), the total treatment time for Phase A was somewhat greater. Since 'initial' scaling was performed in 3 sextants during Phase B, it is understandable that the total treatment time for this phase was greater than the range of 30-60 minutes/person reported previously for maintenance care (Nordland et al., 1987; Pfeifer & Pfeifer, 1988; Kaldahl et al., 1988; Miller et al., 1989, 1990). However, during Phase C when only maintenance scaling was required, the mean total treatment time was still greater than previously reported and was also greater than the 45 to 50 minutes/person estimated for maintenance treatment in TRS 621 (WHO, 1978) for the age cohort 30-44 years.

Subjects who scored CPITN code 4 as their highest score at baseline required a greater number of treatment sessions and a longer mean total treatment time during Phase A than those scoring CPITN codes 2 and 3. This finding is largely in agreement with that of Butterworth & Sheiham (1991) where both the number of treatment sessions and the treatment time/person increased with each successive CPITN score with subjects scoring CPITN code 3 and 4 requiring a mean of 2 visits and 18 minutes of treatment. It should however be noted that these estimates are considerably less than those from this present study possibly attributable to the fees available under the British National Health Service for periodontal treatment, differences in operators and patient factors. There is also evidence that periodontal examinations (Lenox & Kopczyk, 1973) and scaling (Frisch et al., 1970; Bellini et al., 1974; Ekanayaka & Sheiham, 1978) take longer in subjects with more severe periodontal conditions. This presumably explains the differences seen during Phase A for subjects with different CPITN scores. However, during Phases B and C, there were no significant differences in either the number of sessions or the total treatment time for subjects with different CPITN scores irrespective of whether the scores were derived from the baseline, 6 or 12 month examinations. This finding would appear to be inconsistent with the explanation given for the differences in total treatment time seen during Phase A. However, following treatment delivered during Phase A, there were considerable improvements in the periodontal condition seen in both control and experimental sextants (see Chapter 9). Because the highest subject CPITN score could reflect the finding from just one site or tooth, the score might not be as good an indicator of the overall periodontal condition within subjects who have
already undergone some treatment compared to those that have not.

(ii) The time for examination

The study protocol required that a brief examination of PPD and BOP be performed on
each visit. This inevitably meant that the total examination time was dependent upon
the number of visits a subject attended during a particular phase of treatment.

There were statistically significant reductions in the overall total examination time
between Phases A, B and C. This can largely be explained by the fewer number of
visits required by subjects for each successive treatment phase since the mean
examination time per visit for Phases A, B and C were largely similar. While comparisons
between the examination times in this study and those from other studies are difficult
because different examination procedures have been used, the times fall within the
ranges given in Table 5.1 (Appendix II).

The finding that during Phase A the total examination time was significantly greater for
subjects scoring CPITN code 4 as their highest score than for subjects scoring CPITN
codes 2 and 3 is probably in part due to the larger number of visits required by CPITN
code 4 subjects (Table 8.1, Appendix XXXII). In addition, it is possible that the
complexity of periodontal conditions presenting in subjects with CPITN scores of 4
necessitated a longer examination time as was reported similarly by Lenox & Kopczyk
(1973). The same logic explains the lack of significant differences during Phase B in
total examination time between subject with different CPITN scores irrespective of
whether these were obtained at baseline or at the 6-month examination.

For Phase C, the finding that subjects scoring CPITN 4 at baseline had a significantly
higher total examination time than CPITN 2 subjects cannot totally be attributed to the
difference in the mean number of visits, since the mean examination time per visit was
greater for subjects scoring CPITN code 4 than those scoring 2 as their highest score.

The amount of time used for examination in this study was rather large particularly during
Phase A when a mean of 42 minutes/person was used. This is far in excess of any of
the times previously reported even for clinical studies (Glavind & Löe, 1967; Hetland et
al., 1981). It must be assumed however that the times for examination previously
reported relate to a single examination while the times given in Table 8.1 (Annex XXXII)
relate to the total time for multiple examinations per phase. Thus, if the total examination time is divided by the number of visits, then the examination time per visit would range between 8 and 11 minutes/person which is more consistent with the examination times previously reported.

(iii) The time for radiographs

For each subject, a standard set of radiographs comprising five vertical bitewings, two for each posterior side and one anterior film were taken. When necessary these radiographs were supplemented by additional radiographs. The mean time for taking these radiographs was 11 minutes/person [range 5-18 minutes]. The finding that there was no statistical significance in the times required for the taking of radiographs for subjects with different CPITN scores is not surprising considering that the radiographs taken were standardised and only rarely were additional radiographs required.

Considering that only five radiographs were usually taken, the mean time for radiograph taking was more than the 8.5 to 10 minutes reported by Rosenberg et al., (1986) as being required to undertake a full-mouth radiographic survey. However, the radiographs taken in this present study were taken by an Expanded Duty Dental Surgery Assistant who had received training in this procedure but did not routinely undertake this task. This might have led to more time than usual being required. Furthermore, there is some evidence to suggest that radiographs taken by dental assistants take longer than those taken by dentists (Lotzkar et al., 1971a,b).

Caution should be exercised in attempting to extrapolate the time required for radiographs in this study to other situations since vertical bitewings are not the universal norm. They were used in this study as vertical bitewings enable a better appreciation of root anatomy, supporting alveolar and other structures than do routine bitewings while providing a reduced the level of radiographic exposure than would be the case with full-mouth periapicals radiographs.

Lastly, it should be noted that in estimates of periodontal treatment time, account should be taken of the time required for radiographs since this is a fairly time consuming procedure (Lotzkar et al., 1971a,b; Rosenberg et al., 1986; Nash et al., 1979).
A protocol for oral hygiene instruction was provided to both hygienists and periodontists in an attempt to standardise the procedures used. The protocol was based on a system described by Lindhe & Nyman (1983) as used in several clinical trials (Lindhe & Nyman, 1975; Rosling et al., 1976; Lindhe et al., 1982a). This method employs intensive individual instruction in the use of toothbrushes, interdental cleaning aids and the use of disclosing agents. Since no direct monitoring of the operators was employed it can only be assumed that the protocol was followed.

The mean of 39 minutes/person [range 5-72 minutes] devoted to oral hygiene instruction at baseline was close to the 50 minutes estimated in TRS 621 (WHO, 1978) for initial oral hygiene instruction for a similar age group. The mean time in this study was however slightly less than the mean of 56 minutes reported by Ekanayake & Sheiham (1978) and the 72 minutes reported by Johansen et al., (1973) for a similar dental hospital setting.

The time for oral hygiene reinforcement during Phases B and C were less than half that required at baseline at a mean of 15 and 10 minutes/person respectively. This finding that oral hygiene reinforcement during maintenance care took less time than initial oral hygiene corroborates the findings of Milgrom et al., (1988). The times for oral hygiene reinforcement are consistent with the 10 minutes estimated in TRS 621 (WHO, 1978).

It had been expected that those subjects with higher maximum CPITN scores would require a longer period for oral hygiene instruction due to an increased complexity of disease presentation. Surprisingly no statistically significant difference was detected between the mean times spent on oral hygiene instruction for subjects with different maximum CPITN scores during any of the phases of treatment. A possible explanation could be that because operators were requested to follow a standard protocol, all subjects received the same 'blanket' oral hygiene instruction regardless of severity of disease.

Taken overall, the time used for oral hygiene instruction and reinforcement in the hospital setting used in this study is much greater than the treatment times reported for general dental practice (see section 5.2.2). As with the mean time for periodontal examination, it is inevitable that the time for oral hygiene will vary between different settings and
presumably reflect both different approaches to oral hygiene instruction and other factors.

Although there is a reduction in the time spent on oral hygiene at follow-up appointments, it will be seen that oral hygiene delivered on a one-to-one basis, under the conditions of the study, is a very time consuming procedure. Therefore investigation of other approaches for delivery of effective oral hygiene instruction to both individuals and to communities is warranted. One possible direction is to evaluate if similar clinical outcomes can be achieved if smaller periods of time are spent for oral hygiene instruction. The findings of Söderholm et al., (1982) and Söderholm & Egelberg (1982) suggest that no clinical advantage is achieved if the duration of oral hygiene instruction is increased beyond 45 minutes. Further studies are required to ascertain whether similar clinical results can be achieved if less time is used for oral hygiene instruction.

Irrespective of whether it is possible to decrease the amount of time required for oral hygiene instruction delivered one a one-to-one basis, as Glavind et al. (1981) point out, "the need for improved oral cleanliness in adults presents a large scale resource requirement for professional manpower if oral hygiene instruction is to be accomplished conventionally on an individual basis at the chairside". Since self-instructional material has been shown, in small scale studies in general practice, to be as effective as personal instruction by dental personnel (Glavind et al., 1985), then this option should be explored further in other working environments and in other communities. Thus, if Glavind's findings are corroborated by other studies elsewhere, then it would largely negate the need for dental personnel to expend time on individual instruction. This would naturally have considerable resource implications in the planning of periodontal health services.

(iv) The time for scaling and correction/removal of plaque retentive factors

The treatment time control sheet (Appendix XIV & XXI) permitted the time for scaling and the time for correction/removal of plaque retentive factors such as overhangs from restorations to be recorded separately. However, removal of overhangs was only required in two sextants which concurs with the finding from the activity sampling exercise that only 0.1% of hygienists' primary activity time was devoted to this procedure. This is probably due to the relatively low number of teeth which are filled in this age cohort of the Hong Kong population and because many are one-surface occlusal
restorations (Lind et al., 1987a). Thus, in common with the findings from Sri Lanka, calculus is the most prevalent plaque retentive factor unlike the U.S.A. and Norway where restorations with defective margins have been reported to be the most common (Ånerud et al., 1983). The remaining part of this section will therefore deal only with the time for scaling.

The mean time for initial scaling when delivered to control sextants during Phase A was 23 minutes/sextant, however the range was considerable (4-75 minutes). The mean time is in accordance with the 30 minutes/quadrant (equivalent to 20 minutes/sextant) estimate given in TRS 621 (WHO, 1978) for subjects of a comparable age cohort. Considering however that the operators were both experienced in their task and had access to both ultrasonic and hand instruments, the mean time for this initial scaling was somewhat greater than most of the estimates provided in Table 5.3 (Appendix IV). One reason for this could be the omnipresence of calculus seen in the study sample, most of which was subgingivally located and which affected over half the available sites (see section 9.4.2). This finding for the study sample concurs with a more recent survey of Hong Kong adults aged 35-44 years where the mean proportion of teeth with calculus was 88% (Holmgren et al., 1994).

During Phase B, both control and experimental sextants received scaling, however, for the former it should be considered as a maintenance scaling while for the latter as initial scaling. The mean time for the initial scaling in experimental sextants during Phase B was 12 minutes/sextant which is approximately half that required for the initial scaling in control sextants during Phase A. Considering that at the baseline examination the clinical conditions in both control and experimental sextants were very similar, this finding was unexpected. It is particularly interesting since a reduction in scaling time through deferment of the procedure until a later stage in the treatment has not previously been reported. The most plausible reason for this reduction in scaling time is that it is a reflection the improvement in periodontal conditions brought about by improved oral hygiene over the 6-month period. The clinical results described in section 9.4 support this contention since there was a decrease in both sites with BOP and PPDs ≥4 mm over this period. While it is not certain whether a reduction of sites with BOP will result in reduced bleeding during instrumentation, this is most likely to be the case. Any reduced bleeding would have the potential of improving visibility therefore simplifying the task of calculus removal and thus reduce the scaling time. Furthermore, the reduction in PPDs would in part be due to recession thereby exposing calculus which had
previously been subgingivally placed thereby improving both access and visibility.

The finding that less than half the time was required to provide 'initial' instrumentation in experimental sextants when compared to control sextants begs the question as to whether the thoroughness of the instrumentation performed in experimental sextants during Phase B was as good as for control sextants during Phase A. However, a comparison between control sextants at the 3-month examination and experimental sextants at 9-months showed minimal difference in the mean proportions of sites with calculus.

The time for maintenance scaling for control sextants carried out during Phase B required on average 7 minutes/sextant compared to the 5 minutes/sextant required for the maintenance scaling of the experimental sextants during Phase C. It must be assumed that this was largely to remove the small amounts of calculus remaining following the initial scaling, as the clinical data shows only a minimal increase in sites with calculus between the 3- and 6-month examinations for control sextants and between the 9- and 12-month examinations for the experimental sextants (see section 9.8.2). The difference in time for the first maintenance scaling between control and experimental sextants was statistically significant although the scaling time/sextant differed by only 2 minutes. At the subject level, however, this difference could amount to 12 minutes/person. There was also a significant difference between the time required for the first (Phase B) and the second maintenance scaling (Phase C) for control sextants. The mean difference was however only 0.5 minutes/person.

The times for maintenance scaling are slightly greater than the 5 minutes/quadrant (equivalent to 3 minutes/sextant) estimate given in TRS 621 (WHO, 1978) for subjects of a comparable age cohort and by Schallhorn & Snider (1981) for maintenance patients (Table 5.1, Appendix II). The differences are small however and of no import.

A comparison was made between the highest CPITN sextant score and the time required for scaling provided during each of the treatment phases (see section 8.1.6). Control sextants were alone in showing a significant difference in mean scaling time between sextants with different CPITN scores for initial scaling. Scaling in control sextants with a maximum CPITN score of 4 at baseline took on average over twice the time required of sextants with a CPITN score of 2 and one-third longer than sextants with a CPITN score of 3. These findings are in line with those of Frisch et al., (1970), Bellini (1974)
and Ekanayaka & Sheiham (1978) who reported that scaling times are related to severity of periodontal disease. Unfortunately, statistically significant differences could not be detected in the mean scaling time for sextants with different CPITN scores at any of the treatment phases for experimental sextants. Similarly, for control sextants, no significant difference could be detected in the time required for maintenance scaling between sextants with different CPITN scores except for a small difference during Phase B between sextants scored 1 and 2 at the 6-month examination.

Thus, based on the findings from this study, the CPITN sextant score would only appear to be useful in providing a more accurate estimate of the time required for scaling if this is provided according to common practice i.e. delivered at the start of treatment.

It must be recognised that the study design demanded that each sextant be scaled to the best of the operator's ability before proceeding to the next sextant to permit the scaling time/sextant to be recorded. This imposed an unnatural work pattern on the operators which might have influenced the scaling time. There is also the possibility that since the operators knew their work would be assessed by the examiner (CJH), that they were more conscientious about their work than would normally be the case resulting in longer treatment times. This however is a problem of a study design in which both treatment times and outcomes are evaluated concurrently.

(v) The time for complex periodontal treatment

The assessment of the time required for complex treatment in terms of root planing and surgery proved to be problematic firstly because such treatment was provided in only a limited number of subjects and sextants and secondly, because periodontal surgery did not feature as a component of complex treatment until after the end of the study proper. This necessitated an extension of the study period for a further six months after the fifteen-month examination for the four subjects who required this procedure.

As previously mentioned there are difficulties in comparing the treatment times between different studies. This is particularly so with respect to complex periodontal treatment since the unit under consideration often differs between studies as does the nature and sequence of complex periodontal treatment. Furthermore, terms such as 'deep scaling' and 'root planing' might not be synonymous though they are often taken to mean the same.
Root planing as a component of complex treatment took place during Phases B, C, and D. A cautious interpretation of the data suggests that surprisingly little time was devoted solely to root planing when compared to time estimates for either initial or follow-up ‘deep scaling’ given in TRS 621 (WHO, 1978). This might be either a reflectance of the small number of sites per sextant which generally required root planing but is more likely to be due to the fact that scaling had already been provided during earlier phases of the treatment.

While periodontal surgery was only undertaken in four sextants, the mean of 37 minutes/sextant spent on periodontal surgery is rather less than the 60 minutes/quadrant estimated in TRS 621 (WHO, 1978) and of similar times reported by other authors (Edwardsson & Mobius, 1966; Helöe, 1973; Johansen et al., 1973; Bellini & Johansen, 1973; Markkanen et al., 1978; Nash et al., 1979). These variations in treatment time could either be due to differences in the size of the unit under consideration or due to other reasons such as operator variability.

In spite of attempts to select subjects for the study who were more likely to require complex periodontal treatment, these were largely in vain since so few subjects and sextants eventually underwent complex periodontal treatment.

10.3.3 Discussion of the activity sampling results

Activity sampling was used as an adjunct to the method of time-study as it was considered necessary to obtain a more complete assessment of the time spent by the operators on different activities particularly with respect to secondary and unproductive activities. As discussed previously, activity sampling permits a single observer to concurrently collect information on a large number of different activities being performed by different operators (see chapter 4). While it is possible to estimate the mean time required for specific procedures using this technique (Hobdell & Evans, 1977), this becomes very difficult when procedures are not completed in one session and extend over a number of sessions as might be the case with periodontal treatment. Thus, in this study the activity sampling data was solely used to assess the proportion of time spent on different activities.

One of the prerequisites of an activity sampling exercise is the definition of a list of activities to be sampled. The list of activities employed by Hobdell & Evans (1977) was
used as a basis for the definition of activities utilised in this study but with primary
activities being grouped so as to be CPITN related. The pilot study which tested both
the criteria and the recording sheet was invaluable as problems were identified and
rectified before the collection of data proper.

Dental surgery assistants (DSAs) were used as activity sampling observers as they were
cognisant of the procedures undertaken by operators working in the Department of
Periodontology and Public Health. Other studies employing the method of activity
sampling have similarly used dental personnel as observers (Hobdell & Evans, 1977;
Tan & van Gemert, 1977; Swedberg et al., 1993). The original intention was to restrict
the number of observers to two in order to minimise inter-observer variability. However,
the requirement for the DSAs to rotate through the individual hospital departments on a
regular basis meant that additional observers needed to be recruited. To reduce inter-
observer variability to a minimum, individual training was provided and written guidelines
distributed.

Some unexpected problems did however occur during the activity sampling exercise.
The intention to collect activity data on the periodontists proved very difficult since
neither of them had treatment sessions of fixed duration with patients often being treated
in between their other teaching and administrative duties. Although some preliminary
data was collected, this proved to be extremely difficult to interpret since without a
formally defined end to a treatment session, it is impossible to calculate the proportion
of time devoted to separate activities. Thus, the activity sampling exercise was
eventually restricted solely to the hygienists.

Ideally the period of activity sampling should have coincided with those sessions when
the study subjects were being treated so that the data collected from the activity
sampling corresponded with that collected by time study. Unfortunately, logistically this
was impossible as study subjects were treated during routine treatment sessions at times
which were convenient to the subjects rather than on specific sessions. Furthermore,
activity sampling restricted solely to the times when study subjects were being treated
would not have provided sufficient samples for meaningful analysis. Notwithstanding this
problem, the data obtained from activity sampling was more likely to represent the
routine daily activities than would be achieved had the activity sampling been restricted
to times when study subjects were being treated.
From the activity sampling data collected, it was surprising that less than one-third of the hygienists' total activity time was devoted to primary activities. Of this, most of the time was devoted to instrumentation (71%) and oral hygiene instruction (21%). Very little time was spent on examination and charting or other preventive activities. Since in Hong Kong hygienists are required to work under the prescription of a dentist, it can be deduced that in this hospital setting, the range of activities for which the hygienists are trained are not utilised fully and that hygienists are used largely as a means of providing oral hygiene instruction and scaling. The implications of this finding is that either the referring dentists themselves undertake preventive procedures such as the application of fissure sealants, fluorides and other preventive measures, or that such preventive measures do not feature largely as part of the treatment philosophy within the hospital.

As expected, the majority of the overall time spent on oral hygiene was devoted to toothbrushing instruction (52%). A further 31% of oral hygiene time was spent talking to the patient. Unfortunately the activity sampling method used in this study did not elucidate the content of the 'talking to patient' activity so as to subdivide this activity into, for example, talking about toothbrushing or interdental cleaning. If this had been done then the proportion of oral hygiene instruction time spent on different procedures might have been different. Only 15% of oral hygiene instruction time was used for instruction on interdental cleaning. This could be because this component of oral hygiene instruction was less time consuming than instruction in toothbrushing or that interdental cleaning techniques were infrequently taught. Only 1% of oral hygiene time was devoted to the use of disclosing agents which could point to the possibility that disclosing agents were not routinely used by the hygienists and is an area where the oral hygiene instruction given to the study subjects possibly differed from that given to routine patients. Unfortunately, the nature of the data collected did not permit clarification as to the absolute frequency to which disclosing agents were used or patients instructed in interdental cleaning. This could relatively easily be deduced in a further study by adding a more detailed record of the procedures completed on each patient during a specific observation period.

With respect to instrumentation, although ultrasonic scalers were available in all of the hygienists' units, almost twice as much time was spent using hand compared to ultrasonic scalers. Similar clinical improvements have been reported irrespective of whether ultrasonic or hand instrumentation have been used (Torfason et al., 1979; Badersten et al., 1981). However, because of the nature of the calculus found in Hong
Kong Chinese, hygienists working in the Department of Periodontology and Public Health have been taught to first use the ultrasonic scaler to remove as much calculus as possible before resorting to hand scalers to complete the task. One could therefore surmise from the activity sampling findings that ultrasonic scaling can only partially complete the task of scaling in these patients but that the additional tactile sensitivity provided by hand scalers over ultrasonic scalers is still required to remove any remaining deposits of calculus.

Secondary activities which are defined by Hobdell & Evans (1977) as activities "which are not ends in themselves but which are nevertheless essential" accounted for only 9% of overall hygienist time. Half the time spent on secondary activities related to preparation of the operatory and patient while a further 24% of time was used to fetch and return the patient from the waiting room. A small saving in time might be made if a system of intercoms could call the patient into the operatory.

Of particular concern was the finding that almost two-thirds of hygienists' time was unproductive. While not being directly comparable, Hobdell & Evans (1977) reported levels of unproductiveness for different teams of operators in a dental hospital to vary between 19 and 51%, while Tsui (1989) reported that approximately one-third of Hong Kong dentists' time was unproductive. Thus, the level of unproductiveness of these hygienists could be considered to be very high and was largely due to patients not being booked (63%). The reasons for this are unclear but could include an oversupply of hygienists in the hospital, a lack of referrals, or patients being unwilling to attend for treatment during certain times of the day. This should be investigated further to ensure that in future efficient use is made of the resources provided by the hygienists. Patients failing to attend (13%) and appointments finishing early (13%) were the second most common causes of hygienists being unproductive. With respect to the former, patients failing to attend is common in Hong Kong as shown by Tsui (1989) where 10% of dentists' unproductive time were due to this cause. While there is little one can do to prevent patients failing to attend, unproductive time caused through appointments finishing early could be reduced by more careful timetabling of patients.

In general, the activity sampling exercise proved to be an effective and straightforward method of assessing and monitoring time utilisation of hygienists in the clinical setting. It was capable of collecting extremely useful data on a large number of activities being undertaken simultaneously by multiple operators. While the method also enables the
work patterns for individual operators to be determined, this was however outwith the objectives of the study. A particular advantage of activity sampling is that since the data is collected by direct observation, the method minimises any possible interference with the work patterns of the operators. Problems encountered with the method was firstly that it was very difficult to calculate specific treatment times for periodontal procedures as these normally take place over several sessions, and secondly, the method cannot realistically be used when operators do not have defined finishing times to their clinical sessions.

Although the activity sampling method was used in a few studies in the 1970's (Hobdell & Evans, 1977; Tan & van Gemert, 1977) it is surprising that it has not been used more often in the clinical setting. Recently however, Swedberg et al., (1993) have reported on the use of activity sampling in the Public Dental Service in Göteborg, Sweden with encouraging results. The findings from the data collected in this present study support the usefulness of the method.

In summary:

- The principal productive activity undertaken by the hygienists was scaling, mostly with hand instruments, and oral hygiene instruction. Other preventive activities featured only minimally;

- Most of the time spent on secondary activities was spent preparing the operatory and the patient;

- The finding that two-thirds of hygienists' time was unproductive show that there is an urgent need to examine ways of reducing this particularly with respect to the reasons why clinical sessions are not fully booked with patients;

- The method of activity sampling proved to be very useful but could be improved upon by simultaneously collecting more detailed information on the number of procedures performed on each patient.
10.3.4 Overall discussion of the treatment time results

First and foremost it must be emphasised that the treatment times determined in this study only relate to treatment provided under the conditions specified in this study i.e. treatment provided largely by hygienists working under hospital conditions on Hong Kong Chinese subjects. Several studies have shown large differences in the time used for periodontal treatment in different working environments (Ekanayake & Sheiham, 1978). It would therefore be inadvisable to extrapolate the findings to conditions as they might apply in general dental practice in Hong Kong for a number of reasons including: (1) most periodontal treatment in general dental practice is provided by dentists because only about 30 hygienists work in practice (1995 figures); (2) the types of patients who attend general dental practice might well differ from those in this study; (3) general dental practitioners might have different treatment philosophies; and, (4) the financial constraints imposed by general dental practice might mean less time is devoted to periodontal treatment procedures than in the hospital environment. Thus, one criticism of the study is that the treatment time data from this study has only limited value for manpower planning purposes since most periodontal treatment in Hong Kong is delivered in general dental practice. While it had been the intention of the investigator to collect such data from general dental practice, preliminary discussions with a number of general dental practitioners in Hong Kong indicated a reluctance to participate in a study of this type and the idea was thus abandoned.

Irrespective of the problems of extrapolating the figures to other situations, the study highlights the danger of using only time study derived treatment times for manpower planning purposes since secondary and unproductive activities are usually excluded from the calculations. This calls into question the treatment times reported in other studies which do not take into account these factors. In this work setting, if the treatment times determined by time study (see section 8.1) were the sole data used for planning purposes, then it would lead to a substantial underestimation of the total time and resources required to provide periodontal treatment. Thus, when determining treatment times for planning purposes, not only should these be determined for those who will ultimately deliver the treatment but also some assessment must be made of the proportion of time spent on secondary and unproductive activities including annual and maternity leave and leave due to illness. Once this has been done it is possible to apply a correction to the treatment times to take these factors into account.
Some aspects of the treatment times obtained in this study which have not been reported in the results as they were out with the remit of this study. These include the effect of operator on treatment time, the types of treatment provided by hygienists and periodontists, and the relative proportion of total treatment time spent by periodontists and hygienists. It is however interesting to note that most of the periodontal treatment in this study was provided by hygienists. These additional findings will be the subject of a separate report.

The results from this study show that when periodontal treatment was provided on a one-to-one operator to patient basis under hospital conditions in a sample who had received little or no previous periodontal treatment, an inordinate amount of time was required to deliver treatment by this traditional approach. If these times were directly applied to determine personnel requirements for periodontal treatment in Hong Kong adults, then such treatment would place inordinate demands on resources disproportionate to the public health importance of periodontal disease in this population. Thus, less time consuming approaches must be explored which might make periodontal treatment less resource demanding. As mentioned in sections 6.1 and 10.3.2.iv, possible savings in time spent on oral hygiene instruction can be made through self-instructional material, group oral-hygiene instruction or finding the optimal time required to provide oral hygiene instruction on a one-to-one basis. Data from this present study also suggests that scaling time can be halved if this procedure is deferred until improvements in oral hygiene take place. Other options are possible, however there remains an urgent need to explore alternative, less time consuming but effective approaches to the delivery of community periodontal care. In this respect, particular emphasis should be placed on the development and testing of other minimal periodontal care regimes.
10.4 Discussion of the clinical results

10.4.1 Examiner reproducibility

For the purposes of this study, examiner reproducibility was expressed as both percent agreement and Kappa statistic, the former being the traditional method of reporting examiner reproducibility while the latter has the advantage of quantifying agreement beyond chance (Chilton, 1982; Fleiss & Chilton, 1983; Hunt, 1986). It should however be noted that Kappa does not hold in extreme cases when most of the observations are concentrated in one cell of a contingency table (Hartshorne et al., 1987).

It is difficult to define the exact meaning of the terms 'an acceptable consistency' or 'an adequate level of reproducibility' as both terms solicit the question as to what is considered to be 'acceptable' or 'adequate'. Davies & Emslie (1977) have suggested that for most measurement parameters or indices, a proportion of agreement level of 85 percent, or better, should be expected while the manual Oral Health Surveys - Basic Methods, 3rd. edition, (WHO, 1987) suggests a similar proportion. Based on these standards, the examiner could be considered to have achieved an acceptable level of consistency before the start of the study and which was maintained throughout the study with the exception of BOP, which falls just short of this standard.

Standards suggested for interpretation of Kappa values are that values < 0.4 represent poor agreement beyond chance, values in the range 0.4 to 0.75 represent fair to good agreement beyond chance, while values > 0.75 to 1 represent excellent agreement (Landis & Koch, 1977). Based on these standards, the majority of calibration results show Kappa values consistent with excellent examiner agreement, with the exception of BOP during one of the training sessions. The remainder are in the upper end of the range of scores considered to represent fair to good agreement.

The low reproducibility of BOP could either be due to intra-examiner inconsistency or due to a systematic error. Birkeland & Jorkjend (1975) have shown an increase in bleeding sites on the second probing, however Abbas et al., (1982) and Janssen et al., (1986) failed to show this systematic error when using constant force probing. Since van der Velden (1980b) showed a time interval of 15 minutes between re-examinations to be adequate to prevent an increased bleeding tendency even when a force of 0.75N was employed, the time of approximately 30 minutes between re-examinations in this present study should have been more than adequate to reduce the possibility of such a
systematic error. Furthermore, the lack of standardised probing force in this present study could have contributed to the low reproducibility of BOP since van der Velden (1980b) has shown much lower BOP reproducibility when using standard periodontal probes compared to constant force probes.

The examiner reproducibility for subgingival calculus was consistently lower than for supragingival calculus. This is consistent with the findings by Sherman et al., (1990) and Pippin & Feil (1992) showing the reproducibility of scoring subgingival calculus to be modest to poor. Such a finding is to be expected since, unlike the scoring of supragingival calculus which can be visually detected, subgingival calculus scoring is based entirely on tactile sensation. While the ball-end of the CPITN probe is purported to enhance the detection of subgingival calculus, it might have a detrimental effect on examiner reproducibility since the cement-enamel junction might inadvertently be scored as subgingival calculus (Page & Morrison, 1994).

Although a pressure probe was not used, the examiner reproducibility for probing depth during the study proper was good to excellent. This is in part due to the method of scoring where probing depth ranges rather than millimetre measurements were scored. This meant that variations in probing depth of up to 3 mm could be accommodated within the same score.

With the exception of session 1 of the training sessions, the intraexaminer reproducibility for sextant CPITN scores expressed as Kappa statistic were comparable to those obtained by Hartshorne et al., (1987) \( k=0.53-1 \), Mubarak & Gjermo (1990) \( k=0.78 \), and Manji & Sheiham (1985) \( k=0.92 \).

One criticism of the calibration sessions was that they were undertaken on subjects who had not received periodontal treatment. It is possible that if the calibration exercises had been conducted on treated subjects, the results would have been different. Subjects, other than those involved in the study were used for calibration purposes since it was considered that additional examinations of the study subjects would not be well tolerated. It is therefore recommended that in future studies of this nature that calibration sessions are conducted on untreated subjects at the beginning of the study and on treated subjects during the study.
10.4.2 Discussion of the treatment responses assessed by the CPITN

The responses to the different treatment modalities in this study were assessed by use of the CPITN since the index has been recommended for such purposes (Croxson, 1984; Cutress et al., 1987; Ainamo et al., 1987). Unfortunately, rather few studies have used the index longitudinally in either community studies or clinical trials and therefore its ability to discern change following periodontal intervention remains equivocal (for review, see Holmgren, 1994). Concern still remains as to the CPITN's ability to monitor responses since as recently as 1994, Page & Morrison recommended the need for "studies aimed at determining the capacity of the CPITN to accurately detect spontaneously occurring changes in periodontal status, or changes resulting over time from either preventive or therapeutic intervention".

In monitoring a minimal periodontal treatment programme where calculus removal does not feature, the hierarchical design of the CPITN has the potential of permitting improvements to be detected from the higher CPITN scores, namely codes 3 and 4, mediated through a reduction in PPDs. Unfortunately, however, the CPITN code of 2 [calculus] poses an effective block to the detection of other improvements which might take place in, for instance, reductions of BOP. Further improvements could potentially only be identified by the CPITN if calculus removal were to be undertaken. However, this would defeat the objective of this minimal periodontal treatment programme. Since no studies to date have used the CPITN to monitor changes in response to a minimal periodontal treatment programme where calculus was not removed, it was considered important to assess what if any changes might be detected by the CPITN in response to such a programme. Furthermore, it was hoped that it would be able to determine whether there were any limitations when using the index for this purpose.

The differences between treatment modalities used in this study were at the sextant rather than the subject level as a split-mouth design was used. Thus, responses expressed in terms of changes in the subjects' highest CPITN score were not reported since any such changes would be meaningless for comparing between the treatment modalities. Analysis and reporting for the CPITN was thus solely at the sextant level.

The findings at the baseline examination that none of the sextants were scored as healthy and that over 90% scoring CPITN code 2 or 3 was somewhat worse than that reported for the 1984 HKSAOH (Lind et al., 1987a; Corbet et al., 1989) where almost 7%
of sextants were scored as healthy. Possible explanations for this difference is the sampling procedure for the present study which weighted the selection of subjects with more severe periodontal conditions but also that all teeth were examined in this study whereas in the 1984 HKSAOH only index teeth were used.

The delivery of oral hygiene instruction and instrumentation in control sextants following the baseline examination resulted in a significant improvement in CPITN scores. However, in spite of considerable effort in terms of time being expended on these sextants, only one-fifth of sextants were assessed as being healthy at the 3-month examination. Furthermore, over one-half of sextants were scored as still having calculus and/or pockets present [codes 2, 3 & 4]. Thus, while some changes could be detected by the CPITN, traditional periodontal treatment failed to result in conditions defined as healthy by the CPITN, save for in a few sextants.

In experimental sextants, the effect of oral hygiene instruction alone resulted in a small but statistically insignificant improvement in the CPITN scores at the 3-month examination, but with the majority of sextants retaining the same score. As expected, the main changes were in sextants initially scoring CPITN codes 3 and 4 changing to code 2. This failure of the CPITN to detect significant changes in response to oral hygiene instruction must be considered in light of the substantial and significant improvements detected by the use of conventional periodontal criteria particularly with respect to BOP (discussed in section 10.4.4). This highlights one of the deficiencies of the CPITN in monitoring treatment responses for minimal periodontal treatment programme where calculus is not removed or is only partially removed. Furthermore, this deficiency is undoubtedly far more serious in those populations where there is an omnipresence of calculus as found in many developing countries where such minimal intervention programmes might be considered. Were communities to have to plan for the removal of all calculus in all individuals in order to achieve any further shift towards low CPITN scores, the manpower and economic consequences would be, to say the least, considerable.

The small but statistically insignificant deterioration observed in the CPITN scores for both control and experimental sextants at the six-month re-examination, when compared to the 3-month examination results was to be expected since oral hygiene instruction had not been reinforced since baseline, a period of up to six months. This might have been too long a period between treatments for some of the subjects, although Listgarten &
Schifter (1982) have shown that some patients can remain stable for periods of up to 15-18 months between prophylaxes.

The monitoring of treatment responses as assessed by the CPITN was continued past the 6-month examination and was analysed for those subjects who completed Phases A, B and C. This permitted the effects of instrumentation in experimental sextants which hitherto had only been subjected to oral hygiene to be evaluated while concurrently allowing the appraisal of longer term responses to conventional treatment in control sextants over a 15-month period.

A particularly interesting finding was that the CPITN treatment responses seen in experimental sextants at the 9-month examination following instrumentation during Phase B were inferior to those achieved in control sextants at the 3-month examination following instrumentation during Phase A. The differences were largely in respect to the smaller reduction at the 9-month examination in experimental sextants scoring code 3 and a smaller increase in sextants scoring code 0 when compared to control sextants at the 3-month examination. The overall proportion of sextants scoring code 2 or higher were however comparable. It is unlikely therefore that these differences in treatment responses between control and experimental sextants following instrumentation could be attributed to the fact that less time was spent on instrumenting the experimental sextants during Phase B when compared to the time for instrumentation of the control sextants during Phase A. Further evidence that the quality of instrumentation is not the reason for these differences in CPITN assessed responses is provided by the calculus site data (see section 9.8.2) where the proportion of sites with calculus in experimental sextants following instrumentation during Phase B was smaller than that achieved during Phase A for control sextants (see section 10.4.4).

In common with the findings at the 6-month examination, the 12-month examination also showed a trend for small deterioration in CPITN scores compared to the 9-month examination. A 'see-saw' pattern is thus observed in the CPITN scores where, following a treatment phase, there is improvement at 3-months followed by a slight deterioration after 6-months. This points to the need to optimise the period of recall according to the subject rather than according to some arbitrary criteria. Three month recall visits as used by some (Suomi et al., 1971; Ramfjord et al., 1973,82; Axelson & Lindhe, 1978,81a,b,c) would not however be practical as part of a minimal periodontal treatment programme.
10.4.3 Discussion of the treatment responses assessed by the CPITN modified by Takahashi et al., (1988)

In light of the CPITN's apparent inability to detect changes in sextants beyond the score of 2 in situations where calculus was not removed, data was analysed according to the modification proposed by Takahashi et al., (1988) whereby in the absence of pockets, sextants with calculus and BOP (C+B+) were assigned a score of 2+ while sextants with calculus without bleeding (C+B-) were assigned a score of 2-. The logic behind the use of this modification was that for experimental sextants where calculus was not removed during Phase A, improvements in terms of a reduction of bleeding on probing which would otherwise be obscured due to the presence of calculus and the hierarchical nature of the CPITN might be reflected in a CPITN score of 2-.

At baseline, between 13 and 15% of all code 2 sextants scored code 2-. This was much smaller than the 24% reported by Holmgren & Corbet (1990) for the 35-44 year-olds surveyed in the 1984 HKSAOH. A possible explanation for this discrepancy is that either the sub-sample recruited to this study was quite different to the total 1984 HKSAOH sample or that periodontal conditions deteriorated from the time of the survey and the start of this study. A more plausible explanation however is that whereas in this present study, individual sextant CPITN scores were derived from the examination of all teeth, the sextant scores in the 1984 HKSAOH were index teeth based. The greater number of sites probed per sextant when examining all teeth possibly increased the likelihood of detecting a sextant where calculus and BOP were concurrent (C+B+) since if any one site within a CPITN 2 sextant exhibited BOP then the sextant would become code 2+.

It is interesting to note however this was not the case for Tanzanians of a similar age group, since Baelum et al., (1993) reported little difference in the proportions obtained by scoring index teeth or all teeth of code 2 sextants scoring code 2-. Analysis of data according to index teeth for this present study was not performed as it was outwith the objectives of the study. The periodontal data collected both in this study and in the more recent 1991 HKSAOH (Holmgren et al., 1994) will permit comparison between CPITN results obtained by scoring all teeth or only index teeth for Hong Kong Chinese and is worthy of further investigation.

Treatment responses in experimental sextants following oral hygiene instruction showed only a minimal change in the proportion of sextants scoring CPITN code 2- from baseline at both the 3- or 6-month examinations. This must be viewed in the perspective of the substantial reduction in the proportion of sites exhibiting BOP at the 3- and 6-month
The responses in control sextants are more difficult to interpret since instrumentation was undertaken in these sextants following the baseline examination. However, in spite of this, over one-half of sextants were scored at the three-month examination as having calculus and/or pockets present. It is therefore not surprising that the minimal changes in experimental sextants with respect to the relative proportions of CPITN codes 2- and 2+ were reflected in the control sextants.

Based on the findings of this analysis, the modification to the CPITN proposed by Takahashi et al., (1988) does not appear to improve the ability of the index to detect improvements in periodontal health that have taken place in the absence of instrumentation in sextants scoring code 2. A possible explanation for the failure of the Takahashi modification to detect change has been given above. Such a modification might be useful in population studies where only index teeth are used thereby potentially reducing the likelihood that bleeding will be detected. Furthermore, additional work must be performed to determine if other modifications to the CPITN would be more appropriate for the assessment of treatment responses.

10.4.4 Discussion of the treatment responses assessed by conventional criteria

In addition to the assessment of treatment responses using CPITN criteria, responses were also assessed using conventional periodontal criteria since it was feared that the CPITN by nature of its hierarchical design would either be inadequately sensitive to detect changes, or that changes should they occur, would be difficult to interpret. This concern was borne out by the finding that the CPITN failed to detect significant improvements in response to oral hygiene alone in experimental sextants. However, as evidenced by responses assessed by convention criteria described below, this should not be taken to indicate an overall lack of improvement in periodontal conditions in these sextants.

(i) Responses to oral hygiene alone (Phase A - Experimental sextants)

The most noticeable changes in experimental sextants in response to oral hygiene alone were with respect to the proportion of sites with BOP. Interestingly, in this study, the mean of just over 30% of sites which exhibited BOP at the baseline examination in both
control and experimental sextants was almost half the baseline levels reported in other studies (Cercek et al., 1983; Loos et al., 1988; Gaare et al., 1990; Al-Yahfoufi et al., 1995). These differences are probably a combination of real differences between sample populations combined with differences in probing technique. With respect to the latter, the light probing forces recommended by the CPITN method are more likely to predispose to less bleeding than when greater forces are used (Lang et al., 1991).

The significant reduction in BOP observed in experimental sextants at the 3-month examination, largely maintained over a 6-month period, was achieved solely by oral hygiene instruction in the absence of instrumentation. The almost 40% reduction in sites with BOP in this study in response to oral hygiene alone was surprisingly similar to the overall reductions reported by Cercek et al., (1983), Loos et al., (1988), Gaare et al., (1990) and Turner et al., (1994). Moreover, in two of these studies, reductions in BOP of the order of 60% were observed in sites with PPDs <4 mm (Cercek et al., 1983; Turner et al., 1994). These studies taken together confirm that under certain circumstances, improvements in BOP can be achieved through oral hygiene alone (see section 10.5.2).

The finding at baseline that over 50% of sites had calculus in both control and experimental sextants is largely consistent with the findings from the 1991 HKSAOH where calculus was scored on a mean of 88% of teeth (Holmgren et al., 1994). For the most part, the calculus comprised thick bands of calculus with a preponderance of subgingival calculus even in anterior sextants. Thus, in common with many other Asian populations, calculus could be considered to be omnipresent in this population. Unfortunately, of the other studies which have directly examined the effect of oral hygiene alone, none have reported on the proportion of sites with calculus except that Gaare et al., (1990) noted the presence of "large amounts of calculus".

An unexpected finding in experimental sextants was the 23% reduction between the baseline and the 3-month examination in the mean proportion of sites scored with calculus, a finding little changed at the 6-month examination. Two possible explanations could account for this, firstly that some of the experimental sextants could inadvertently have been instrumented, or secondly, that the examiner was inconsistent with his scoring. The former explanation is unlikely since clear printed instructions were provided to the operators concerning the assignment of sextants for instrumentation. Furthermore, in none of the subjects were the reductions in the mean proportion of experimental sites
with calculus of the order seen in the respective control sextants, nor were the reductions confined to a single subject, as might have been expected if an operator had made a simple error, but was a finding common to many of the subjects.

The most plausible reason to explain the reduction in sites scored with calculus is that there were problems with the scoring of subgingival calculus at the baseline examination. This is borne out by the finding that 93% of the discrepancies were relating to subgingival calculus being scored at baseline and not at the 3-month examination. While the examiner reproducibility for calculus based on Kappa during the calibration sessions both before and during the study proper was good to excellent, subgingival calculus scoring was less reproducible than for supragingival calculus. Furthermore, on a longitudinal basis, changes in the examination conditions brought about by changes in the periodontal tissues might have affected the scoring of calculus. The CPITN probe with its unique spherical tip is designed specifically to assist with the detection of subgingival calculus and irregularities on the root surface. At the baseline examination, many of the sites showed bleeding on probing which obscured the tooth surface. As mentioned previously, under such circumstances, the cement-enamel junction might inadvertently have been scored as calculus in some sites, as has been alluded to by Page & Morrison (1994). At the three-month examination when there had been a reduction in the amount of inflammation, there was less bleeding and therefore the cement-enamel junction could be more easily discerned. Thus, it is likely that the reduction in the mean proportion of sites with calculus between the baseline and 3-month examination was largely due to examiner error rather than a true reduction in calculus.

It is also interesting that almost 30% of sites initially scored with only subgingival calculus at baseline were scored with either supra- and subgingival calculus or just supragingival calculus at the 3-month examination. There was also a coincident increase in sites scoring supragingival calculus between the baseline and the 3-month examination which remained at the 6-month examination. While it is possible that these changes were due to examiner error, another explanation is that in response to oral hygiene there was shrinkage of the marginal gingiva which exposed calculus that was previously placed subgingivally. Moreover, in some instances subgingival calculus eventually became positioned entirely supragingival. This finding concurs with that of Gaare et al., (1990) who reported that "calculus which had originally been located subgingivally and which was black was situated supragingivally after 1 & 2 months of toothbrushing".
In this present study, the suggestion that shrinkage of the gingiva exposed calculus which was previously subgingival is largely based upon clinical observation since no assessment of the amount of recession was made. However, based on the scoring of the type of calculus and the decreases in probing depth (discussed later), it is fair to assume that recession did take place as a component of resolution of marginal gingival inflammation. Furthermore, this is supported by other studies which have reported recession to be a feature of the response to oral hygiene alone in the absence of instrumentation (Cercek et al., 1983; Loos et al., 1988; & Turner et al., 1994).

The assessment of treatment responses by conventional criteria also permitted a closer examination of one of the assumptions of the CPITN, namely that the presence of calculus is always associated with BOP (for review, see Holmgren, 1994). This present study provides further evidence that this assumption is incorrect since, even when the potential problems of scoring calculus are taken into account, the finding that half the sites scored with calculus present did not exhibit bleeding on probing (C+B-) at baseline is extremely significant (Figure 10.1).

There are a number of possible mechanisms which could explain this phenomenon. The role of calculus in the pathogenesis of periodontal disease has been extensively reviewed (Mandel & Gaffar, 1986; Mandel, 1995). It is generally accepted that plaque is the primary cause of periodontal disease but that calculus can play a supporting role by retaining plaque on its rough surface and by acting as a reservoir of toxic substances derived either from plaque or the inflammatory process (Friskopp & Hammarstrom, 1980; Friskopp, 1983; Schueback & Guggenheim, 1992). However, as a result of recession, calculus could become 'high and dry' i.e. sufficiently far away from the gingiva that any pathologic potential the calculus or plaque retained on the calculus might have is minimised (Figure 10.2). The evidence provided above suggests that this might be a factor in some instances. Secondly, if the calculus is physically accessible to oral hygiene measures, that is, it is supragingival or just below the gingival margin, then it might be possible that toothbrushing, flossing etc., could remove sufficient plaque to render the calculus 'biologically acceptable'. In this context, an in-vitro pilot study conducted by Holmgren et al., (1990) showed that little stainable plaque was detectable on the surface of calculus after ten stokes of a toothbrush. It is also conceivable that any toxic substances which had diffused into the calculus from the plaque would leach out over time. However, if the calculus is overhanging the gingival margin or is deeply subgingival it would be expected that plaque removal from calculus by oral hygiene
measures would be limited. Thirdly, there is some evidence that calculus in itself might not be as harmful as previously considered. At the epidemiological level, Douglas et al., (1983) reported that in the USA, 26% of subjects were free of gingival disease in 1960-62 compared to 51% in 1971-74. This was associated with a significant decrease in plaque levels but not calculus levels pointing to plaque as the major culprit in periodontal disease. Ånerud et al., (1991) showed that in those who had optimal dental care (Norwegians) supra- and subgingival calculus had little or no influence on loss of attachment while in individuals who do not practice good oral hygiene or who do not have regular access to professional care (Sri Lankan tea workers), teeth with subgingival calculus lose more periodontal attachment then teeth without calculus. The former statement is supported by Burt et al., (1985) who have hypothesised that a good oral hygiene status and Calculus Index (Greene & Vermillion, 1964) values of 0.1-0.2 might be compatible with virtual absence of destructive periodontal disease throughout life.

At the clinical and laboratory level, Listgarten & Ellegaard (1973) reported electron microscopic evidence of a cellular attachment between junctional epithelium and dental calculus in monkeys. In dogs, Fujikawa et al., (1988) and in monkeys (Blomlöf et al., 1989) showed that that after flap surgery where calculus was not removed but meticulous plaque control was instituted post-operatively, that inflammation decreased over time and eventually became minimal despite the presence of calculus. Lastly, in humans, Sherman et al., reported that following subgingival instrumentation, 59% of the sites which did not bleed had retained calculus.

With these considerations in mind, it had been expected that in response to oral hygiene alone in experimental sextants, the proportion of sites with calculus but without bleeding (C+B-) would increase. Based on the data presented as mean proportions, this did not appear to be the case since the proportions of C+B- sites remained virtually the same at the baseline, 3- and 6-month examinations. However, a site-by-site analysis of the data revealed that this was because the number of C+B+ sites which changed to C+B-, were masked by C+B- sites which changed to C-B- sites, mainly between the baseline and 3-month examination. If the sites that converted from C+ to C- between the baseline and 3-month examination had been excluded, then there would have been a net increase of C+B- sites during this time. This would therefore indicate that following oral hygiene alone, some reduction in gingival inflammation as evidence by BOP can take place even in sites with calculus.
Between the 3- and 6-month examinations, the mean proportions of various combinations of clinical indicator hardly changed, however at the individual site level there were some reversals in scoring of certain combinations of calculus and BOP e.g. some sites with BOP at the 3-month examination did not exhibit BOP at the 6-month examination and vice-versa. This is to be expected since the presence of BOP at a site often fluctuates over time (Lang et al., 1990) while the potential problems of scoring calculus have been discussed above.

In spite of attempts to weight the sample to include a higher proportion of subjects with deep pockets than would be the population norm, only 0.6% of experimental sites had probing depths ≥6 mm (P2+) while 6% of sites had pockets in the range 4-5 mm (P1+). Thus the vast majority of sites (94%) had probing depths <4 mm (P-). This meant that the number of sites with increased PPDs available for analysis was limited. This was a problem attributable both to the study design and to the fact that the size of the eventual sample was smaller than expected. Unless subjects are highly selected e.g. recruited from patients attending a periodontal clinic, as is often the case in clinical studies, or the sample size is increased, it is unlikely that there will be many sites with increased PPDs available for analysis.

The almost two-thirds reduction in the mean proportion of P2+ sites overall between the baseline and 3-month examination, largely sustained at the 6-month examination, is encouraging particularly since the studies of Listgarten et al., (1978), Helldén et al., (1978), Lindhe et al., (1983b,c) and Greenwell et al., (1985), failed to find any statistically significant reduction in deep probing depths in response to oral hygiene alone. Most of these changes were in posterior sextants since, in anterior sextants where it would be expected that oral hygiene would be better, no statistically significant changes in P2+ sites could be discerned. This is possibly due to the small number of anterior P2+ sites involved in this study.
Figure 10.1  Site with subgingival calculus present but exhibiting no bleeding on probing

Figure 10.2  Calculus (previously positioned subgingivally) becomes supragingival in response to oral hygiene
Figure 10.3  Experimental posterior sextant at the six-month reexamination

Figure 10.4  Control posterior sextant at the six-month reexamination
At baseline only 5% of sites had pockets in the range 4-5 mm (P1+), the majority being located in posterior sextants. The almost 40% reduction in P1+ sites overall between the baseline and 3-month examination is somewhat less than that achieved in P2+ sites. This is consistent with the findings of Cercek et al., (1983); Loos et al., (1988); & Turner et al., (1994), who reported the greatest reductions in probing depth in response to oral hygiene alone to be in sites with deeper PPDs. In common with the findings for P2+ sites, the decrease in P1+ sites was largely due to reductions in posterior sextants since the rather small reduction in P1+ sites in anterior sextants was not statistically significant. The slight deterioration seen in P1+ sites between the 3- and 6-month examination were not statistically significant and is to be expected since oral hygiene had not been reinforced since the treatment provided at baseline. Throughout the study the reduction in the mean proportion of P1+ and P2+ sites seen at the 3-month examination was mirrored by a small increase overall in P- sites mainly in posterior sextants.

The results from this present study with respect to changes in PPDs in response to oral hygiene alone are largely consistent with the studies of Cercek et al., (1983); Loos et al., (1988); & Turner et al., (1994), since all three studies showed small reductions in probing depths following oral hygiene instruction over a 3-month period. It is however impossible to compare the extent of improvement achieved since the three studies reported only mean millimetre reductions in PPDs unlike the present study where the proportions of PPD ranges were reported.

Over a longer 6-month period of oral hygiene alone it is only possible to compare results from the present study with those of Cercek et al., (1983) since the studies of Loos et al., (1988); & Turner et al., (1994) were only of 3-months duration. The small but statistically insignificant deterioration in PPDs seen in P1+ and P2+ sites in the present study between the 3- and the 6-month examinations were not reported by Cercek et al., (1983) presumably because, unlike in this study, oral hygiene was reinforced as required on a monthly basis. While such a treatment regimen would be impractical under normal conditions it once again emphasises the importance of oral hygiene in the management of periodontal disease.

It should be noted that the results relating to PPDs as reported in this study might have underestimated the real changes that took place had responses been assessed by a probe graduated in millimetres. Probing depth measurements made with the CPITN probe are restricted to ranges of PPDs by virtue of the design of the probe, therefore in
some sites a change in PPD of up to 2 mm would be required to move the score from one probing depth range to another. For example, an initial PPD of 5 mm (P1+) would need to reduce to 3 mm in order to become a P- site. Thus, in future studies of this nature it might be advisable to make use of the recently available CPITN probes with millimetre markings thereby permitting more flexibility in data analysis.

As indicated in section 6.2, the response to supragingival plaque control alone in the absence of instrumentation is influenced by a number of factors including level of plaque control achieved. The study method did not include an assessment of the levels of plaque control achieved by the subjects since, in line with the recommendations made in TRS 621 (WHO, 1978), it was considered more important to assess the outcomes of plaque control rather than measuring plaque directly (WHO, 1978). Secondly, it was considered necessary in such a relatively long-term study to minimise the time required to examine the subjects in an attempt to minimise the subject ‘drop-out’. Therefore it was not possible in this study to equate changes in periodontal parameters within subjects to plaque levels. While it was outside the remit of this study, in retrospect it would have been useful to make some assessment of plaque levels to compare these with the responses achieved. In further studies of this nature some simple assessment of plaque levels should be included especially since Loos et al., (1988) reported that improvements in periodontal conditions from oral hygiene alone was highly dependant upon the quality of oral hygiene achieved.

These overall findings confirm those from other studies which show that some improvements in periodontal conditions can be achieved through oral hygiene in the absence of instrumentation.

(ii) Comparison of the effects of oral hygiene and instrumentation to the effects of oral hygiene alone

The study design permitted two comparisons between the effects of oral hygiene and instrumentation to the effects of oral hygiene alone. Firstly, during Phase A, control and experimental sextants could be compared, and secondly, the clinical responses in experimental sextants could be compared between Phase A (oral hygiene alone) and Phase B (oral hygiene and instrumentation).

A comparison of the responses in control and experimental sextants during Phase A showed that for most parameters assessed, the changes were greater in the former. In
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terms of BOP, instrumentation augmented the effects of the oral hygiene, however at the 3-month examinations this only amounted to a further 20% reduction in sites with BOP over and above that obtained from oral hygiene alone. Similarly, instrumentation in experimental sextants carried out during Phase B resulted in a further 23% reduction in BOP at the 9-month examination when compared to that achieved by oral hygiene alone at the 3-month examination. These two findings show that with respect to BOP, instrumentation enhanced the effect of oral hygiene instruction to a relatively small but statistically significant extent. This finding differs considerably with those of Lindhe et al., (1983b) and Badersten et al., (1984a) who reported that oral hygiene alone had little effect on BOP while oral hygiene combined with instrumentation reduced BOP by over 80%. In contrast, Gaare et al., (1990) reported that instrumentation conferred no additional benefit to oral hygiene alone in young Indonesians without periodontal pockets but with large amounts of calculus (CPITN $\leq 2$). The most likely reason for these incongruities relates to the PPDs of the sites under investigation since in the studies of Lindhe et al., (1983b) and Badersten et al., (1984a) PPDs were predominantly $\geq 6 \text{ mm}$ while in the study of Gaare et al., (1990), there were no increased PPDs. Support for this assertion is that both the studies of Cercek et al., (1983) and Turner et al., (1994) show that the most significant changes in BOP following instrumentation occur in sites with PPDs $\geq 6 \text{ mm}$ while instrumentation in sites $< 4 \text{ mm}$ confers only minimal additional benefit. In this present study the limited additional benefit provided by instrumentation is probably because the majority of sites (94%) had probing depths $< 4 \text{ mm}$ (P-).

Calculus was used as a clinical indicator in this study and the apparent reduction in the number of sites with calculus in experimental sextants during Phase A has already been discussed. It is often assumed that instrumentation results in total calculus removal but this is not always the case. In this study, 7% of sites in control sextants at the 3-month examination were scored with calculus, this mainly being subgingival calculus with some supragingival calculus in the anterior sextants. Similarly, at the 9-month examination, 3% of sites in experimental sextants were scored with calculus. While it is possible that in some instances the cement-enamel junction was scored as calculus, it is unlikely that this reason accounted for all sites scored with calculus since it common for some calculus to remain after instrumentation Brayer et al., (1989), Rateitschak-Plüss et al., (1992), Kepic et al., (1990) and Sherman et al., (1990a,b). It is also likely that some calculus reformed in the period between the instrumentation and the re-examination.

As mentioned earlier, the number of P2+ sites in both control and experimental sextants
were small and therefore comparisons between the effects of oral hygiene alone as against oral hygiene and instrumentation is difficult. Significant reductions from baseline to the 3-month examination in the proportion of sites with PPDs of ≥6 mm (P2+) and 4-5 mm (P1+) were however observed in both control and experimental sextants with no statistically significant difference between control and experimental sextants for either P2+ or P1+ sites. While this would seem to imply that in the short term scaling confers no additional benefit over oral hygiene alone in sites with increased PPDs, between the 3-month and 6-month examination, scaled (control) sites continued to improve while a small but statistically insignificant deterioration was seen in non-scaled experimental sites. Thus, at the 6-month examination, there were significant differences between control and experimental sextants with respect to sites with increased PPDs. Therefore, it can be concluded that over the longer term, scaling would appear to confer some additional benefit over oral hygiene alone in sites with PPDs ≥ 4 mm.

(iii) Responses to maintenance treatment (Control sextants - Phases B & C; Experimental sextants - Phase C)

Maintenance treatment attempts to maintain or improve upon the treatment responses achieved after initial treatment. This usually involves reinforcement of oral hygiene, removal of any deposits of calculus and root planing of deep sites.

In this study, maintenance oral hygiene instruction was provided at 6-, 12-, and, for some subjects, 15-months. Maintenance scaling and/or root planing was provided in control sextants at 6-, 12- and 15 months while in experimental sextants such maintenance treatment was only provided at 12- and 15-months since the 6-month scaling was 'initial' scaling.

In control sextants, the scheduling of treatment at six-month intervals with examinations at three-month intervals resulted in a 'see-saw' pattern of improvements after treatment followed by a deterioration in the time leading up to the next treatment Phase (Figure 8.11). Only after the treatment had been provided in experimental sextants at 6-months did any pattern begin to emerge for such sextants. The 'see-saw' pattern can probably be attributed both to the treatment provided at the maintenance appointments combined with possible temporary shifts in oral hygiene resulting from oral hygiene reinforcement at these appointments (Cohen & Bryant, 1984).
10.4.5 Other considerations

The major problem alluded to in earlier sections was the failure to achieve the total sample size of subjects which had been estimated prior to the study. This resulted in problems in achieving some of the objectives of the study since inadequate numbers of subjects with severe periodontal disease were available for the study. This meant that not only was it difficult to obtain adequate meaningful data on the time for complex periodontal treatment but also that the assessment of the outcome of the minimal periodontal treatment programme in such patients was limited.

O'Mullane (1976) has described the differences between clinical trials and field trials. In many respects this study was a hybrid between the two since subjects were recruited from the community to participate in what amounted to in part a clinical trial. Since this study was the first study of its nature undertaken in Hong Kong it was not possible to foresee many of the problems which were ultimately encountered. It is however hoped that through the experience gained with this study, the design of future studies of this nature can be improved upon.

10.5 Implications of the findings of this study

10.5.1 The estimation of the need for periodontal treatment in Hong Kong Chinese using the CPITN

The normative needs for periodontal treatment of Hong Kong Chinese adults expressed according to the proportion of subjects and mean number of sextants requiring different types of periodontal treatment have already been published (Lind, Holmgren et al., 1987a; Corbet, Holmgren et al., 1989; Holmgren et al., 1994). As described in Chapter 3, Ainamo et al., (1982) suggested that treatment needs could also be expressed according to the time required to perform the CPITN defined treatment procedures and such needs can also be used for manpower planning purposes.

One of the objectives of this study was to assess the time required to provide periodontal treatment in a group of adult Hong Kong Chinese so that some estimate of the normative treatment needs of the population expressed according to the amount of time required for treatment could be made. Because of difficulties encountered in the study both with respect to achieving the total sample size and because so few of the sample eventually were deemed to require 'complex' treatment, the treatment time results from this study
could not be used to calculate an estimate of periodontal treatment needs in terms of time for the Hong Kong adult population. Another important consideration is that it was realised that, as mentioned previously, the treatment times determined in this study are unlikely to reflect those that would be found in general dental practice where the bulk of periodontal treatment is likely to be provided.

Caution must therefore be exercised when applying the treatment time findings from this study to other situations, largely because of the many factors which influence treatment time, it can however be deduced that traditional periodontal treatment, when delivered under the conditions of this study is very time consuming. Notwithstanding these concerns, the treatment times determined in this study are similar to those suggested for CPITN related treatment procedures (TRS621, WHO, 1978). The total initial treatment time for a TN2 subject with almost all sextants exhibiting calculus could be calculated to be of the order of three to four hours. It is therefore reasonable to assume that a straightforward translation of the treatment needs as determined by the CPITN for Hong Kong adults to numbers and personnel required to undertake the treatment, in a manner akin to Manji & Sheiham (1986) would indicate a potential commitment in terms of both manpower and resources that would be prohibitive in cost, with a substantial proportion of resources used to remove calculus. The findings of the minimal periodontal treatment programme where calculus was not removed initially are therefore particularly pertinent.

10.5.2 The evaluation of a minimal periodontal treatment programme

This component of the study was undertaken in the realisation that traditional periodontal treatment, as suggested by the CPITN would be impractical at a population level due to the huge resources required for its provision. It was anticipated that because of the omnipresence of calculus in the Hong Kong adult population, scaling/instrumentation would be the most resource intensive component of treatment required. A minimal periodontal treatment programme where the effects of oral hygiene in the absence of instrumentation could be evaluated was therefore devised.

The findings from this study which show that substantial improvements in periodontal parameters can be achieved through oral hygiene instruction in the absence of instrumentation are both important and encouraging in the context of periodontal care for individuals and communities. Particularly important is the finding that improvements
in BOP can be achieved through oral hygiene alone even in individuals with large amounts of calculus. While BOP has a low predictive ability for progression never exceeding 30-40% (Lang et al., 1986; Badersten et al., 1990), the absence of BOP would appear to be a good indicator of stability (Lang et al., 1990). Thus, if it is possible to shift a substantial proportion of sites from bleeding to non-bleeding through oral hygiene alone then it could be hypothesised that this would in turn reduce the possibility of progression at those sites. The effects of such a strategy could form the basis of a population strategy for the management of periodontal disease (Sheiham, 1984). Thus, where resources are limited for oral health care, which often applies to even the richest of countries, it would be possible to target resources to effect an improvement in self-performed oral hygiene. Moreover, instruction and motivation of individuals, groups and communities is not dependent upon highly trained oral health professionals but should be achieved through minimally but appropriately trained personnel devoted to this task.

The finding that instrumentation had some adjunctive effect to the responses achieved through oral hygiene alone was not an unexpected finding and is corroborated by a number of other studies (see Chapter 6). However, the additional benefit conferred through instrumentation is in itself not without a therapeutic penalty since it has been demonstrated that in some instances the treatment itself can lead to damage and loss of periodontal attachment. There is now considerable evidence that instrumentation undertaken in shallow probing depths is accompanied by some loss of attachment and alveolar bone (Knowles et al., 1980; Badersten et al., 1981; Pihlstrom et al., 1981; Lindhe et al., 1982a,b; Claffey, 1988; Nyland & Egberg, 1990; Claffey, 1991; Claffey & Egberg, 1994). Through regression analysis, Lindhe et al., (1982c) found that for scaling and root planing, the initial probing depth below which loss of attachment occurred was 2.9mm. This was termed the 'critical probing depth'. More recently, Westfelt et al., (1985) reported a similar critical probing depth for scaling and root planing alone or in combination with other treatment procedures.

Taken that epidemiological data collected from many countries have shown that most sites in most individuals have PPDs <4mm (Baelum et al., 1986; Baelum et al., 1988; Yoneyama et al., 1988) while sites <4mm are the least likely to lose attachment longitudinally in untreated subjects (Halazonetis et al., 1989; Haffajee et al, 1991), it could be questioned on a biological basis whether instrumentation should be carried out for all sites with calculus in all individuals. Furthermore, since the provision of
instrumentation is highly resource intensive, it must also be questioned on economic
grounds whether a treatment which might for some might cause more harm than good
should be undertaken. Indeed, FDI/WHO Working Group 10 on Periodontal Health
Services (1992) has questioned whether regular scaling on a population basis is likely
to be cost beneficial. Naturally such doubts as to the value of scaling calls for further
research into various oral health strategies.

If instrumentation is to be provided, then based on the findings from this study, there
would appear to be clear advantages in terms of reduced scaling time if the procedure
is deferred until the optimal results of oral hygiene have taken place. The design of this
study called for deferment of the instrumentation of experimental sextants for a period
of 6-months after the provision of oral hygiene instruction. This period was selected
since Cercek et al., (1983) showed no further improvements in either BOP or PPDs after
5 months of oral hygiene alone. The substantial reduction in scaling time in this present
study resulting from deferring this procedure until after the periodontal tissues had
benefited from the effects of oral hygiene alone leads to the question as to how long
instrumentation, if provided, should be deferred. If it is assumed that the greatest
reduction in scaling time is realised by deferring the procedure until the maximal
responses have been achieved through oral hygiene alone, then how long does this take
to occur? In this present study most of the clinical improvements in experimental
sextants in response to oral hygiene alone took place between the baseline and the
three-month examination, with no further clinical improvements thereafter. Because of
the present study's design, it is not known whether these improvements took place
gradually over the whole 3-month period or over a shorter period of time. Data from
other studies suggest however that most improvements generally take place over a
shorter period, usually between 1-2 months after the provision of oral hygiene instruction
(Cercek et al., 1982; Kho et al., 1985; Greenwell et al., 1985; Loos et al., 1988; Garre
et al., 1990; Turner et al., 1994). If this is the case, then it might be questioned whether
it is necessary to defer instrumentation for a full 6-months to take advantage of the
possible reductions in 'initial' scaling time seen in experimental sextants when compared
to control sextants. The optimal time period required between oral hygiene instruction
and initial scaling to achieve a meaningful reduction in scaling time most probably varies
according to existing periodontal conditions and other factors such as level of oral
hygiene achieved (Loos et al., 1988). This is obviously an important area for further
research as it has huge practical implications in the delivery of periodontal treatment
(see section 10.7.1).
In this context, another essential consideration is whether the deferment of scaling once calculus has been detected might place the subject under increased threat of loss of attachment. Long-term studies of up to 50 weeks duration which have examined the effects of supragingival plaque control performed in the absence of instrumentation have shown either little change in PAL (Helldén et al., 1979; Lindhe et al., 1983b,c) or only a slight loss of PAL over this period (Lindhe et al., 1983b; Cercek et al., 1983). In shorter term studies involving periods of up to 3 months, PALs either remain stable (Tagge et al., 1975; Badersten et al., 1984; Turner et al., 1994) or might improve (Loos et al., 1988). Thus, available evidence would suggest that if scaling is deferred for a period of approximately 3 months after oral hygiene instruction has been provided, not only is there a benefit from the reduction in the time required for the procedure, but that the risk of further attachment loss is minimal. In future research studies which examine the optimal deferment period between delivery of oral hygiene instruction and provision of scaling in order to reduce scaling time, the PAL levels should be monitored.

The questions remains as to whether instrumentation is necessary. In this context the potential benefits derived from instrumentation must be carefully weighed against the disadvantages of instrumentation namely the possibility of attachment loss in shallow sites and the cost of delivering the treatment.
11.1 Conclusions

The conclusions which can be drawn from this study are as follows:

- For adult Hong Kong Chinese treated under the conditions of this study, the mean initial oral hygiene time was somewhat less than the time estimates provided in TRS 621 (WHO, 1978);

- The mean time for initial scaling of sextants at baseline was within the range suggested by TRS 621;

- For subsequent maintenance phases, the mean oral hygiene time per subject and the mean scaling time per sextant were greater than the TRS 621 estimates;

- Deferment of initial scaling for a period of six-months after oral hygiene instruction reduced scaling time by one-half thereby providing a basis for the development of more time efficient methods for the provision of periodontal treatment;

- The CPITN score was not useful as an indicator of the time required for individual components of treatment except for initial scaling time at baseline;

- Activity sampling revealed that over half of hygienist time was unproductive;

- Improvements in periodontal health can take place following oral hygiene instruction in the absence of scaling;

- Scaling enhances to some extent the improvements in periodontal health achieved through oral hygiene alone;

- The CPITN has deficiencies due to its hierarchical nature when used for the monitoring periodontal treatment outcomes. This is particularly so when the CPITN is use to monitor changes which result from oral hygiene practices alone as the index is effectively overwhelmed by the presence of calculus;

- The CPITN as modified by Takahashi et al., (1988) confers no advantage in monitoring the outcomes of a minimal periodontal treatment programme involving oral hygiene in the absence of scaling.
11.2 Summary of recommendations for future research

The methods used and the resultant findings from the present study provide a sound basis for further investigations in a number of important areas, as follows:

11.2.1 Further evaluation of the CPITN

Many deficiencies in the CPITN have been identified both in this study and in reviews (Holmgren, 1994; Page & Morrison, 1994). However, for the present time the CPITN remains the global standard for collection of periodontal epidemiological data and continues to become more widely used for periodontal assessments in general practice.

A comprehensive list of further areas of CPITN related research were proposed in the Fifteen Years of CPITN world workshop (Page & Morrison, 1994), most of which remain to be undertaken. These were as follows:

- "Additional research should explore new ways to design studies and manage, analyze, and interpret (CPITN) data, and to assess variability and method error, including the effect of reporting (person, sextant, tooth, tooth site);"

- "Additional studies to better document sensitivity, specificity, and predictive value of CPITN are badly needed";

- "As new diagnostic aids such as tests that detect pathogenic bacteria or actively deteriorating periodontal sites become validated, their incorporation into the CPITN should be explored to better detect and assess destructive periodontal disease";

- "Research that more clearly documents the degree of association between changing periodontal status and CPITN outcome is needed";

- "Modification of the CPITN by inclusion of additional measures such as recession and attachment level, for example, aimed at its capacity to detect changes in disease status, needs to be further explored"; and,

- "Additional studies validating the use of CPITN data to health planning and promotion are badly needed".
In addition to these areas, further research should be undertaken in different clinical environments to ascertain whether there is a relationship between CPITN scores and treatment times, since unless there is any relationship, then the CPITN is of little use for planning purposes.

The value of recording each of the separate components of the CPITN as against recording a single score for each sextant as shown in this present study should be further investigated for each of the applications to which the CPITN is to be used. In this context, the calculus/bleeding phenomenon which was identified by such scoring of the CPITN should be further investigated since, it calls into question the precise relationship between calculus and periodontal disease.

11.2.2 The development of alternative periodontal treatment need indices

The newer concepts of the behaviour of periodontal disease call for periodontal treatment needs and therefore the indices used to assess these needs to be redefined. Alternative periodontal treatment need indices must be designed according to the ultimate objective of the treatment to be provided. If treatment and resources are to be concentrated on those individuals and groups within communities who are at risk of destructive periodontal disease then periodontal treatment need indices will need to incorporate prognostic indicators which are both sensitive and specific. The use of indices based solely on clinical indicators as BOP, calculus and PPDs such as the CPITN are insufficiently sensitive or specific to determine high-risk individuals and groups and it will therefore be necessary to develop indices incorporating tests based upon either microbiological profiles or host factors. Such indices when and if developed must be easy to use, affordable and have a high sensitivity, specificity, reproducibility and predictive value.

In addition to the development of alternative normative periodontal treatment need indices, there is an urgent need to develop sociological indicators in the definition of periodontal treatment need.
11.2.3 The assessment of treatment times for periodontal treatment

i. The use of data from this study

The data from the present study has not been fully explored since analysis was confined to the study's remit. Further analysis could include the effect of different operators on treatment times and the relative proportion of the time spent by hygienists and periodontists both on specific procedures and overall. This latter information would be of great use in formulating models for skill-mix for the delivery of periodontal treatment.

ii. New studies

The present study has shown that neither time study nor activity sampling are adequate in themselves to determine the treatment times for periodontal procedures and that to obtain a more realistic assessment of treatment times there is value in using both methods in combination. Unfortunately, many of the studies which have reported on treatment times have failed to take into account such factors as the time for secondary activities and unproductive time. Thus, further studies are required to properly evaluate the time required to provide different forms of periodontal treatment in different settings.

11.2.4 The testing of other models for the delivery of periodontal treatment

There is an urgent need for research to determine the most cost effective methods of providing periodontal treatment both to individuals and communities. Some suggested areas of further research are given below:

(i) Delivery of oral hygiene instruction

Efficient self-performed plaque control is an essential component of any periodontal treatment programme but especially one where only minimal intervention by oral health professionals is the objective. Thus, different methods of providing oral hygiene instruction should be explored at the individual, small group and community level to determine those which are most effective and cost efficient. The outcomes of such methods should therefore be assessed not only by clinical parameters but also in terms of resources involved (time and personnel required) and acceptability by participants.

As mentioned in Chapter 6, further evaluation of self-assessment and instructional material to replace time consuming oral hygiene instruction delivered at the individual
level (Glavind et al., 1979, 1981, 1984) is worthy of further investigation particularly at the community level. However, for situations where oral hygiene instruction must be provided at the individual level then further research examining the effect of varying the length, number and spacings of oral hygiene instruction appointments as reported by Söderholm et al., (1982) and Söderholm & Egelberg (1982) should be undertaken.

Oral hygiene instruction is usually provided by oral health professionals e.g. either dentists or hygienists. The use of highly trained personnel is expensive and might be inappropriate; since they are trained for tasks additional to oral hygiene instruction. Some research evaluating the use of other less highly trained personnel for such purposes has been carried out (Hetland et al., 1982; Craft et al., 1981) however work in this area should be continued.

(ii) Delivery of instrumentation

The important finding of this study where the scaling time was reduced by one-half when scaling was deferred until six-months after oral hygiene instruction must be investigated further. There is a need for independent corroboration of this finding both in populations with large deposits of calculus such as those in South-East Asia but also in those where deposits might not be so pronounced e.g. Western countries. Furthermore, in view of the findings both from this and other studies which show that most of the effects of oral hygiene in the absence of instrumentation take place over a period of less than six-months, it might be possible to achieve similar reductions in scaling time if scaling was deferred for a shorter period. Thus, it is necessary to determine the optimal timing of instrumentation after the benefits of oral hygiene have taken effect.

The findings from this and other studies which show that the effects of improved oral hygiene are enhanced by instrumentation suggest that various minimal instrumentation techniques should be explored more fully. One alternative is to restrict the removal of calculus to that which is visible i.e. supragingival calculus. Long term effects of oral hygiene instruction combined with a single episode of supragingival scaling have been reported (Dahlén et al., 1992) while Kalkwalf et al., (1988) and Kaldahl et al., (1990) have shown the effects of such treatment in a limited number of patients with more severe periodontal disease. However, further work in this area is required since supragingival instrumentation alone is likely to be easier and less time consuming than instrumentation involving the subgingival areas. Furthermore, as a result of shrinkage
of the marginal gingiva in response to improved plaque control, many subgingival deposits eventually become supragingival.

An alternative approach worthy of evaluation longitudinally would be the exact opposite, namely the restriction of instrumentation to deep pockets. Such an approach is based on the logic that instrumentation confers the greatest benefit to sites with deep PPDs while conversely some damage appears to be caused through instrumentation in shallow sites. There is also some evidence to show that sites with deep PPDs are more likely to undergo further progression. Such an approach would be expected to considerably reduce the time required for instrumentation.

This present study did not control the length of time an operator spent on instrumentation and it is therefore possible that operators spent more time on this procedure than was required to achieve an optimal response. The treatment responses achieved through spending shorter, pre-defined periods of time on instrumentation should be evaluated. Such research could follow the same general protocol as was used in this present study. Furthermore, the value of a single one-visit scaling should be evaluated against multiple-visit scalings.

11.2.5 Recommendations for further research - concluding statement

The last decade has seen huge advances in the understanding of the periodontal disease process and the development of increasingly more complicated, potentially more time consuming, methods to treat it. There remains however a paucity of research on the most appropriate, cost effective and acceptable method of delivering periodontal treatment both to individuals and in particular communities. Such studies must be encouraged for the betterment of oral health in the future. It is hoped that through specifically targeted research it will be possible to achieve scientifically based recommendations on how communities can best utilise their health resources to obtain the greatest benefit for the most people.
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<table>
<thead>
<tr>
<th>Age group</th>
<th>Number of examinees</th>
<th>No periodontal disease (Code 0)</th>
<th>Bleeding only (Code 1)</th>
<th>Calculus (Code 2)</th>
<th>Shallow pockets (Code 3)</th>
<th>Deep pockets (Code 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 - 19</td>
<td>563</td>
<td>2</td>
<td>2</td>
<td>70</td>
<td>26</td>
<td>1</td>
</tr>
<tr>
<td>35 - 44</td>
<td>668</td>
<td>1</td>
<td>0</td>
<td>28</td>
<td>56</td>
<td>16</td>
</tr>
</tbody>
</table>

Table 1.1 Percentage distribution of survey subjects according to the highest CPITN score

<table>
<thead>
<tr>
<th>Age group</th>
<th>Number of examinees</th>
<th>No periodontal disease (Code 0)</th>
<th>Bleeding only (Codes 1+2+3+4)</th>
<th>Calculus (Codes 2+3+4)</th>
<th>Shallow pockets (Codes 3+4)</th>
<th>Deep pockets (Code 4)</th>
<th>Excluded less than 2 teeth (Code X)</th>
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</thead>
<tbody>
<tr>
<td>15 - 19</td>
<td>563</td>
<td>1.1</td>
<td>4.9</td>
<td>4.4</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>35 - 44</td>
<td>668</td>
<td>0.4</td>
<td>5.5</td>
<td>5.4</td>
<td>1.8</td>
<td>0.3</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Table 1.2 Mean number of sextants per person according to CPITN-scores and age-group
<table>
<thead>
<tr>
<th>Age group</th>
<th>Number of examinees</th>
<th>No treatment (TN=0)</th>
<th>Oral hygiene instruction (TN=1)</th>
<th>Oral hygiene &amp; scaling (TN=2)</th>
<th>Oral hygiene, scaling &amp; complex treatment (TN=3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 - 19</td>
<td>563</td>
<td>2</td>
<td>98</td>
<td>96 (4.4)</td>
<td>1 (0.0)</td>
</tr>
<tr>
<td>35 - 44</td>
<td>668</td>
<td>1</td>
<td>99</td>
<td>99 (5.4)</td>
<td>16 (0.3)</td>
</tr>
</tbody>
</table>

*Table 1.3 Percentage of survey subjects in each treatment need category according to age (Numbers in parentheses are mean numbers of sextants per person)*
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>(N=409)</td>
<td>429 procedures</td>
<td></td>
<td>16.0/person</td>
<td>Without chairside assistant.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>800 procedures</td>
<td></td>
<td>14.7/person</td>
<td>All above.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>303 procedures</td>
<td>Examination with explorer</td>
<td>8.9/person</td>
<td>With chairside assistant.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>403 procedures</td>
<td></td>
<td>10.9/person</td>
<td>Without chairside assistant.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>706 procedures</td>
<td></td>
<td>9.9/person</td>
<td>All above.</td>
</tr>
<tr>
<td>Penman et al.</td>
<td>1949</td>
<td>UK</td>
<td>NHS dentists (N=263)</td>
<td>3692 appointments</td>
<td>Examination</td>
<td>13/person</td>
<td>NHS patients of NHS dentists.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Private dentists (N=16)</td>
<td>87 appointments</td>
<td></td>
<td>16/person</td>
<td>Private patients of NHS dentists.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>210 appointments</td>
<td></td>
<td>11/person</td>
<td>Private dentists only.</td>
</tr>
<tr>
<td>Glavind &amp; Løe</td>
<td>1967</td>
<td>Unspecified</td>
<td>Unspecified</td>
<td>Unspecified</td>
<td>Examination</td>
<td>22.5/person</td>
<td>Over two examinations (total 45 min.). Probing depth and loss of attachment.</td>
</tr>
<tr>
<td>Lotzkar et al.</td>
<td>1971</td>
<td>USA</td>
<td>Dentists (N=4)</td>
<td>1270 procedures</td>
<td>Medical history &amp; oral examination.</td>
<td>5.7/person.</td>
<td>Mean range 4.1-8.5/person.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1034 procedures</td>
<td>Charting.</td>
<td>7.2/person.</td>
<td>Mean range 5.0-8.7/person.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5564 procedures</td>
<td>Adult radiographs.</td>
<td>13.4/person.</td>
<td>Mean range 11.5-18.4/person.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dental assistants</td>
<td>3112 procedures</td>
<td>Charting.</td>
<td>8.9/person.</td>
<td>Mean range 7.2-13.2/person.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1395 procedures</td>
<td>Adult radiographs.</td>
<td>20.8/person.</td>
<td>Mean range 16.8-25.8/person.</td>
</tr>
<tr>
<td>Lenox &amp; Kopczyk</td>
<td>1973</td>
<td>USA</td>
<td>Dental auxiliaries</td>
<td>Unspecified</td>
<td>Plaque and bleeding</td>
<td>8-10/person.</td>
<td>Intact dentition with below average oral hygiene.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4-6/person.</td>
<td>Intact dentition with improved oral hygiene.</td>
</tr>
<tr>
<td>Bellini &amp; Gjermo</td>
<td>1973</td>
<td>Norway</td>
<td>Dentist</td>
<td>317 industrial employees</td>
<td>Examination using PTNS</td>
<td>1.4/person (0.9-2.7)</td>
<td>Comprises scoring of bleeding after flossing of interdental area.</td>
</tr>
<tr>
<td>Carter &amp; Barnes</td>
<td>1974</td>
<td>USA</td>
<td>Dentist</td>
<td>50 patients</td>
<td>Gingival Bleeding Index*</td>
<td>&gt;3/person.</td>
<td>See section 2.6.5 on treatment need indices.</td>
</tr>
<tr>
<td>Oliver</td>
<td>1976</td>
<td>USA</td>
<td>General dentists (N=4)</td>
<td>18 patients</td>
<td>Application of the PSE*</td>
<td>&lt;5/person.</td>
<td>Total time spent on examination and charting throughout treatment until patients placed on recall.</td>
</tr>
<tr>
<td>Ekanayaka and Shelham</td>
<td>1978</td>
<td>UK</td>
<td>Dentists (x=36 years)</td>
<td>62 patients</td>
<td>Examination</td>
<td>26.2/person (SD 17.3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Auxiliaries</td>
<td></td>
<td>Charting (G.I. &amp; P.I.)</td>
<td>8.0/person</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.1a Studies reporting treatment times for periodontal procedures (Examination, charting and radiographs)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nash et al.</td>
<td>1979</td>
<td>US</td>
<td>Dentists (N=739)</td>
<td>Unspecified</td>
<td>Examination</td>
<td>12/person</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Radiographs</td>
<td>11/person</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Radiographs</td>
<td>6/person</td>
<td></td>
</tr>
<tr>
<td>Holst &amp; Brembo</td>
<td>1980</td>
<td>Norway</td>
<td>District dental officers (N=40)</td>
<td>Unspecified</td>
<td>Examination including X-rays</td>
<td>10.5/person</td>
<td></td>
</tr>
<tr>
<td>Hetland et al.</td>
<td>1981</td>
<td>Norway</td>
<td>Periodontists</td>
<td>77 patients (25-44 years)</td>
<td>Examination</td>
<td>≥30/person.</td>
<td>DMFT, GI, Retention Index, plaque, probing depth</td>
</tr>
<tr>
<td>Schallhorn &amp; Snider</td>
<td>1981</td>
<td>USA</td>
<td>Hygienist</td>
<td>100 maintenance patients</td>
<td>Dental screening Plaque index</td>
<td>1.1/person</td>
<td>Brief extra- &amp; intraoral examination</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Periodontal assessment</td>
<td>3.5/person</td>
<td>With dental assistant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Plaque index</td>
<td>3.0/person</td>
<td>Without dental assistant</td>
</tr>
<tr>
<td>Rosenberg et al.</td>
<td>1986</td>
<td>USA</td>
<td>Unspecified</td>
<td>3316 patients 558 patients 627 patients 396 patients</td>
<td>Examination &amp; charting</td>
<td>5.5/person</td>
<td>Non-special patients</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X-ray (full-mouth survey)</td>
<td>5.7/person</td>
<td>Developmentally disabled</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Plaque index</td>
<td>5.4/person</td>
<td>Severely medically compromised</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Periodontal assessment</td>
<td>5.4/person</td>
<td>Moderately medically compromised</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Plaque Index and oral hygiene review.</td>
<td>9.5/person</td>
<td>Non-special patients</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Check after hygienist examination.</td>
<td>10.0/person</td>
<td>Developmentally disabled</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Plaque Index and oral hygiene review.</td>
<td>8.5/person</td>
<td>Severely medically compromised</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Check after hygienist examination.</td>
<td>9.0/person</td>
<td>Moderately medically compromised</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Plaque Index and oral hygiene review.</td>
<td>6.3/person</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Check after hygienist examination.</td>
<td>1.8-3/person</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.1b  Studies reporting treatment times for periodontal procedures (Examination, charting and radiographs)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightner et al.</td>
<td>1968</td>
<td>USA</td>
<td>Hygienists</td>
<td>470 patients of US Airforce Academy (17-21 years)</td>
<td>Oral hygiene instruction</td>
<td>10/person</td>
<td>Over two visits 5-11 days apart; 1/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(N=2)</td>
<td>(N=364) (19-34 years)</td>
<td></td>
<td></td>
<td>Maintenance visit; after 6 months</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Oral hygiene instruction &amp;</td>
<td>20/person</td>
<td>Four times per year.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>motivation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scheinin et al.</td>
<td>1970</td>
<td>Finland</td>
<td>Unspecified</td>
<td>Finnish university students (N=394)</td>
<td>Oral hygiene instruction &amp;</td>
<td>20/person</td>
<td>Estimated time for patients with Pl.I. = 0.0-0.19.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>motivation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lotzkar et al.</td>
<td>1971</td>
<td>USA</td>
<td>Dentists</td>
<td>891 procedures</td>
<td>Oral health instruction</td>
<td>10.0/person.</td>
<td>Mean range 4.2-11.5/person.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(N=4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dental assistants</td>
<td>3246 procedures</td>
<td>Education and oral hygiene</td>
<td>6.4/person.</td>
<td>Mean range 7.2-12.4/person.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>instruction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elliott &amp; Bowers</td>
<td>1972</td>
<td>USA</td>
<td>Unspecified</td>
<td>US Naval staff</td>
<td>Instruction in self-examination,</td>
<td>160/group of 6 persons</td>
<td>Oral physiotherapy centre. Instruction through demonstrations, videos, use of cleaning aids etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>self-scaling, toothbrushing &amp;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heibe</td>
<td>1973</td>
<td>Norway</td>
<td>Unspecified</td>
<td>Unspecified</td>
<td>Oral hygiene instruction &amp;</td>
<td>30/person</td>
<td>Time estimate based on empirical data collected from surveys of dentists in Sweden &amp; Norway.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>motivation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Johansen et al.</td>
<td>1973</td>
<td>Norway</td>
<td>Periodontist</td>
<td>42 patients (24-53 years)</td>
<td>Oral hygiene instruction &amp;</td>
<td>72/person SD=28.2 (32-172)</td>
<td>Dental school clinic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>motivation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Godin</td>
<td>1976</td>
<td>UK</td>
<td>Dentist</td>
<td>12 patients</td>
<td>Instruction in self-examination,</td>
<td>180/person</td>
<td>Over 5 visits.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>self-scaling, toothbrushing &amp;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>flossing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gibson &amp; Wade</td>
<td>1977</td>
<td>UK</td>
<td>Hygienist</td>
<td>38 dental students</td>
<td>Verbal explanation, demonstration</td>
<td>4-10/person</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>on models, oral hygiene instruction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tan &amp; Saxton</td>
<td>1978</td>
<td>Netherlands</td>
<td>Hygienists</td>
<td>47 army recruits</td>
<td>Group discussion. Personal oral</td>
<td>30/group 10/person</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>hygiene instruction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ekanayaka &amp; Shehham</td>
<td>1978</td>
<td>UK</td>
<td>Mostly by dental ancillaries. Hygienist.</td>
<td>82 patients (x=36 years) 60 patients</td>
<td>Oral hygiene instruction</td>
<td>55.9/person (SD=21.8)</td>
<td>Hospital clinic.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>8.0/person (SD=4.7)</td>
<td>Industrial clinic.</td>
</tr>
</tbody>
</table>

Table 5.1c Studies reporting treatment times for periodontal procedures (Oral hygiene instruction)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Markkanen et al.</td>
<td>1978</td>
<td>Finland</td>
<td>Periodontists (N=135)</td>
<td>Unspecified</td>
<td>Oral hygiene instruction</td>
<td>30/person approx.</td>
<td>Based on questionnaire to Periodontal division of Finnish Dental Society.</td>
</tr>
<tr>
<td>Nash et al.</td>
<td>1979</td>
<td>USA</td>
<td>Dentists (N=736)</td>
<td>Unspecified</td>
<td>Oral hygiene instruction</td>
<td>7/person</td>
<td></td>
</tr>
<tr>
<td>Schallhorn &amp; Snider</td>
<td>1981</td>
<td>USA</td>
<td>Hygienists</td>
<td>100 maintenance patients</td>
<td>Oral hygiene instruction</td>
<td>4.2/person</td>
<td></td>
</tr>
<tr>
<td>Hetland et al.</td>
<td>1981</td>
<td>Norway</td>
<td>Dental assistants</td>
<td>71 patients (25-44 years)</td>
<td>Oral hygiene instruction</td>
<td>90/person</td>
<td>Three visits over three weeks. (45+30+15mins.)</td>
</tr>
<tr>
<td>Giavind et al.</td>
<td>1981</td>
<td>Denmark</td>
<td>Hygienist</td>
<td>13 patients</td>
<td>Oral hygiene instruction</td>
<td>19/person (10-27)</td>
<td></td>
</tr>
<tr>
<td>Söderholm et al.</td>
<td>1982</td>
<td>Sweden</td>
<td>'Plaque control' dental nurses</td>
<td>69 patients (29-44 years)</td>
<td>Oral hygiene instruction</td>
<td>120/person 150/person</td>
<td>Two 1 hour visits 7-10 days apart. Five 30 min. visits 2-3 days apart. (No difference in clinical results)</td>
</tr>
<tr>
<td>Söderholm &amp; Egelberg</td>
<td>1982</td>
<td>Sweden</td>
<td>'Plaque control' dental nurses</td>
<td>59 patients (36-47 years)</td>
<td>Oral hygiene instruction</td>
<td>90/person 45/person</td>
<td>Three 30 min. visits over 14 days. Three 15 min. visits over 14 days. (No difference in clinical results)</td>
</tr>
<tr>
<td>Douglass et al.</td>
<td>1984</td>
<td>USA</td>
<td>?hygienists</td>
<td>Unspecified</td>
<td>Oral hygiene instruction</td>
<td>10/person</td>
<td></td>
</tr>
<tr>
<td>Giavind et al.</td>
<td>1985</td>
<td>Denmark</td>
<td>Dentists</td>
<td>26 patients</td>
<td>Oral hygiene instruction</td>
<td>≥25-30/person</td>
<td></td>
</tr>
<tr>
<td>Gordon et al.</td>
<td>1988</td>
<td>Israel</td>
<td>Hygienists</td>
<td>Israeli Defence Force personnel</td>
<td>Oral hygiene instruction</td>
<td>≥15/person</td>
<td></td>
</tr>
<tr>
<td>Miller et al.</td>
<td>1998</td>
<td>France</td>
<td>Periodontists (N=282)</td>
<td>Unspecified</td>
<td>Oral hygiene instruction</td>
<td>≥60/person</td>
<td>Per appointment: mean=18/person, median=15.5/person. For initial treatment phase over an average of 4 appointments.</td>
</tr>
</tbody>
</table>

Table 5.1d Studies reporting treatment times for periodontal procedures (Oral hygiene instruction)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milgrom et al.</td>
<td>1988</td>
<td>USA</td>
<td>Dentists (N=427)</td>
<td>Predominantly adults</td>
<td>Oral hygiene instruction</td>
<td>10.4/visit (median)</td>
<td>Initial OHI, Follow-up OHI, Initial OHI, no fee charged.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8.5/visit</td>
<td>Initial OHI, fee charged.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13.4/visit</td>
<td>Initial OHI, no fee charged.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14.3/visit</td>
<td>Follow-up OHI, fee charged.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.4/visit</td>
<td>Follow-up OHI, no fee charged.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7.8/visit</td>
<td>(Some patients may have multiple visits).</td>
</tr>
<tr>
<td>Milgrom et al.</td>
<td>1989</td>
<td>USA</td>
<td>Therapists, primarily hygienists (N=19)</td>
<td>71 adult patients</td>
<td>Oral hygiene instruction</td>
<td>9.4/visit (SD=7.4, range 2-35)</td>
<td>Patients considered to be in need of oral hygiene at recall appointment.</td>
</tr>
<tr>
<td>Takahashi et al.</td>
<td>1989</td>
<td>Japan</td>
<td>Hygienist</td>
<td>33 patients</td>
<td>Oral hygiene instruction</td>
<td>20-30/person</td>
<td>4 patients at once</td>
</tr>
</tbody>
</table>

Table 5.1e Studies reporting treatment times for periodontal procedures (Oral hygiene instruction)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penman et al.</td>
<td>1949</td>
<td>UK</td>
<td>NHS dentists (N=263), Private dentists (N=16)</td>
<td>1407 appointments, 48 appointments, 121 appointments</td>
<td>Presumably hand-scaling</td>
<td>25/patient</td>
<td>NHS patients of NHS dentists</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Private patients of NHS dentists only</td>
</tr>
<tr>
<td>Johnson &amp; Wilson</td>
<td>1957</td>
<td>USA</td>
<td>Unspecified</td>
<td>1 patient</td>
<td>Ultrasonic scaling</td>
<td>18/sextant</td>
<td>For sextant 07 only</td>
</tr>
<tr>
<td>Burman et al.</td>
<td>1958</td>
<td>USA</td>
<td>2 dentists</td>
<td>6 patients (30-73 years)</td>
<td>Ultrasonic scaling</td>
<td>16.2/sextant (10-30)</td>
<td>For sextant 07 only</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 other dentists (45-47 years)</td>
<td>Hand scaling</td>
<td>13/sextant</td>
<td>For sextant 07 only</td>
</tr>
<tr>
<td>Jarabak</td>
<td>1961</td>
<td>USA</td>
<td>Dentist</td>
<td>Unspecified</td>
<td>Hand scaling</td>
<td>46 max/person</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt; 300 orthodontic patients</td>
<td>Ultrasonic scaling</td>
<td>15-20/person</td>
<td></td>
</tr>
<tr>
<td>Moskow &amp; Bressman</td>
<td>1964</td>
<td>USA</td>
<td>Unspecified</td>
<td>42 extracted teeth, 53 extracted teeth</td>
<td>Hand scaling, Ultrasonic scaling</td>
<td>3.8/tooth</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.9/tooth</td>
<td></td>
</tr>
<tr>
<td>Sorrin &amp; Ewen</td>
<td>1965</td>
<td>USA</td>
<td>Unspecified</td>
<td>18 patients (27-62 years)</td>
<td>Hand scaling</td>
<td>0.6/tooth* (0.2-1.4), 0.5/tooth* (0.3-1.0)</td>
<td>Lateral incisors and canines</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ultrasonic scaling</td>
<td></td>
<td>Lateral incisors and canines (Probing depths 1-6 mm)</td>
</tr>
<tr>
<td>Forrest</td>
<td>1967</td>
<td>UK</td>
<td>Hygienist students</td>
<td>Phantom heads</td>
<td>Hand scaling, Ultrasonic scaling, Hand scaling, Ultrasonic scaling</td>
<td>36.5/quadrant, 13.0/quadrant, 16.0/quadrant, 12.2/quadrant</td>
<td>Start of course, Start of course, End of course, End of course</td>
</tr>
<tr>
<td>Stewart et al.</td>
<td>1967</td>
<td>USA</td>
<td>Dental students</td>
<td>92 patients (18-66 years)</td>
<td>Hand scaling, Ultrasonic scaling, Hand scaling, Ultrasonic scaling</td>
<td>12.3/quadrant, 12.3/quadrant, 20.4/quadrant, 17.9/quadrant</td>
<td>Maxillary quadrants, Maxillary quadrants, Mandibular quadrants, Mandibular quadrants (LA used for deep subgingival calculus)</td>
</tr>
</tbody>
</table>

Table 5.1f  Studies reporting treatment times for periodontal procedures (Scaling, root planing & removal of plaque retentive factors)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frisch et al.</td>
<td>1970</td>
<td>USA</td>
<td>83 dentists</td>
<td>83 patients (18-57 years)</td>
<td>Ultrasonic and hand scaling</td>
<td>43/quadrant (25-90/quadrant)</td>
<td>Probing depths 4 - 7 mm deep</td>
</tr>
<tr>
<td>Lotzkar et al.</td>
<td>1971</td>
<td>USA</td>
<td>Dentists (N=4)</td>
<td>966 procedures</td>
<td>Scaling</td>
<td>15.6/person.</td>
<td>Mean range 11.5-19.6/person.</td>
</tr>
<tr>
<td>Donzé et al.</td>
<td>1973</td>
<td>Switzerland</td>
<td>Unspecified</td>
<td>23 patients (x=31 SD=10 years); 200 teeth.</td>
<td>Hand scaling, Hand scaling</td>
<td>2.5/tooth* SD=1.2</td>
<td>36 maxillary teeth</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hand scaling, Hand scaling</td>
<td>5.1/tooth* SD=2.6</td>
<td>65 mandibular teeth</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ultrasonic scaling, Ultrasonic scaling</td>
<td>4.2/tooth* SD=2.6</td>
<td>100 maxillary &amp; mandibular teeth</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ultrasonic scaling, Ultrasonic scaling</td>
<td>1.2/tooth* SD=0.8</td>
<td>35 maxillary teeth</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ultrasonic scaling</td>
<td>2.4/tooth* SD=1.2</td>
<td>65 mandibular teeth</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ultrasonic scaling</td>
<td>2.0/tooth* SD=1.2</td>
<td>100 maxillary &amp; mandibular teeth</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>'-' Probing depths ≤ 3mm</td>
</tr>
<tr>
<td>Heide</td>
<td>1973</td>
<td>Norway</td>
<td>Unspecified</td>
<td>Unspecified</td>
<td>Supragingival scaling, Subgingival scaling &amp; removal of overhangs.</td>
<td>60/person</td>
<td>Time estimate based on empirical data collected from surveys of dentists in Sweden &amp; Norway (Time for supragingival scaling was not added when subgingival scaling was needed in ≥ 2 quadrants)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60/quadrant</td>
<td></td>
</tr>
<tr>
<td>Johansen et al.</td>
<td>1973</td>
<td>Norway</td>
<td>Periodontist</td>
<td>41 patients with 159 quadrants (24-53 years)</td>
<td>Hand scaling, polishing, removal of overhangs</td>
<td>30.6/quadrant SD=11.0 (17-66) 5/tooth</td>
<td>Dental school clinic</td>
</tr>
<tr>
<td>Bellini &amp; Gjermo</td>
<td>1973</td>
<td>Norway</td>
<td>Periodontists &amp; postgraduates (N=6)</td>
<td>22 quadrants 140 teeth</td>
<td>Hand scaling, polishing, removal of overhangs</td>
<td>24.3/quadrant SD=7.9 (17-45)</td>
<td>Dental school clinic (Probing depths &lt;5mm)</td>
</tr>
<tr>
<td>Scarrot (quoted by Ekanayaka, 1976)</td>
<td>1976</td>
<td>UK</td>
<td>British NHS dentists (N=11845)</td>
<td>Unsatisfactory</td>
<td>Scaling &amp; polishing</td>
<td>11.6/person</td>
<td>From Dental Rates Study Group of NHS.</td>
</tr>
</tbody>
</table>

*Table 5.1g Studies reporting treatment times for periodontal procedures (Scaling, root planing & removal of plaque retentive factors)*
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ekanayaka &amp; Sheiham</td>
<td>1978</td>
<td>UK</td>
<td>Mostly dental ancillaries, Hygienist</td>
<td>62 patients (x=36 years) 60 patients</td>
<td>Scaling &amp; polishing. Scaling &amp; polishing</td>
<td>72.8/person (SD=41.0), 25.7/person (SD=16.1)</td>
<td>Hospital clinic</td>
</tr>
<tr>
<td>Markkanen et al.</td>
<td>1978</td>
<td>Finland</td>
<td>Periodontists</td>
<td>Unspecified</td>
<td>Scaling</td>
<td>30/quadrant approx.</td>
<td>Based on questionnaire to Periodontal division of the Finnish Dental Society.</td>
</tr>
<tr>
<td>Nash et al.</td>
<td>1979</td>
<td>USA</td>
<td>Dentists (N=736) Hygienists</td>
<td>Unspecified</td>
<td>Scaling and root planing ?</td>
<td>29/quadrant</td>
<td></td>
</tr>
<tr>
<td>Schallhorn &amp; Snider</td>
<td>1981</td>
<td>USA</td>
<td>Hygienist</td>
<td>100 maintenance patients</td>
<td>Ultrasonic S &amp; RP Hand S &amp; RP</td>
<td>6.8/person 10.0/person</td>
<td>With dental assistant</td>
</tr>
<tr>
<td>Hetland et al.</td>
<td>1981</td>
<td>Norway</td>
<td>Trainee periodontists (N=2)</td>
<td>48 patients</td>
<td>Ultrasonic &amp; hand scaling, removal of overhangs</td>
<td>Up to 45/person allotted</td>
<td></td>
</tr>
<tr>
<td>Söderholm et al.</td>
<td>1982</td>
<td>Sweden</td>
<td>Hygienist</td>
<td>69 patients (29-44 years)</td>
<td>Initial prophylaxis comprising scaling &amp; removal of overhangs</td>
<td>60/person max.</td>
<td>Treatment completed in one hour.</td>
</tr>
<tr>
<td>Douglass et al.</td>
<td>1984</td>
<td>USA</td>
<td>Dentists &amp; hygienists</td>
<td>Patients of all ages</td>
<td>Scaling</td>
<td>15/quadrant</td>
<td>Estimated time from US time studies.</td>
</tr>
<tr>
<td>Solovan</td>
<td>1984</td>
<td>USA</td>
<td>Hygienist students</td>
<td>Unspecified</td>
<td>Scaling (gloved). Scaling (ungloved).</td>
<td>42.8 SD=21.4 36.0 SD=21.1</td>
<td>Time for half-mouth scaling.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20 mandibular incisors</td>
<td>Air-turbine scaling</td>
<td>1.2/tooth</td>
<td>Calculus air-turbine scaler.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20 mandibular incisors</td>
<td>Air-turbine scaling</td>
<td>1.1/tooth</td>
<td>Titan-S air-turbine scaler.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10 mandibular incisors</td>
<td>Ultrasonic scaling</td>
<td>1.1/tooth</td>
<td>Cavitrion (medium power).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10 mandibular incisors</td>
<td>Ultrasonic scaling</td>
<td>1.0/tooth</td>
<td>Cavitrion (maximum power).</td>
</tr>
</tbody>
</table>

Table 5.1h Studies reporting treatment times for periodontal procedures (Scaling, root planing & removal of plaque retentive factors)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rosenberg et al.</td>
<td>1986</td>
<td>USA</td>
<td>Unspecified</td>
<td>3316 patients 558 patients 627 patients 306 patients</td>
<td>Scaling</td>
<td>13.9/person</td>
<td>Non-special patients</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>558 patients</td>
<td></td>
<td></td>
<td>Developmentally disabled</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>627 patients</td>
<td></td>
<td></td>
<td>Severely medically compromised</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>306 patients</td>
<td></td>
<td></td>
<td>Moderately medically compromised</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30.5/sextant.</td>
<td>Sextant 06.</td>
</tr>
<tr>
<td>Lavanchy et al.</td>
<td>1987</td>
<td>Switzerland</td>
<td>Unspecified</td>
<td>7 patients (41-60 x=49)</td>
<td>Scaling &amp; root planing</td>
<td>300/person approx.</td>
<td>Completed within 1 week. (Some sites with probing depths &gt; 6 mm)</td>
</tr>
<tr>
<td>Nordland et al.</td>
<td>1987</td>
<td>USA</td>
<td>Unspecified (N=2)</td>
<td>19 patients (29-68 median=45 years)</td>
<td>Hand and ultrasonic instrumentation under local anaesthesia</td>
<td>3.2/tooth</td>
<td>Non-molar teeth. (Some teeth with probing depths ≥ 7 mm) Molar teeth.</td>
</tr>
<tr>
<td>Loos et al.</td>
<td>1987</td>
<td>USA</td>
<td>Periodontist</td>
<td>10 patients (35-65 years)</td>
<td>Air-turbine scaling Ultrasonic scaling</td>
<td>4.0/tooth (SD=3)</td>
<td>Probing depths 0.5 - 9.5 mm.</td>
</tr>
<tr>
<td>Laurel &amp; Pettersson</td>
<td>1988</td>
<td>Sweden</td>
<td>Dental hygiene students (N=6)</td>
<td>12 patients (36-55 years, x=47)</td>
<td>Hand scaling</td>
<td>1.2/tooth (SD=3)</td>
<td>Probing depths 4-7 mm.</td>
</tr>
<tr>
<td>Pfeifer &amp; Pfeifer</td>
<td>1988</td>
<td>USA</td>
<td>Hygienists (N=4)</td>
<td>153 patients</td>
<td>Root planing with hand instruments</td>
<td>24.1/person</td>
<td>In only three quadrants. (Sites with probing depths 1 -&gt; 7 mm). 1 month after hygienist treatment.</td>
</tr>
<tr>
<td>Kaldahl et al.</td>
<td>1988</td>
<td>USA</td>
<td>Hygienist</td>
<td>82 patients (x=43.5 years)</td>
<td>Root planing with hand &amp; ultrasonic instruments</td>
<td>252/person</td>
<td>In only three quadrants. (Sites with probing depths 1 -&gt; 7 mm). 1 month after hygienist treatment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Periodontist</td>
<td></td>
<td></td>
<td>18/quadrant</td>
<td></td>
</tr>
<tr>
<td>Kaldahl et al.</td>
<td>1988</td>
<td>USA</td>
<td>Hygienist</td>
<td>82 patients (x=43.5 years)</td>
<td>Root planing with hand &amp; ultrasonic instruments</td>
<td>252/person</td>
<td>In only three quadrants. (Sites with probing depths 1 -&gt; 7 mm). 1 month after hygienist treatment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Periodontist</td>
<td></td>
<td></td>
<td>18/quadrant</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.1: Studies reporting treatment times for periodontal procedures (Scaling, root planing & removal of plaque retentive factors)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brayer et al.</td>
<td>1989</td>
<td>USA</td>
<td>Experienced periodontists</td>
<td>28 single rooted teeth</td>
<td>Open S &amp; RP*</td>
<td>5.3/tooth</td>
<td>Selection criteria: Teeth to be extracted, calculus index ≥ 2, no periodontal treatment within previous year.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>24 single rooted teeth</td>
<td>Closed S &amp; RP*</td>
<td>8.1/tooth</td>
<td>(See under &quot;Periodontal surgery&quot;)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Student periodontists</td>
<td>26 single rooted teeth</td>
<td>Open S &amp; RP**</td>
<td>6.7/tooth</td>
<td>(Therapy initiated with ultrasonic scaler &amp; finished with hand instruments)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21 single rooted teeth</td>
<td>Closed S &amp; RP**</td>
<td>9.5/tooth</td>
<td>(Probing depth 1 - &gt;6 mm)</td>
</tr>
<tr>
<td>Takahashi et al.</td>
<td>1989</td>
<td>Japan</td>
<td>Hygienist</td>
<td>Unspecified</td>
<td>Ultrasonic scaling</td>
<td>30 min.</td>
<td>Patients with CPITN 3 or 4</td>
</tr>
</tbody>
</table>

Table 5.1j  Studies reporting treatment times for periodontal procedures (Scaling, root planing & removal of plaque retentive factors)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torfason et al.</td>
<td>1979</td>
<td>USA</td>
<td>Operator # 1</td>
<td>18 patients (19-61 years); single rooted teeth 1.</td>
<td>Hand S &amp; RP</td>
<td>5.6/tooth total</td>
<td>No periodontal treatment, subgingival scaling or root planing in previous 5 years. Instrumentation performed over two sessions, one month apart.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Operator # 2</td>
<td></td>
<td>Ultrasound S &amp; RP</td>
<td>5.0/tooth total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Operator # 3</td>
<td></td>
<td>Hand S &amp; RP</td>
<td>8.1/tooth total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Operator # 4</td>
<td></td>
<td>Ultrasound S &amp; RP</td>
<td>7.0/tooth total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hand S &amp; RP</td>
<td>4.8/tooth total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ultrasound S &amp; RP</td>
<td>4.1/tooth total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hand S &amp; RP</td>
<td>6.4/tooth total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ultrasound S &amp; RP</td>
<td>4.5/tooth total</td>
<td></td>
</tr>
<tr>
<td>Badersten et al.</td>
<td>1981</td>
<td>Sweden</td>
<td>Periodontist # 1</td>
<td>15 patients (22-60 years) Excluding molars.</td>
<td>Hand scaling</td>
<td>6.6/tooth total</td>
<td>Time indicated represents the total instrumentation time at appointments scheduled 2 months &amp; 6 months after initial instrumentation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Periodontist # 2</td>
<td></td>
<td>Ultrasonic scaling</td>
<td>4.9/tooth total</td>
<td></td>
</tr>
<tr>
<td>Stambaugh et al.</td>
<td>1981</td>
<td>USA</td>
<td>Hygienists (N=2)</td>
<td>4 maxillary posterior teeth 3 mandibular posterior teeth</td>
<td>Hand scaling</td>
<td>9.0/tooth total</td>
<td>One week after an initial ultrasonic scaling. Ramfjord index teeth had probing depths ≥ 5 mm. (Mean probing depth = 6.9 mm, range 1-10mm)</td>
</tr>
<tr>
<td>Ciancio et al.</td>
<td>1982</td>
<td>USA</td>
<td>Hygienists (N=2)</td>
<td>26 patients (35-65 years)</td>
<td>Scaling and root planing</td>
<td>45-60/half mouth</td>
<td></td>
</tr>
<tr>
<td>Thornton &amp; Garnick</td>
<td>1982</td>
<td>USA</td>
<td>Unspecified</td>
<td>5 patients 24 non-molar teeth</td>
<td>Hand or ultrasonic scaling</td>
<td>3/tooth</td>
<td>Probing depths &gt; 5mm.</td>
</tr>
</tbody>
</table>

Table 5.1k Studies reporting treatment times for periodontal procedures (Complex treatment, non-surgical)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Badersten et al.</td>
<td>1984a</td>
<td>Sweden</td>
<td>Periodontist, # 1&lt;sup&gt;1&lt;/sup&gt;</td>
<td>16 patients (38-58 years)</td>
<td>Hand scaling, Hand scaling</td>
<td>9.4/tooth&lt;sup&gt;†&lt;/sup&gt;, total</td>
<td>Time indicated represents the total instrumentation time at appointments scheduled 3 months, 6 months &amp; 9 months after oral hygiene instruction. (Probing depths 4-12 mm).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Periodontist, # 2&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Excluding molars.</td>
<td>Ultrasonic scaling</td>
<td>7.6/tooth&lt;sup&gt;†&lt;/sup&gt;, total</td>
<td></td>
</tr>
<tr>
<td>Badersten et al.</td>
<td>1984b</td>
<td>Sweden</td>
<td>Periodontist, # 1&lt;sup&gt;1&lt;/sup&gt;</td>
<td>13 patients (30-55 years)</td>
<td>Hand scaling, Hand scaling</td>
<td>12.5/tooth&lt;sup&gt;†&lt;/sup&gt;, total</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Excluding molars.</td>
<td>Ultrasonic scaling</td>
<td>13.3/tooth&lt;sup&gt;†&lt;/sup&gt;, total</td>
<td></td>
</tr>
<tr>
<td>Badersten et al.</td>
<td>1985</td>
<td>Sweden</td>
<td>Periodontist, Hygienists (N=5)</td>
<td>20 patients (28-64 years)</td>
<td>Hand &amp; ultrasonic instrumentation</td>
<td>9.1/tooth&lt;sup&gt;†&lt;/sup&gt;, Operator # 2&lt;sup&gt;1&lt;/sup&gt; (Periodontist).</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Excluding molars</td>
<td></td>
<td>10.4/tooth&lt;sup&gt;†&lt;/sup&gt;, Operator # 3 (Hygienist).</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>12.2/tooth&lt;sup&gt;†&lt;/sup&gt;, Operator # 4 (Hygienist).</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>9.4/tooth&lt;sup&gt;†&lt;/sup&gt;, Operator # 5 (Hygienist).</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.6/tooth&lt;sup&gt;†&lt;/sup&gt;, Operator # 6 (Hygienist).</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>8.7/tooth&lt;sup&gt;†&lt;/sup&gt;, Operator # 7 (Hygienist).</td>
<td>(Single instrumentation of teeth with probing depths 4-11 mm)</td>
</tr>
</tbody>
</table>

Table 5.11 Studies reporting treatment times for periodontal procedures (Complex treatment, non-surgical)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penman et al.</td>
<td>1949</td>
<td>UK</td>
<td>NHS dentists</td>
<td>15 appointments</td>
<td>Gingivectomy</td>
<td>175/patient</td>
<td>NHS patients of NHS dentists</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(N=263)</td>
<td></td>
<td></td>
<td></td>
<td>Private dentists only</td>
</tr>
<tr>
<td>Edwardsson &amp; Mobius</td>
<td>1966</td>
<td>Sweden</td>
<td>Unspecified</td>
<td>7 appointments</td>
<td>Gingivectomy</td>
<td>160/patient</td>
<td>(Estimated from time studies performed in Sweden 1946 &amp; 1956)</td>
</tr>
<tr>
<td>Heloe</td>
<td>1973</td>
<td>Norway</td>
<td>Unspecified</td>
<td>Unspecified</td>
<td>Periodontal surgery</td>
<td>60/quadrant</td>
<td>Time estimate based on empirical data collected from surveys of dentists in Sweden &amp; Norway</td>
</tr>
<tr>
<td>Johansen et al.</td>
<td>1973</td>
<td>Norway</td>
<td>Periodontist</td>
<td>31 patients with 73 quadrants (24-53 years)</td>
<td>Periodontal surgery</td>
<td>57.4/quadrant</td>
<td>Dental school clinic. No prescaling performed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>26 quadrants</td>
<td>Mainly gingivectomy</td>
<td>11/tooth</td>
<td>Prescaled 44 mins./quadrant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>52 quadrants in total</td>
<td>Both</td>
<td>460/quadrant</td>
<td>Not prescaled 48 mins./quadrant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Prescaled 59 mins./quadrant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not prescaled 57 mins./quadrant</td>
</tr>
<tr>
<td>Bellini &amp; Johansen</td>
<td>1973</td>
<td>Norway</td>
<td>Periodontist &amp; postgraduates (N=6)</td>
<td>26 quadrants</td>
<td>Flap operation</td>
<td>52 quadrants in total</td>
<td>Both</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>51.6/quadrant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>58/quadrant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60/quadrant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Approximation</td>
</tr>
<tr>
<td>Markkanen et al.</td>
<td>1978</td>
<td>Finland</td>
<td>Periodontists (N=135)</td>
<td>Unspecified</td>
<td>Periodontal surgery</td>
<td>60/quadrant approx.</td>
<td>Based on questionnaire to Periodontal division of Finnish Dental Society</td>
</tr>
<tr>
<td>Ekanayaka &amp; Sheiham</td>
<td>1978</td>
<td>UK</td>
<td>Dentists</td>
<td>17 patients</td>
<td>Periodontal surgery</td>
<td>78.1/patient (SD=59.0)</td>
<td>Hospital clinic. Flap surgery accounted for 86% of procedures.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>75 procedures</td>
<td></td>
<td>71/patient (SD=59.0)</td>
<td>Flap surgery accounted for 86% of procedures.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14.3/tooth (SD=12.0)</td>
</tr>
<tr>
<td>Nash et al</td>
<td>1979</td>
<td>US</td>
<td>Dentists (N=739)</td>
<td>Unspecified</td>
<td>Periodontal surgery</td>
<td>57/quadrant</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.1m Studies reporting treatment times for periodontal procedures (Complex treatment, surgical)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglass et al.</td>
<td>1984</td>
<td>USA</td>
<td>Dentists &amp; hygienists</td>
<td>Patients of all ages</td>
<td>Surgery</td>
<td>45/quadrant</td>
<td>Estimated time from US time studies.</td>
</tr>
<tr>
<td>Miller et al.</td>
<td>1986</td>
<td>France</td>
<td>Periodontists (N=282)</td>
<td>Unspecified</td>
<td>Periodontal surgery</td>
<td>77/sextant 110/sextant</td>
<td>Probing depths 3.5-5.5mm. Probing depths ≥ 6mm.</td>
</tr>
<tr>
<td>Gordon et al.</td>
<td>1986</td>
<td>Israel</td>
<td>Unspecified</td>
<td>Israeli Defence Force personnel</td>
<td>Localised surgery Quadrant surgery</td>
<td>50/treatment 75/quadrant</td>
<td>Estimated time</td>
</tr>
<tr>
<td>Brayer et al.</td>
<td>1989</td>
<td>USA</td>
<td>Experienced periodontists</td>
<td>28 teeth</td>
<td>Elevate flap &amp; debride Open S &amp; RP Total</td>
<td>6.5/tooth 5.3/tooth 11.8/tooth</td>
<td>Selection criteria: single rooted teeth to be extracted, calculus index ≥ 2, no periodontal treatment within previous year.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Student periodontists</td>
<td>26 teeth</td>
<td>Elevate flap &amp; debride Open S &amp; RP Total</td>
<td>7.8/tooth 6.7/tooth 14.5/tooth</td>
<td></td>
</tr>
</tbody>
</table>

*Table 5.1n Studies reporting treatment times for periodontal procedures (Complex treatment, surgical)*
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altman et al.</td>
<td>1946</td>
<td>USA</td>
<td>Dentists (N=5) &amp; hygienists (N=6)</td>
<td>559 children</td>
<td>Prophylaxis</td>
<td>15.5/person SD=6.1</td>
<td></td>
</tr>
<tr>
<td>Klein et al.</td>
<td>1947</td>
<td>USA</td>
<td>Practicing dentists (N=409)</td>
<td>150 procedures</td>
<td>Prophylaxis</td>
<td>24.2/person</td>
<td>With chairside assistant.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>204 procedures</td>
<td></td>
<td>32.9/person</td>
<td>Without chairside assistant.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>354 procedures</td>
<td></td>
<td>28.5/person</td>
<td>All above.</td>
</tr>
<tr>
<td>Baird et al.</td>
<td>1963</td>
<td>Canada</td>
<td>Royal Canadian Dental Corps</td>
<td>Canadian forces</td>
<td>Prophylaxis</td>
<td>30/person</td>
<td></td>
</tr>
<tr>
<td>Edwardsson &amp; Mobius</td>
<td>1966</td>
<td>Sweden</td>
<td>Unspecified</td>
<td>Unspecified</td>
<td>Prophylaxis &amp; oral hygiene instruction.</td>
<td>30/person</td>
<td>For persons with gingivitis without calculus.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Prophylaxis, oral hygiene instruction &amp; scaling.</td>
<td>45/person</td>
<td>For persons with gingivitis with calculus.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>90/person</td>
<td>For persons with initial pocket formation.</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>(' Estimated from time studies performed in Sweden 1946 &amp; 1956)</td>
<td></td>
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</tr>
<tr>
<td>Lightner et al.</td>
<td>1968</td>
<td>USA</td>
<td>Hygienists (N=2)</td>
<td>470 patients of US Airforce Academy (17-21 years)</td>
<td>Scaling &amp; polishing</td>
<td>50/person.</td>
<td>One 50 min. visit; 1/year; No OHI given. Two 30 min. visits 5-11 days apart; 1/year; OHI given but time not included. Two 30 min. visits 5-11 days apart; third 30 min. visit after 6 months; OHI given but time not included. One 30 min. visit every 3 months; OHI given but time not included.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>60/person.</td>
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<td></td>
<td></td>
<td>60/person.</td>
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<td></td>
<td>30/person.</td>
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<td></td>
<td>30/person.</td>
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<td></td>
<td></td>
<td></td>
<td>80/person.</td>
<td></td>
</tr>
<tr>
<td>Lotzkar et al.</td>
<td>1971</td>
<td>USA</td>
<td>Dentists (N=4) Dental assistants</td>
<td>889 procedures</td>
<td>Pumice prophylaxis</td>
<td>10.0/person.</td>
<td>Mean range 8.5-13.8/person.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>19.7/person.</td>
<td>Mean range 14.5-24.5/person.</td>
</tr>
<tr>
<td>Axelsson &amp; Lindhe</td>
<td>1978</td>
<td>Sweden</td>
<td>Hygienists</td>
<td>Unspecified</td>
<td>Prophylaxis</td>
<td>90-120/person</td>
<td>Approximate time over 3-4 visits.</td>
</tr>
</tbody>
</table>

*Table 5.1o* Studies reporting treatment times for periodontal procedures (Miscellaneous and combinations of procedures)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Christen et al.</td>
<td>1979</td>
<td>USA</td>
<td>US Airforce dental personnel</td>
<td>US Airforce personnel</td>
<td>Preventive treatment</td>
<td>36/person</td>
<td>Prophylaxis, preventive dentistry counseling, periodontal scaling for 30% of personnel with calculus scores ≥ 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Nonsurgical periodontal treatment</td>
<td>31/sextant</td>
<td>Prophylaxis, preventive dentistry counseling and periodontal scaling.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Surgical periodontal treatment</td>
<td>55/sextant</td>
<td>Prophylaxis, preventive dentistry counseling, periodontal scaling, surgery, and postoperative treatment.</td>
</tr>
<tr>
<td>Holst &amp; Brembo</td>
<td>1980</td>
<td>Norway</td>
<td>District dental officers (N=40)</td>
<td>Unspecified</td>
<td>Cleaning &amp; polishing</td>
<td>12.7/person</td>
<td></td>
</tr>
<tr>
<td>Schallhorn &amp; Snider</td>
<td>1981</td>
<td>USA</td>
<td>Hygienist</td>
<td>100 maintenance patients</td>
<td>Polishing &amp; flossing</td>
<td>10.9/person</td>
<td>In a periodontal practice.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Oral prophylaxis</td>
<td>52.6/person</td>
<td>Comprising: Greeting, health history, dental screening, assessment of periodontium, caries &amp; defective restorations, P.I., oral hygiene review, polishing &amp; flossing, scaling &amp; root planing, chemical therapy, F rinse, dismissal, re-appointment.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hill et al.</td>
<td>1981</td>
<td>USA</td>
<td>Hygienists</td>
<td>90 patients (24-68 x=45 years)</td>
<td>Initial oral hygiene instruction, scaling &amp; root planing</td>
<td>≥300-480/person.</td>
<td>Performed in 4-6 appointments over 1 month prior to treatment by periodontist.</td>
</tr>
<tr>
<td>Pihlstrom et al.</td>
<td>1981,1984</td>
<td>USA</td>
<td>Trainee periodontist</td>
<td>17 patients (22-69 x=43 years)</td>
<td>Initial oral hygiene instruction, scaling &amp; root planing under local anaesthesia, occlusal adjustment, recontouring of overhangs and defective restorations.</td>
<td>≥300-480/person.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hygienists (N=3)</td>
<td></td>
<td>Maintenance, oral hygiene reinforcement &amp; scaling</td>
<td>≥60/person</td>
<td>Hygienist required to clean teeth to the best of her ability within 1 hour. Took place 3-4 times per year.</td>
</tr>
</tbody>
</table>

Table 5.1p Studies reporting treatment times for periodontal procedures (Miscellaneous and combinations of procedures)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglass et al.</td>
<td>1984</td>
<td>USA</td>
<td>Dentists &amp; hygienists</td>
<td>Patients of all ages</td>
<td>Oral hygiene instruction &amp; prophylaxis</td>
<td>30/person approx.</td>
<td>Estimated time from US time studies</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>28/person(21-33)</td>
<td>1979</td>
</tr>
<tr>
<td>Gordon et al.</td>
<td>1986</td>
<td>Israel</td>
<td>Hygienists</td>
<td>Israeli Defence Force personnel</td>
<td>Oral hygiene instruction, scaling &amp; root planing</td>
<td>45-75/person estimated. 75-105/person estimated. 135-195/person estimated.</td>
<td>Pockets ≤5mm &amp; bone loss ≤½ root length. Pockets &gt;5mm &amp; bone loss &gt;½ root length; under LA (localized surgery required). Pockets &gt;5mm &amp; bone loss &gt;½ root length; under LA (quadrant surgery required).</td>
</tr>
<tr>
<td>Rosenberg et al.</td>
<td>1966</td>
<td>USA</td>
<td>Unspecified</td>
<td>3316 patients</td>
<td>Polishing</td>
<td>6.3/person</td>
<td>Non-special patients Developmentally disabled SeVERELY medically compromised Moderately medically compromised</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>558 patients</td>
<td></td>
<td>9.0/person</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>627 patients</td>
<td></td>
<td>8.3/person</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>396 patients</td>
<td></td>
<td>6.3/person</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7/overhang</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15/overhang</td>
<td></td>
</tr>
<tr>
<td>Miller et al.</td>
<td>1986</td>
<td>France</td>
<td>Periodontists (N=282)</td>
<td>Unspecified</td>
<td>Maintenance</td>
<td>45/person</td>
<td></td>
</tr>
<tr>
<td>Nordland et al.</td>
<td>1987</td>
<td>USA</td>
<td>Unspecified</td>
<td>19 patients (29-68 median=45 years)</td>
<td>Maintenance</td>
<td>30-60/person</td>
<td>Scaling, polishing, &amp; isolated root debridement of deep and/or bleeding sites.</td>
</tr>
</tbody>
</table>

Table 5.1q: Studies reporting treatment times for periodontal procedures (Miscellaneous and combinations of procedures)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Country</th>
<th>Operator</th>
<th>Sample</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
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<td></td>
<td></td>
<td>Maintenance patients</td>
<td>Oral prophylaxis</td>
<td>57.4/person</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td>Dentists (N=574)</td>
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<td></td>
<td></td>
<td>Maintenance patients</td>
<td>Oral prophylaxis</td>
<td>46.9/person</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Periodontists (N=17)</td>
<td></td>
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<tr>
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<td></td>
<td>Maintenance patients</td>
<td>Oral prophylaxis</td>
<td>38.9/person</td>
<td></td>
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</tr>
<tr>
<td>Kaidahl et al.</td>
<td>1988</td>
<td>USA</td>
<td>Hygienist</td>
<td>82 maintenance patients (x = 43 years)</td>
<td>Oral hygiene reinforcement, polishing and subgingival instrumentation</td>
<td>&gt;45-60/person</td>
<td>Every three months. (Instrumentation only performed in 3 quadrants).</td>
</tr>
</tbody>
</table>

Table 5.1r Studies reporting treatment times for periodontal procedures (Miscellaneous and combinations of procedures)
<table>
<thead>
<tr>
<th>Age-group (years)</th>
<th>Positive score for</th>
<th>Service</th>
<th>Time required</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-19</td>
<td>Gingivitis</td>
<td>Oral hygiene education (OHE)</td>
<td>60 min</td>
</tr>
<tr>
<td></td>
<td>Calculus or shallow pockets</td>
<td>Scaling + OHE</td>
<td>15 min + 10 min/quadrant + 50 min for OHE</td>
</tr>
<tr>
<td></td>
<td>Deep pockets</td>
<td>Deep scaling + OHE</td>
<td>45 min/quadrant + 50 min for OHE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>initial</td>
<td>15 min + 5 min/quadrant + 10 min for OHE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>follow-up</td>
<td>10 min/quadrant + 10 min for OHE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surgery</td>
<td>60 min/quadrant + 30 min postop. care</td>
</tr>
<tr>
<td>20-29</td>
<td>Treatment as for age-group 15-19 except that the time required for initial scaling is 15 min/quadrant.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-44</td>
<td>Gingivitis</td>
<td>Oral hygiene education (OHE)</td>
<td>10 min</td>
</tr>
<tr>
<td></td>
<td>Calculus or shallow pockets</td>
<td>Scaling + OHE</td>
<td>15 min + 30 min/quadrant + 50 min for OHE</td>
</tr>
<tr>
<td></td>
<td>Deep pockets</td>
<td>Deep scaling + OHE</td>
<td>45 min/quadrant + 50 min for OHE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>initial</td>
<td>15 min + 5 min/quadrant + 10 min for OHE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>follow-up</td>
<td>10 min/quadrant + 10 min for OHE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surgery</td>
<td>60 min/quadrant + 30 min postop. care</td>
</tr>
<tr>
<td>45 &amp; over</td>
<td>Gingivitis</td>
<td>Oral hygiene education (OHE)</td>
<td>10 min</td>
</tr>
<tr>
<td></td>
<td>Calculus or shallow pockets</td>
<td>Scaling + OHE</td>
<td>15 min + 30 min/quadrant + 50 min for OHE</td>
</tr>
<tr>
<td></td>
<td>Deep pockets</td>
<td>Deep scaling</td>
<td>45 min/quadrant + 50 min for OHE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>initial</td>
<td>15 min + 5 min/quadrant + 10 min for OHE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>follow-up</td>
<td>10 min/quadrant + 10 min for OHE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surgery</td>
<td>60 min/quadrant + 30 min postop. care</td>
</tr>
</tbody>
</table>

Table 5.2  Estimates of mean treatment time required to provide periodontal services (Technical Report Series 621, WHO, 1978)
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Operator</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penman</td>
<td>1949</td>
<td>NHS dentists</td>
<td>Hand scaling</td>
<td>4/sextant^^ (NHS patients) 5/sextant^^ (Private) 4/sextant^ (Private)</td>
</tr>
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<td></td>
<td></td>
<td>NHS dentists</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Private dentists</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Johnson &amp; Wilson</td>
<td>1957</td>
<td>Unspecified</td>
<td>Ultrasonic scaling</td>
<td>18/sextant</td>
</tr>
<tr>
<td>Burman et al.</td>
<td>1958</td>
<td>Dentists</td>
<td>Ultrasonic scaling</td>
<td>16/sextant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hand scaling</td>
<td>Hand scaling</td>
<td>13/sextant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ultrasonic scaling</td>
<td>Ultrasonic scaling</td>
<td>13/sextant</td>
</tr>
<tr>
<td>Jarabak</td>
<td>1961</td>
<td>Dentist</td>
<td>Hand scaling</td>
<td>7/sextant^^ (Max.) 2-3/sextant^^ (Max.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ultrasonic scaling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sorrin &amp; Ewen</td>
<td>1965</td>
<td>Unspecified</td>
<td>Hand scaling</td>
<td>4/sextant^^</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ultrasonic scaling</td>
<td></td>
<td>3/sextant^^</td>
</tr>
<tr>
<td>Stewart et al.</td>
<td>1967</td>
<td>Dental students</td>
<td>Hand scaling</td>
<td>8/maxillary sextant^^ 8/maxillary sextant^^</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ultrasonic scaling</td>
<td>8/maxillary sextant^^ 14/mandibular sextant^^ 12/mandibular sextant^^</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hand scaling</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ultrasonic scaling</td>
<td></td>
</tr>
<tr>
<td>Frisch et al.</td>
<td>1970</td>
<td>Dentists</td>
<td>Ultrasonic &amp; hand scaling</td>
<td>29/sextant^^</td>
</tr>
<tr>
<td>Lotzkar et al.</td>
<td>1971</td>
<td>Dentists</td>
<td>Scaling</td>
<td>3/sextant^^</td>
</tr>
<tr>
<td>Donzé et al.</td>
<td>1973</td>
<td>Unspecified</td>
<td>Hand scaling</td>
<td>15/maxillary sextant^^ 31/mandibular sextant^^ 25/sextant overall^^</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hand scaling</td>
<td>Hand scaling</td>
<td>14/mandibular sextant^^</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ultrasonic scaling</td>
<td>12/mandibular sextant^^</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ultrasonic scaling</td>
<td></td>
</tr>
<tr>
<td>Helöe</td>
<td>1973</td>
<td>Unspecified</td>
<td>Supragingival scaling</td>
<td>10/sextant^^</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subgingival scaling &amp; removal of overhangs</td>
<td></td>
<td>40/sextant^^</td>
</tr>
<tr>
<td>Johansen et al.</td>
<td>1973</td>
<td>Periodontist</td>
<td>Hand scaling, polishing, removal of overhangs</td>
<td>20/sextant^^</td>
</tr>
<tr>
<td>Bellini &amp; Gjermo</td>
<td>1973</td>
<td>Periodontists &amp; postgraduates</td>
<td>Hand scaling, polishing, removal of overhangs</td>
<td>30/sextant^^</td>
</tr>
<tr>
<td>Hobdell</td>
<td>1976</td>
<td>Unspecified</td>
<td>Scaling &amp; polishing</td>
<td>2/sextant^^</td>
</tr>
<tr>
<td>Scarrott</td>
<td>1976</td>
<td>Dentists</td>
<td>Scaling &amp; polishing</td>
<td>2/sextant^^</td>
</tr>
<tr>
<td>Ekanayaka &amp; Sheiham</td>
<td>1978</td>
<td>Mostly ancillaries, hygienist</td>
<td>Scaling &amp; polishing</td>
<td>12/sextant^^</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hygienist</td>
<td>Scaling &amp; polishing</td>
<td>4/sextant^^</td>
</tr>
<tr>
<td>Markkanen et al.</td>
<td>1978</td>
<td>Periodontists</td>
<td>Scaling</td>
<td>20/sextant^^</td>
</tr>
</tbody>
</table>

Table 5.3a Treatment times for scaling (root planing) per sextant

\^ Time per tooth multiplied by factor of 6.
\^\^ Computed from time per quadrant.
\^\^\^ Computed from time per person.
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Operator</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nash et al.</td>
<td>1979</td>
<td>Dentists &amp; Hygienists</td>
<td>Scaling &amp; root planing</td>
<td>19/sextant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Scaling &amp; root planing</td>
<td>24/sextant</td>
</tr>
<tr>
<td>Schallhorn &amp; Snider</td>
<td>1981</td>
<td>Hygienists</td>
<td>Ultrasonic S &amp; RP</td>
<td>1/sextant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hand S &amp; RP</td>
<td>2/sextant</td>
</tr>
<tr>
<td>Hetland et al.</td>
<td>1981</td>
<td>Trainee periodontists</td>
<td>Ultrasonic &amp; hand scaling, removal of overhangs</td>
<td>7/sextant</td>
</tr>
<tr>
<td>Söderholm et al.</td>
<td>1982</td>
<td>Hygienist</td>
<td>Scaling &amp; removal of overhangs</td>
<td>10/sextant (Max.)</td>
</tr>
<tr>
<td>Thornton &amp; Gamick</td>
<td>1982</td>
<td>Unspecified</td>
<td>Hand or ultrasonic scaling</td>
<td>18/sextant</td>
</tr>
<tr>
<td>Douglass et al.</td>
<td>1984</td>
<td>Dentists &amp; hygienists</td>
<td>Scaling</td>
<td>10/sextant</td>
</tr>
<tr>
<td>Solovan</td>
<td>1984</td>
<td>Hygienist students</td>
<td>Scaling (gloved)</td>
<td>14/sextant</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Scaling (ungloved)</td>
<td>13/sextant</td>
</tr>
<tr>
<td>Lie &amp; Leknes</td>
<td>1985</td>
<td>Unspecified</td>
<td>Air-turbine scaling</td>
<td>6-7/sextant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ultrasonic scaling</td>
<td>6/sextant</td>
</tr>
<tr>
<td>Rosenberg et al.</td>
<td>1986</td>
<td>Unspecified</td>
<td>Scaling</td>
<td>2-3/sextant</td>
</tr>
<tr>
<td>Miller et al.</td>
<td>1986</td>
<td>Periodontists</td>
<td>Scaling &amp; root planing</td>
<td>30/sextant</td>
</tr>
<tr>
<td>Lavanchy et al.</td>
<td>1987</td>
<td>Unspecified</td>
<td>Scaling &amp; root planing</td>
<td>50/sextant</td>
</tr>
<tr>
<td>Nordland et al.</td>
<td>1987</td>
<td>Unspecified</td>
<td>Hand &amp; ultrasonic scaling</td>
<td>19/sextant (non-molars)</td>
</tr>
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<td></td>
<td>33/sextant (molars)</td>
</tr>
<tr>
<td>Loos et al.</td>
<td>1987</td>
<td>Periodontist</td>
<td>Air-turbine scaling</td>
<td>24/sextant</td>
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<td>Ultrasonic scaling</td>
<td>20/sextant</td>
</tr>
<tr>
<td>Laureli &amp; Pettersson</td>
<td>1988</td>
<td>Hygienist students</td>
<td>Hand scaling</td>
<td>72/sextant</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Air-turbine scaling</td>
<td>48/sextant</td>
</tr>
<tr>
<td>Pfeifer &amp; Pfeifer</td>
<td>1988</td>
<td>Hygienists</td>
<td>'Root planing' with hand instruments</td>
<td>4/sextant</td>
</tr>
<tr>
<td>Kaldahl et al.</td>
<td>1988</td>
<td>Hygienist &amp; Periodontist</td>
<td>Root planing with hand &amp; ultrasonic instruments</td>
<td>56/sextant</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>12/sextant (1 month later)</td>
</tr>
<tr>
<td>Brayer et al.</td>
<td>1989</td>
<td>Experienced periodontists</td>
<td>Open S &amp; RP</td>
<td>32/sextant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Student periodontists</td>
<td>Closed S &amp; RP</td>
<td>49/sextant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Open S &amp; RP</td>
<td>40/sextant</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>Closed S &amp; RP</td>
<td>57/sextant</td>
</tr>
</tbody>
</table>

Table 5.3b: Treatment times for scaling (root planing) per sextant

- * Time per tooth multiplied by factor of 6.
- ** Computed from time per quadrant.
- *** Computed from time per person.
<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Operator</th>
<th>Procedure</th>
<th>Time estimate (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torfason et al.</td>
<td>1979</td>
<td>Operator # 1</td>
<td>Hand S &amp; RP</td>
<td>34/sexant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ultrasonic S &amp; RP</td>
<td>30/sexant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operator # 2</td>
<td>Hand S &amp; RP</td>
<td>49/sexant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ultrasonic S &amp; RP</td>
<td>42/sexant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operator # 3</td>
<td>Hand S &amp; RP</td>
<td>29/sexant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ultrasonic S &amp; RP</td>
<td>25/sexant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operator # 4</td>
<td>Hand S &amp; RP</td>
<td>38/sexant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ultrasonic S &amp; RP</td>
<td>27/sexant</td>
</tr>
<tr>
<td>Stambaugh et al.</td>
<td>1981</td>
<td>Hygienists</td>
<td>Hand S &amp; RP (maxillary posterior teeth)</td>
<td>195/sexant*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(N=2)</td>
<td>Hand S &amp; RP (mandibular posterior teeth)</td>
<td>125/sexant*</td>
</tr>
<tr>
<td>Thornton &amp; Garnick</td>
<td>1982</td>
<td>Unspecified</td>
<td>Hand or ultrasonic scaling</td>
<td>18/sexant</td>
</tr>
<tr>
<td>Ciancio et al.</td>
<td>1982</td>
<td>Hygienists</td>
<td>Scaling and root planing</td>
<td>15-20/sexant**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(N=2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Badersten et al.</td>
<td>1981</td>
<td>Periodontist # 1</td>
<td>Hand S &amp; RP</td>
<td>40/sexant</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>Ultrasonic S &amp; RP</td>
<td>29/sexant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Periodontist # 2</td>
<td>Hand S &amp; RP</td>
<td>54/sexant</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>Ultrasonic S &amp; RP</td>
<td>51/sexant</td>
</tr>
<tr>
<td>Badersten et al.</td>
<td>1984</td>
<td>Periodontist # 1</td>
<td>Hand S &amp; RP</td>
<td>56/sexant</td>
</tr>
<tr>
<td></td>
<td>a</td>
<td></td>
<td>Ultrasonic S &amp; RP</td>
<td>46/sexant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Periodontist # 2</td>
<td>Hand S &amp; RP</td>
<td>75/sexant</td>
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<td></td>
<td></td>
<td>Ultrasonic S &amp; RP</td>
<td>80/sexant</td>
</tr>
<tr>
<td>Badersten et al.</td>
<td>1984</td>
<td>Periodontist # 1</td>
<td>Ultrasonic S &amp; RP</td>
<td>29/sexant</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td></td>
<td>Over one visit</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Over three visits</td>
<td>47/sexant</td>
</tr>
<tr>
<td>Badersten et al.</td>
<td>1985</td>
<td>Periodontist # 2</td>
<td>Hand &amp; ultrasonic S &amp; RP</td>
<td>55/sexant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hygienist # 3</td>
<td></td>
<td>62/sexant</td>
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<td>Hygienist # 4</td>
<td></td>
<td>73/sexant</td>
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<td>Hygienist # 5</td>
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<td>56/sexant</td>
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<td>Hygienist # 6</td>
<td></td>
<td>58/sexant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hygienist # 7</td>
<td></td>
<td>52/sexant</td>
</tr>
</tbody>
</table>

Table 5.4. Treatment times for complex non-surgical treatment per sextant

* Time per tooth multiplied by factor of 5 as reported time refers to posterior teeth.
** Computed from time for half-mouth.
Sample sizes required to achieve different degrees of accuracy according to different subdivisions of treatment (Table 7.1)

<table>
<thead>
<tr>
<th>SAMPLE SIZE</th>
<th>Degree of accuracy required</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>± 60 secs.</td>
</tr>
<tr>
<td><strong>ORAL HYGIENE TIMES PER SUBJECT</strong></td>
<td></td>
</tr>
<tr>
<td>(number of subjects)</td>
<td></td>
</tr>
<tr>
<td>ALL CPITN</td>
<td>21</td>
</tr>
<tr>
<td><strong>SCALING TIMES PER SEXTANT</strong></td>
<td></td>
</tr>
<tr>
<td>(number of sextants) (number of subjects in parentheses)</td>
<td></td>
</tr>
<tr>
<td>ALL CPITN</td>
<td>82 (14)</td>
</tr>
<tr>
<td>CPITN=2</td>
<td>81 (14)</td>
</tr>
<tr>
<td>CPITN=3</td>
<td>73 (12)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Degree of accuracy required</th>
<th>± 10 mins.</th>
<th>± 5 mins.</th>
<th>± 2 mins.</th>
<th>± 60 secs.</th>
<th>± 30 secs.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SCALING TIME PER SUBJECT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(number of subjects)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPITN (MAX)=2</td>
<td>25</td>
<td>98</td>
<td>613</td>
<td>2453</td>
<td>9813</td>
</tr>
<tr>
<td>CPITN (MAX)=3</td>
<td>30</td>
<td>119</td>
<td>746</td>
<td>2984</td>
<td>11934</td>
</tr>
<tr>
<td>TN=2</td>
<td>24</td>
<td>97</td>
<td>608</td>
<td>2433</td>
<td>9732</td>
</tr>
</tbody>
</table>

| **TREATMENT TIME PER SUBJECT** |             |           |           |             |             |
| (number of subjects) |             |           |           |             |             |
| CPITN (MAX)=2 | 25 | 99 | 620 | 2482 | 9927 |
| CPITN (MAX)=3 | 36 | 143 | 896 | 3584 | 14335 |
| TN=2 | 26 | 104 | 650 | 2602 | 10408 |

*Table 7.1* Estimated sample size required to provide different degrees of accuracy for oral hygiene time per subject, scaling time per sextant and per subject, and overall treatment time per subject.
Sample sizes required to achieve different degrees of accuracy according to different subdivisions of treatment (Table 7.2)

<table>
<thead>
<tr>
<th>ORAL HYGIENE TIMES PER SUBJECT</th>
<th>SAMPLE SIZE</th>
<th>Degree of accuracy required</th>
</tr>
</thead>
<tbody>
<tr>
<td>(number of subjects)</td>
<td></td>
<td>± 60 secs.</td>
</tr>
<tr>
<td>ALL CPITN</td>
<td></td>
<td>59</td>
</tr>
<tr>
<td>CPITN (MAX)=2</td>
<td></td>
<td>34</td>
</tr>
<tr>
<td>CPITN (MAX)=3</td>
<td></td>
<td>66</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SCALING TIME PER Sextant</th>
<th>SAMPLE SIZE</th>
<th>Degree of accuracy required</th>
</tr>
</thead>
<tbody>
<tr>
<td>(number of sextants)</td>
<td></td>
<td>± 10 mins.</td>
</tr>
<tr>
<td>ALL CPITN</td>
<td></td>
<td>130 (22)</td>
</tr>
<tr>
<td>CPITN (MAX)=2</td>
<td></td>
<td>133 (22)</td>
</tr>
<tr>
<td>CPITN (MAX)=3</td>
<td></td>
<td>108 (18)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SCALING TIME PER SUBJECT</th>
<th>SAMPLE SIZE</th>
<th>Degree of accuracy required</th>
</tr>
</thead>
<tbody>
<tr>
<td>(number of subjects)</td>
<td></td>
<td>± 10 mins.</td>
</tr>
<tr>
<td>CPITN (MAX)=2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>CPITN (MAX)=3</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>TN=2</td>
<td></td>
<td>14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TREATMENT TIME PER SUBJECT</th>
<th>SAMPLE SIZE</th>
<th>Degree of accuracy required</th>
</tr>
</thead>
<tbody>
<tr>
<td>(number of subjects)</td>
<td></td>
<td>± 10 mins.</td>
</tr>
<tr>
<td>CPITN (MAX)=2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>CPITN (MAX)=3</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>TN=2</td>
<td></td>
<td>14</td>
</tr>
</tbody>
</table>

*Table 7.2 Estimated sample size required to provide different degrees of accuracy for oral hygiene time per subject, scaling time per sextant and per subject and overall treatment time per subject*
<table>
<thead>
<tr>
<th>EXAM NUMBER</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>TREATMENT PROVIDED (Y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXAM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPERATOR</th>
</tr>
</thead>
</table>

| DAY |

| MONTH |

| YEAR |

<table>
<thead>
<tr>
<th>APPOINTMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
</tbody>
</table>
A
DATE OF CALL: □ □ □ □
TIME OF CALL: □ □ □ □
CALL ANSWERED: A2 — NO / YES
A3 — NO / YES
A4 — NO / YES
SUBJECT AVAILABLE: B — NO / YES

B: IS SUBJECT STILL LIVING HERE?
NO / YES
KNOWS WHERE SUBJECT IS LIVING NOW?
NO / YES
WHERE TELEPHONE NUMBER
ADDRESS: ______________

C: SUBJECT AVAILABLE:
* EXPLAIN PROPOSALS *
SUBJECT PREPARED TO ATTEND FOR TREATMENT
NO / YES

SUBJECT WILL ANSWER A FEW QUESTIONS
NO / YES
BEST TIME TO ATTEND
8-10 MTWTF
10-12 MTWTF
2-4 MTWTF
4-6 MTWTF
NONE OF THE ABOVE TIMES SUITABLE
SUBJECT WILL ANSWER A FEW QUESTIONS
REASON: USE TELEPHONE QUESTIONNAIRE 1.

REASON: USE TELEPHONE QUESTIONNAIRE 2.
Instructions to Receptionists for the Telephone Follow-Up

CPITN TREATMENT STUDY

INSTRUCTIONS TO RECEPTIONISTS FOR THE TELEPHONE FOLLOW-UP OF SUBJECTS EXAMINED IN THE 1984 HONG KONG SURVEY OF ORAL HEALTH

Side 1 of the control card gives information pertaining to the name, address, telephone number of the subject, as well as data relevant to periodontal treatment, should this eventually take place.

Use the telephone number as it appears on this side of the control card.

Turn to side 2 of the control card for the purpose of this telephone follow-up.

1) Enter date of call in the following format:
   YY   MM   DD   e.g. 86 05 09
   year month day

2) Enter time of call in the following format:
   HH :  MM   e.g. 16 :  32
   hour minutes

3) Enter if the call is answered or not with a tick in the appropriate box.
   e.g. NO / YES

4) If the call is not answered, then place the control card in the repeat call box.

5) If the call is answered, then proceed with the telephone follow-up.

6) Explain that you are phoning from the Prince Philip Dental Hospital. Ascertain whether the subject named on the control card is available or not, enter response with a tick in the appropriate box.

7) If the subject is available, go to part C of the card (for instructions see under paragraph 10).
   If the subject is unavailable, go to part B of the control card and ask if the subject is still living at the same address. Tick the appropriate box.

8) If the subject is no longer living at the same address, ask if the person you are speaking to knows where the subject can be contacted. Enter the details in the appropriate boxes and space provided.

9) If the subject is still living at the same address, ascertain the best day and time to contact the subject. Enter the details in the space provided. Check if there is another contact telephone number where the subject can be reached. If there is, then enter the number in the boxes provided.

10) If contact is made with the subject named on the control card, follow the sequence outlined overleaf:-

"CONFIRM THE NAME OF THE SUBJECT"
A) Explain that you are phoning from the Department of Periodontology and Public Health, Prince Philip Dental Hospital, members of which carried out an oral health survey in the summer of 1984 which the subject kindly participated in.

B) The survey identified that the subject had a need for dental treatment, and that the department is now prepared to offer treatment, as part of a research project. The treatment provided will be given free of charge for the duration of the study.

C) Ask if the subject is prepared to attend the Prince Philip Dental Hospital for treatment.

D) If the subject is prepared to attend for treatment, then enter response with a tick in the appropriate box. (Go to paragraph F)

E) If the subject is not prepared to attend for treatment, then enter response with a tick in the appropriate box.

Ask the subject if he/she is prepared to attend for a free dental check-up. Write in the response and the most convenient time to attend during normal working hours as in F (iv). Check address etc. as in F (v)

If the subject is not prepared to either attend for treatment or a dental check-up, ask if he/she is prepared to answer a few short questions. If yes, then complete the telephone questionnaire sheet for those subjects who are not willing to attend for dental treatment.

F) i. Explain that the treatment will be performed by members of staff and hygienists within the Prince Philip Dental Hospital.

ii. Explain that the treatment will extend over a number of visits and will require short recall examinations, probably every three months.

iii. Explain that there will be no obligation on behalf of the Prince Philip Dental Hospital to undertake any other dental treatment apart from periodontal treatment unless the subject is deemed to be suitable for teaching purposes.

iv. Ascertain the best time and day for the patient to attend.

e.g. 8 - 10 MTWTF
10 - 12 MTWTF
2 - 4 MTWTF ANY TIME
4 - 6 MTWTF

v. Check the address listed on side 1 of the control card. If the address has changed make the necessary changes. Explain that the department will be making contact either by phone or by letter to arrange an appointment for treatment within the next two months.

vi. Should none on the given times be suitable, explain that currently, these times are the only times when the dental hospital is open for treatment. However, ask if the subject will answer a few questions to assist the study.

vii. Complete the telephone questionnaire sheet for subjects prepared to attend for treatment but who are unavailable.

THANK THE SUBJECT FOR HIS/HER TIME
Letter to Subjects (English version) - Side A

University of Hong Kong
Faculty of Dentistry

The Prince Philip Dental Hospital, Hospital Road, Hong Kong.

GUM TREATMENT STUDY

Dear 

In 1984, you were kind enough to participate in a survey of adult oral health which was carried out by the Department of Periodontology and Public Health at the Prince Philip Dental Hospital.

The results of the survey identified that you had some gum disease which was in need of treatment. We are pleased to inform you that our department is now prepared to offer you gum treatment which will be totally free of charge as it is part of a research project.

This will include:

1. A free dental check-up by a dentist.
2. Free instruction on oral health and how you should clean your teeth.
3. Free cleaning and scaling of your teeth.

If you are at all interested, then please complete the attached form and send it to our department in the enclosed stamped addressed envelope within one month of the date of this letter.

If you have any queries, please phone our hotline on 5-8590371 during normal office hours (0830 - 1730 Mon - Fri). Please give your reference number CPITN/

Yours sincerely,

Dr. Christopher Holmgren.
GUM TREATMENT STUDY

Please complete the form and return it to our department in the enclosed stamped addressed envelope.

Name ___________________________ CPITN#_______

Please tick the appropriate boxes:

____ I am prepared to attend for a free dental check-up by a dentist.

____ I am prepared to attend for free instruction on how I should clean your teeth.

____ I am prepared to attend for free cleaning and scaling of my teeth.

____ I am not prepared to attend for a free dental check-up or for treatment but I am prepared to answer a short telephone questionnaire about my teeth.

Please give your telephone number and the best times when we can contact you.

Telephone number ___________ Work.

___________ Home.

Address _______________________________________

___________________________________________

Thank you for your assistance.
牙周病治療研究

菲麗牙科醫院醫護護理及公共衛生學系曾於一九八四年進行一項
成年人口口腔健康調查，獲閣下鼎力支持，該調查得以順利完成，
我們深表謝意。

該調查結果顯示患上牙周病及腫瘤接受治療，本部門現正進
行一項牙周病研究並提供下列免費服務。

1. 免費檢查牙齦
2. 免費口腔衛生指導
3. 免費洗牙服務
4. 免費治療急性牙痛

如閣下有興趣接受上述服務，請盡速填寫參加表格及使用信函
及在信發出日起一個月內寄回本部門。如有任何查詢，可於辦
公時間內（上午八時至下午五時半）致電 5-8590271，並寫明
閣下之CPITN號碼。

菲麗牙科醫院講師

[簽名]
牙周病治療研究參加表格

請填寫這份表格及寄回本部門。

姓名: ___________________ CPITN#: ___________________

請在適當方格內加上 '✓'

[ ] 本人願意接受免費檢查牙齒
[ ] 本人願意接受免費口腔衛生指導
[ ] 本人願意接受免費洗牙服務
[ ] 本人不願意接受任何檢查或治療，但願意接受電話訪問
有關於本人的口腔衛生情況。

請寫上聯絡電話，地址及時間。

電話: _______________ (辦公室)
       _______________ (住宅)

地址: ___________________
       ___________________
       ___________________
       ___________________

多謝合作。
Consent Form - Side A

CPITN STUDY NO ________

DEPARTMENT OF PERIODONTOLOGY
AND PUBLIC HEALTH

CPITN STUDY-
PROVISION OF PERIODONTAL TREATMENT

CONSENT TO PARTICIPATE IN THE STUDY

I consent to take part in this study examining the provision of periodontal treatment. I have had this study explained to me in a way that I understand, and I have had the chance to ask questions.

Unless assessed as being suitable for student teaching purposes I understand that there is no commitment of the part of the Prince Philip Dental Hospital to provide dental treatment apart from for periodontal disease.

Signature ___________________________ Date _______________________

Witness ___________________________
牙周病学及公共卫生科系

牙周病治疗服务

同意书

本人同意接受一项口腔检验，看是否需要牙周病治疗。我得到该项检验的详细解释，亦有机会发问些有关问题。

我明白，除非是适合教学用途，菲臘牙科医院是没有责任供应给我牙周病治疗以外任何口腔治疗。

签名：___________ 日期：___________

见证人：___________
CPITN TREATMENT STUDY

QUESTIONNAIRE FOR SUBJECTS ATTENDING FOR TREATMENT OR FOR REEXAMINATION

To be completed by trained CPITN TREATMENT STUDY staff only:

SECTION 1: IDENTIFICATION

NAME ............................................................................ STUDY NUMBER □□□□

DATE □□□□□□□□

Y Y M M D D

SECTION 2: MEDICAL HISTORY

Q1. Medical History (tick appropriate boxes)

1. Are you in poor general health? □ Yes □ No

2. Are you receiving medical treatment from your doctor, hospital or clinic? □ Yes □ No

3. Are you taking any medicine, pills or tablets either from your doctor or of your own accord? □ Yes □ No

4. Have you received antibiotic treatment in the last 6 months? □ Yes □ No

5. Have you attended a hospital previously as an in-patient or out-patient? □ Yes □ No

6. Have you ever had a general anaesthetic? □ Yes □ No

7. Are you allergic to penicillin or any other medicine, food or substance? □ Yes □ No

8. Do you suffer from hay fever, eczema or asthma? □ Yes □ No

9. Have you ever had rheumatic fever? □ Yes □ No

10. Have you ever had abnormal bleeding after extractions, surgery or injury? □ Yes □ No

11. Have you undergone steroid, anti-coagulant or irradiation therapy? □ Yes □ No

12. Have you ever suffered from jaundice, hepatitis or other liver disease? □ Yes □ No
13. Do you have sudden fainting attacks or giddiness?

14. Have you had any childhood diseases?

15. Are you an expectant mother?

16. Have you suffered from any of the following illnesses?
   - Heart Disease
   - Kidney Disease
   - Tuberculosis
   - Hypertension
   - Diabetes
   - Epilepsy
   - Blood Disease
   - Thyroid Disease
   - Stroke

17. Is there any other medical information about which we should know?

Positive answers to any of the above questions indicate the necessity for further enquiry and this may be written up below.

18. Do you smoke? Yes □ No □

If yes:

19. How many cigarettes do you smoke per day? □□ cigarettes

20. How many years have you smoked? □□ year

SECTION 3: SERVICE UTILIZATION.

Q2. Have you ever received dental treatment?
   YES □ go to Q3
   (Tick only one box)
   NO □ go to Q7

Q3. If YES, how frequently do you normally visit the dentist?
   (Tick only one box)
   1. Every 3 months □
   2. Every 6 months □
   3. Every year □
   4. Irregular time intervals □
   5. Only when in pain □
Q4. How long ago did you last receive dental treatment?  
(Tick only one box)  
1. 0 - 6 months □  
2. 7 - 12 months □  
3. 13 - 24 months □  
4. 25 - 36 months □  
5. > 36 months □  
6. Never □  
7. Don't remember □  

Q5. What was the main reason for you to seek dental treatment on your last visit or last series of visits to the dentist?  
(Tick only one box)  
1. Check up - no other complaint □  
2. Emergency treatment including toothache □  
3. I had a broken tooth □  
4. I had a broken filling □  
5. I had tooth decay □  
6. I had problems with my gums □  
7. To get false teeth or have them adjusted □  
8. For tooth extraction □  
9. To get my teeth straightened (orthodontics) □  
10. Other reason (specify) _____________________________
Q6. On your last visit, or last series of visits for dental treatment, what type of treatment did you receive? 
(Tick appropriate box or boxes)

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Don't know</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Check up only. Involving examination of teeth and gums</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fillings</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Crown and Bridge work</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Had new dentures made or adjusted</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Orthodontics (Straightening of the teeth)</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Oral Hygiene Instruction (including toothbrushing)</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Tooth cleaning including scaling (removal of calculus)</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Gum treatment</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Gum surgery</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Tooth extraction</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Other (please specify)</td>
<td></td>
</tr>
</tbody>
</table>

*THANK THE SUBJECT FOR COMPLETING THE QUESTIONNAIRE*
Appendix X

Questionnaire (Chinese version)

CPITN TREATMENT STUDY
QUESTIONNAIRE FOR SUBJECTS ATTENDING FOR TREATMENT OR FOR REEXAMINATION

此問卷須經由本研究調查員填寫

第一部份：個人資料

姓名

編號

日期

年

月

日

第二部份：病歴

一、病歴（在適當格內勾上答項）

1. 你的體重係唔係太大？

2. 你現在有沒有接受醫藥治療？

3. 你現在有沒有服食藥物？

4. 過去六個月內你有沒有食過抗生素？

5. 你有沒有入住醫院或在門診部接受治療？

6. 你有沒有接受過全麻麻醉？

7. 你對魚、黃蜂或其他食物或藥物有沒有敏感？

8. 你患過（或現有）（過敏）（哮喘）（氣喘）沒有？

9. 你患過（風濕性關節炎）沒有？

10. 你在移植手術或肝移植時有過流血不止未？

11. 你有沒有使用抗凝血藥物？

12. 你患過（或現有）（肝炎）（肝炎）（肝炎）（肝炎）（肝炎）沒有？

13. 你有沒有患過癲癇？

14. 你現在患過（中風）（中風）（中風）（中風）（中風）沒有？

15. 你現在是否懷孕？

16. 請指出你有沒有患過以下所列的任何疾病？

- 心臟病
- 腎病
- 糖尿病
- 血壓高
- 糖尿病
- 血病
- 甲狀腺病
- 腫瘤
- 腫瘤
17. 請說明其他有關健康資料:


以上有正面回答問題，必須加以詳調，並將答案列在下面。


18. 你吸煙嗎？
有...... 沒有......

19. 如果有，每天吸幾多枝？
......枝

20. 你吸了幾幾多年？
......年

第三部份：使用服務的情況

二、你有否接受過牙科治療？

□ 有 轉去第三類
（在適當的格內）

□ 有 轉去第七類

三、如答有，你幾耐去見牙醫一次？
（只　一格）

1. 每三個月一次
2. 每六個月一次
3. 每年 一次
4. 沒有固定
5. 只有牙痛時才去見牙醫

四、你上次見牙醫係幾耐以前嘅事？
（只　一格）

1. 0 - 6 個月
2. 7 - 12 個月
3. 13 - 24 個月
4. 25 - 36 個月
5. 多過36 個月
6. 沒有
7. 記唔清楚
五．你上次，或者近幾次點解去睇牙醫？
（只√一格）
1. 無特別原因，例行檢查略
2. 緊急治療包括牙痛在內
3. 緩牙
4. 補蛀缺牙或缺咬或裂咬
5. 拮牙
6. 牙肉冇問題
7. 配假牙，或者較好配假牙
8. 鉈牙
9. 假牙牙齒
10. 其他（請註明）

六．你上次睇牙醫，或者上一次睇牙醫時，醫生同你點好啲嘅呀？
（在適當格內√答案）

<table>
<thead>
<tr>
<th>係</th>
<th>嘅係</th>
<th>嘅唔知道</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>例行檢查，包括檢查牙齒及牙肉</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>拘牙</td>
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</tr>
<tr>
<td>3.</td>
<td>裝假牙牌及牙冠</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>配假牙，或者較好配假牙</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>假牙牙齒</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>口腔衛生指導（剔牙在內）</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>洗牙（去除牙石）</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>治療牙肉</td>
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<tr>
<td>9.</td>
<td>牙肉手術</td>
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<tr>
<td>10.</td>
<td>剔牙</td>
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<tr>
<td>11.</td>
<td>其他（請註明）</td>
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</table>

回頭頁去第八題
Appendix XI

Data Collection Form for Clinical Examination by Examiner (CJH)

CPITN TREATMENT STUDY

<table>
<thead>
<tr>
<th>NAME</th>
<th>DATE OF BIRTH</th>
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</table>

<table>
<thead>
<tr>
<th>COLUMN</th>
<th>TOOTH</th>
<th>SUPRAGINGIVAL CALCULUS</th>
<th>INFRAGINGIVAL CALCULUS</th>
<th>BLEED</th>
<th>TOOTH</th>
<th>CONTOUR</th>
<th>CALCIUM</th>
<th>DENTINE</th>
<th>TOOTH</th>
<th>CONTOUR</th>
<th>CALCIUM</th>
<th>DENTINE</th>
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</tbody>
</table>

Columns 1 - 15
Enter Same Values as Above

POCKETS 0 1 2 3 4  CPITN 0 1 2 3 4  MISSING TOOTH = 9
CALCULUS 0 1  TN 0 1 2 3  PARTIALLY ERUPTED TOOTH = 8
OVERHANG 2  MISSING SEXTANT = 9  EXTRACTION CARIES = 7
BLEEDING 0 1  EXTRACTION PERIODONTAL = 6
Clinical criteria for clinical examination by examiner (CJH)

The examiner will examine the mouth and record all missing teeth, partially erupted teeth not in occlusion, and teeth indicated for extraction due to caries or for periodontal reasons. All other teeth which are present and functioning in the mouth will be scored, with the exception of third molars. These will only be scored if they are functioning in place of second molars. The parameters will be assessed at six sites around each tooth, namely mesio-buccal, mid-buccal, disto-buccal, disto-lingual, mid-lingual and mesio-lingual.

Supragingival calculus, overhanging restorations and crowns will then be scored. The teeth and the marginal gingiva will be gently dried with a stream of air from the 3 in 1 syringe. Saliva will be removed with an aspirator tip. The buccal sites of teeth in quadrant 1 will be examined first, starting at the most posterior tooth, excluding the third molar, and will continue until the most anterior tooth is examined. The lingual sites will then be examined in the same sequence. The examination of quadrant 2 will then be followed by examination of quadrants 3 and 4.

After the examination for supragingival calculus, each tooth will be probed using the WHO periodontal probe to determine the probing depths, to detect subgingival calculus and to determine the bleeding response. The probing procedure will follow CPITN criteria (Ainamo et al., 1982), so that:

1. The probing force will be divided into a working component to determine the probing depth, and a sensing component to detect subgingival calculus.
2. The working force will be no more than 25 g.
3. When the probe is inserted into the gingival pocket, the ball point will follow the anatomic configuration of the surface of the tooth root.
4. When sensing subgingival calculus, the lightest possible force which will allow movement of the probe ball point along the tooth surface will be used.

The sequence of examination for the scoring of probing depths, subgingival calculus and bleeding response will be the same as that followed for the scoring of supragingival calculus, with two exceptions. The first is that the probing depth and the presence or absence of subgingival calculus will be scored simultaneously at the same site, before the next site is probed. Secondly, to permit adequate time for bleeding response to take place, three teeth, comprising a total of nine sites, will be probed and scored for probing depths and subgingival calculus before the same sites are re-examined for bleeding response. The next three teeth will then be examined, following the same sequence until all the teeth in a quadrant are scored.

The CPITN was originally designed for epidemiological purposes and as such may not be adequately sensitive for use in a controlled clinical study. With this consideration in mind, the data collected during the clinical assessment will comprise the separate components of the CPITN. The sole modification is that supra- and subgingival calculus will be scored separately. This method permits computer synthesis of CPITN and TN scores from the scores for the separate clinical components, as well as permitting a more indepth analyses of the data to be made. Considerable flexibility in data analysis is therefore possible with this method which would not be so if only the highest CPITN score for a sextant had been recorded.
1. **Missing teeth**
All missing teeth will be identified and recorded on the clinical examination sheet, where:

\[
\text{Missing tooth} = 9
\]

2. **Partially erupted teeth**
All partially erupted teeth, which are not in occlusion, i.e. non-functional, will be identified and recorded on the clinical examination sheet, where:

\[
\text{Partially erupted tooth, not in occlusion} = 8
\]

3. **Teeth indicated for extraction due to caries or for periodontal reasons.**
A tooth is indicated for extraction due to caries when carious destruction has progressed to beyond the point of reasonable repair and extraction is the only treatment option.

\[
\text{Extraction indicated for caries} = 7
\]

A tooth is indicated for extraction for periodontal reasons when periodontal disease has progressed to a stage which impairs masticatory function or causes subjective pain or discomfort.

\[
\text{Extraction indicated for periodontal reasons} = 6
\]

4. **Overhanging crowns or restorations.**

5. **Supragingival calculus.**
This refers to obvious, visible hard deposits on the tooth surface above the level of the gingival margin.

\[
\text{If calculus is observed record 1, if not 0}
\]

Note: With age, gingival recession often exposes subgingival calculus which then becomes visible above the gingival margin. This will be recorded as supragingival.

6. **Subgingival calculus.**
This refers to hard deposits detected with the WHO periodontal probe on the tooth surface below the level of the gingival margin.

\[
\text{If calculus is detected record 1, if not 0}
\]

Note: Sometimes it is not easy to decide on the presence of subgingival calculus - record 0 if in doubt. However any calculus detected below the gingival margin requires a recording of 1.

7. **Probing depth.**
This refers to the distance between the gingival margin and the most apical position reached by the probe tip whilst probing the gingival sulcus/pocket.

- **Record as 0 if probing depth is less than 4 mm**
  - (less than the black band)

- **Record as 1 if the probing depth is between 4 and 5 mm**
  - (in the region of the black band)
Record as 2 if the probing depth is between 6 and 8 mm
(greater than the black band but not in the region of the indented silver band)

Record as 3 if the probing depth is between 9 and 11 mm
(in the region of the indented silver band)

Record as 4 if the probing depth is 12 mm or deeper
(beyond the indented silver band)

Sites exhibiting false pocketing, where there is an apparent increase in probing depth due to the gingival margin being positioned coronal to the cement enamel junction, will not be scored unless true pocketing coexists at the same site. Increased probing depths distal to second molars due to impacted third molars will be scored but will be excluded for the purposes of computing the overall CPITN score.

Record 1 if after gently probing the sulcus/pocket to determine the presence of subgingival calculus and probing depth, any bleeding occurs from the gingival margin or depth of the pocket.

Note: Bleeding may occur immediately and prolifically on touching the gingival tissues with the periodontal probe or only a small speck of blood may exude. Bleeding may be delayed for 10 to 30 seconds following probing, however, because of the specific sequence of examination, ample time will pass before bleeding response is scored.
Computer program written in Microsoft® Basic to randomly assign treatment to individual sextants according to CPITN scoring Phase A

10 REM **********************************************************************************************
20 REM * PROGRAM NAME : RAN3.BAS *
30 REM * FUNCTION : PROGRAM TO RANDOMLY ASSIGN TREATMENT *
40 REM * : TO INDIVIDUAL SEXTANTS ACCORDING TO *
50 REM * : SCORING USING CPITN PHASE A *
60 REM * : DATE : 870514 *
70 REM **********************************************************************************************
80 CLS
90 PRINT " THIS PROGRAM IS CALLED RAN3.BAS AND IS DESIGNED"
100 PRINT " TO GIVE RANDOM ALLOCATION OF TREATMENT MODES"
110 PRINT " ACCORDING TO CPITN DATA"
120 PRINT
120 PRINT
130 PRINT
140 DIM A(6), T$(4), CE$(4)
150 FOR I=0 TO 4: READ T$(I): NEXT I
160 FOR I=1 TO 4: READ CE$(I): NEXT I
170 DATA "NO TREATMENT REQUIRED"
180 DATA "ORAL HYGIENE ONLY"
190 DATA "OHI + SCALING"
200 DATA "OHI + SCALING + COMPLEX"
210 DATA "3*4 5 6*7 8 "
220 DATA "3 4*5*6 7*8*"
230 DATA "3 4 5*6 7 8*"
240 DATA "3*4*5*6 7*8*"
250 DATA "3 4 5*6 7*8*"
260 INPUT "ENTER PATIENT'S NAME IN FULL :" ;N$
270 PRINT
280 INPUT "ENTER REGISTRATION NUMBER :" ;R
290 PRINT
300 INPUT "ENTER STUDY NUMBER :" ;S
310 PRINT
320 INPUT "ENTER DATE OF BIRTH (YYMMDD) :" ;B$
330 PRINT
340 INPUT "DATE OF EXAMINATION (YYMMDD) :" ;D$
350 PRINT
360 INPUT "ENTER CPITN (SIX SEXTANTS) :" ;CP$
370 PRINT
380 RANDOMIZE S
390 FOR I=1 TO 6
400 CPI$(I)=MID$(CP$,I,1)
410 IF CPI$(I)="" THEN CPI(I)=0: GOTO 440
420 CPI(I)=VAL(CPI$(I))
430 IF CPI(I)<0 OR CPI(I) > 4 THEN PRINT "INVALID DATA, PLEASE RE-ENTER" : GOTO 360
440 NEXT I
450 GOSUB 2820
460 SE$=CE$(CN)
470 LPRINT " *** CPITN TREATMENT STUDY - CONTROL SHEET FOR HYGIENISTS ***"
480 LPRINT
490 LPRINT " PATIENT NAME : " ;N$
500 LPRINT
510 LPRINT " REG NUMBER : " ;R ; TAB(37) ; "STUDY NUMBER : " ;S
520 LPRINT
530 LPRINT " DATE OF BIRTH : " ;B$ ; TAB(37) ; "EXAM DATE : " ;D$
540 LPRINT
550 LPRINT " SEXTANT CPITN TREATMENT MODALITY"
560 LPRINT " "-----------------------------------------------"
570 LPRINT 
580 Jw=2*I-1: CPI$(I)=MID$(SE$,Jw,1):CPI=VAL(CPI$)
590 IF CPI$="" AND CPI(I) > 1 THEN CPI(I) = 1
600 LPRINT 
610 LPRINT " ;CP$(I) ;" ;T$(CPI(I))
620 NEXT I
630 LPRINT " "-----------------------------------------------"
640 LPRINT " * RECORD THE START TIME AND FINISH TIME FOR APPOINTMENT *
650 LPRINT " * RECORD THE TIME TAKEN FOR : EXAMINATION *
660 LPRINT " * : ORAL HYGIENE INSTRUCTION *
670 LPRINT " * : PER SEXTANT FOR : SCALING *
680 LPRINT " TIME IN MINUTES/SECONDS"
FOR I = 1 TO 6
J=2*I-1: CI$="MID$(SE$,J,1):C2$:MID$(SE$,J+1,1):CP=VAL(CI$)
1120 IF CI$ > 1 THEN CPI(I) = 1
1130 LPRINT ";C1$;C2$;";CI$(I);" ; T$(CPI(I))
1140 LPRINT **C P I T N TREATMENT STUDY - CONTROL SHEET FOR DENTISTS **
1150 LPRINT ** PATIENT NAME : "; N$
1160 LPRINT ** REG NUMBER : "; R;TAB(37);"STUDY NUMBER : "; S
1170 LPRINT ** DATE OF BIRTH : "; B$;TAB(37);" EXAM DATE : "; D$
1180 LPRINT ** SEXTANT CPITN TREATMENT MODALITY**
1190 LPRINT ** FOR ALL ITEMS OF CCS 4PLEX TREATMENT i.e. ROOT PLANNING OR SURGERY **
1200 NEXT I
1210 LPRINT *RECORD THE START TIME AND FINISH TIME FOR APPOINTMENT **
1220 LPRINT *RECORD THE TIME TAKEN FOR : EXAMINATION, RADIOGRAPHS **
1230 LPRINT * : ORAL HYGIENE INSTRUCTION **
1240 LPRINT * : PER SEXTANT FOR : SCALING **
1250 LPRINT * : ROOT PLANNING OR SURGERY **
1260 LPRINT * TIME IN MINUTES/SECONDS **
1270 LPRINT **VISIT 1 VISIT 2 VISIT 3 VISIT 4 VISIT 5 VISIT 6**
1280 LPRINT **DATE (YMD) **
1290 LPRINT **START TIME **
1300 LPRINT **EXAM TIME**
1310 LPRINT **X-RAY TIME**
1320 LPRINT **OHII TIME**
1330 LPRINT **VISIT VISIT VISIT VISIT VISIT VISIT**
1340 LPRINT **DATE (YMD) **
1350 LPRINT **START TIME **
1360 LPRINT **EXAM TIME**
1370 LPRINT **X-RAY TIME**
1380 LPRINT **OHII TIME**
1390 LPRINT **VISIT VISIT VISIT VISIT VISIT VISIT**
1400 LPRINT **DATE (YMD) **
1410 LPRINT **START TIME **
1420 LPRINT **EXAM TIME**
1430 LPRINT **X-RAY TIME**
1440 LPRINT **OHII TIME**
1450 LPRINT "SEXANT"
1460 LPRINT "---------------------------------------------"  
1470 LPRINT " 03 + - - + - - + - - + - - + - - + - - + - - + - - +"  
1480 LPRINT "---------------------------------------------"  
1490 LPRINT " 04 + - - + - - + - - + - - + - - + - - + - - + - - +"  
1500 LPRINT "---------------------------------------------"  
1510 LPRINT " 05 + - - + - - + - - + - - + - - + - - + - - + - - +"  
1520 LPRINT "---------------------------------------------"  
1530 LPRINT " 06 + - - + - - + - - + - - + - - + - - + - - + - - +"  
1540 LPRINT "---------------------------------------------"  
1550 LPRINT " 07 + - - + - - + - - + - - + - - + - - + - - + - - +"  
1560 LPRINT "---------------------------------------------"  
1570 LPRINT " 08 + - - + - - + - - + - - + - - + - - + - - + - - +"  
1580 LPRINT "---------------------------------------------"  
1590 LPRINT "FINISH TIME"
1600 LPRINT "---------------------------------------------"  
1610 LPRINT "TOTAL"
1620 LPRINT "---------------------------------------------"  
1630 LPRINT CHR$(12)

2810 END
2820 REM *********************************************
2830 REM * THIS PART OF THE PROGRAM GENERATES THE RANDOM ASSIGNMENT *
2840 REM *********************************************
2850 CN=INT(RND*5)
2860 IF CN=5 OR CN = 0 THEN GOTO 2850
2870 RETURN
Example of computer output from program written to randomly assign treatment to individual sextants according to CPITN scoring Phase A

*** CPITN TREATMENT STUDY - CONTROL SHEET FOR HYGIENISTS ***

PATIENT NAME : KO SIU KUEN

REG NUMBER : 36748 STUDY NUMBER : 477

DATE OF BIRTH: 480103 EXAM DATE : 880512

SEXTANT CPITN TREATMENT MODALITY
-----------------------
3 2 OHI + SCALING
-----------------------
4* 3 ORAL HYGIENE ONLY
-----------------------
5* 2 ORAL HYGIENE ONLY
-----------------------
6 4 OHI + SCALING + COMPLEX
-----------------------
7 2 OHI + SCALING
-----------------------
8* 3 OHI + SCALING
-----------------------

* RECORD THE START TIME AND FINISH TIME FOR APPOINTMENT *
* RECORD THE TIME TAKEN FOR : EXAMINATION *
* : ORAL HYGIENE INSTRUCTION *
* PER SEXTANT FOR : SCALING *

TIME IN MINUTES/SECONDS

VISIT 1 VISIT 2 VISIT 3 VISIT 4 VISIT 5 VISIT 6
-----------------------
DATE (YYMMDD)
-----------------------
START TIME
-----------------------
EXAM TIME
-----------------------
OHI TIME
-----------------------

* RECORD BELOW THE SCALING TIME PER SEXTANT FOR EACH APPOINTMENT *

SEXTANT
-----------------------
03
-----------------------
04
-----------------------
05
-----------------------
06
-----------------------
07
-----------------------
08
-----------------------
FINISH TIME
-----------------------
TOTAL TIME
-----------------------
OPERATOR
-----------------------
*** CPI T N TREATMENT STUDY - CONTROL SHEET FOR DENTISTS ***

**PATIENT NAME:** KO SIU KUEN

**REG NUMBER:** 36748  **STUDY NUMBER:** 477

**DATE OF BIRTH:** 480103  **EXAM DATE:** 880512

**SEXTANT CPITN TREATMENT MODALITY**

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<tr>
<td>3 2</td>
<td>OHI + SCALING</td>
</tr>
<tr>
<td>4* 3</td>
<td>ORAL HYGIENE ONLY</td>
</tr>
<tr>
<td>5* 2</td>
<td>ORAL HYGIENE ONLY</td>
</tr>
<tr>
<td>6 4</td>
<td>OHI + SCALING + COMPLEX</td>
</tr>
<tr>
<td>7 2</td>
<td>OHI + SCALING</td>
</tr>
<tr>
<td>8* 3</td>
<td>OHI + SCALING</td>
</tr>
</tbody>
</table>

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**RECORD THE START TIME AND FINISH TIME FOR APPOINTMENT**

**RECORD THE TIME TAKEN FOR:**
- EXAMINATION
- ORAL HYGIENE INSTRUCTION
- SCALING
- ROOT PLANING OR SURGERY

**TIME IN MINUTES/SECONDS**

<table>
<thead>
<tr>
<th>visit</th>
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<td>exam time</td>
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<td>OHI time</td>
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**RECORD BELOW THE TREATMENT TIME PER SEXTANT FOR SCALING AND FOR**

**ALL ITEMS OF COMPLEX TREATMENT i.e. ROOTPLANING OR SURGERY**

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<tr>
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</table>

**FINISH TIME**

**TOTAL TIME**
Description of treatment procedures used in the study

1. Oral Hygiene instruction

To ensure that all subjects participating in this study receive the same basic information concerning the nature of periodontal disease and methods of oral hygiene, an attempt will be made to standardize this information. In order to do so a seminar will be held with all the operators involved to discuss approaches to oral hygiene instruction. The method for oral hygiene used in this study will be based on a modification of system described by Nyman & Lindhe (1983) which has been used in other clinical trials (Lindhe & Nyman 1975, Rosling et al., 1976, Lindhe et al., 1982). This is detailed below.

First appointment

i. The patient is asked to clean the teeth using his/her own traditional technique.

ii. The use of disclosing agents is explained to the patient to identify plaque at sites where tooth cleaning has been inadequate. The disclosing agent, either tablet or liquid, is applied. The result is demonstrated to the patient using a hand-mirror and he/she is asked to identify all sites where plaque remains.

iii. The patient is asked to clean his/her teeth again stressing the importance of removing plaque from the stained sites. The possibility of modifying his/her traditional tooth brushing technique is discussed should this be necessary.

iv. The results of the second tooth cleaning is checked with the patient observing. If there are still sites with plaque further instruction is given.

Second appointment

i. The disclosing agent, either tablet or liquid is applied. The patient is asked to evaluate the results of his/her oral hygiene technique.

ii. The result is discussed and toothbrushing technique is modified should this be necessary.

iii. The need for adjunctive aids for interproximal clean e.g. toothpicks, dental floss, interproximal brushes is discussed and the appropriate techniques demonstrated.

Third and subsequent appointments

i. The disclosing agent, either tablet or liquid is applied. The patient is asked to evaluate the results of his/her oral hygiene technique at the discretion of the operator.

ii. The result is discussed and toothbrushing and interdental cleaning is modified should this be necessary.

The importance of self performed plaque control will be stressed to all patients and the efficacy will be evaluated and presented to the patient during each stage of treatment.
All patients will be provided with toothbrushes, disclosing tablets and other adjunctive aids as may be necessary.

2 Scaling

Instrumentation will be performed by means of both ultrasonic and hand scalers, as is the routine practice of operators in the Department of Periodontology and Public Health. The choice of instrument will be entirely according to operator preference. The operator will however be requested to make an entry on the control sheet indicating whether ultrasonic and/or hand- instruments were used.

Scaling instruments that are most commonly used by operators within the Department comprise the following:

**Ultrasonic instruments**
- Litton Ultrasonic
  - Unit LT200 with M7 'Universal' Ultrasonic tip

**Hand instruments**
- Sickle scaler H5 (double ended) (Ash)
- MacFarlane hoes H6 H7(double ended)(Ash)
- H8 H9(double ended)(Ash)
- Push scaler SCL G1 (Ash)
- Columbia curette 4L 4R (double ended)(American Dental)

Included in each of the operators' set of instruments will be a WHO periodontal probe which the operator will be at liberty to use for checking of calculus removal.

3 "Complex" treatment

"Complex" treatment suggest by CPITN criteria "may involve deep scaling and root planing under local anaesthesia, or require surgical exposure of the infected root surface in order to gain access needed to clean it" Ainamo (1984). Current trends in periodontal treatment are towards a more conservative, predominantly non-surgical approach to the treatment of deep pockets (for review, see Garrett, 1983). The Department of Periodontology and Public Health teaches and practices this approach with the effect that the majority of sites with deep pockets are treated by root planing in combination with routine oral hygiene and scaling procedure. It is therefore envisaged that for the most part "complex treatment" will be based mainly on root planing.

The instruments which are most commonly used for root planing comprise a specially colour coded set of Gracey curettes:

- Gracey curette 1 - 2 (American Dental)
- Gracey curette 7 - 8 (American Dental)
- Gracey curette 11 - 14 MD (American Dental)
- Gracey curette 12 - 13 MD (American Dental)

Surgical intervention may however be indicated in some instances, when sites have failed to respond to a non-surgical approach. This may occur in sites with deep tortuous pockets, in furcation areas or where complex root anatomy limits access and visibility for adequate root instrumentation. The surgical method of choice will be ad modum Widman. The instruments used for periodontal surgery vary from operator to operator and are therefore not specified here.
Manual of instructions provided for periodontists participating in the study

1. INTRODUCTION

The Community Periodontal Index of Treatment Needs (CPITN) (Ainamo et al. 1982) was developed by a Joint FDI/WHO working group as a simple and rapid method for determining the prevalence of and treatment needs for chronic inflammatory periodontal disease in communities.

In 1984, the Department of Periodontology and Public Health performed an epidemiological survey to determine the oral health status of Hong Kong Chinese (Hong Kong Survey of Adult Oral Health, HKSAOH 1984, Lind et al.). As recommended by the World Health Organization, the CPITN was used in this survey, however members of the survey team were aware that further research was necessary to determine whether the CPITN was a valid tool to assess the time, resources and manpower required to provide periodontal treatment.

The CPITN Treatment Study, which continues on from the HKSAOH 1984 therefore has two principal objectives:

• To estimate the needs for periodontal treatment in adult Hong Kong Chinese using the Community Periodontal Index of Treatment Needs (CPITN), and,

• To assess the feasibility and need for calculus removal on a community basis.

In order to accomplish these objectives, a sub-sample of those participants examined in the HKSAOH 1984 have been recruited to receive periodontal treatment in the Department of Periodontology and Public Health. Treatment will be provided by members of the dental team involving participation of dentist, hygienist and dental surgery assistant. At fixed periods during the course of treatment, detailed clinical examinations will be performed by the examiner (C.J.H.) to assess the response of the periodontal tissues to treatment. The time taken to provide periodontal treatment will also be assessed with a record being made for both the overall time required for each clinical appointment and the time required to perform each item of treatment.

A clinical study such as this requires that all the operators providing the treatment follow a standardized sequence of procedures as laid out in the research protocol governing the study. A summary of the relevant details is given overleaf.

2 CLINICAL INSTRUCTIONS FOR THE INITIAL PHASE OF TREATMENT (PHASE A).

2.1 First appointment (examiner, dentist, and hygienist).

On the first clinical appointment for each patient, a baseline periodontal examination will be performed by the examiner (C.J.H.) assisted by a DSA. Standardized pre-treatment radiographs will then be taken in the department by a specially trained EDDSA.

Immediately after the radiographs have been taken, the patient will be examined by the dentist using conventional clinical criteria. The dentist will not have access to the results of the baseline periodontal examination (performed by C.J.H.) and will examine the
patient with a view to the provision of comprehensive dental care as if working in general dental practice. The pre-treatment radiographs will be available to the dentist for periodontal diagnosis.

The sequence of examination, the content of the examination, the choice of probes and respective charting or other records will be entirely at the discretion of the dentist, however, in most instances the examination should include the following:

i. Chief complaint/s (C/O),
ii. History of present complaint/s (HPC),
iii. Medical history,
iv. General extra-oral examination.
v. Intra-oral examination to include:

Examination of soft tissue,
Examination of teeth for caries, etc.,
Examination of the periodontium and associated factors, e.g. loss of attachment as evidenced by recession and/or increased probing depth, bleeding on gentle probing, the presence of plaque and calculus, overhanging restorations, furcation involvement, mobility.
Special tests, e.g. tests of pulpal responsiveness, radiographs (see below).

On the basis of the examination and any special tests that may be performed, a diagnosis and treatment plan will be made. Relevant details will be recorded in the usual manner in the patient's green hospital folder.

The "START TIME" and the "FINISH TIME" are to be recorded by the DSA on the special computer printout provided at the time of the appointment (Annex 1). This enables the total duration of the appointment, including the time taken for examination, special tests, diagnosis and treatment planning to be calculated at a later stage. The definitions of the "START TIME" and the "FINISH TIME" are detailed in Annex 3 "MEASUREMENT AND RECORDING OF TREATMENT TIMES FOR PERIODONTAL PROCEDURES".

Furthermore, the time required for (i) the taking of radiographs and, (ii) the examination of the periodontium and associated factors, will be recorded under the appropriate headings. The definitions of these times are detailed in Annex 3.
On the basis of the periodontal examination performed by the examiner (C.J.H.), sextants will be randomly assigned by a computer programme to either an experimental or control category. This will be indicated on the computer printout mentioned above. Thus, during Phase A of treatment, only three of the sextants (the control sextants) will receive conventional periodontal treatment in the form of oral hygiene, scaling and 'Complex' treatment. 'Complex' treatment, when indicated, will for the most part comprise root planing and will be provided by the dentist. The remaining three sextants (the experimental sextants) will receive only oral hygiene irrespective of whether calculus or pockets are present.

After the examination by the dentist, the patient will be randomly assigned to one of the team of hygienists for oral hygiene and scaling in those sextants indicated on the computer printout. This initial treatment phase will start on this first appointment, immediately after the patient has been examined by the dentist.

2.2 Subsequent appointments (hygienist).

Oral hygiene instruction and scaling will be provided by the hygienist on subsequent appointments. This will be performed to the best of the hygienist's ability until he/she considers that the optimal response has been achieved by this treatment.

The treatment provided by the hygienist may take a number of appointments and it is expected that this will vary between individual patients. However, based on previous experience, it is envisaged that the hygienist treatment should be completed within the period of one month. This does not imply that all patients will require a whole month of hygienist treatment.

On the last appointment with the hygienist, an appointment must be made for the patient to see the dentist. This should be scheduled as close to one month as possible after the last hygienist appointment.

2.3 Subsequent appointment/s (dentist).

The subsequent appointment/s with the dentist during this phase of treatment is for the re-examination of the periodontal status and to assess the need for further treatment in the control sextants.

The period of a month between the last hygienist appointment and the subsequent review appointment with the dentist allows periodontal tissue responses to take place.

THE START TIME AND THE FINISH TIME FOR EACH APPOINTMENT ARE RECORDED ON THE COMPUTER PRINTOUT
2.3.1 Re-examination of the periodontal status.

The periodontal status is re-examined to monitor the response of the periodontium to the treatment provided by the hygienist. The findings are recorded on the special monitoring chart (Annex 2).

The need for further periodontal treatment will be assessed by the dentist for the control sextants. Should this be required, then treatment will be provided over as many appointments as may be required.

Clinical parameters used to assess the periodontal status will comprise probing depth (range) and gingival bleeding. The method of scoring is detailed in Annex 4 "SCORING OF CLINICAL PERIODONTAL PARAMETERS". A WHO periodontal probe should be used.

THE TIME FOR RE-EXAMINATION OF THE PERIODONTAL STATUS IS RECORDED ON THE COMPUTER PRINTOUT

2.3.2 Oral Hygiene Instruction.

Oral hygiene reinforcement will be provided at the discretion of the dentist. Should oral hygiene reinforcement be considered necessary, then it will be provided by the dentist assisted by the DSA. The following serves as a guide.

a. The patient's teeth are disclosed, at the discretion of the operator, using disclosing agent. The patient should then evaluate the results of his/her oral hygiene technique.

b. The results are discussed and tooth-brushing and interdental cleaning is modified should this be necessary.

The importance of self performed plaque control will be stressed to all patients and the efficiency will be evaluated and presented to the patient during each stage of treatment.

All patients will be provided with appropriate toothbrushes, disclosing tablets and other adjunctive aids as may be necessary.

THE TIME FOR ORAL HYGIENE INSTRUCTION IS RECORDED ON THE COMPUTER PRINTOUT
2.3.3 Scaling.

The hygienists have been instructed to scale the control sextants to the best of their ability, however it is envisaged that some small deposits of calculus may still remain. The dentist should therefore remove these only in the control sextants.

Scaling must only be performed in those sextants indicated for instrumentation on the computer printout. Both ultrasonic and hand-instruments may be used, the choice of which will be entirely according to the operator's preference. Each sextant indicated for scaling should be scaled to the best of the operator's ability coincident with existing clinical conditions before the next sextant is scaled. Scaling one sextant at a time permits the time for scaling each sextant to be determined. This is detailed in Annex 3 "MEASUREMENT AND RECORDING OF TREATMENT TIMES FOR PERIODONTAL PROCEDURES".

DO NOT SCALE EXPERIMENTAL SEXTANTS
THE TIME FOR SCALING EACH SEXTANT IS RECORDED ON THE COMPUTER PRINTOUT

2.3.4 Root planing.

On the basis of the charting from the re-examination of the periodontal status, any sites in sextants indicated for instrumentation on the computer printout which still exhibit increased probing depths of code 2 or more i.e. probing depths of 6mm and above, and which also exhibit bleeding, will be indicated for root planing. This should be performed by the dentist.

Each sextant indicated for root planing should be instrumented to the best of the operator's ability coincident with existing clinical conditions before the next sextant is instrumented. Root planing one sextant at a time permits the time for root planing each sextant to be determined.

DO NOT ROOT-PLANE EXPERIMENTAL SEXTANTS
THE TIME FOR ROOT-PLANING EACH SEXTANT IS RECORDED ON THE COMPUTER PRINTOUT

All treatment procedures provided by the dentist will be performed to the best of his ability until the operator considers that the optimal response has been achieved. This treatment may take a number of appointments and it is expected that this will vary between individual patients. However, it is envisaged that the treatment provided by the dentist should be completed within the period of one month. This does not imply that all patients will need a whole month of treatment provided by the dentist.
On the last appointment with the dentist, an appointment will be made for the patient to see the examiner (C.J.H.). This should be scheduled as close to three months as possible after the baseline periodontal examination and should be at least two weeks after the last dentist appointment.

3. CLINICAL INSTRUCTIONS FOR THE "MAINTENANCE" PHASE OF TREATMENT (PHASE B).

This phase of treatment takes place as close to six months as possible after the baseline periodontal examination and follows the basic sequence and outline as for Phase A with the exception that scaling and complex treatment will be provided for all six sextants, i.e both control and experimental sextants, as may be required.

3.1 First maintenance appointment (examiner, dentist and hygienist).

On the first maintenance appointment, a six-month periodontal examination will be performed by the examiner (C.J.H.) assisted by a DSA. Immediately afterwards, the patient will be re-examined by the dentist using the same clinical criteria as detailed in section 2.3.1.

After the periodontal examination, the dentist will refer the patient to the same hygienist as in Phase A (should this be possible) for oral hygiene and scaling. This treatment will start on this first maintenance appointment of Phase B, immediately after the patient has been examined by the dentist.

3.2 Subsequent appointments (hygienist).

Oral hygiene instruction and scaling will be provided by the hygienist on subsequent appointments. This will be performed to the best of the hygienist's ability until he/she considers that the optimal response has been achieved by this treatment.

The treatment provided by the hygienist may take a number of appointments and it is expected that this will vary between individual patients. It is however envisaged that the hygienist treatment should be completed within the period of one month. This does not imply that all patients will need a whole month of hygienist treatment.
On the last appointment with the hygienist, an appointment will again be made for the patient to see the dentist. This should be scheduled as close to one month as possible after the last hygienist appointment.

3.3 Subsequent appointments (dentist).

The period of a month between the last hygienist appointment and the subsequent review appointment with the dentist allows further periodontal tissue responses to take place.

The need for additional periodontal treatment will be assessed by the dentist for the control sextants. Should this be required, then treatment will be provided over as many appointments as may be required.

**THE START TIME AND THE FINISH TIME FOR EACH APPOINTMENT ARE RECORDED ON THE COMPUTER PRINTOUT**

3.3.1 Re-examination of the periodontal status.

This will follow the same format as detailed in section 2.3.1.

**THE TIME FOR RE-EXAMINATION OF THE PERIODONTAL STATUS IS RECORDED ON THE COMPUTER PRINTOUT**

3.3.2 Oral Hygiene Instruction.

This will follow the same format as detailed in section 2.3.2.

**THE TIME FOR ORAL HYGIENE INSTRUCTION IS RECORDED ON THE COMPUTER PRINTOUT**

3.3.3 Scaling.

This will follow the same format as detailed in section 2.3.3 with the exception that all sextants with calculus remaining, irrespective of whether they are experimental or control sextants, should be scaled. Sextants are scaled one at a time to enable scaling times to be assessed.

**THE TIME FOR SCALING EACH SEXTANT IS RECORDED ON THE COMPUTER PRINTOUT**
3.3.4 Root planing.

This will follow the same format as detailed in section 2.3.4 with the exception that all sextants which require root planing, irrespective of whether they are experimental or control sextants, should be instrumented. Sextants are root planed one at a time to enable the times for root planing to be assessed.

THE TIME FOR ROOT-PLANING EACH SEXTANT IS RECORDED ON THE COMPUTER PRINTOUT

3.3.5 Periodontal Surgery.

At the discretion of the operator, periodontal surgery may be performed in those control sextants where, in the opinion of the operator, root planing has been unsuccessful. (The control sextants are those which during the initial phase "Phase A" of treatment received oral hygiene, scaling and root planing). As a general guide, sites which still exhibit increased probing depths of code 2 or more i.e. probing depths of 6mm and above, and which also exhibit bleeding and/or pus can be regarded as indicating periodontal surgery. **However this is not obligatory.** Periodontal surgery must be performed by the dentist.

THE TIME FOR PERIODONTAL SURGERY FOR EACH SEXTANT IS RECORDED ON THE COMPUTER PRINTOUT

All treatment procedures provided by the dentist will be performed to the best of his ability until the operator considers that the optimal response has been achieved. This treatment may take a number of appointments and it is expected that this will vary between individual patients. However, it is envisaged that the treatment provided by the dentist should be completed within the period of one month. This does not imply that all patients will need a whole month of treatment provided by the dentist.

On the last appointment with the dentist, an appointment will be made for the patient to see the examiner (C.J.H.). This should be scheduled as close to nine months as possible after the baseline periodontal examination and should be at least two weeks after the last dentist appointment.
4. CLINICAL INSTRUCTIONS FOR THE "MAINTENANCE" PHASE OF TREATMENT (PHASE C).

This phase of treatment takes place exactly twelve months after the baseline periodontal examination and follows the basic sequence and outline as detailed for Phase B. Treatment times are recording for all appointments and all items of periodontal treatment.

THE START TIME AND THE FINISH TIME FOR EACH APPOINTMENT ARE RECORDED ON THE COMPUTER PRINTOUT

THE TIME FOR RE-EXAMINATION OF THE PERIODONTAL STATUS IS RECORDED ON THE COMPUTER PRINTOUT

THE TIME FOR ORAL HYGIENE INSTRUCTION IS RECORDED ON THE COMPUTER PRINTOUT

THE TIME FOR SCALING EACH SEXTANT IS RECORDED ON THE COMPUTER PRINTOUT

THE TIME FOR ROOT-PLANING EACH SEXTANT IS RECORDED ON THE COMPUTER PRINTOUT

During Phase C of the treatment it is not obligatory to refer the patient for hygienist treatment if in the opinion of the dentist little or no oral hygiene or scaling is required and can be performed by the dentist.

4.1 Periodontal Surgery.

At the discretion of the operator, periodontal surgery may be performed in any sextant where root planing has, in the opinion of the operator, been unsuccessful. As a general guide, sites which still exhibit increased probing depths of code 2 or more i.e. probing depths of 6mm and above, and which also exhibit bleeding and/or pus despite the evidence of adequate oral hygiene, can be regarded as having an indication for periodontal surgery. However, this is not obligatory. Periodontal surgery must be performed by the dentist.
THE TIME FOR PERIODONTAL SURGERY
FOR EACH SEXTANT IS
RECORDED ON THE COMPUTER PRINTOUT

On the last appointment with the dentist, an appointment will be made for the patient to see the examiner (C.J.H.). This should be scheduled exactly fifteen months after the baseline periodontal examination and should be at least two weeks after the last dentist appointment.

Christopher Holmgren
*** CPITN TREATMENT STUDY - CONTROL SHEET FOR DENTISTS ***

**PATIENT NAME:** TEST PATIENT  
**REG NUMBER:** 4321  
**STUDY NUMBER:** 1234  
**DATE OF BIRTH:** 450624  
**EXAM DATE:** 880415

<table>
<thead>
<tr>
<th>SEXTANT</th>
<th>CPITN TREATMENT MODALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1 ORAL HYGIENE ONLY</td>
</tr>
<tr>
<td>4</td>
<td>2 OHI + SCALING</td>
</tr>
<tr>
<td>5</td>
<td>3 ORAL HYGIENE ONLY</td>
</tr>
<tr>
<td>6</td>
<td>4 OHI + SCALING + COMPLEX</td>
</tr>
<tr>
<td>7</td>
<td>2 ORAL HYGIENE ONLY</td>
</tr>
<tr>
<td>8</td>
<td>2 ORAL HYGIENE ONLY</td>
</tr>
</tbody>
</table>

* RECORD THE START TIME AND FINISH TIME FOR APPOINTMENT  
* RECORD THE TIME TAKEN FOR: EXAMINATION, RADIOGRAPHS  
* : ORAL HYGIENE INSTRUCTION  
* : ROOT PLANING OR SURGERY  
* TIME IN MINUTES/SECONDS  

**VISIT 1 VISIT 2 VISIT 3 VISIT 4 VISIT 5 VISIT 6**

<table>
<thead>
<tr>
<th>DATE(YYMMDD)</th>
<th>START TIME</th>
<th>EXAM TIME</th>
<th>X-RAY TIME</th>
<th>OHI TIME</th>
<th>OHI TIME</th>
</tr>
</thead>
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<td>5:26</td>
<td>10:04</td>
<td>0</td>
<td>5:02</td>
</tr>
</tbody>
</table>

**FINISH TIME:** 10:30

**TOTAL:** Leave blank
Measurement and recording of treatment time for periodontal procedures

The time taken to perform each treatment procedure is to be measured in minutes and seconds by means of the stopwatch provided. The treatment times are to be entered on the computer printout, under the appropriate heading, by either the operator or dental surgery assistant.

1. Time for examination of the periodontium and associated factors (First appointment).

This is considered to be the time required to examine all factors relating to the periodontium and in most instances will include the following:

- Examination for loss of attachment as evidenced by recession and/or increased probing depth, bleeding after gentle probing, the presence of plaque and calculus, overhanging restorations, furcation involvement and mobility.

Start time: The moment the operator starts examining any of the above criteria either visually or with a probe.

Stop time: The moment when the operator has finished examining and recording all those factors mentioned above which he considers relevant to the case.

The time taken for the examination of the periodontium and associated factors is to be entered on the computer printout under the heading of the "EXAM TIME".

2. Time for the taking of radiographs

This is the time required to take the radiographs necessary to treat the patient.

Start time: The moment the patient sits in the chair in the X-ray room.

Stop time: The moment the patient leaves the chair in the X-ray room.

The time needed to take the radiographs is to be entered on the computer printout under the heading of the "X-RAY TIME".

3. Time for the re-examination of the periodontal status

The re-examination of the periodontal status will take place on subsequent appointments with the dentist.

Start time: The moment the operator starts examining the periodontal tissues of the patient and includes the time required for charting.

Stop time: The moment when the re-examination and charting has been completed.

The time taken for re-examination of the periodontal status is to be entered on the computer printout under the heading of the "EXAM TIME".
4 Time for oral hygiene instruction

The unit under consideration will comprise the whole mouth.

Start time: The moment the operator starts speaking to the patient either for the purpose of specific oral hygiene instruction or for motivation. Included in this timing will be the use of disclosing agents and relevant demonstrations.

Stop time: The moment when the operator stops speaking to the patient about oral hygiene or when the relevant demonstration has been completed.

Timings are to be taken for each session of oral hygiene instruction or motivation and are to be entered on the computer printout under the heading of "OHI TIME".

5. Time for scaling

The unit under consideration will comprise a sextant and separate timings are to be made for each sextant where scaling is indicated.

Start time: The moment the operator picks up an instrument or is handed an instrument to start scaling in a particular sextant. Included in the time for scaling is the time spent checking the completeness of calculus removal during the scaling procedure.

Stop time: The moment when the operator considers that calculus has been removed to the best of his/her ability on that session, coincident with existing clinical conditions.

Timings are to be taken on each session when scaling is performed until the scaling is completed. The time is recorded prefixed by "Sc" to indicate "SCALING" under the relevant sextant heading.

6. Time for "complex treatment"

"Complex" treatment can be subdivided into two main activities, namely root planing and periodontal surgery. In both instances the unit under consideration comprises a sextant. Separate timings are to be ascertained for each sextant assigned for "complex" treatment and separately for each of the two activities. The time is to be recorded prefixed by a "Rp" to indicate "ROOT PLANING" or "Su" to indicate "SURGERY" under the relevant sextant heading.

6.1 Root planing

Start time: The moment the operator picks up an instrument or is handed an instrument to start root planing in a particular sextant. Included in the time for root planing is the time spent checking for root smoothness. Should local anaesthesia be required for the procedure, then the time required for its administration is to be included in the time for root planing.

Stop time: The moment when the operator considers that the procedure has been performed optimally coincident with the clinical conditions and the ability of the operator. Timings are to be taken for each session of root planing until the procedure is completed.
6.2 Periodontal Surgery.

Start time: The moment the operator starts to administer the local anaesthetic.
Stop time: The moment after the patient has received post-operative instruction and the patient is dismissed.

The time for periodontal surgery will include the time necessary for removal of sutures and periodontal packs on a subsequent appointment. Also included is the time spent checking the results of the surgical operation.

Start time: The moment the operator starts to remove the suture or periodontal pack.
Stop time: The moment when the operator puts down the instruments, after completing the procedure.

7. Total duration of each appointment

The overall time taken for each appointment is to be recorded. This is defined as the total time the patient remains seated in the chair receiving treatment. Both the "START TIME" and the "FINISH TIME", as determined by the clinic clock, are to be recorded in hours and minutes.

Start time: This will be taken to be the time in hours and minutes when the patient sits in the operator's dental chair as recorded from the clinic clock.
Finish time: This will be taken to be the time in hours and minutes when the patient leaves the operator's dental chair as recorded from the clinic clock.

A computer programme will determine the overall total operating time from the start and finish time. It is therefore unnecessary for the operator or DSA to make this calculation.
Data Collection Form for Clinical Examination by Dentist/Hygienist

CPITN TREATMENT STUDY

DATE OPERATOR

1  |  2

Po  
Bl  

3  |  4

Po  
Bl  

4  |  3

Po  
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5

Bucc  
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POCKETS 0 1 2 3 4
BLEEDING 0 1
1. INTRODUCTION

The Community Periodontal Index of Treatment Needs (CPITN) (Ainamo et al. 1982) was developed by a Joint FDI/WHO working group as a simple and rapid method for determining the prevalence of and treatment needs for chronic inflammatory periodontal disease in communities.

In 1984, the Department of Periodontology and Public Health performed an epidemiological survey to determine the oral health status of Hong Kong Chinese (Hong Kong Survey of Adult Oral Health, HKSAOH 1984, Lind et al.). As recommended by the World Health Organization, the CPITN was used in this survey, however members of the survey team were aware that further research was necessary to determine whether the CPITN was a valid tool to assess the time, resources and manpower required to provide periodontal treatment.

The CPITN Treatment Study, which continues on from the HKSAOH 1984 therefore has two principal objectives:

- To estimate the needs for periodontal treatment in adult Hong Kong Chinese using the Community Periodontal Index of Treatment Needs (CPITN), and,
- To assess the feasibility and need for calculus removal on a community basis.

In order to accomplish these objectives, a sub-sample of those participants examined in the HKSAOH 1984 have been recruited to receive periodontal treatment in the Department of Periodontology and Public Health. Treatment will be provided by members of the dental team involving participation of dentist, hygienist and dental surgery assistant. At fixed periods during the course of treatment, detailed clinical examinations will be performed by the examiner (C.J.H.) to assess the response of the periodontal tissues to treatment. The time taken to provide periodontal treatment will also be assessed with a record being made for both the overall time required for each clinical appointment and the time required to perform each item of treatment.

A clinical study such as this requires that all the operators providing the treatment follow a standardized sequence of procedures as laid out in the research protocol governing the study. A summary of details relevant to hygienists participating in the study is given below:

2 CLINICAL INSTRUCTIONS FOR THE INITIAL PHASE OF TREATMENT (PHASE A).

2.1 First appointment (examiner, dentist, and hygienist).

On the first clinical appointment for each patient, a baseline periodontal examination will be performed by the examiner (C.J.H.) assisted by a DSA.

Standardized pre-treatment radiographs will then be taken in the department by a specially trained EDDSA. The patient will then be examined by the dentist using conventional clinical criteria and an overall treatment plan constructed. Relevant details
will be recorded in the usual manner in the patient's green hospital folder.

On the basis of the periodontal examination performed by the examiner (C.J.H.), sextants will be randomly assigned by a computer programme to either an experimental or control category. This will be indicated on a printout produced by the computer programme. Thus, during Phase A of treatment, only three of the sextants (the control sextants) will receive conventional periodontal treatment in the form of oral hygiene, scaling and 'complex' treatment. 'Complex' treatment, when indicated, will for the most part comprise root planing and will be provided by the dentist. The remaining three sextants (the experimental sextants) will receive only oral hygiene irrespective of whether calculus or pockets are present.

After the examination by the dentist, the patient will be randomly assigned to one of the hygienists for initial treatment. This will start on this first appointment, immediately after the patient has been examined by the dentist and will comprise oral hygiene and scaling in those sextants so indicated on the computer printout.

**IT IS ESSENTIAL IN THIS STUDY TO FOLLOW THE ASSIGNMENT OF TREATMENT CATEGORIES FOR INDIVIDUAL SEXTANTS AS INDICATED ON THE COMPUTER PRINTOUT**

The "START TIME" and the "FINISH TIME" must to be recorded by the hygienist on the computer printout provided at the time of the appointment (Annex 1). This enables the total duration of the appointment to be calculated at a later stage. The definitions of the "START TIME" and the "FINISH TIME" are detailed in Annex 3 "MEASUREMENT AND RECORDING OF TREATMENT TIMES FOR PERIODONTAL PROCEDURES".

**THE START TIME AND THE FINISH TIME FOR EACH APPOINTMENT ARE RECORDED ON THE COMPUTER PRINTOUT**

### 2.1.1 Oral Hygiene Instruction.

An attempt has been made to standardise the format of the oral hygiene instruction for the initial stages of treatment to ensure that all subjects participating in this study receive the same basic instruction in both oral hygiene techniques and information relating to periodontal disease. The format for the oral hygiene instruction used in this study will largely be based on a method described by Nyman & Lindhe (1983) which has been used in other clinical studies (Lindhe & Nyman 1975, Rosling et al. 1976, Lindhe et al. 1982). This method is detailed overleaf:
i. The patient is asked to use his/her routine method to clean the teeth.

ii. The use of a disclosing agent to identify sites where the patient's own tooth cleaning method has been inadequate is explained. A disclosing agent, either tablet or liquid, is then used. The result is demonstrated to the patient using a mirror and he/she is asked to identify all sites where stained plaque remains.

iii. The patient is then asked to clean his/her teeth again. Particular emphasis should be placed on the importance of removing the stained plaque which remains.

iv. The results of the second tooth cleaning is checked with the patient observing. If there are still sites with plaque remaining, then the patient's routine tooth brushing technique is modified accordingly. Unless the patient routinely performs interdental cleaning, this is not introduced at this stage.

THE TIME FOR ORAL HYGIENE INSTRUCTION IS RECORDED ON THE COMPUTER PRINTOUT

The importance of self performed plaque control is to be stressed to all patients and the efficiency will be evaluated and presented to the patient during each stage of treatment.

All patients will be provided with toothbrushes, disclosing tablets and other adjunctive aids as may be necessary.

2.1.2 Scaling.

Scaling must only be performed in those sextants indicated for instrumentation on the computer printout. Both ultrasonic and hand-instruments may be used, the choice of which will be entirely according to the operator's preference. Each sextant indicated for scaling should be scaled to the best of the operator's ability coincident with existing clinical conditions before the next sextant is scaled.

It is important to scale one sextant at a time as this method permits the scaling time for each sextant to the determined. The recording of scaling time is described in more detail in Annex 3 "MEASUREMENT AND RECORDING OF TREATMENT TIMES FOR PERIODONTAL PROCEDURES".

It is not necessary to complete all the scaling in one visit but the hygienist should try to remove as much calculus as possible at each visit coincident with clinical conditions.

A WHO periodontal probe is provided in the operator's set of instruments and may be used to check for completeness of calculus removal.
2.2 Second appointment (hygienist).

2.2.1 Re-examination of the periodontal status.

The periodontal status will be re-examined to monitor the response of the periodontium to treatment. The findings are to be recorded on the special monitoring chart (Annex 2).

A DSA should normally be available to assist the hygienist in recording the findings of the re-examination.

Clinical parameters used to assess the periodontal status will comprise probing depth (range) and gingival bleeding. The method of scoring is detailed in Annex 4 "SCORING OF CLINICAL PERIODONTAL PARAMETERS". A WHO periodontal probe should be used.

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THE TIME FOR RE-EXAMINATION OF THE PERIODONTAL STATUS IS RECORDED ON THE COMPUTER PRINTOUT

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2.2.2 Oral Hygiene Instruction.

i. The patient’s teeth are disclosed using disclosing agent. The patient then evaluates the results of his/her oral hygiene technique.

ii. The results are discussed and the tooth-brushing technique is modified should this be necessary.

iii. The need for specific interdental cleaning using e.g. toothpicks, dental floss, interproximal brushes is discussed and the appropriate techniques demonstrated, according to patient requirements and operator preference.

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THE TIME FOR ORAL HYGIENE INSTRUCTION IS RECORDED ON THE COMPUTER PRINTOUT
2.2.3 Scaling.

As for the first appointment, scaling must only be performed in those sextants indicated for scaling on the computer printout. Each sextant so indicated should be scaled to the best of the operator's ability coincident with existing clinical conditions before the next sextant is scaled. It is not necessary to complete all the scaling in this visit, but the hygienist should try to remove as much calculus as possible.

**DO NOT SCALE EXPERIMENTAL SEXTANTS**

**THE TIME FOR SCALING EACH SEXTANT IS RECORDED ON THE COMPUTER PRINTOUT**

2.3 Third and subsequent appointments (hygienist).

2.3.1 Re-examination of the periodontal status.

This will be performed as described in section 2.2.1 using the same clinical parameters. The findings are to be recorded on the special monitoring chart (Annex 2).

**THE TIME FOR RE-EXAMINATION OF THE PERIODONTAL STATUS IS RECORDED ON THE COMPUTER PRINTOUT**

2.3.2 Oral Hygiene instruction.

i. The patient's teeth are disclosed, at the discretion of the operator, using disclosing agent. The patient then evaluates the results of his/her oral hygiene technique.

ii. The results are discussed and tooth-brushing and interdental cleaning is modified should this be necessary.

**THE TIME FOR ORAL HYGIENE INSTRUCTION IS RECORDED ON THE COMPUTER PRINTOUT**
2.3.3 Scaling

Scaling is performed as under section 2.2.3.

DO NOT SCALE EXPERIMENTAL SEXTANTS

THE TIME FOR SCALING EACH SEXTANT IS RECORDED ON THE COMPUTER PRINTOUT

NOTE: Duration of initial (hygienist) treatment

The treatment provided by the hygienist may take a number of appointments and it is expected that this will vary between individual patients. However, based on previous experience, it is envisaged that the hygienist treatment should be completed within the period of one month. This does not imply that all patients should routinely require one whole month of hygienist treatment involving oral hygiene instruction and scaling.

Oral hygiene instruction and scaling should be performed to the best of the operator's ability until the hygienist considers that the patient's oral hygiene is optimal and that scaling has been performed to the best of his/her ability.

On the last appointment with the hygienist, an appointment must be made for the patient to see the dentist. This should be scheduled as close to one month as possible after the last hygienist appointment.

2.4 Subsequent appointment/s (dentist).

The period of one month between the last hygienist appointment and the subsequent review appointment with the dentist allows periodontal tissue responses to take place.

The subsequent appointment/s with the dentist during this phase of treatment is for re-examination of the periodontal status and to assess the need for further treatment in the control sextants. The dentist will provide oral hygiene reinforcement and any scaling or complex treatment as may be indicated.

3. CLINICAL INSTRUCTIONS FOR THE "MAINTENANCE" PHASE OF TREATMENT (PHASE B).

This phase of treatment will take place as close to six months as possible after the baseline periodontal examination and will follow the same basic sequence and outline as for Phase A. The sole exception is that scaling and complex treatment will be provided now for all six sextants, i.e. both control and experimental sextants, should this be required.

Treatment times must be recorded for all appointments and all items of periodontal treatment.
THE START TIME AND THE FINISH TIME FOR EACH APPOINTMENT ARE RECORDED ON THE COMPUTER PRINTOUT

3.1 First maintenance appointment (examiner, dentist, and hygienist).

On the first maintenance appointment, a six-month periodontal examination will be performed by the examiner (C.J.H.) assisted by a DSA. Immediately afterwards, the patient will be reexamined by the dentist.

After the periodontal examinations, the dentist will refer the patient to the same hygienist as in Phase A (should this be possible) for oral hygiene and scaling. This treatment will start on the first maintenance appointment of Phase B, immediately after the patient has been examined by the dentist.

3.1.1 Oral Hygiene Instruction.

Oral hygiene is performed as under section 2.3.2.

THE TIME FOR ORAL HYGIENE INSTRUCTION IS RECORDED ON THE COMPUTER PRINTOUT

3.1.2 Scaling.

Each sextant indicated for scaling, i.e. those with calculus, should be scaled to the best of the operator's ability coincident with existing clinical conditions before the next sextant is scaled. It is not necessary to complete all the scaling in this visit, but the hygienist should try to remove as much calculus as possible.

THE TIME FOR SCALING EACH SEXTANT IS RECORDED ON THE COMPUTER PRINTOUT

3.2 Subsequent maintenance appointments (hygienist).

3.2.1 Re-examination of the periodontal status.

This will be performed as described in section 2.2.1 using the same clinical parameters. The findings are to be recorded on the special monitoring chart (Annex 2).
3.2.2 Oral Hygiene Instruction.

Oral hygiene is performed as under section 2.3.2.

3.2.3 Scaling.

Scaling is performed as under section 3.1.2.

NOTE: Duration of maintenance (hygienist) treatment

It is envisaged that maintenance treatment procedures provided by the hygienist should be completed within the period of one month. This does not imply that all patients should routinely require one whole month of hygienist treatment involving oral hygiene instruction and scaling.

Oral hygiene instruction and scaling should be performed to the best of the operator's ability until the hygienist considers that the patient's oral hygiene is optimal and that scaling has been performed to the best of his/her ability.

On the last hygienist appointment, an appointment must be made for the patient to see the dentist. This should be scheduled as close to one month as possible after the last hygienist appointment.

3.3 Subsequent maintenance appointments (dentist)

The period of one month between the last hygienist appointment and the subsequent review appointment with the dentist allows periodontal tissue responses to take place.

The subsequent appointment/s with the dentist during this phase of treatment is for re-examination of the periodontal status and to assess the need for further treatment in the control sextants. The dentist will provide oral hygiene reinforcement and any scaling or complex treatment as may be indicated.
4. CLINICAL INSTRUCTIONS FOR THE "MAINTENANCE" PHASE OF TREATMENT (PHASE C).

This phase of treatment will take place as close to six months as possible after the baseline periodontal examination and will follow the same basic sequence and outline as for Phase B.

Treatment times must be recording for all appointments and all items of periodontal treatment.

<table>
<thead>
<tr>
<th>THE START TIME AND THE FINISH TIME FOR EACH APPOINTMENT ARE RECORDED ON THE COMPUTER PRINTOUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>THE TIME FOR RE-EXAMINATION OF THE PERIODONTAL STATUS IS RECORDED ON THE COMPUTER PRINTOUT</td>
</tr>
<tr>
<td>THE TIME FOR ORAL HYGIENE INSTRUCTION IS RECORDED ON THE COMPUTER PRINTOUT</td>
</tr>
<tr>
<td>THE TIME FOR SCALING EACH SEXTANT IS RECORDED ON THE COMPUTER PRINTOUT</td>
</tr>
</tbody>
</table>
### C P I T N TREATMENT STUDY - CONTROL SHEET FOR HYGIENISTS

**PATIENT NAME:** TEST PATIENT  
**REG NUMBER:** 4321  
**STUDY NUMBER:** 1234  
**DATE OF BIRTH:** 450624  
**EXAM DATE:** 880723  

### SEXTANT CPITN TREATMENT MODALITY

<table>
<thead>
<tr>
<th>Sextant</th>
<th>Treatment Modality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ORAL HYGIENE ONLY</td>
</tr>
<tr>
<td>2</td>
<td>ORAL HYGIENE ONLY</td>
</tr>
<tr>
<td>3</td>
<td>OHI + SCALING</td>
</tr>
<tr>
<td>4</td>
<td>OHI + SCALING + COMPLEX</td>
</tr>
<tr>
<td>5</td>
<td>ORAL HYGIENE ONLY</td>
</tr>
<tr>
<td>6</td>
<td>OHI + SCALING + COMPLEX</td>
</tr>
<tr>
<td>7</td>
<td>ORAL HYGIENE ONLY</td>
</tr>
<tr>
<td>8</td>
<td>ORAL HYGIENE ONLY</td>
</tr>
</tbody>
</table>

* Record the start time and finish time for appointment *
* Record the time taken for examination *
* Record the time taken for oral hygiene instruction *
* Per sextant for scaling *

### TIME IN MINUTES/SECONDS

<table>
<thead>
<tr>
<th>Visit</th>
<th>Date (YYMMDD)</th>
<th>Start Time</th>
<th>Exam Time</th>
<th>OHI Time</th>
<th>CTAOT Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>880703</td>
<td>10:03</td>
<td>4:58</td>
<td>12:58</td>
<td>6:42</td>
</tr>
</tbody>
</table>

* Record the time the patient leaves the chair at the end of treatment (hours:minutes) *

### SEXTANT

- **03**: No scaling indicated as no calculus detected  
- **04**: No scaling indicated Experimental sextant  
- **05**: No scaling indicated Experimental sextant  
- **06**: No scaling indicated Experimental sextant  
- **07**: No scaling indicated Experimental sextant  
- **08**: No scaling indicated Experimental sextant

### FINISH TIME

- **VISIT 1**: 11:50  
- **VISIT 2**: 9:48

### TOTAL TIME

- **4:12**

### OPERATOR

- **Fanny**
Computer program written in Microsoft® Basic to assign treatment to individual sextants according to CPITN scoring Phases B and C

```
10 REM *******************************************************
20 REM * PROGRAM NAME : NORAN.BAS *
30 REM * FUNCTION : PROGRAM TO ASSIGN TREATMENT *
40 REM * : TO INDIVIDUAL SEXTANTS ACCORDING TO *
50 REM * : SCORING USING CPITN PHASES B & C *
60 REM * DATE : 870514 *
70 REM *******************************************************
80 CLS
90 PRINT " THIS PROGRAM IS CALLED NORAN.BAS AND IS DESIGNED"  
100 PRINT " TO GIVE ALLOCATION OF TREATMENT MODES"  
110 PRINT " ACCORDING TO CPITN DATA"
120 PRINT
130 PRINT
140 DIM A(6), T$(4), CE$(4)
150 FOR I=0 TO 4: READ T$(I): NEXT I
160 FOR I=1 TO 4: READ CE$(I): NEXT I
170 DATA "NO TREATMENT REQUIRED"
180 DATA "ORAL HYGIENE ONLY"
190 DATA "OH1 + SCALING"
200 DATA "OH1 + SCALING + COMPLEX"
210 DATA "OH1 + SCALING"
220 DATA "1 2 3 4 5 6 7 8"
230 DATA "1 2 3 4 5 6 7 8"
240 DATA "1 2 3 4 5 6 7 8"
250 DATA "1 2 3 4 5 6 7 8"
260 INPUT "ENTER PATIENT'S NAME IN FULL :-" ; N$
270 PRINT
280 INPUT "ENTER REGISTRATION NUMBER : " ; R
290 PRINT
300 INPUT "ENTER STUDY NUMBER : " ; S
310 PRINT
320 INPUT "ENTER DATE OF BIRTH (YYMMDD) : " ; B$
330 PRINT
340 INPUT "DATE OF EXAMINATION (YYMMDD) : " ; D$
350 PRINT
360 INPUT "ENTER CPITN (SIX SEXTANTS) : " ; CP$
370 PRINT
380 RANDOMIZE S
390 FOR I=1 TO 6
400 CPI$(I)=MID$(CP$, I, 1)
410 IF CPI$(I)="/" THEN CPI(I)=0: GOTO 440
420 CPI(I)=VAL(CPI$(I))
430 IF CPI(I)<0 OR CPI(I)>4 THEN PRINT "INVALID DATA, PLEASE RE-ENTER" : GOTO 360
440 NEXT I
450 REM GOSUB 2820
460 REM SE$=CE$(CN)
470 LPRINT " *** CPITN TREATMENT STUDY - CONTROL SHEET FOR HYGIENISTS ***"
480 LPRINT
490 LPRINT " PATIENT NAME : " ; N$
500 LPRINT
510 LPRINT " REG NUMBER : " ; R; TAB(37); "STUDY NUMBER : " ; S
520 LPRINT
530 LPRINT " DATE OF BIRTH : " ; B$; TAB(37); "EXAM DATE : " ; D$
540 LPRINT
550 LPRINT " SEXTANT CPITN TREATMENT MODALITY"
560 LPRINT " --------------------------------------------------------------"
570 FOR I=1 TO 6
580 J=2*I-1: CL$=MID$(SE$, J, 1): CE$=MID$(SE$, J+1, 1): CP=VAL(CI$)
590 IF CP="" AND CPI(I)>1 THEN CPI(I)=1
600 LPRINT " ; "CL$; CP$; " ; T$(CPI(I))",
610 LPRINT " --------------------------------------------------------------"
620 NEXT I
630 LPRINT
640 LPRINT " * RECORD THE START TIME AND FINISH TIME FOR APPOINTMENT *
650 LPRINT " * RECORD THE TIME TAKEN FOR : EXAMINATION *
660 LPRINT " * : ORAL HYGIENE INSTRUCTION *
670 LPRINT " * PER SEXTANT FOR : SCALING *
680 LPRINT
690 LPRINT " TIME IN MINUTES/SECONDS"
700 LPRINT
710 LPRINT
720 LPRINT
730 LPRINT
740 LPRINT
750 LPRINT
760 LPRINT
770 LPRINT
```

VISIT 1 VISIT 2 VISIT 3 VISIT 4 VISIT 5 VISIT 6

DATE (YY/MDD)

START TIME

EXAM TIME

OHl TIME

♦ RECORD BELOW THE SCALING TIME PER SEKTANT FOR EACH APPOINTMENT **

SEX TANT

FINISH TIME

TOTAL TIME

OPERATOR

*** C P I T N TREATMENT STUDY - CONTROL SHEET FOR DENTISTS ***

PATIENT NAME : ":N$

REG NUMBER : ":R;TAB(37);"STUDY NUMBER : ":S

DATE OF BIRTH : ":B$;TAB(37);"EXAM DATE : ":D$

SEX TANT CPI T N TREATMENT MODALITY

FOR I = 1 TO 6

J=2*I-1:C1$=MID$(SE$,J,1):C2$=MID$(SE$,J+1,1):CP=VAL(C1$)

IF CP="*" AND CPI(CJ) > 1 THEN CPI(I) = 1

RECORD THE START TIME AND FINISH TIME FOR APPOINTMENT **

RECORD THE TIME TAKEN FOR : EXAMINATION, RADIOGRAPHS **

ORAL HYGIENE INSTRUCTION **

PER SEKTANT FOR : SCALING **

ROOT PLANNING OR SURGERY **

TIME IN MINUTES/SECONDS **

VISIT _ VISIT _ VISIT _ VISIT _ VISIT _ VISIT _

DATE (YY/MDD)

START TIME

EXAM TIME

OHl TIME

♦ RECORD BELOW THE TREATMENT TIME PER SEKTANT FOR SCALING AND FOR **

♦ FOR ALL ITEMS OF COMPLEX TREATMENT i.e. ROOTPLANNING OR SURGERY **

SEX TANT
Example of computer output from program written to assign individual sextants according to CPITN scoring Phases B and C

*** CPITN TREATMENT STUDY - CONTROL SHEET FOR HYGIENISTS ***

PATIENT NAME: KO SIU KUEN
REG NUMBER: 36748   STUDY NUMBER: 477
DATE OF BIRTH: 480103   EXAM DATE: 881115

<table>
<thead>
<tr>
<th>SEXTANT</th>
<th>CPITN TREATMENT MODALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 2</td>
<td>OHI + SCALING</td>
</tr>
<tr>
<td>4 3</td>
<td>OHI + SCALING</td>
</tr>
<tr>
<td>5 2</td>
<td>OHI + SCALING</td>
</tr>
<tr>
<td>6 4</td>
<td>OHI + SCALING + COMPLEX</td>
</tr>
<tr>
<td>1</td>
<td>ORAL HYGIENE ONLY</td>
</tr>
<tr>
<td>2</td>
<td>OHI + SCALING</td>
</tr>
</tbody>
</table>

* RECORD THE START TIME AND FINISH TIME FOR APPOINTMENT *
* RECORD THE TIME TAKEN FOR: EXAMINATION *
* PER SEXTANT FOR: ORAL HYGIENE INSTRUCTION *
* SCALING *

TIME IN MINUTES/SECONDS

<table>
<thead>
<tr>
<th>VISIT 1</th>
<th>VISIT 2</th>
<th>VISIT 3</th>
<th>VISIT 4</th>
<th>VISIT 5</th>
<th>VISIT 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE (YYMMDD)</td>
<td>+--------+--------+---------+---------+---------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>START TIME</td>
<td>+--------+--------+---------+---------+---------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXAM TIME</td>
<td>+--------+--------+---------+---------+---------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OHI TIME</td>
<td>+--------+--------+---------+---------+---------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* RECORD BELOW THE SCALING TIME PER SEXTANT FOR EACH APPOINTMENT *

<table>
<thead>
<tr>
<th>SEXTANT</th>
<th>03</th>
<th>04</th>
<th>05</th>
<th>06</th>
<th>07</th>
<th>08</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINISH TIME</td>
<td>+--------+--------+---------+---------+---------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL TIME</td>
<td>+--------+--------+---------+---------+---------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPERATOR</td>
<td>+--------+--------+---------+---------+---------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**C P I T N TREATMENT STUDY - CONTROL SHEET FOR DENTISTS**

**PATIENT NAME**: RO SIU KUEN  
**REG NUMBER**: 36748  
**STUDY NUMBER**: 477  
**DATE OF BIRTH**: 480103  
**EXAM DATE**: 881115

<table>
<thead>
<tr>
<th>SEXTANT</th>
<th>CPITN TREATMENT MODALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2 OHI + SCALING</td>
</tr>
<tr>
<td>4</td>
<td>3 OHI + SCALING</td>
</tr>
<tr>
<td>5</td>
<td>2 OHI + SCALING</td>
</tr>
<tr>
<td>6</td>
<td>4 OHI + SCALING + COMPLEX</td>
</tr>
<tr>
<td>7</td>
<td>1 ORAL HYGIENE ONLY</td>
</tr>
<tr>
<td>8</td>
<td>2 OHI + SCALING</td>
</tr>
</tbody>
</table>

* RECORD THE START TIME AND FINISH TIME FOR APPOINTMENT  
* RECORD THE TIME TAKEN FOR:  
  * EXAMINATION  
  * ORAL HYGIENE INSTRUCTION  
  * PER SEXTANT FOR:  
  SCALING  
  ROOT PLANING OR SURGERY  

**TIME IN MINUTES/SECONDS**

<table>
<thead>
<tr>
<th>VISIT</th>
<th>VISIT</th>
<th>VISIT</th>
<th>VISIT</th>
<th>VISIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE (YMMDD)</td>
<td>START TIME</td>
<td>EXAM TIME</td>
<td>OHI TIME</td>
<td>FINISH TIME</td>
</tr>
</tbody>
</table>

* RECORD BELOW THE TREATMENT TIME PER SEXTANT FOR SCALING AND FOR:  
  * ALL ITEMS OF COMPLEX TREATMENT i.e. ROOTPLANING OR SURGERY  

**SEXTANT**

| 04 | +-----------------+-----------------+-----------------+-----------------+-----------------+-----------------|
| 05 | +-----------------+-----------------+-----------------+-----------------+-----------------+-----------------|
| 06 | +-----------------+-----------------+-----------------+-----------------+-----------------+-----------------|
| 07 | +-----------------+-----------------+-----------------+-----------------+-----------------+-----------------|
| 08 | +-----------------+-----------------+-----------------+-----------------+-----------------+-----------------|

**FINISH TIME**

**TOTAL TIME**
Computer program written in Microsoft® Basic to calculate the number of minutes from start time to end time for treatment delivered

```
10 REM  ***********************************************
11 REM  ** PROGRAM NAME : TIMCAL2.BAS **
12 REM  ** FUNCTION : PROGRAM TO CALCULATE NUMBER OF MINUTES **
13 REM  ** FROM START TIME TO END TIME **
14 REM  ** FOR TREATMENT DELIVERED **
15 REM  ** DATE : 870312 **
16 REM  ***********************************************
20 CLS
30 PRINT " THIS PROGRAM IS CALLED TIMCAL2.BAS AND IS DESIGNED"
40 PRINT " TO CALCULATE NUMBER OF MINUTES"
50 PRINT " FOR TREATMENT DELIVERED"
60 PRINT
70 PRINT
80 CLEAR:CLS
90 CAR=1
91 GOSUB 200
100 WHILE CAR
110 GOSUB 1000
120 IF CAR <> 0 THEN GOSUB 2000
130 WEND
140 END
150 STOP
200 REM  display routine
210 REM 220 PRINT TAB (10) ;  "Program to calculate overall time in minutes given start & end time"
230 PRINT TAB (10) ;  "Press any key to continue"
240 PRINT TAB(10):"Program to calculate overall time in minutes given start & end time"
250 C$=INKEY$:IF LEN(C$)=0 THEN GOTO 250
260 RETURN
2000 REM  input routine
2100 REM 2200 INPUT "INPUT START TIME (hh:mm format, press enter to end) : ",ST$
2300 IF LEN(ST$)=0 THEN CAR=0:GOTO 1990
2400 A=INSTR(1,ST$,":") :IF A=0 THEN GOTO 2300
2500 H=VAL(LEFT$(ST$,A-1)) :M=VAL(RIGHT$(ST$,LEN(ST$) -A))
2600 ST=H*60+M
2700 INPUT "INPUT END TIME (hh:mm) : ",ET$
2800 A=INSTR(1,ET$,":") :IF A=0 THEN GOTO 2700
2900 H=VAL(LEFT$(ET$,A-1)) :M=VAL(RIGHT$(ET$,LEN(ET$) -A))
3000 ET=H*60+M
3990 REM 1991 RETURN
2000 REM 2100 REM 2200 print "Invalid time being inputted":GOTO 2040
2300 IF TOT < 0 THEN PRINT "Invalid time being inputted":GOTO 2040
2400 PRINT:PRINT USING "OUTPUT TOTAL TIME = ###";TOT;
3000 PRINT " minutes"
### CPITN Treatment Study

**Activity Sampling Recording Sheet**

**All columns for columns 3-9 should be filled with the same values as above.**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
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<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td>22</td>
<td>23</td>
</tr>
</tbody>
</table>
Activity Sampling Recording Sheet - Side B

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>12</td>
</tr>
</tbody>
</table>

Columns

3-9

Enter Same

Values

as Above

Notes:-
## Activity Sampling Codes and Criteria

### PRIMARY ACTIVITIES

<table>
<thead>
<tr>
<th>CODE</th>
<th>ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.</td>
<td>EXAMINATION, HISTORY TAKING AND TREATMENT PLANNING</td>
</tr>
<tr>
<td>01</td>
<td>Examination and charting before treatment (new patient)</td>
</tr>
<tr>
<td>02</td>
<td>History, diagnosis, treatment planning (new patient)</td>
</tr>
<tr>
<td>03</td>
<td>Examination and charting during treatment</td>
</tr>
<tr>
<td>04</td>
<td>Examination and charting -Recall patient -Case review.</td>
</tr>
<tr>
<td>05</td>
<td>Radiograph taking</td>
</tr>
<tr>
<td>06</td>
<td>Impression / occlusal record for diagnosis and planning</td>
</tr>
<tr>
<td>09</td>
<td>Examination - other (specify in words)</td>
</tr>
</tbody>
</table>

### ORAL HYGIENE INSTRUCTION

<table>
<thead>
<tr>
<th>CODE</th>
<th>ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Oral Hygiene Instruction - talking to patient</td>
</tr>
<tr>
<td>11</td>
<td>Oral Hygiene Instruction - toothbrushing &amp; interspace</td>
</tr>
<tr>
<td>12</td>
<td>Oral Hygiene Instruction - interdental cleaning</td>
</tr>
<tr>
<td>13</td>
<td>Oral Hygiene Instruction - denture</td>
</tr>
<tr>
<td>14</td>
<td>Oral Hygiene Instruction - use of disclosing agent</td>
</tr>
<tr>
<td>19</td>
<td>Oral Hygiene Instruction - other (specify in words)</td>
</tr>
</tbody>
</table>

### SCALING AND PROPHYLAXIS

<table>
<thead>
<tr>
<th>CODE</th>
<th>ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>20*</td>
<td>Scaling - hand-instruments</td>
</tr>
<tr>
<td>21*</td>
<td>Scaling - ultrasonics</td>
</tr>
<tr>
<td>22</td>
<td>Polishing teeth with pumice or prophylaxis paste</td>
</tr>
<tr>
<td>23</td>
<td>Removal of overhangs from restorations for peri</td>
</tr>
<tr>
<td>24</td>
<td>Checking during calculus/overhang removal</td>
</tr>
<tr>
<td>29</td>
<td>Scaling or prophylaxis - other (specify in words)</td>
</tr>
</tbody>
</table>

### COMPLEX PERIODONTAL TREATMENT

<table>
<thead>
<tr>
<th>CODE</th>
<th>ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>30*</td>
<td>Root planing with curettes</td>
</tr>
<tr>
<td>31*</td>
<td>Periodontal surgery - replaced flap</td>
</tr>
<tr>
<td>32*</td>
<td>Periodontal surgery - repositioned flap</td>
</tr>
<tr>
<td>33*</td>
<td>Periodontal surgery - gingivectomy</td>
</tr>
<tr>
<td>34*</td>
<td>Periodontal surgery - root resection / hemisection</td>
</tr>
<tr>
<td>35</td>
<td>Suture and/or pack removal post periodontal surgery</td>
</tr>
<tr>
<td>39*</td>
<td>Periodontal surgery - other (specify in words)</td>
</tr>
</tbody>
</table>
PRIMARY ACTIVITIES CONTINUED

CODE ACTIVITY

4. PREVENTIVE TREATMENT

40 Dietary planning or advice
41 Topical fluoride application for caries prevention
42 Densensitizing agents - includes topical fluoride
43 Fissure sealing
44 Modification of denture for plaque control
45 Polishing restorations - not for perio
49 Prevention - other (specify in words)

* includes time for giving local anaesthetic if required for the activity
If patient is rinsing, then give code of procedure operator is performing immediately before rinse.

SECONDARY ACTIVITIES

CODE ACTIVITY

5. OPERATORY AND PATIENT PREPARATION

50 Preparing operatory
51 Preparing operator - handwashing etc
52 Preparing patient
53 Preparing instruments - sharpening, sterilizing etc.
59 Preparing - other (specify in words)

6. OTHER ACTIVITIES INCLUDING THOSE OUTSIDE OPERATORY

60 Fetching or dismissing patient
61 Fetching or returning patient records
62 Fetching or returning instruments/materials
63 Fetching team member
64 Instructing or consulting team member
65 Discussion with patient other than OHI
66 Reading notes, letters, radiographs
67 Writing day sheet, ODONTICS and other records
69 Other (specify in words)
## UNPRODUCTIVE ACTIVITIES

### CODE ACTIVITY

### 7. WAITING OPERATOR.

- 70 Waiting team member
- 71 Waiting instruments/materials
- 72 Waiting radiograph processing
- 73 Waiting patient during treatment e.g. toilet
- 79 Waiting other (specify in words)

### 8. NO ACTIVITY OF OPERATOR.

- 80 No activity - patient cancelled within last 24 hours
- 81 No activity - patient late (Convert to 82 if fails)
- 82 No activity - patient failed
- 83 No activity - patient not booked
- 84 No activity - operator missing
- 85 No activity - appointment finished early
- 89 No activity - (specify in words)

### NON PERIODONTAL TREATMENT AND MISCELLANEOUS

- 92 Endodontics for primary perio endo lesion
- 93 Splinting for periodontal purposes
- 94 Extraction
- 99 All other treatment e.g. restorations, orthodontics, prosthetics etc. (specify in words)

*If patient is rinsing, then give code of procedure operator is performing immediately before rinse.*
Instructions issued to activity sampling personnel

The following notes refer to problems that have been identified during preliminary trials of activity sampling. These instructions will be updated as further problems arise.

NO ACTIVITY OF OPERATOR Codes beginning with the prefix 8. (i.e. 80 to 89).

1. If there is no activity because there is no patient in the chair at the time of sampling, ask the operator to specify whether
   a. The patient cancelled within the last 24 hours (assign 80)
   b. The patient is late for the appointment (assign 81)
      
      Note: If the patient subsequently fails the appointment then convert 81 to 82.
   c. The patient has failed/broken the appointment (assign 82)
   d. No patient was (assign 83)
   e. The appointment finished early or the operator is finished for the session (assign 85)

ii. If the operator is missing, then when the operator returns, ask what she/he was doing while missing. If there is an activity code to describe what was being done then recode accordingly. Otherwise use code 84.

EXAMINATION, HISTORY TAKING AND TREATMENT PLANNING

It is important to establish from the operator what type of examination is taking place.

Code 01 (Examination and charting before treatment) refers to examination and charting at the start of a course of treatment, for instance on the first visit of a new patient.

Code 03 (Examination and charting during treatment) refers to examination and charting after treatment has commenced, that is on appointments subsequent to the first visit of the patient.

Code 04 (Examination and charting - recall patient) refers to examination and charting at the time of a case review i.e. after a phase of treatment e.g. initial phase has been completed and a patient is recalled for review some months afterwards to assess the need for further treatment and maintenance.
POTENTIAL PROBLEMS WITH SECONDARY ACTIVITIES

50  **Preparing operatory** should be used when the operator is situated in his or her bay (operatory) and is making preparation for a patient. This should not be confused with code 53 - **Preparing instruments** which should only be used when dental instruments are being sharpened or sterilized etc. Furthermore, these codes should not be confused with code 62 - Fetching or returning instruments/materials when the operator leaves the bay (operatory) for this purpose.

52  **Preparing patient** - This code should be used for such activities as seating the patient or placing a paper/plastic bib on the patient. Preparing patient should **not** be used for crown or inlay preparation procedures.

OTHER NOTES

If a patient is rinsing at the time of sampling, ask the operator what activity he or she was performing immediately before the rinse, and use the code relating to that activity.

If you are unsure of the exact activity being performed by the operator **DO NOT HESITATE TO ASK** what activity he or she is performing.
Computer program written in Microsoft® Basic to produce random activity sampling times

10 CLS
20 PRINT ** PROGRAMME TO PRINT RANDOM TIME INTERVALS FOR ACTIVITY SAMPLING ACTIVITIES **
30 PRINT ** PROGRAMME NAME : RANTIME.BAS **
40 PRINT * : B70115 **
50 PRINT ************************************************************
60 PRINT :PRINT :PRINT
70 DIM R(IOO)
80 RANDOMIZE TIMER
90 GOSUB 180 ' input start time

100 FOR 1=1 TO 100:R(I)=0:NEXT I:SM=0
110 FOR I=1 TO N-1
120 RN = INT(RND*(T+1)) : IF RN<U OR RN>T THEN GOTO 120
130 R(I)=RN
140 SM=SM+RN
150 NEXT
160 TM=A-SM
170 IF TM<10 OR TM>T THEN GOTO 110
180 R(N)=TM
190 RETURN

200 REM PRINT OUT RESULT
210 LPRINT " TOTAL TIME FOR THE ACTIVITY SAMPLING SESSION = ";A ;"MINUTES"
220 LPRINT ********** STARTING TIME FOR SESSION = ";T$
IF MM > 3 THEN MM = MM - 3 ELSE EH = HH - 1; MM = MM + 60 - 3
FOR I = 1 TO N - 1
GOSUB 800 ' calculate time
NEXT
RETURN
IF MM < MM < 60 AND MM > 9 THEN GOTO 940
IF MM < 10 THEN GOTO 870
IF MM > 59 THEN GOTO 830
IF HH > 23 THEN HH = HH - 24
GOTO 820
HH$ = STR$(HH); MM$ = STR$(MM)
IF LEN(HH$) = 3 THEN HH$ = MID$(HH$, 2, 2)
IF LEN(MM$) = 3 THEN MM$ = MID$(MM$, 2, 1) ELSE MM$ = "0"
TT$ = HH$ + " : " + MM$
IF N = 1 THEN GOTO 1000
LPRINT " ; TT$
GOTO 1000
RETURN
Example of computer output from program written to produce random activity sampling times

TOTAL TIME FOR THE ACTIVITY SAMPLING SESSION = 270 MINUTES
STARTING TIME FOR SESSION = 08:30
FINISH TIME FOR SESSION = 13:00
NUMBER OF SAMPLES = 45
MINIMUM TIME INTERVAL BETWEEN SAMPLING = 3
THE TIMES SELECTED FOR ACTIVITY SAMPLING ARE AS FOLLOWS:

8:31
8:34
8:37
8:43
8:49
8:52
8:57
9:08
9:11
9:20
9:26
9:32
9:41
9:45
9:51
9:58
10:03
10:10
10:14
10:19
10:22
10:30
10:41
10:44
10:55
11:06
11:10
11:15
11:21
11:26
11:33
11:37
11:40
11:46
11:53
12:01
12:08
12:14
12:25
12:30
12:40
12:43
12:47
12:52
12:56
Activity Sampling - Number of observations required according to degree of accuracy required (Table 7.3)

<table>
<thead>
<tr>
<th>Proportion of time devoted to an activity</th>
<th>Degree of accuracy (95% confidence limits)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1%</td>
</tr>
<tr>
<td>1 or 99%</td>
<td>380</td>
</tr>
<tr>
<td>2 or 98%</td>
<td>752</td>
</tr>
<tr>
<td>5 or 95%</td>
<td>1824</td>
</tr>
<tr>
<td>10 or 90%</td>
<td>3457</td>
</tr>
<tr>
<td>20 or 80%</td>
<td>6164</td>
</tr>
<tr>
<td>30 or 70%</td>
<td>8067</td>
</tr>
<tr>
<td>40 or 60%</td>
<td>9219</td>
</tr>
<tr>
<td>50</td>
<td>9603</td>
</tr>
</tbody>
</table>

Table 7.3 The number of observations required according to degree of accuracy required and the expected proportion of time devoted to an activity.
### CPITN STUDY: CALIBRATION

**NAME:**

<table>
<thead>
<tr>
<th>TEAM NUMBER</th>
<th>YEAR</th>
<th>MONTH</th>
<th>AGE</th>
<th>SEX</th>
<th>AM</th>
<th>PM</th>
<th>TOTH</th>
<th>SUPRAGINGIVAL</th>
<th>CALCULUS</th>
<th>MBL</th>
<th>BLEED</th>
<th>BLEED</th>
<th>BLEED</th>
<th>BLEED</th>
<th>BLEED</th>
<th>BLEED</th>
<th>BLEED</th>
<th>BLEED</th>
<th>BLEED</th>
<th>BLEED</th>
</tr>
</thead>
<tbody>
<tr>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<td>4</td>
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<td>7</td>
<td>8</td>
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<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
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<tr>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Columns 1 - 15**
Enter Same Values as Above

**POCKETS:** 0 1 2 3 4 5
**CALCULUS:** 0 1 2 3 4 5
**OVERHANG:** 0 1 2
**BLEEDING:** 0 1
**MISSING TOOTH:** 9
**PARTIALLY ERUPTED TOOTH:** 8
**EXTRACTION CARIES:** 7
**EXTRACTION PERIODONTAL:** 6

---

**CPITN:** 0 1 2 3 4
**TN:** 0 1 2 3
**MISSING SEXTANT:** 9
### Statistical Analysis (Table 7.4)

<table>
<thead>
<tr>
<th>Clinical criteria</th>
<th>Sextant</th>
<th>Transformation</th>
<th>Sphericity (univariate)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Time</td>
</tr>
<tr>
<td><strong>Bleeding</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td></td>
<td>Square Root</td>
<td>0.001</td>
</tr>
<tr>
<td>Post</td>
<td></td>
<td>Square Root</td>
<td>0.004</td>
</tr>
<tr>
<td>Ant</td>
<td></td>
<td>Square Root</td>
<td>0.094</td>
</tr>
<tr>
<td><strong>Supra or subgingival calculus</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td></td>
<td>Square Root</td>
<td>0.000</td>
</tr>
<tr>
<td>Post</td>
<td></td>
<td>Square Root</td>
<td>0.000</td>
</tr>
<tr>
<td>Ant</td>
<td></td>
<td>Square Root</td>
<td>0.002</td>
</tr>
<tr>
<td><strong>Supragingival calculus</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td></td>
<td>Square Root</td>
<td>0.000</td>
</tr>
<tr>
<td>Post</td>
<td></td>
<td>Square Root</td>
<td>0.000</td>
</tr>
<tr>
<td>Ant</td>
<td></td>
<td>Square Root</td>
<td>0.040</td>
</tr>
<tr>
<td><strong>Subgingival calculus</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td></td>
<td>Square Root</td>
<td>0.000</td>
</tr>
<tr>
<td>Post</td>
<td></td>
<td>Square Root</td>
<td>0.000</td>
</tr>
<tr>
<td>Ant</td>
<td></td>
<td>Square Root</td>
<td>0.010</td>
</tr>
<tr>
<td><strong>Probing depths ≤ 3.5 mm</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td></td>
<td>Arc Sine</td>
<td>0.002</td>
</tr>
<tr>
<td>Post</td>
<td></td>
<td>Arc Sine</td>
<td>0.010</td>
</tr>
<tr>
<td><strong>Probing depths 4-5 mm</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td></td>
<td>Square Root</td>
<td>0.025</td>
</tr>
<tr>
<td>Post</td>
<td></td>
<td>Square Root</td>
<td>0.056</td>
</tr>
<tr>
<td><strong>All above</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td></td>
<td>Square Root</td>
<td>0.000</td>
</tr>
<tr>
<td>Post</td>
<td></td>
<td>Square Root</td>
<td>0.000</td>
</tr>
<tr>
<td>Ant</td>
<td></td>
<td>Square Root</td>
<td>0.000</td>
</tr>
</tbody>
</table>

*Table 7.4 The p-values of repeated measures testing procedures for sphericity according to the method of Mauchly (1940).*
<table>
<thead>
<tr>
<th>Maximum CPITN score per subject</th>
<th>Number of sessions</th>
<th>Total treatment time</th>
<th>Total examination time</th>
<th>Total oral hygiene time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phase A</td>
<td>Phase B</td>
<td>Phase C</td>
<td>Phase A</td>
</tr>
<tr>
<td>At Baseline</td>
<td>2</td>
<td>6</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>(3.3 (0.5)</td>
<td>2.7 (0.5)</td>
<td>2.2 (0.4)</td>
<td>176 (34)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>25</td>
<td>4.8 (1.1)</td>
<td>4.8 (1.1)</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>5</td>
<td>2.6 (0.5)</td>
<td>2.6 (0.5)</td>
</tr>
<tr>
<td>All</td>
<td>36</td>
<td>36</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>3.8 (0.8)</td>
<td>2.9 (0.8)</td>
<td>2.4 (0.8)</td>
<td>218 (74)</td>
</tr>
</tbody>
</table>

At 6 months

|                                 | 2      | 16      | 2.9 (0.8) | 2.9 (0.8) | 2.9 (0.8) | 2.9 (0.8) | 2.9 (0.8) | 2.9 (0.8) | 2.9 (0.8) | 2.9 (0.8) | 2.9 (0.8) | 2.9 (0.8) | 2.9 (0.8) |
|                                 | 3      | 15      | 134 (54)  | 134 (54)  | 134 (54)  | 134 (54)  | 134 (54)  | 134 (54)  | 134 (54)  | 134 (54)  | 134 (54)  | 134 (54)  | 134 (54)  |
|                                 | 4      | 5       | 103 (20)  | 103 (20)  | 103 (20)  | 103 (20)  | 103 (20)  | 103 (20)  | 103 (20)  | 103 (20)  | 103 (20)  | 103 (20)  | 103 (20)  |
| All                             | 36     | 36      | 121 (55)  | 121 (55)  | 121 (55)  | 121 (55)  | 121 (55)  | 121 (55)  | 121 (55)  | 121 (55)  | 121 (55)  | 121 (55)  | 121 (55)  |

At 12 months

|                                 | 1      | 1       | 2.0 (0.0) | 2.0 (0.0) | 2.0 (0.0) | 2.0 (0.0) | 2.0 (0.0) | 2.0 (0.0) | 2.0 (0.0) | 2.0 (0.0) | 2.0 (0.0) | 2.0 (0.0) | 2.0 (0.0) |
|                                 | 2      | 14      | 82 (27)   | 82 (27)   | 82 (27)   | 82 (27)   | 82 (27)   | 82 (27)   | 82 (27)   | 82 (27)   | 82 (27)   | 82 (27)   | 82 (27)   |
|                                 | 3      | 15      | 81 (41)   | 81 (41)   | 81 (41)   | 81 (41)   | 81 (41)   | 81 (41)   | 81 (41)   | 81 (41)   | 81 (41)   | 81 (41)   | 81 (41)   |
|                                 | 4      | 6       | 115 (34)  | 115 (34)  | 115 (34)  | 115 (34)  | 115 (34)  | 115 (34)  | 115 (34)  | 115 (34)  | 115 (34)  | 115 (34)  | 115 (34)  |
| All                             | 36     | 36      | 86 (36)   | 86 (36)   | 86 (36)   | 86 (36)   | 86 (36)   | 86 (36)   | 86 (36)   | 86 (36)   | 86 (36)   | 86 (36)   | 86 (36)   |

Table 8.1 Crosstabulation of the number of sessions, the mean total treatment time, examination time and oral hygiene time in minutes for Phases A, B & C against maximum sextant CPITN code in a subject (all teeth) as determined at the baseline, 3-, and 6-month examinations (Subjects who completed all three phases of treatment N = 36).
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Number of procedures completed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phase A</td>
</tr>
<tr>
<td>Examination</td>
<td>184</td>
</tr>
<tr>
<td>Radiographic examination</td>
<td>43</td>
</tr>
<tr>
<td>Oral hygiene</td>
<td>43</td>
</tr>
<tr>
<td>Scaling control *</td>
<td>129</td>
</tr>
<tr>
<td>Scaling experimental *</td>
<td>-</td>
</tr>
<tr>
<td>Overhang removal control *</td>
<td>2</td>
</tr>
<tr>
<td>Overhang removal experimental *</td>
<td>-</td>
</tr>
<tr>
<td>Root planing control *</td>
<td>-</td>
</tr>
<tr>
<td>Root planing experimental *</td>
<td>-</td>
</tr>
<tr>
<td>Surgery control *</td>
<td>-</td>
</tr>
<tr>
<td>Surgery experimental *</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 8.2 The number of procedures completed at each treatment phase according to nature of procedure (* = sextants)
### Table 8.3
Crosstabulation of the mean time expended on scaling at baseline, 6-, and 12 month treatment stages for subjects who completed all three stages of treatment against maximum sextant CPITN code in a subject (all teeth) as determined at the baseline, 3-, and 6-month examinations.
<table>
<thead>
<tr>
<th>CODE</th>
<th>ACTIVITY</th>
<th>% TT</th>
<th>% 1*</th>
<th>% 2*</th>
<th>% SECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Examination and charting before treatment (new patient)</td>
<td>0.2</td>
<td>0.7</td>
<td>10.1</td>
<td>1.3</td>
</tr>
<tr>
<td>02</td>
<td>History, diagnosis, treatment planning (new patient)</td>
<td>0</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Examination and charting during treatment</td>
<td>0.7</td>
<td>2.5</td>
<td>37.1</td>
<td>15.1</td>
</tr>
<tr>
<td>04</td>
<td>Examination and charting - Recall patient - Case review</td>
<td>1.0</td>
<td>3.3</td>
<td>48.2</td>
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</tr>
<tr>
<td>05</td>
<td>Radiograph taking</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>09</td>
<td>Examination - other</td>
<td>0.1</td>
<td>0.2</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Oral Hygiene Instruction - talking to patient</td>
<td>1.9</td>
<td>6.4</td>
<td>30.6</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Oral Hygiene Instruction - toothbrushing &amp; interspace</td>
<td>3.2</td>
<td>10.9</td>
<td>52.4</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Oral Hygiene Instruction - interdental cleaning</td>
<td>0.9</td>
<td>3.1</td>
<td>15.1</td>
<td></td>
</tr>
<tr>
<td>13</td>
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<tr>
<td>20*</td>
<td>Scaling - hand-instruments</td>
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<td>21*</td>
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<td>22.6</td>
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<tr>
<td>22</td>
<td>Polishing teeth with pumice or prophylaxis paste</td>
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<td>2.9</td>
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<tr>
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<td>0.6</td>
<td>2.1</td>
<td>3.0</td>
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<tr>
<td>29</td>
<td>Scaling or prophylaxis - other</td>
<td>0</td>
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<td>0.1</td>
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<tr>
<td>30*</td>
<td>Root planing with curettes</td>
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<tr>
<td>41</td>
<td>Topical fluoride application for caries prevention</td>
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<td>0.5</td>
<td>41.0</td>
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<tr>
<td>42</td>
<td>Desensitizing agents - includes topical fluoride</td>
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<td>0.6</td>
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<tr>
<td>43</td>
<td>Fissure sealing</td>
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<td>Prevention - other</td>
<td>0</td>
<td>0</td>
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<td>Preparing operator - handwashing etc</td>
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<td>Preparing instruments - sharpening, sterilizing etc.</td>
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<td>0.2</td>
<td>1.7</td>
<td>3.4</td>
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<td>7.3</td>
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<td>7.2</td>
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<td>67</td>
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<td>7.5</td>
<td>15.0</td>
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<td>70</td>
<td>Waiting team member</td>
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<td>0</td>
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<td>0</td>
<td>15.8</td>
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<td>0</td>
<td>0</td>
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<td>Waiting other</td>
<td>0.1</td>
<td>0.1</td>
<td>47.3</td>
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<td>80</td>
<td>No activity - patient cancelled within last 24 hours</td>
<td>1.1</td>
<td>1.9</td>
<td>10.0</td>
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<tr>
<td>81</td>
<td>No activity - patient late (Convert to 02 if fails)</td>
<td>5.3</td>
<td>8.6</td>
<td>8.7</td>
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<td>82</td>
<td>No activity - patient failed</td>
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<td>13.4</td>
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<td>No activity - patient not booked</td>
<td>38.1</td>
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<td>84</td>
<td>No activity - operator missing</td>
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<td>0.5</td>
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<td>85</td>
<td>No activity - appointment finished early</td>
<td>7.6</td>
<td>12.5</td>
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<td>89</td>
<td>No activity - (specify in words)</td>
<td>0.1</td>
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Table 8.4 Proportion of time spent on different activities
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<th>Session</th>
<th># Sites</th>
<th>PROBING DEPTH RANGE</th>
<th>SUPRAGINGIVAL CALCULUS</th>
<th>SUBGINGIVAL CALCULUS</th>
<th>BLEEDING</th>
<th>HIGHEST CPITN TOOTH SCORE</th>
<th>SEXTANT CPITN SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>% Agree</td>
<td>k</td>
<td>% Agree</td>
<td>k</td>
<td>% Agree</td>
<td>k</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training 1</td>
<td>396</td>
<td>94.4</td>
<td>0.51 (.08)</td>
<td>96.7</td>
<td>0.87 (.04)</td>
<td>90.1</td>
<td>0.79 (.03)</td>
</tr>
<tr>
<td>Training 2</td>
<td>498</td>
<td>93.2</td>
<td>0.66 (.05)</td>
<td>97.0</td>
<td>0.89 (.03)</td>
<td>85.7</td>
<td>0.72 (.03)</td>
</tr>
<tr>
<td>Training 3</td>
<td>498</td>
<td>96.8</td>
<td>0.88 (.03)</td>
<td>99.2</td>
<td>0.95 (.02)</td>
<td>91.6</td>
<td>0.83 (.03)</td>
</tr>
<tr>
<td>Training overall</td>
<td>1392</td>
<td>94.8</td>
<td>0.75 (.03)</td>
<td>97.7</td>
<td>0.90 (.02)</td>
<td>89.1</td>
<td>0.78 (.02)</td>
</tr>
<tr>
<td>Prestudy 1</td>
<td>474</td>
<td>98.3</td>
<td>0.57 (.13)</td>
<td>96.4</td>
<td>0.90 (.02)</td>
<td>88.8</td>
<td>0.78 (.03)</td>
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<tr>
<td>Prestudy 2</td>
<td>480</td>
<td>94.4</td>
<td>0.61 (.06)</td>
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<td>0.87 (.03)</td>
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<td>0.73 (.03)</td>
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<tr>
<td>Prestudy overall</td>
<td>954</td>
<td>96.3</td>
<td>0.61 (.06)</td>
<td>95.7</td>
<td>0.88 (.02)</td>
<td>87.7</td>
<td>0.75 (.03)</td>
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</table>

Note: Figures in parenthesis give the standard error of $k$.

Table 9.1 Clinical examiner reproducibility - training and prestudy calibration sessions
<table>
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<tr>
<th>Session</th>
<th>Sites</th>
<th>% Agree</th>
<th>k</th>
<th>% Agree</th>
<th>k</th>
<th>% Agree</th>
<th>k</th>
<th>% Agree</th>
<th>k</th>
<th>% Agree</th>
<th>k</th>
<th>% Agree</th>
<th>k</th>
</tr>
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<tbody>
<tr>
<td>Period 1</td>
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<td>99.6</td>
<td>.84</td>
<td>96.0</td>
<td>.88</td>
<td>89.4</td>
<td>.79</td>
<td>76.9</td>
<td>.34</td>
<td>92.5</td>
<td>.55</td>
<td>94.4</td>
<td>.85</td>
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<tr>
<td></td>
<td></td>
<td>(.10)</td>
<td></td>
<td>(.03)</td>
<td></td>
<td>(.03)</td>
<td></td>
<td>(.05)</td>
<td></td>
<td>(.14)</td>
<td></td>
<td>(.13)</td>
<td></td>
</tr>
<tr>
<td>Period 2</td>
<td>750</td>
<td>91.9</td>
<td>.66</td>
<td>96.8</td>
<td>.91</td>
<td>88.9</td>
<td>.78</td>
<td>79.7</td>
<td>.60</td>
<td>77.4</td>
<td>.64</td>
<td>82.1</td>
<td>.73</td>
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<tr>
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<td></td>
<td>(.04)</td>
<td></td>
<td>(.02)</td>
<td></td>
<td>(.02)</td>
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<td>(.03)</td>
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<td>(.03)</td>
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<td>(.06)</td>
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<td>.71</td>
<td>96.7</td>
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<td>81.4</td>
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<td>.82</td>
<td>94.1</td>
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<td>(.04)</td>
<td></td>
<td>(.02)</td>
<td></td>
<td>(.03)</td>
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<td>(.04)</td>
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<td>(.05)</td>
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<td>(.08)</td>
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<td>Period 4</td>
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<td>.76</td>
<td>95.6</td>
<td>.88</td>
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<td>.84</td>
<td>74.4</td>
<td>.46</td>
<td>85.3</td>
<td>.68</td>
<td>83.3</td>
<td>.69</td>
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<tr>
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<td>(.05)</td>
<td></td>
<td>(.02)</td>
<td></td>
<td>(.02)</td>
<td></td>
<td>(.04)</td>
<td></td>
<td>(.07)</td>
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<td>(.14)</td>
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<tr>
<td>Overall</td>
<td>2370</td>
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<td>.71</td>
<td>92.3</td>
<td>.90</td>
<td>90.2</td>
<td>.80</td>
<td>78.0</td>
<td>.55</td>
<td>84.7</td>
<td>.71</td>
<td>87.3</td>
<td>.79</td>
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<td>(.02)</td>
<td></td>
<td>(.01)</td>
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<td>(.01)</td>
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<td>(.03)</td>
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<td>(.06)</td>
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</table>

Note: Figures in parenthesis give the standard error of k.

Table 9.2  Clinical examiner reproducibility - study proper
### Table 9.3
The number of sextants, teeth and sites within control and experimental sextants according to position within the mouth at the baseline examination (Phase A subjects)

<table>
<thead>
<tr>
<th>Number</th>
<th>Anterior Sextants</th>
<th>Posterior Sextants</th>
<th>All sextants</th>
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</thead>
<tbody>
<tr>
<td>Control sextants</td>
<td>41</td>
<td>82</td>
<td>123</td>
</tr>
<tr>
<td>Experimental sextants</td>
<td>40</td>
<td>81</td>
<td>121</td>
</tr>
<tr>
<td>Missing sextants</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Control teeth</td>
<td>240</td>
<td>299</td>
<td>539</td>
</tr>
<tr>
<td>Experimental teeth</td>
<td>236</td>
<td>293</td>
<td>529</td>
</tr>
<tr>
<td>Control sites</td>
<td>1440</td>
<td>1794</td>
<td>3234</td>
</tr>
<tr>
<td>Experimental sites</td>
<td>1414</td>
<td>1760</td>
<td>3174</td>
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<td>Examination</td>
<td>Sextant</td>
<td>Treatment</td>
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<td>-------------</td>
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<td>-----------</td>
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</tr>
<tr>
<td>Baseline</td>
<td>All</td>
<td>C</td>
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<td></td>
<td></td>
<td>E</td>
<td>0 (0.0)</td>
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<tr>
<td>Anterior</td>
<td>C</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
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<tr>
<td></td>
<td>E</td>
<td>0 (0.0)</td>
<td>1 (2.5)</td>
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<tr>
<td>Posterior</td>
<td>C</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
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<tr>
<td>3 month</td>
<td>All</td>
<td>C</td>
<td>28 (22.8)</td>
</tr>
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<td></td>
<td></td>
<td>E</td>
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<tr>
<td>Anterior</td>
<td>C</td>
<td>12 (29.3)</td>
<td>6 (14.6)</td>
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<td>E</td>
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<td>2 (5.0)</td>
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<tr>
<td>Posterior</td>
<td>C</td>
<td>16 (19.5)</td>
<td>24 (29.3)</td>
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<td>E</td>
<td>0 (0.0)</td>
<td>1 (1.2)</td>
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<td>6 month</td>
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<td>C</td>
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<td>E</td>
<td>1 (0.8)</td>
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<tr>
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<td>C</td>
<td>6 (14.6)</td>
<td>9 (22.0)</td>
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<td>E</td>
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<td>E</td>
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Table 9.4 Number and proportion of CPITN codes (derived from scoring all teeth) for control and experimental sextants at the baseline, 3- and 6-month examinations for subjects completing Phase A (Proportions in parentheses) (Shaded area indicates no instrumentation performed)
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<td>9</td>
<td>3</td>
<td>30</td>
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<td>2</td>
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<td>25</td>
<td>18</td>
<td>1</td>
<td>44</td>
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<td>0</td>
<td>4</td>
<td>10</td>
<td>6</td>
<td>20</td>
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</tr>
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<td>4</td>
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<tr>
<td>Tot</td>
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<td>46</td>
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<td>43</td>
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<table>
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Table 9.5  Crosstabulations of the treatment responses for control and experimental sextants expressed as CPITN sextant codes derived for all teeth at baseline, 3-month (3M), and 6-month (6M) examinations (Phase A subjects)
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<th>CPITN Sextant Code</th>
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<td>All</td>
<td>C</td>
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</tr>
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<td></td>
<td>E</td>
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<tr>
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<td>C</td>
<td>21 (75.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E</td>
<td>22 (78.6)</td>
</tr>
<tr>
<td></td>
<td>Posterior</td>
<td>C</td>
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<td></td>
<td>E</td>
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<td>All</td>
<td>C</td>
<td>41 (93.2)</td>
</tr>
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<td></td>
<td>E</td>
<td>74 (88.1)</td>
</tr>
<tr>
<td></td>
<td>Anterior</td>
<td>C</td>
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<td></td>
<td>E</td>
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</tr>
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<td>Posterior</td>
<td>C</td>
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<td>E</td>
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<td>C</td>
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<td>E</td>
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Table 9.6 Number and proportion of sextants with CPITN 2+ (bleeding present) and 2- (bleeding absent) (derived from scoring all teeth) for control and experimental sextants at the baseline, 3- and 6-month examinations for subjects completing Phase A (Proportions in parentheses) (Shaded area indicates no instrumentation performed)
<table>
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<tr>
<th>Clinical Criteria</th>
<th>Sextant</th>
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<th>3M</th>
<th>6M</th>
</tr>
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<td>19.9 (13.9)</td>
<td>22.4 (17.9)</td>
</tr>
<tr>
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<td>Ant</td>
<td>C</td>
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<td>9.5 (12.0)</td>
<td>12.8 (14.6)</td>
</tr>
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<td>18.7 (21.5)</td>
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<td>C</td>
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<td>16.2 (12.3)</td>
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<td>E</td>
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<td>24.1 (17.0)</td>
<td>24.7 (17.7)</td>
</tr>
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<td>9.0 (10.1)</td>
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<td>C</td>
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<td>C</td>
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<td>0.0 (0.0)</td>
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<td>0.1 (0.4)</td>
<td>0.1 (0.9)</td>
</tr>
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<td>Post</td>
<td>C</td>
<td>1.0 (3.3)</td>
<td>0.1 (0.3)</td>
<td>0.2 (0.6)</td>
</tr>
<tr>
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<td></td>
<td>E</td>
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<td>0.3 (1.4)</td>
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Table 9.7 Summary of the treatment responses for subjects completing Phase A of the study expressed as the mean proportion of sites scoring a clinical parameter (C = control, E = experimental, Ant = anterior, Post = posterior sextants)(Standard deviations in parentheses)
<table>
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<th>Supra Sub -</th>
<th>Supra Sub +</th>
<th>Supra Sub -</th>
<th>Supra Sub +</th>
<th>Total</th>
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<td>28</td>
<td>61</td>
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<td>652</td>
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<td>190</td>
<td>444</td>
<td>644</td>
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<td>Total</td>
<td>1443</td>
<td>13</td>
<td>1142</td>
<td>564</td>
<td>3162</td>
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</table>

<table>
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<tr>
<th>Baseline 6 months</th>
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<th>Supra Sub -</th>
<th>Supra Sub +</th>
<th>Total</th>
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</thead>
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<td>1781</td>
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<td>25</td>
<td>39</td>
<td>93</td>
</tr>
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<td>488</td>
<td>97</td>
<td>682</td>
</tr>
<tr>
<td>Supra Sub +</td>
<td>10</td>
<td>4</td>
<td>193</td>
<td>399</td>
<td>606</td>
</tr>
<tr>
<td>Total</td>
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<td>13</td>
<td>1142</td>
<td>564</td>
<td>3162</td>
</tr>
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</table>

<table>
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<th>3 months</th>
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<th>Supra Sub +</th>
<th>Supra Sub -</th>
<th>Supra Sub +</th>
<th>Total</th>
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<td>174</td>
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<td>1781</td>
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<tr>
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<td>39</td>
<td>25</td>
<td>7</td>
<td>22</td>
<td>93</td>
</tr>
<tr>
<td>Supra Sub -</td>
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<td>7</td>
<td>382</td>
<td>117</td>
<td>682</td>
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<td>9</td>
<td>89</td>
<td>493</td>
<td>606</td>
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<td>Total</td>
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<td>61</td>
<td>652</td>
<td>644</td>
<td>3162</td>
</tr>
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</table>

Table 9.8 Crosstabulation of calculus according to its presence and location relative to the gingival margin at baseline, 3-, & 6-months in experimental sextants for subjects completing Phase A
### Table 9.9

Mean proportions of different combinations of clinical parameters for control (C) and experimental (E) sites at the baseline, 3- and 6-month examinations (Standard deviations in parentheses) (Phase A subjects)

<table>
<thead>
<tr>
<th>Clinical Criteria</th>
<th>Treatment</th>
<th>Baseline</th>
<th>3M</th>
<th>6M</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-C-B-</td>
<td>C</td>
<td>36.6 (21.2)</td>
<td>81.7 (13.7)</td>
<td>78.7 (14.9)</td>
</tr>
<tr>
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<td>E</td>
<td>39.8 (20.2)</td>
<td>52.8 (22.8)</td>
<td>50.8 (22.3)</td>
</tr>
<tr>
<td>P-C-B+</td>
<td>C</td>
<td>5.8 (6.4)</td>
<td>10.1 (8.3)</td>
<td>10.8 (7.8)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>5.7 (5.2)</td>
<td>4.8 (5.2)</td>
<td>6.0 (5.7)</td>
</tr>
<tr>
<td>P-C-B-</td>
<td>C</td>
<td>27.8 (13.7)</td>
<td>4.3 (5.5)</td>
<td>5.5 (6.5)</td>
</tr>
<tr>
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<td>E</td>
<td>25.1 (13.8)</td>
<td>25.7 (16.7)</td>
<td>25.1 (15.9)</td>
</tr>
<tr>
<td>P-C+B+</td>
<td>C</td>
<td>23.2 (17.5)</td>
<td>1.7 (3.0)</td>
<td>2.8 (4.2)</td>
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<tr>
<td></td>
<td>E</td>
<td>22.8 (18.9)</td>
<td>12.9 (9.7)</td>
<td>13.2 (11.9)</td>
</tr>
<tr>
<td>P1+C-B-</td>
<td>C</td>
<td>0.2 (0.5)</td>
<td>0.5 (1.5)</td>
<td>0.6 (1.5)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>0.2 (0.6)</td>
<td>0.3 (1.6)</td>
<td>0.2 (0.7)</td>
</tr>
<tr>
<td>P1+C-B+</td>
<td>C</td>
<td>0.2 (0.8)</td>
<td>0.7 (1.4)</td>
<td>0.6 (1.3)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>0.1 (0.6)</td>
<td>0.3 (0.8)</td>
<td>0.3 (0.8)</td>
</tr>
<tr>
<td>P1+C+B-</td>
<td>C</td>
<td>1.8 (2.6)</td>
<td>0.2 (0.5)</td>
<td>0.3 (0.7)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>2.0 (4.1)</td>
<td>1.2 (2.5)</td>
<td>1.2 (2.6)</td>
</tr>
<tr>
<td>P1+C+B+</td>
<td>C</td>
<td>3.8 (5.0)</td>
<td>0.6 (1.6)</td>
<td>0.3 (1.0)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>3.5 (4.8)</td>
<td>1.6 (2.6)</td>
<td>2.6 (5.5)</td>
</tr>
<tr>
<td>P2+C-B-</td>
<td>C</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.1 (0.3)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
</tr>
<tr>
<td>P2+C-B+</td>
<td>C</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
</tr>
<tr>
<td>P2+C+B-</td>
<td>C</td>
<td>0.2 (0.6)</td>
<td>0.1 (0.3)</td>
<td>0.2 (0.5)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>0.3 (0.9)</td>
<td>0.2 (0.4)</td>
<td>0.1 (0.4)</td>
</tr>
<tr>
<td>P2+C+B+</td>
<td>C</td>
<td>0.6 (1.5)</td>
<td>0.0 (0.2)</td>
<td>0.1 (0.4)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>0.6 (1.5)</td>
<td>0.3 (0.8)</td>
<td>0.4 (0.8)</td>
</tr>
<tr>
<td>Number</td>
<td>Anterior Sextants</td>
<td>Posterior Sextants</td>
<td>All Sextants</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------</td>
<td>--------------------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td>Control sextants</td>
<td>36</td>
<td>72</td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>Experimental sextants</td>
<td>35</td>
<td>71</td>
<td>106</td>
<td></td>
</tr>
<tr>
<td>Missing sextants</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Control teeth</td>
<td>210</td>
<td>263</td>
<td>473</td>
<td></td>
</tr>
<tr>
<td>Experimental teeth</td>
<td>206</td>
<td>258</td>
<td>464</td>
<td></td>
</tr>
<tr>
<td>Control sites</td>
<td>1260</td>
<td>1578</td>
<td>2838</td>
<td></td>
</tr>
<tr>
<td>Experimental sites</td>
<td>1236</td>
<td>1550</td>
<td>2786</td>
<td></td>
</tr>
</tbody>
</table>

Table 9.10  The number of sextants, teeth and sites within control and experimental sextants according to position within the mouth at the baseline examination for subjects completing all phases
<table>
<thead>
<tr>
<th>Examination</th>
<th>Treatment</th>
<th>CPITN Sextant Code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Baseline</td>
<td>C</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>0</td>
</tr>
<tr>
<td>3 month</td>
<td>C</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>0</td>
</tr>
<tr>
<td>6 month</td>
<td>C</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>1</td>
</tr>
<tr>
<td>9 month</td>
<td>C</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>10</td>
</tr>
<tr>
<td>12 month</td>
<td>C</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>9</td>
</tr>
<tr>
<td>15 month</td>
<td>C</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>15</td>
</tr>
</tbody>
</table>

Table 9.11 Number and proportion of CPITN codes (derived from scoring all teeth) for control and experimental sextants at the baseline, 3-, 6-, 9-, 12- and 15-month examinations for subjects completing all phases (Proportions in parentheses) (Shaded area indicates no instrumentation performed)

* One subject absent from the 9-month examination
<table>
<thead>
<tr>
<th>Clinical Criteria</th>
<th>Sextant</th>
<th>Treatment</th>
<th>Base</th>
<th>3M</th>
<th>6M</th>
<th>9M</th>
<th>12M</th>
<th>15M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleeding</td>
<td>All</td>
<td>C</td>
<td>33.2 (22.4)</td>
<td>13.3 (11.6)</td>
<td>14.6 (11.1)</td>
<td>10.8 (8.0)</td>
<td>12.7 (7.6)</td>
<td>12.1 (8.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E</td>
<td>33.6 (22.8)</td>
<td>20.3 (14.4)</td>
<td>21.9 (17.7)</td>
<td>12.5 (8.3)</td>
<td>13.7 (9.1)</td>
<td>13.1 (9.8)</td>
</tr>
<tr>
<td>Supra or subgingival calculus</td>
<td>All</td>
<td>C</td>
<td>55.2 (22.6)</td>
<td>6.0 (7.1)</td>
<td>8.4 (9.8)</td>
<td>3.6 (6.7)</td>
<td>4.9 (6.6)</td>
<td>3.0 (4.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E</td>
<td>52.4 (21.8)</td>
<td>39.5 (24.6)</td>
<td>39.4 (22.4)</td>
<td>3.4 (3.1)</td>
<td>5.7 (8.3)</td>
<td>2.9 (4.2)</td>
</tr>
<tr>
<td>Supragingival calculus</td>
<td>All</td>
<td>C</td>
<td>16.5 (15.9)</td>
<td>4.4 (5.4)</td>
<td>7.6 (9.2)</td>
<td>1.4 (3.7)</td>
<td>1.1 (2.2)</td>
<td>2.4 (4.8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E</td>
<td>15.6 (17.1)</td>
<td>38.4 (24.8)</td>
<td>37.6 (22.4)</td>
<td>2.4 (2.4)</td>
<td>1.7 (3.5)</td>
<td>1.1 (3.5)</td>
</tr>
<tr>
<td>Subgingival calculus</td>
<td>All</td>
<td>C</td>
<td>54.6 (22.6)</td>
<td>94.6 (7.6)</td>
<td>98.3 (3.6)</td>
<td>98.6 (2.6)</td>
<td>98.5 (2.7)</td>
<td>98.0 (4.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E</td>
<td>52.1 (21.7)</td>
<td>94.9 (7.2)</td>
<td>96.7 (5.2)</td>
<td>96.5 (6.0)</td>
<td>97.5 (4.3)</td>
<td>97.0 (7.7)</td>
</tr>
<tr>
<td>Probing depths &lt; 4 mm (P-)</td>
<td>All</td>
<td>C</td>
<td>4.9 (6.6)</td>
<td>4.9 (6.6)</td>
<td>1.3 (2.5)</td>
<td>1.4 (2.5)</td>
<td>1.8 (4.1)</td>
<td>1.0 (1.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E</td>
<td>4.7 (6.8)</td>
<td>4.7 (6.8)</td>
<td>3.2 (5.1)</td>
<td>2.6 (4.4)</td>
<td>2.7 (6.7)</td>
<td>2.0 (3.6)</td>
</tr>
<tr>
<td>Probing depths 4 - 5 mm (P1+)</td>
<td>All</td>
<td>C</td>
<td>0.5 (1.5)</td>
<td>0.0 (0.2)</td>
<td>0.1 (0.4)</td>
<td>0.1 (0.4)</td>
<td>0.1 (0.4)</td>
<td>0.1 (0.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E</td>
<td>0.6 (1.8)</td>
<td>0.4 (1.0)</td>
<td>0.3 (0.7)</td>
<td>0.2 (0.6)</td>
<td>0.5 (1.6)</td>
<td>0.4 (1.0)</td>
</tr>
</tbody>
</table>

Table 9.12 Summary of clinical findings for subjects completing all phases of the study expressed as the mean proportion of sites scoring a clinical parameter (C = control, E = experimental) (Standard deviations in parentheses)
<table>
<thead>
<tr>
<th>Clinical Criteria</th>
<th>Treatment</th>
<th>Baseline</th>
<th>3M</th>
<th>6M</th>
<th>9M</th>
<th>12M</th>
<th>15M</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-C-B-</td>
<td>C</td>
<td>37.6 (21.7)</td>
<td>81.3 (14.7)</td>
<td>78.3 (15.0)</td>
<td>84.8 (12.7)</td>
<td>82.7 (12.0)</td>
<td>84.4 (10.4)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>41.0 (21.0)</td>
<td>53.9 (23.1)</td>
<td>52.9 (21.7)</td>
<td>83.1 (10.2)</td>
<td>81.4 (12.5)</td>
<td>83.4 (11.0)</td>
</tr>
<tr>
<td>P-C-B+</td>
<td>C</td>
<td>6.1 (6.7)</td>
<td>10.5 (8.6)</td>
<td>11.0 (9.0)</td>
<td>9.0 (5.7)</td>
<td>10.3 (7.8)</td>
<td>9.9 (5.1)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>6.1 (5.3)</td>
<td>5.1 (5.3)</td>
<td>6.1 (5.5)</td>
<td>10.3 (6.7)</td>
<td>10.3 (6.7)</td>
<td>10.4 (7.4)</td>
</tr>
<tr>
<td>P-C+B-</td>
<td>C</td>
<td>27.3 (13.5)</td>
<td>4.6 (6.2)</td>
<td>6.2 (7.7)</td>
<td>3.2 (6.0)</td>
<td>3.7 (5.5)</td>
<td>2.7 (5.0)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>23.4 (12.6)</td>
<td>24.2 (16.2)</td>
<td>23.8 (14.4)</td>
<td>2.8 (4.0)</td>
<td>3.2 (3.9)</td>
<td>2.3 (4.0)</td>
</tr>
<tr>
<td>P-C+B+</td>
<td>C</td>
<td>23.1 (18.1)</td>
<td>1.7 (3.1)</td>
<td>2.8 (4.2)</td>
<td>1.1 (2.8)</td>
<td>1.5 (2.7)</td>
<td>1.1 (2.0)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>23.7 (19.6)</td>
<td>13.0 (10.3)</td>
<td>13.0 (12.4)</td>
<td>0.7 (1.2)</td>
<td>1.7 (2.8)</td>
<td>0.9 (1.4)</td>
</tr>
<tr>
<td>P1+C-B-</td>
<td>C</td>
<td>0.2 (0.6)</td>
<td>0.5 (1.6)</td>
<td>0.5 (1.5)</td>
<td>0.9 (1.7)</td>
<td>0.7 (1.6)</td>
<td>0.6 (1.2)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>0.2 (0.6)</td>
<td>0.3 (1.7)</td>
<td>0.3 (0.7)</td>
<td>1.1 (1.9)</td>
<td>1.0 (2.6)</td>
<td>0.9 (1.9)</td>
</tr>
<tr>
<td>P1+C-B+</td>
<td>C</td>
<td>0.2 (0.8)</td>
<td>0.6 (1.3)</td>
<td>0.7 (1.45)</td>
<td>0.4 (1.1)</td>
<td>0.8 (1.9)</td>
<td>0.4 (0.9)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>0.1 (0.6)</td>
<td>0.3 (0.7)</td>
<td>0.3 (0.9)</td>
<td>1.0 (2.0)</td>
<td>0.6 (1.3)</td>
<td>0.8 (1.5)</td>
</tr>
<tr>
<td>P1+C+B-</td>
<td>C</td>
<td>1.6 (2.4)</td>
<td>0.2 (0.5)</td>
<td>0.2 (0.6)</td>
<td>0.1 (0.3)</td>
<td>0.2 (0.6)</td>
<td>0.1 (0.3)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>1.6 (3.9)</td>
<td>1.1 (2.5)</td>
<td>1.0 (2.2)</td>
<td>0.3 (0.9)</td>
<td>0.5 (1.1)</td>
<td>0.1 (0.5)</td>
</tr>
<tr>
<td>P1+C+B+</td>
<td>C</td>
<td>3.4 (4.3)</td>
<td>0.4 (1.2)</td>
<td>0.0 (0.2)</td>
<td>0.2 (0.5)</td>
<td>0.3 (1.4)</td>
<td>0.1 (0.4)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>3.1 (4.4)</td>
<td>1.6 (2.7)</td>
<td>2.1 (5.2)</td>
<td>0.3 (0.7)</td>
<td>0.9 (3.6)</td>
<td>0.4 (0.9)</td>
</tr>
<tr>
<td>P2+C-B-</td>
<td>C</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.1 (0.3)</td>
<td>0.0 (0.2)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.2)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.1 (0.3)</td>
<td>0.1 (0.3)</td>
<td>0.2 (0.7)</td>
</tr>
<tr>
<td>P2+C-B+</td>
<td>C</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.1 (0.4)</td>
<td>0.1 (0.4)</td>
<td>0.1 (0.5)</td>
</tr>
<tr>
<td></td>
<td>E</td>
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<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.1 (0.3)</td>
<td>0.1 (0.3)</td>
<td>0.1 (0.5)</td>
</tr>
<tr>
<td>P2+C+B-</td>
<td>C</td>
<td>0.1 (0.3)</td>
<td>0.1 (0.3)</td>
<td>0.2 (0.5)</td>
<td>0.1 (0.6)</td>
<td>0.2 (0.4)</td>
<td>0.1 (0.3)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>0.3 (0.9)</td>
<td>0.2 (0.4)</td>
<td>0.1 (0.4)</td>
<td>0.0 (0.2)</td>
<td>0.2 (0.7)</td>
<td>0.0 (0.0)</td>
</tr>
<tr>
<td>P2+C+B+</td>
<td>C</td>
<td>0.6 (1.4)</td>
<td>0.0 (0.2)</td>
<td>0.1 (0.4)</td>
<td>0.1 (0.3)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>0.6 (1.5)</td>
<td>0.3 (0.8)</td>
<td>0.2 (0.8)</td>
<td>0.2 (0.7)</td>
<td>0.2 (0.7)</td>
<td>0.1 (0.5)</td>
</tr>
</tbody>
</table>

Table 9.13  Mean proportions of different combinations of clinical parameters for control (C) and experimental (E) sites at the baseline, 3-, 6-, 9-, 12- and 15-month examinations for subjects completing all phases (Standard deviations in parentheses)
Appendix XXXIII - Publications

International Dental Journal (1994) 44, 533–546

Summary

As with all indices which impose numerical scales on a biological process, there are limitations with CPITN which must be identified and recognised. The limitations are due to the index being used for purposes for which it was not originally designed and recent advances in understanding which question the underlying assumptions of the index. Whilst questioning whether these limitations are sufficient to abandon the CPITN in favour of a new index, suggestions are made for modifications to the existing system. These include, the recording of each of the clinical indicators separately, as well as including the measurement of total loss of attachment. In addition an extension of the treatment need scale from four to five points is suggested.

The Community Periodontal Index of Treatment Needs (CPITN) evolved from a survey method proposed by the WHO Scientific Group on Epidemiology, Etiology and Prevention of Periodontal Diseases in Technical Report Series 621*. The Group considered that the clinical indicators which were of importance for population studies of periodontal disease were gingivitis and pocketing, but that, in addition, calculus should also be assessed for the determination of treatment needs. A field trial was subsequently conducted testing the validity of the clinical criteria, the results of which were reported in the WHO document 'Community Periodontal Index of Treatment Need: Development, Field Testing and Statistical Evaluation'. Meanwhile the final recommendations for scoring the CPITN were published*. A review of the index was carried out in 1985 by FDI/WHO Working Group 1, resulting in updated recommendations for the use of the CPITN 

Since its introduction, the Community Periodontal Index of Treatment Needs (CPITN) has been widely used for epidemiological purposes and the WHO Global Oral Data Bank now contains extensive CPITN data from many countries around the world. In addition to its epidemiological role, the CPITN has been recommended with minor modifications for the screening and determination of treatment needs in individual patients in clinical practice and the recording of CPITN codes does not involve the scoring of each of the clinical disease indicators separately. Instead, only the 'highest' indicator is scored in the order bleeding (Code 1), calculus (Code 2), probing depth ranges of 4–5 mm (Code 3) and of 6 mm or greater (Code 4), the latter being considered the 'highest' score. The index is thus based upon a hierarchical relationship between the indicators where a finding of calculus assumes there will also be bleeding on probing (C 4- B 4- ), and if probing depths of 4 mm or more are detected then it is inferred that calculus and bleeding will also be present (P +  C +  B 4- ). Conversely, the index also assumes that in the absence of bleeding on probing, calculus and probing depths of 4 mm or greater will be absent (P −  C −  B − ), a

How well does the CPITN serve as an indicator of periodontal conditions?

The three clinical disease indicators assessed as part of the CPITN are probing depth range, calculus and bleeding after probing. As a means to simplification however, the recording of CPITN codes does not involve the scoring of each of the clinical disease indicators separately. Instead, only the 'highest' indicator is scored in the order bleeding (Code 1), calculus (Code 2), probing depth ranges of 4–5 mm (Code 3) and of 6 mm or greater (Code 4), the latter being considered the 'highest' score. The index is thus based upon a hierarchical relationship between the indicators where a finding of calculus assumes there will also be bleeding on probing (C + B + ), and if probing depths of 4 mm or more are detected then it is inferred that calculus and bleeding will also be present (P +  C +  B + ). Conversely, the index also assumes that in the absence of bleeding on probing, calculus and probing depths of 4 mm or greater will be absent (P −  C −  B − ), a
The relationship between each of the three clinical indicators which together form the basis for the hierarchical design of the CPITN was examined by Takahashi et al.\textsuperscript{15} in a study of 257 Japanese company employees. The scoring method was modified so that a CPITN Code 2+ indicated a sextant in which calculus and bleeding on probing were coincident (C + B +) while Code 2− indicated a sextant with calculus but without bleeding (C + B−). In the 20–29 year age cohort, 46 per cent of sextants scored Code 2−, with the proportions of sextants with this classification for the 30–44 and 45–56 year cohort being 31 per cent and 38 per cent respectively. The Takahashi modification to the scoring system of the CPITN was similarly used by Addo-Yobo et al.\textsuperscript{17} in a 12-year-old Ghanaian rural schoolchildren. Calculus was identified in the majority of children (between 73 per cent to 91 per cent) but in spite of a common finding of 'substantial deposits of debris', between 55 per cent and 88 per cent of subjects with CPITN Code 2 as their highest score failed to exhibit bleeding on probing (C + B−). At the sextant level, the proportion of sextants scoring Code 2 which did not display bleeding was between 76 per cent and 95 per cent. By means of regression analysis neither the method of self-performed tooth cleaning nor its frequency were significant predictors for the overall CPITN although there was a trend for Code 2 subjects to be more common in those who used a toothbrush over other methods of cleaning.

A more detailed analysis of the validity of the CPITN's hierarchical scoring method was reported by Grytten et al.\textsuperscript{18} in a study of 3330 Norwegian subjects. The results based on index teeth alone for each of five age cohorts are summarised as part of Table 2. In terms of CPITN Code 2, the predictive validity that calculus and bleeding on probing would be coincident (C + B +) on an index tooth varied for this sample from between 0.70 for the 13–14-year-olds to 0.92 for the over 65-year-olds. The predictive validity was lowest for the lower anterior mandibular sextant (sextant 07) as overall 26 per cent of these teeth had calculus without bleeding (C + B−).

Moreover, in the 13–14-year age cohort, 42 per cent of the index teeth in sextant 07 displayed this phenomenon. For CPITN Code 3, when considering all index teeth, the predictive validity that shallow pockets (probing depth 4–5 mm), calculus and bleeding would be coincident (P1 + C + B +) ranged from a very low 0.14 in the 13–14-year age cohort to 0.83 in the over 65-year-olds. It is interesting to observe that in this sample the reason for the failure of the hierarchy relating to CPITN Code 3 was largely because of the frequent absence of calculus on index teeth with shallow pockets and bleeding (P1 + C + B+). With respect to CPITN Code 4, a similar failing of the hierarchy is found for the two age groups reported, as just over a quarter of index teeth with deep pockets (probing depths of 6 mm and over) and bleeding did not have calculus (P2 + C− B +).

Using a similar format to that of Grytten and coworkers\textsuperscript{19} for presenting the CPITN’s hierarchy, Holmgren and Corbet\textsuperscript{20} reported results based on a national survey of Hong Kong Chinese adults\textsuperscript{20}. For CPITN Code 2, a quarter of index teeth with calculus did

Table 1: Relationship between periodontal indicators for different CPITN codes based on examination of all teeth

<table>
<thead>
<tr>
<th>Subject CPITN score</th>
<th>Combination of indicators</th>
<th>Himmiche et al. (1984)</th>
<th>Miller et al. (1988)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(age 15–35)</td>
<td>(age 15–60)</td>
</tr>
<tr>
<td>2</td>
<td>−P + C − B</td>
<td>5</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>−P + C + B</td>
<td>95</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>Total (n)</td>
<td>704</td>
<td>484</td>
</tr>
<tr>
<td>3</td>
<td>+P1 + C − B</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>+P1 + C + B</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>+P1 + C + B</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>+P1 + C + B</td>
<td>87</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>Total (n)</td>
<td>602</td>
<td>323</td>
</tr>
<tr>
<td>4</td>
<td>+P2 + C + B</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>+P2 + C + B</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>+P2 + C + B</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>+P2 + C + B</td>
<td>95</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>Total (n)</td>
<td>232</td>
<td>102</td>
</tr>
</tbody>
</table>
### Table 2: Relationship between periodontal indicators for different CPITN codes for teeth based on examination of index teeth only

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Norway (35-44) (45-54)</td>
<td>Hong Kong (15-19) (35-44) (45-54)</td>
<td></td>
<td>Kenyan (15-19) (35-44) (45-54)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>over 65</td>
<td>(35-44)</td>
<td></td>
<td>(45-54)</td>
</tr>
<tr>
<td>1</td>
<td>-P+C+B</td>
<td>30 10 15 14</td>
<td>8 28 24 11</td>
<td>6 9 14</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-P+C+B</td>
<td>70 90 85 86</td>
<td>92 72 70 69</td>
<td>89 92 91 86</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>+P1-C-B</td>
<td>4 1 1 1</td>
<td>0 0 0 11</td>
<td>0 0 0 1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>+P1+C+B</td>
<td>0 1 2 2</td>
<td>3 6 0 5</td>
<td>5 4 1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>+P1+C+B</td>
<td>81 35 27 28</td>
<td>17 1 1 69</td>
<td>49 4 4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>+P1+C+B</td>
<td>14 6 2 68</td>
<td>83 94 93 40</td>
<td>91 92 93</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>+P2-C-B</td>
<td>- 1 1 1</td>
<td>- 0 0 0</td>
<td>- 0 0 0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>+P2+C-B</td>
<td>- 0 0 0</td>
<td>- 0 0 0</td>
<td>- 0 0 0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>+P2+C-B</td>
<td>0 1 1 1</td>
<td>1 1 1 6</td>
<td>3 3 1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>+P2+C+B</td>
<td>- 26 24 1</td>
<td>- 2 22 6 1</td>
<td>- 1 1 1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>+P2+C+B</td>
<td>- 73 74 4</td>
<td>- 97 67 90 96</td>
<td>- 97 67 90 96</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

not exhibit bleeding on probing (C+B—) (Table 2). Moreover, in common with the findings of Grytten et al., the index tooth for sextant 07 had the lowest predictive validity which for this sample was 0.60 in the younger and 0.61 in the older age cohort. Conversely, the assumptions made in the CPITN’s hierarchy with respect to Codes 3 and 4 had a good predictive validity of over 0.90 for this sample. The deficiencies in the CPITN’s hierarchy for Hong Kong Chinese adults are reflected in the findings for Indonesian 12- and 15-year-olds where overall, 14 per cent of teeth with CPITN Code 2 did not exhibit bleeding, with sextant 07 again having the lowest predictive validity for this code. Code 3 however had a better predictive validity for indicators.

In Tanzania, Lembariti examined the CPITN’s hierarchy based upon examination of all teeth within a sextant. The extent of overestimation of bleeding associated with CPITN Code 2 was mostly smaller than in the studies of Grytten et al. and Holmgren and Corbet, while for Codes 3 and 4 the predictive validity for calculus and bleeding were generally good. In Kenya, Baelum et al. assessed the hierarchy of the CPITN at the individual tooth level for both index teeth (Table 2) and for all teeth (Table 3) in subjects aged 15- to 65-year-olds. They found that the presence of bleeding was consistently overestimated by Code 2 by between 4 and 18 per cent, dependent upon age and teeth under consideration. The predictive validity that pockets, calculus and bleeding would be concurrent for CPITN Codes 3 and 4 was low in the younger age group, irrespective of the teeth under consideration, but improved considerably after the age of 30 years. The failure of the hierarchy in the younger age groups was most commonly due to the absence of calculus on teeth with pockets.

The most severe deficiencies in the CPITN’s hierarchy were reported in the 1985 survey of adults in Melbourne, Australia, where, based on examination of all teeth, 47 per cent of teeth scored CPITN Code 2 did not exhibit bleeding. Moreover, the concurrence of pockets, calculus and bleeding was found in only 40 per cent of teeth scoring Code 3, rising to 57 per cent with respect to Code 4.

All of the studies which have examined the assump-

### Table 3: Relationship between periodontal indicators for different CPITN codes for teeth based on examination of all teeth

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Kenya (15-19) (35-44) (45-54)</td>
<td>Tanzania (20-29) (30-44) (45-64)</td>
<td>Australia (Adults)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(20-29) (30-44) (45-64)</td>
<td>(50-64)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-P+C+B</td>
<td>16 10 12 10 9 2</td>
<td>47</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-P+C+B</td>
<td>84 90 88 90 91 98</td>
<td>53</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>+P1-C-B</td>
<td>10 1 1 2 0 0</td>
<td>23</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>+P1+C-B</td>
<td>2 6 5 3 4 2</td>
<td>14</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>+P1+C+B</td>
<td>43 5 5 13 3 2</td>
<td>22</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>+P1+C+B</td>
<td>44 86 89 83 93 90</td>
<td>40</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>+P2-C-B</td>
<td>0 1 0 3 4 0</td>
<td>9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>+P2+C-B</td>
<td>10 10 5 3 0 16</td>
<td>16</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>+P2+C-B</td>
<td>15 3 2 3 6 0</td>
<td>18</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>+P2+C+B</td>
<td>75 80 93 90 90 100</td>
<td>57</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
tions behind the hierarchical basis of the CPITN have found some deficiencies in the validity of certain CPITN codes to predict the presence of other disease indicators. The relevance of these deficiencies depends upon the use to which the CPITN is to be put. If the CPITN is to be used as an indicator of periodontal conditions there is a consistent finding that a scoring of CPITN Code 2 will, to some extent overestimate the prevalence of bleeding after probing at the individual tooth, sextant and subject level. This overestimation of bleeding with CPITN Code 2 has implications in terms of treatment needs and will be discussed later. CPITN Codes 3 and 4 as indicators of periodontal conditions appear to have inconsistent validity as for instance, in Hong Kong Chinese and older Tanzanians, overestimations of calculus and bleeding appear to be only minimal while these two codes quite markedly overestimate the prevalence of calculus in Norwegians and calculus and bleeding in Australians. It has been suggested that these differences could be due either to examiner differences or to real differences between populations particularly with respect to prevalence and extent of calculus. Support for this latter possibility is provided by CPITN data which shows, at least for young adults, that Asian populations tend to have more sextants affected with calculus than their European counterparts. CPITN based data however for older subjects shows considerable inconsistency between regions and thus the possibility of differences in calculus is equivocal. It should also be borne in mind that unlike many developing nations both the Norwegian and Australian populations are exposed to a well developed oral health care delivery system where scaling would feature as a component of the routine dental treatment. This might go some way to explaining the differences.

Another feature of the CPITN which might influence its reliability as an indicator of periodontal conditions is the recommendation that index teeth be employed when the CPITN is used for epidemiological purposes, thus permitting sample size to be increased per unit of examination time. In the development and field testing of the CPITN, several different groups of teeth were evaluated for their ability to provide reliable indications of the overall disease status of the population as well as their efficiency to classify subjects correctly into the various treatment need categories. The findings resulted in a subset of ten index teeth being recommended for use in adults, namely the first and second molars in posterior sextants, the maxillary right first incisor for sextant 04 and the mandibular left first incisor for sextant 07. For scoring purposes only six recordings are made, each one relating to a sextant. The original recommendations for the scoring of the CPITN state that if the index teeth in a particular sextant are missing, all remaining teeth in that sextant are examined. This recommendation has since been modified so that for anterior maxillary sextant, tooth 21 is examined if tooth 11 is missing, but if both these teeth are missing all remaining teeth in that sextant are examined. The same applies for the anterior mandibular sextant where a missing 31 is substituted by tooth 41. Furthermore, when only one tooth remains in a sextant, it is included in the adjacent sextant.

The use of CPITN index teeth has been shown to underestimate the highest CPITN disease indicator within subjects to a varying degree dependent upon the indicator. Miller et al. reported that 23 per cent of subjects who should have been assigned CPITN Code 4 on the basis of examination of all the teeth were assigned lower scores by the use of index teeth. Similar magnitudes of underestimation of subjects with CPITN Code 4 have been reported by Ainamo and Ainamo and Sivaneswaran at 21 per cent, Gaengler et al. at between 10—15 per cent, Holmgren at 25 per cent and Baerum et al. with a 26 per cent underestimation. Diamanti-Kipioti et al. however reported only a 7 per cent underestimation of subjects with CPITN Code 4 by the use of index teeth, while Aucott and Ashley found that CPITN index teeth correctly identified all subjects with deep pockets. With respect to CPITN Codes 1 and 3, the data from Miller et al. showed that the within-subject underestimations were 14 per cent and 23 per cent respectively, while for CPITN Code 2 the underestimation was only 2 per cent. Due to the hierarchical nature of the CPITN, misclassified subjects who should have received a higher overall CPITN score contribute to the proportions of subjects assigned lower scores producing what Miller et al. term a cascade effect. Thus, within-subject underestimations produced by the use of index teeth may be partially or totally obscured when reporting the proportion of subjects who have as their highest score CPITN Codes from 1 to 3. For example, a potential underestimation of subjects with CPITN Code 2 as their highest score could be compensated by subjects with shallow or deep pockets (CPITN Codes 3 or 4) but who were misclassified as CPITN Code 2 on the basis of the examination of index teeth only. Miller et al. show that although there is a within-subject underestimation for CPITN Code 2 of 2 per cent the cascade effect results in a net 13 per cent overestimation of the prevalence of subjects with CPITN Code 2 as their highest score. In data from Kenya, the inability to identify subjects with Codes 3 or 4 leads to a massive 89 per cent overestimation of subjects with Code 2 as their highest score. This compensatory effect however cannot occur with CPITN Code 4, this being the highest score and thus cannot be so affected. Conversely CPITN Code 0, being the lowest score cannot be underestimated by the use of index teeth however the cascade effect can result in an overestimation of the proportion of subjects who are assessed as healthy. In this context, Sivaneswaran reported the CPITN index teeth overestimated the prevalence of healthy individuals to the order of 47 per cent, while Miller et al. found a 53 per cent overestimation of which over half had a CPITN score of 2 or higher when all the teeth were examined.

While there is a tendency to underestimate the prevalence of pockets in adults by use of CPITN index teeth, in children and young adults the opposite can occur due to the presence of false pockets around erupting teeth. Failure to take account of such false pockets would obviously lead to substantial and erroneous overesti-
mations of the prevalence and extent of pathological pockets. Evidence for this potential problem is provided by Ainamo et al.22 who reported that at age 12, false pockets were found in the majority of subjects on tooth 37 and 47, while at age 17, between 75 per cent and 90 per cent of subjects were so affected. This is substantiated in part by Sivaneswaran27 who showed that in subjects aged 15 to 19 years, inclusion of second molars in CPITN assessments considerably increased both the proportion of subjects and the mean number of sextants with pockets. Possible further evidence of the potential problems with the scoring of the CPITN caused through false pockets was provided by Gjermo et al.24 who, even after disregarding pockets on the distal of second molars, found that 17 per cent of a group of 15-year-old Brazilians scored CPITN Code 4 (pockets of 6 mm or more) while only 3 per cent exhibited radiological bone loss. As a measure to prevent such overestimation, a modification to the original CPITN tooth subset of ten index teeth was proposed by Ainamo et al.23 and later adopted25 where for children and adolescents below the age of 20 years, second molars are excluded from the periodontal assessment.

In terms of the extent of periodontal indicators, Sivaneswaran27 failed to find significant differences between mean sextant scores obtained with either whole mouth recording and CPITN index teeth although there was a trend to underestimate the mean sextant scores for CPITN Codes 3 and 4. More recently, Diamanti-Kipioti et al.28 reported a 20 per cent underestimation of the mean number of sextants with CPITN Code 4 due to the use of index teeth, a finding corroborated by Baelum et al.26 who reported a 38 per cent underestimation of the mean number of Code 4 sextants along with a 31 per cent underestimation of Code 3 sextants. These underestimations resulted in overestimations of the mean number of sextants with Codes 0, 1 and 2. Schaub29 similarly found underestimations in the number of sextants per subject with both Codes 3 and 4. Comparisons of the extent of periodontal conditions expressed as the proportion of sextants with gingival bleeding (Code 1) and/or calculus (Code 2) have been assessed for CPITN index teeth and whole mouth examinations in teenage Finns by Ainamo et al.24. The proportion of sextants with calculus was assessed equally well by both methods; however the use of index tooth 11 underestimated bleeding on probing by 30 per cent in the maxillary anterior sextant (sextant 04) when compared to examination of all teeth in that sextant.

The CPITN index teeth have been evaluated as predictors of whole mouth periodontal conditions with the best fit obtained when either combination was used. Acan in a study of prevalence of conditions, Ainamo and Ainamo26 reported the CPITN index teeth to give reliable estimates of the prevalence of subjects with gingival bleeding, to give slight underestimations of those with supra- or subgingival calculus, but to underestimate the prevalence of shallow (4–5 mm) and deep pockets (6 mm and over) by 16 and 21 per cent respectively in older individuals. Conversely, the extent of these periodontal conditions expressed as proportion of sites affected, were all overestimated by the CPITN index teeth, this however being only slight in relation to bleeding and calculus. In younger individuals, the extent of shallow pockets were overestimated by 30 per cent but to a lesser extent in older individuals, whereas deep pockets were overestimated by 100 per cent. Overestimation of the proportion of sites affected by use of the CPITN index teeth have also been reported by Aucott and Ashley25 who found a 17 per cent overestimation of bleeding, a 143 per cent overestimation of shallow pockets and a massive 193 per cent overestimation of deep pockets. Silness and Raynstrand30 compared both the 10 CPITN index teeth recommended for adults and the six index teeth recommended for children and adolescents with whole mouth examinations. The former sub-set underestimated the proportion of sites which failed to bleed and those with probing depths of 2 mm or less by 47 per cent and 24 per cent respectively. Conversely, the proportion of sites with bleeding or probing depth of 4 mm and above were overestimated by 86 per cent and 30 per cent respectively. When assessments of extent were based on just the six index teeth, these inconsistencies were reduced so that the frequency of probing depths of 2 mm or less were underestimated by only 1.5 per cent, while probing depths of 4 mm or greater were overestimated by 23 per cent. The extent of non-bleeding sites was underestimated by 19 per cent while bleeding sites were overestimated by 27 per cent.

In terms of estimations of the number of teeth affected by periodontal indicators, Schaub29 reported good correlations between CPITN index teeth and full-mouth estimations for bleeding on probing (r = 0.85), calculus (r = 0.83), and shallow pockets (r = 0.83), but with a weaker correlation for deep pockets (r = 0.55). Conversely, he reported substantial disagreements between individual sextant scores obtained by the two methods, the CPITN tooth subset underestimating CPITN Codes 3 and 4. In spite of this, treatment needs calculated from the CPITN subset and whole mouth recording showed an 80 per cent agreement.

The major implications of these overall findings is that the use of the CPITN index teeth results in an underestimation of adult subjects and sextants identified with shallow and deep pockets and an overestimation of those considered to be healthy. These deficiencies can to some extent be compensated for in population estimates by conducting full mouth examinations of between 5 per cent and 10 per cent of survey subjects, the results of which can then be compared with those from index teeth alone. Thus, if necessary, a coefficient of correction can be applied in the data analysis. If however the CPITN is used as a screening tool for periodontal disease in dental practice, then failure to identify subjects with pocketing or those who are not 'healthy' because of the reliance on index teeth could have more serious consequences. Thus, for the screening and monitoring of patients aged over 19 in dental practice, it is recommended that all teeth in a sextant are examined. The implications of deficiencies caused through the use of index teeth on treatment needs
estimations will be discussed later.

The widespread adoption of the CPITN for epidemiological purposes has provided supportive evidence for the existence of groups and individuals within populations who experience greater periodontal destruction than would be the norm for their age. A review of CPITN data in the WHO Global Oral Data Bank for the age cohort 35–44 by Miyasaka et al. showed that while calculus and shallow pockets were the most commonly found conditions, the proportion of subjects and the mean number of sextants per subject with deep pockets were small to very small ranging from 5–20 per cent of populations so affected. Unfortunately the CPITN, being primarily designed as a treatment need index, only provides estimates of past periodontal destruction in terms of the probing depth and thus CPITN based data does not necessarily reflect the total amount of attachment loss as the recession component is excluded. There is however evidence from clinical studies that extensive loss of attachment can occur in the absence of deep pockets12,18, whilst epidemiologically, assessments of past destruction based on probing depths alone have been shown to lead to underestimates of total attachment loss, underestimations which become more severe with increasing age19,44. For example, in elderly Hong Kong Chinese, CPITN derived probing depths based on index teeth resulted in a four-fold underestimation of the proportion of subjects with attachment loss of 6 mm and over, and a six-fold underestimation of the number of sextants so affected45. Moreover, Miller et al.46 showed that 22 per cent of subjects classified as having a maximum loss of attachment of 5 mm on the basis of CPITN recorded probing depths would be classified as having loss of attachment of 7 mm or more if the recession component were taken into account. It has therefore been suggested that either a measure of gingival recession or total loss of attachment should be included in studies involving the CPITN12,38, Miller et al.46 considered however that such a modification 'would greatly modify the CPITN and result in a loss of a number of its inherent qualities'. The problem of measuring recession separately is that in order to obtain an estimate of total loss of attachment, there is a need to summate a probing depth range with a recession range, the product of which gives many overlapping ranges as the markings on the CPITN probe are of unequal intervals. One alternative is to use a separate probe with millimetre markings to measure recession which defeats the objective of simplicity while the other alternative is to measure loss of attachment directly with the CPITN probe. Such an application would be useful in population studies or where the objective was to identify groups or individuals who have experienced greater periodontal destruction than would be the norm for their age. This latter objective will be discussed later in the next section.

How valid is the CPITN as a treatment need indicator?

As its name implies, the design of the CPITN was primarily directed to the assessment of periodontal treat-
about largely through self-care and forms a prerequisite for other periodontal treatment. Cutress et al.\textsuperscript{4} consider the elimination of bleeding on probing to be the prime goal even if further treatment is not available. Recently, the need for the elimination of gingival inflammation has been questioned on the grounds that it might be considered a healthy defence reaction, and that is seldom causes discomfort or loss of function\textsuperscript{49}. A population strategy aims at controlling periodontal disease in communities through a reduction of plaque which in turn would reduce bleeding on probing. In this context, there is some evidence that a reduction in plaque will stop or even reverse early periodontal disease and might reduce the need for tooth extractions\textsuperscript{60}.

Calculations and other plaque retentive factors can only be removed through professional care and are therefore assigned a separate treatment need category (TN 2). The dilemma of the precise role of calculus in the pathogenesis of periodontal disease combined with recent evidence that calculus and gingival inflammation as evidenced by bleeding on probing are not always co-incident, begs the question whether calculus must be removed from all sites and from all individuals. In this context, Gaare et al.\textsuperscript{41} have shown that substantial improvements in gingival health can be achieved in response to oral hygiene instruction alone even in individuals with large amounts of calculus and that scaling provided no additional benefit. Moreover, while the removal of calculus and other plaque retentive factors will facilitate self performed oral hygiene, total elimination of the former may not be clinically achievable\textsuperscript{12}.

Probing depths of 4 or 5 mm (Code 3) indicate the need for scaling and root planing while probing depths ≥ 6 mm (Code 4) indicate ‘complex’ treatment. Many studies evaluating the response to periodontal treatment have shown that reductions in probing depth in response to treatment can occur but that there often remain residual probing depths, that is, probing depths which are greater than the normally accepted probing depth of a healthy gingival sulcus\textsuperscript{55-59}. The implications of the apparent inability of such treatment to eliminate probing depths in deep pockets implies a continued treatment need as the CPITN fails to distinguish between untreated increased probing depths and ‘treated’ residual probing depths. The pocket elimination philosophy implicit in the CPITN leans therefore towards the use of surgical techniques which produce greater initial reductions in probing depths than non-surgical approaches\textsuperscript{54,55-59,62}, and particularly to resective approaches which produce the greatest reductions in probing depth\textsuperscript{29,38,55-62}. To add further to the dilemma, longitudinal studies have indicated that sites with increased probing depths can remain stable for long periods of time which challenges the therapeutic basis for invariably seeking automatic reductions in probing depth. Listgarten\textsuperscript{64} therefore concluded in his review of periodontal probing that ‘it may be necessary to redefine the objectives of periodontal therapy in terms of tooth survival over a person’s lifetime rather than in terms of some arbitrary yardstick of periodontal normality such as minimal probing depth measurements’.

Much of the criticism relating to the CPITN has centred around its somewhat mechanistic and non-biological indications for periodontal treatment. The precursors of the CPITN, namely the PTNS\textsuperscript{65} and the TRS 621 method\textsuperscript{1}, were developed at a time when the natural history of periodontal disease was believed to follow an inexorable progression from marginal gingival inflammation, through periodontitis, to eventual tooth loss\textsuperscript{66-67}. Furthermore, at that time periodontal disease was considered to destroy a large part of the dentition in middle age and to deprive many of all their teeth before old age\textsuperscript{1}. Treatment needs indicated by these indices, the CPITN included, were therefore based on an understanding of the disease process whereby the only means of preventing progressive disease was believed to be the elimination of periodontal inflammation\textsuperscript{66}. Thus, a treatment need is always indicated by the CPITN save when all sextants score 0 (healthy) or X (missing), though the former is rarely achieved even after periodontal treatment\textsuperscript{48,66}.

Recent research however suggests that ‘traditional’ concepts requiring the elimination of periodontal disease might be largely incorrect as it would appear that the vast majority of sites within the majority of individuals remain stable even in the presence of continued inflammation and that the few sites which do exhibit extensive progressive destruction probably do so in short bursts of activity followed by periods of quiescence\textsuperscript{70-76}. Furthermore, there is now conclusive epidemiological evidence that destructive periodontal disease is not as widespread in populations as originally believed, even in populations without access to dental care\textsuperscript{69-70,79}. The corollary of these findings is that most recent studies on tooth loss show that periodontal disease is not the major cause of tooth extractions\textsuperscript{80} and that even populations with large amounts of plaque and calculus can retain most of their teeth for most of their lifetime\textsuperscript{62,81}. These very dramatic changes in our understanding of the behaviour of periodontal disease have substantial implications in terms of preventive and treatment strategies. If the objective of periodontal treatment was to eliminate periodontal disease, then periodontal treatment delivered according to the indications of the CPITN would result in massive over-treatment. It could similarly be argued that the total prevention of loss of attachment is unrealistic. Either of these scenarios is undesirable in terms of cost, wasted time for both the provider and the recipient of treatment, and paradoxically might be harmful as the treatment itself could result in loss of attachment\textsuperscript{33,82}. Moreover, it has been questioned whether conventional periodontal treatment therapies are totally effective anyway\textsuperscript{63}.

The biological considerations set aside, another area of concern relating to the treatment needs component of the CPITN is its use as a planning tool to estimate manpower and resource requirements within populations. The periodontal treatment needs of communities are usually reported as the proportion of subjects in each treatment need category and the mean number of sextants so affected. Such estimates can then be utilised in dental personnel planning models such as the one developed by...
WHO/FDI Working Group 6 and described in the manual 'Health Through Oral Health: Guidelines for Planning and Monitoring Oral Health Care'. This model involves four steps which are: The assessment of the dental health status of a population; the translation of dental conditions into the need for service; the estimation of the time required to provide that service; and the conversion of the required time into estimates of personnel needed. For the purposes of planning for periodontal care the first three steps of the model are CPITN based. Concerns expressed by Gjermo that the CPITN, in common with other treatment need indices, only assesses normative need and therefore does not take into account either the 'wants' or the 'demands' of patients or populations can to some extent however be taken into account by the model along with other modifying factors. Broekhorst et al. consider the WHO model to have major methodological shortcomings and have very little added value for estimating the future need for periodontal care. In spite of this, the use of the model for the planning of an industrialised country has been described by Bourgeois et al. who estimated that, excluding oral hygiene instruction, 10.7 minutes of a dentist's time per patient per year was required for periodontal treatment. This might at first seem excessive, however Manji and Sheiham in an exercise to determine dental personnel requirements for Kenyan children using the CPITN method and suggested treatment times found that direct application of the CPITN made inordinate demands on resources which were disproportionate to the public health importance of periodontal disease in the population.

Overviews of CPITN surveys show calculus (Code 2) to be the most prevalent condition in adolescents, with calculus and shallow pockets (Codes 2 and 3) the most prevalent condition in adults. Thus, in most populations, but particularly in most developing countries, scaling (TN 2) would comprise the greatest periodontal treatment need. Notwithstanding the biological problems with recommending scaling for all, planners in developing countries have balked at such recommendations considering them both unrealistic and probably unnecessary considering the relatively small proportion of these populations that will ultimately experience severe periodontal destruction to an extent that will compromise the dentition within a lifetime. Equally, it has been questioned whether in industrialised nations regular scaling and treatment (TN 3) would probably have little predictive validity. Probing depths in untreated subjects failed to predict which sites would lose attachment over a 12 month period while over a similar period, Haas et al. found that individuals with large numbers of sites with attachment loss are more likely to exhibit additional loss and that probing on probing with various combinations of attachment loss indicators gave a sensitivity of 55 per cent and specificity > 80 per cent for future loss of attachment. Longitudinally in treated patients, Caffrey et al. found that residual probing depths of ≥ 0.6 mm for patients on maintenance therapy gave a predictive value of 36 per cent after 3 years, while after 5 years, Badersten et al. reported that such probing depths had a predictive value of 25 per cent. Similarly, Vanooteghem et al. reported that a combination of bleeding and residual probing depths gave a predictive value of 47–50 per cent.

Thus, although most clinical indicators used by the CPITN are either inadequately sensitive or specific as predictors, Johnson still considers the CPITN might be useful to facilitate the identification of high risk individuals showing 'severe periodontal destruction for age' although it would still be necessary to define what this actually constitutes. It should however be borne in mind that a screening process totally reliant on the CPITN is likely to underestimate those within the category of high risk unless all teeth were examined and total attachment loss rather than probing depths assessed.

Can the CPITN be used to monitor therapeutic outcomes?

As mentioned previously, the CPITN has been recommended for the monitoring of treatment outcomes for both individual patients and for populations. Since traditional periodontal treatment aims to reduce or eliminate pockets, plaque retentive factors and gingival inflammation, the very clinical indicators which form the basis of the CPITN, then it would not be unexpected to see some changes in the CPITN in response to treatment.
In terms of the monitoring of treatment outcomes for populations, Ainamo et al.\(^4\) suggested that a cross-tabulation for each age group of the number and percentage of individuals scoring CPITN Codes 0–4, or X (missing sextant) by the number of sextants so affected (CPITN Table 4\(^5\)) could be sensitive enough for this purpose. Thus, longitudinally, if periodontal conditions improved, there should be a shift on Table 4 from a large prevalence of high CPITN codes with many sextants involved, towards a low prevalence of high CPITN codes with few sextants involved. One problem with the interpretation of such shifts in this cross-tabulation arises because of the CPITN's hierarchy. As Ainamo et al.\(^5\) point out, if there is a longitudinal change in the proportion of individuals with Code 2 as their highest score, it is still unclear whether this was because of improvement (Code 2 becoming Code 1 or 0) or due to deterioration (Code 1 becoming Code 3 or 4). In this respect, only Codes 0 and 4 are mutually exclusive as they are extremes of the scale.

Unfortunately, rather few studies have monitored longitudinal changes of the CPITN in the community setting. One such study which did use the CPITN to evaluate a primary oral health care programme in Thailand where Village Scalers had been used to remove calculus\(^6\). In subjects aged 15–18-years-old who had received scaling, a higher mean number of healthy sextants was found, while for 35–44-year-olds, no differences were detected in the distribution of the mean number of sextants scored by CPITN between those who had received scaling and those who had not. Cutress et al.\(^7\) reported results of a three-year community study in Tonga where one village received oral hygiene instruction and scaling, another only oral hygiene instruction while a third served as a control. In the former, detectable changes were observed in CPITN data, namely a two-fold increase in sextants scoring Code 0 (healthy), a 50 per cent reduction of sextants scoring Code 2 and a doubling of sextants scoring Code 1 (bleeding on probing). When considering matched sextant results, the most marked improvements were seen in the village receiving scaling, however net reductions were seen in sextants scoring Codes 3, 4 and 4 in the oral hygiene instruction and control village.

Thus, at the community level, these two studies provide evidence that the CPITN is sensitive enough to detect some changes following the implementation of an oral health care programme. Due however to the hierarchy of the CPITN, there are potential problems with the interpretation of results in minimal intervention programmes where oral hygiene instruction alone or in combination with limited scaling is the sole intervention provided. This is because any improvements in gingival inflammation which might take place in sextants with calculus would effectively be obscured by getting ‘stuck’ on CPITN Code 2\(^8\). In such an intervention programme there may be some benefit in either scoring each of the clinical indicators of the CPITN separately, this still permitting routine CPITN data to be derived, or to use the Takahashi\(^9\) modification where sextants with calculus but without bleeding on probing are distinguished from those which exhibit bleeding.

In the clinical setting, Takahashi et al.\(^10\) showed that 40 days after receiving oral hygiene and ultrasonic scaling, only 2 of 8 subjects reduced from a pre-treatment maximum CPITN score of 4 to 3, while 88 per cent of subjects with a maximum score of CPITN 3 showed no change. There was however a significant decrease (32 per cent) in the mean number of sextants initially scoring Code 3, but only a small and insignificant decrease in the mean number of sextants scoring Code 4. No subjects were rendered healthy (CPITN Code 1) in response to the treatment delivered. This study might be criticised for being of inadequate duration for maximal treatment responses to take place as Badersten et al.\(^11\) have shown that gradual and marked improvements can take place in response to non-surgical treatment over a nine-month period.

In a dental hospital setting, Lennon et al.\(^12\) found that 56 per cent of subjects showed no change in their highest CPITN code in response to oral hygiene and scaling/root planing. Nonetheless, 50 per cent of subjects initially scoring CPITN Code 4 subsequently scored a lower code at a six-month recall, while 86 per cent showed a reduction in the number of sextants with deep pockets. Four of the 9 subjects who initially scored CPITN Code 3, showed a lower score at 6 months while only 6 per cent of subjects scored CPITN Code 1. No subjects scored CPITN Code 0. Butterworth and Sheiham\(^13\) also reporting on the outcome of non-surgical periodontal treatment, but delivered in general dental practice, found a decrease in the percentage of patients with CPITN Code 4, 3 and 2 as their highest score after treatment. In common with the findings of Takahashi et al.\(^10\) there was only a very small decrease in the mean number of sextants initially scoring CPITN Code 4 and some decrease in those scoring Code 3. Considerable decreases were however found in the mean number of sextants scoring Code 2. Very few subjects and sextants were scored healthy (CPITN Code 0) after treatment.

Persson et al.\(^14\) in a three-year retrospective study using derived CPITN scoring in subjects with CPITN score 3 or 4 as their highest score, showed that one year after periodontal treatment which, in some cases involved periodontal surgery, there was a reduction from 95 per cent to 34 per cent of subjects scoring CPITN Code 4. Despite this, the authors noted that CPITN Code 0 was unattainable for most patients with only 20 per cent of patients presenting with 4 or more healthy sextants after treatment while 42 per cent had no healthy sextants. It is interesting to note that at this one-year recall, surgery appeared to be more effective than non-surgical therapy in reducing CPITN codes in posterior sextants although there were no differences at a three-year recall. At this recall, deterioration in CPITN scores was reported with the prevalence of subjects scoring CPITN 4 increasing to 63 per cent. The authors also noted that the extraction of a single tooth in a sextant could result in a lower CPITN score in many sextants and thus affect the outcome of therapy as assessed by the CPITN.
It would therefore appear that, in the clinical setting, some changes in CPITN scores can be detected and thus the index might to some extent be useful to monitor the outcome of periodontal treatment. There are however problems since even after treatment a sizeable proportion of subjects and sextants initially scoring CPITN Code 4 do not appear to improve. This phenomenon could be due to treatment being ineffective or because the CPITN is inadequately sensitive to any improvements that might have taken place. For example, a tooth with a 9 mm probing depth before treatment might become a residual 6 mm probing depth in response to treatment, however such changes would fail to be detected by the application of the CPITN criteria. Another problem identified by all the clinical studies described above is the failure to achieve periodontal ‘health’ CPITN Code 0 in but a few subjects. However it could be argued that this is an indictment of the success of periodontal treatment rather than a failure of the CPITN itself.

Conclusions

Some fifteen years on from its genesis, the CPITN has gained much favour both as an epidemiological tool and as a screening tool for use in dental practice. However, as with all indices which impose numerical scales on a biological process there are limitations which must be identified and recognised. Most of the limitations relating to the CPITN have come about either because the index has been adopted for purposes outwith those for which it was originally designed or because recent advances in our understanding of the disease process question the basic underlying assumptions of the index. With this in mind, it might be questioned whether these limitations are of sufficient concern to abandon the CPITN and design a totally new index. Unfortunately, there remain many voids even in our basic knowledge in such areas as how to manage periodontal conditions in the most cost effective and efficacious manner at both the community and individual level. As a ‘blanket’ approach to the delivery to traditional periodontal treatment irrespective of age and risk is biologically and economically unsound then alternative strategies must be considered. These might include a population strategy, a secondary prevention strategy or a high risk strategy or a combined approach. The design of the CPITN is most applicable to the secondary prevention strategy and it remains to be seen whether it has any value in either the population or high risk strategy. In terms of the latter, it is likely that the development of sensitive and specific tests for the detection of groups and individuals susceptible to periodontal destruction will make the CPITN obsolete.

Considering the current widespread adoption of the CPITN, it might be pertinent to propose some minor modifications to the CPITN when it is used for specific purposes, modifications which would still permit basic CPITN data to be derived. These are as follows:

1. **The recording of total loss of attachment in addition to the basic CPITN**
   This would be of value in situations where more accurate assessments of total attachment loss within populations is required. Such a modification would benefit from the use of the CPITN-C probe which has additional markings at 8.5 and 11.5 mm. This modification might also serve as a possible means of identifying high risk groups and individuals.

2. **The recording of each of the separate clinical indicators of the CPITN**
   This would provide improved estimates of periodontal indicators within populations where there are concerns about deficiencies in the hierarchical scoring system of the CPITN. Recording each of the clinical indicators would resolve potential problems in monitoring possible improvements in periodontal health in oral care programmes where scaling does not form a component. A compromise solution which largely preserves the inherent simplicity of the index is to use the Takahashi modification to the CPITN where distinction is made between sextants with calculus which do and do not exhibit bleeding after probing.

3. **To extend the Treatment Need (TN) scale**
   An extension of the existing four point scale to five points to be consistent with the CPITN codes might permit more accurate estimates in dental personnel planning.

More extensive modifications to the CPITN are uncalled for until such time as the voids in our knowledge become resolved. Meanwhile, those who apply the index in any of its particular guises should be cognisant of its many limitations and interpret the findings accordingly.
demandant si ces limites sont suffisantes pour abandonner le CPITN en faveur d'un nouvel indice, des suggestions sont faites pour modifier le système existant. Celles-ci incluent la notation séparée de chaque indicateur clinique, ainsi que la mesure de la perte totale de l'attache. Par ailleurs, une extension de l'échelle des besoins en traitement de quatre à cinq points a également été suggérée.

**CPITN — Interpretationen und Einschränkungen**

**Zusammenfassung**


**CPITN — Interpretaciones y limitaciones**

**Resumen**

Como con todos los índices que imponen escalas numéricas en un proceso biológico, el CPITN tiene sus limitaciones que deben ser identificadas y admitidas. Ellas se deben a que el índice es utilizado para fines para los que no había sido originariamente concebido y a los recientes adelantos en el conocimiento que cuestionan las conjeturas del índice. Aunque se pone en duda si estas limitaciones son suficientes para abandonar el CPITN a favor de un nuevo índice, se hacen sugerencias para modificar el sistema existente, entre ellas: el registro separadamente de cada uno de los indicadores clínicos como también la inclusión de la medida de la pérdida total de la conexión. Se sugiere además una extensión de la escala de necesidad de tratamiento de cuatro a cinco puntos.

**References**

Appendix XXXIII - Publications

463

84.1, 1984.
88. Songpaisan Y, Davies G N. Periodontal status and...


Correspondence to: Dr C. J. Holmgren, Department of Conservative Dentistry, Prince Philip Dental Hospital, Hospital Road, Hong Kong.
HONG KONG SURVEY OF ADULT ORAL HEALTH
Part 1: Clinical findings


Department of Periodontology and Public Health, Faculty of Dentistry, University of Hong Kong, The Prince Philip Dental Hospital, Hospital Road, Hong Kong

An oral health survey of 15-19 and 35- to 44-year-old Chinese subjects living in Hong Kong was conducted in 1984 with the purpose of establishing a database for planning the future oral health care delivery system. Public water supplies, covering almost the total population, have been fluoridated since 1961. A total of 1239 Chinese adolescents and adults of both sexes living in a densely populated urban district of Hong Kong was surveyed utilizing the methods recommended by the World Health Organization. All survey subjects were exposed to a questionnaire inquiry and systematic clinical examinations. Loss of teeth in both age-groups was rare and no person was found to be totally edentulous. Dental caries prevalence was low and the average DMFT per person in the 15-19 and 35- to 44-year-old groups were 1.7 and 7.3 respectively. About half the survey subjects in both age-groups did not require any treatment of dental caries. Root surface caries was detected in 14.5 per cent of the 35- to 44-year-olds. The Community Fluorosis Index was 1.13 and 0.87 for the 15- and 19-year-old subjects respectively, and appears to reflect changes to the fluoride concentration levels. Though few survey subjects were found to have a healthy periodontal condition only a modest number required complex periodontal therapy. Dental calculus was almost omnipresent and a high prevalence of shallow pockets was detected.

Introduction

Geographically, Hong Kong comprises a peninsula on the South China coast together with an adjacent group of islands in the South China Sea. It is located just within the tropics, although for almost half the year the climate is remarkably temperate. The population is 98 per cent Chinese, and this survey report is only concerned with that fraction of the population. The Chinese are predominantly Cantonese in origin. At the end of 1984, the total population was 5,397,500 with an overall population density of 5,012 persons per square kilometre, making Hong Kong one of the most densely populated areas in the world. The proportion of the population aged 15 and under was 23.5 per cent and that aged 65 and over was 7.4 per cent.

The per capita use of sugar has remained steady over the last 15 years, at around 20 kilograms per person per year, which is approximately 40 per cent of that consumed in the United Kingdom or the United States.

The public water supplies, covering almost the total population, have been fluoridated since 1961. The fluoride concentration was set at 0.7 and 0.9 ppm during the summer and winter months respectively until 1967 when it was adjusted to 1.0 ppm all year round. Since 1978, the fluoride level has been reduced to 0.7 ppm.
Practically all toothpaste utilized in Hong Kong is fluoridated, although one leading brand has only been fluoridated since 1983.

A series of dental surveys has been conducted by the Hong Kong Government since water fluoridation was introduced (Medical and Health Department, 1960, 1962, 1968; Wong, 1968; Law, 1981). The purpose of these surveys was to study the dental health status of Chinese children and to monitor the effects of water fluoridation. Two surveys have included adult subjects (Medical and Health Department, 1968; Wong, 1983).

The epidemiological data collected during the period from 1960-1980 are of special interest because they illustrate the beneficial dental caries reducing effects of the water fluoridation derived over the 20-year period.

The main focus of the surveys conducted in 1960 and 1968 was on dental caries and very little attention was directed towards oral hygiene status and diseases of the periodontium. No epidemiologic data on root surface caries have yet been published from Hong Kong.

The Government White Paper (1974) relating to the future development of medical and health services in Hong Kong stated that a School Dental Service would be established and that more dentists would be provided for the general public. It was proposed that in order to prevent dental caries becoming too firmly established in young children, the School Dental Service would provide a basic conservative service. To enable the scheme to proceed, a dental therapists training school and dental clinics would be established. With regard to increasing the number of dentists, it was stated that dentists would be trained in the territory and that a dental school would be established within the University of Hong Kong.

A Faculty of Dentistry was established at the University of Hong Kong and designed so as to have an annual output of 60 graduates. In January 1985 the first students completed their dental degree requirements and entered into practice in Hong Kong.

Major measures such as water fluoridation, the establishment of school dental services and the Faculty of Dentistry were bound to have a significant impact not only on the oral diseases in Hong Kong but also on the needs and demands for services by the people of Hong Kong.

The purposes of the survey were: (1) To collect epidemiological data adequate for describing the existing oral health status, the oral disease situation, and the treatment needs of non-institutionalized Chinese sampled from the 15-19 and 35- to 44-year-old population strata residing in a selected populous district of Hong Kong. (2) To collect socio-cultural data focusing on oral health related knowledge, attitudes and behaviour.

Method

Owing to limited resources, it was not possible to contemplate a territory-wide survey, and therefore a region of Hong Kong was sought with a population of about 300,000. An analysis of data from the 1981 Hong Kong Census was undertaken in order to locate a region corresponding to this population size, conveniently situated for logistical purposes, which in addition could be considered to encompass representative groups of the major socioeconomic strata in
Hong Kong. The area selected was part of the north-western part of Hong Kong Island.

For the purpose of selecting a representative sample of the population residing in the survey region and of increasing sampling efficiency, a cluster sampling method was chosen. Living quarters were selected by systematic sampling and within each living quarter all persons aged 15-19 and 35-44 comprised the potential sample. The sampling strategy was set to yield 700 persons in each age range, 15-19 and 35-44.

A team of six to eight home visitors, working in pairs, systematically called at each selected living quarter over a 10-week period. In the event of not finding anyone at home, a reminder letter was left and up to two further recall visits were made before follow-up was ceased.

The design of the clinical examination was based on WHO guidelines (Møller & Beck, 1976; WHO, 1974; 1977). The diagnosis of dental caries and assessments for treatment need were carried out according to World Health Organization (1979) criteria. Dental fluorosis was assessed according to the method of Dean (1942) but the individual was classified on the basis of an examination of the maxillary incisors and canines only. Periodontal conditions were assessed by applying the Community Periodontal Index of Treatment Needs (CPITN) (Ainamo et al., 1982). The index teeth recommended for the CPITN criteria were used. Many clinical criteria have been used in assessing root surfaces caries (Wagg, 1984): in the present survey, however root surface caries was assessed by applying the method and clinical criteria proposed by the National Institute of Dental Research (1984).

During a two week period just prior to the survey the clinical examiners calibrated themselves in the application of the clinical diagnostic criteria. During the survey, between-examiner variability was monitored by duplicate examinations of the survey subjects, and both between-examiner and within-examiner variability was monitored by duplicate examinations conducted at two weekly intervals on a sample of over 40 members of the hospital staff.

Owing to the high urban population density it was not possible to contemplate conducting the clinical examinations and interviews at the subjects' homes. Instead, the survey was carried out at the Prince Philip Dental Hospital, which is located centrally in the survey region.

The clinical examinations were conducted in fully equipped dental surgeries. The coronal caries assessment, which preceded the periodontal assessment, was conducted by RWE and LLP and the root surface caries and periodontal assessments by EFC, CJH, and WIRD. Fibre optic lighting was used for the coronal and root surface caries assessment, but not for the periodontal assessment for which intra-oral illumination was provided by the clinical overhead lighting.

Data were entered and stored on disc at the Centre of Computer Studies and Applications, University of Hong Kong. The analysis was carried out on the SPERRY UNIVAC 1100 Computer using SPSS-X.
Results

Dental status

The survey subjects were distributed fairly evenly between the two genders and the two age-groups (Table 1). Among the 1239 Chinese examined clinically no individual was found to be totally edentulous. All teenagers and the vast majority of the 35- to 44-year-old subjects were found to have at least 21 natural teeth (Table 2). When third molars were included in the analysis the 35- to 44-year-olds had an average of 27.5 permanent teeth per person.

Table 1. Distribution of sample according to age and sex.

<table>
<thead>
<tr>
<th>Age</th>
<th>Ξ (♀)</th>
<th>δ (♂)</th>
<th>Ξ + δ</th>
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</thead>
<tbody>
<tr>
<td>15-19</td>
<td>286 (50.8)*</td>
<td>277 (49.2)</td>
<td>563 (45.4)</td>
</tr>
<tr>
<td>35-44</td>
<td>340 (50.3)</td>
<td>336 (49.7)</td>
<td>676 (54.6)</td>
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<tr>
<td>Total</td>
<td>626 (50.5)</td>
<td>613 (49.5)</td>
<td>1239 (100.0)</td>
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</table>

* Numbers in parentheses are percentages.

Dental caries

The dental caries prevalence expressed as the percentage of examinees having one or more DMF-T was 56.5 and 89.6 respectively for the two age-groups and the dental caries experience was relatively low for the teenagers (1.7) and moderate for the 35- to 44-year-old group (7.3) (Table 3).

As can be seen from Table 4 about half the examinees did not have any dental caries treatment need and for those in need of therapy the majority needed quite simple treatment modalities in few teeth.
Table 3. *Dental caries prevalence and experience according to age-group and sex.* Third molars included.

<table>
<thead>
<tr>
<th>Age</th>
<th>Number examined</th>
<th>Number of examinees having dental caries</th>
<th>Percentage of examinees having one or more DMF-T</th>
<th>Mean number of</th>
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<tr>
<td></td>
<td>15-19</td>
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<td>Decayed teeth</td>
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</table>
Table 4. *Percentage distribution of survey subjects in need of dental caries treatment according to age-group, sex and type of treatment.* Third molars included.

<table>
<thead>
<tr>
<th>Age</th>
<th>15-19</th>
<th>35-44</th>
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<tbody>
<tr>
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<td>♀</td>
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<tr>
<td>Number examined</td>
<td>286</td>
<td>277</td>
</tr>
<tr>
<td>Percentage having no treatment need</td>
<td>52.8</td>
<td>49.1</td>
</tr>
<tr>
<td>Percentage in need of</td>
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<tr>
<td>One surface restoration</td>
<td>27.6</td>
<td>27.4</td>
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<tr>
<td>Two or more surfaces restoration</td>
<td>9.4</td>
<td>17.3</td>
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<tr>
<td>Crown</td>
<td>1.7</td>
<td>1.8</td>
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<tr>
<td>Pulp treatment</td>
<td>2.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Extractions due to any reason</td>
<td>6.3</td>
<td>11.2</td>
</tr>
</tbody>
</table>

* Numbers in parentheses are the mean number of teeth in need of the specified treatment.
Root surface caries
In Table 5 the root surface caries data are presented and it can be seen that 14.5 per cent of the 35- to 44-year-old Chinese had at least one carious root surface. It appears that there is a trend towards an increase in the number of persons having root surface caries with age.

Table 5. Percentage distribution of survey subjects free of root surface caries and with at least one carious root surface by age.

<table>
<thead>
<tr>
<th>Age</th>
<th>35-39 (462)*</th>
<th>40-44 (214)</th>
<th>35-44 (676)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No root surface caries</td>
<td>86.6</td>
<td>83.2</td>
<td>85.5</td>
</tr>
<tr>
<td>Root surface caries</td>
<td>13.4</td>
<td>16.8</td>
<td>14.5</td>
</tr>
</tbody>
</table>

* Numbers in parentheses are number of survey subjects.

Dental fluorosis
The 15- to 19-year-old subjects had the benefit of life-long water fluoridation, but they also showed some signs of dental fluorosis (Table 6). On the other hand,

Table 6. Community Fluorosis Index (CFI) values and distribution of Hong Kong born 15- to 19-year-olds according to the dental fluorosis classification of Dean.

<table>
<thead>
<tr>
<th>Fluorosis classification</th>
<th>15 (15.6)</th>
<th>16 (16.3)</th>
<th>17 (17.5)</th>
<th>18 (17.5)</th>
<th>19 (12.9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>9 (9.4)*</td>
<td>6 (6.4)</td>
<td>9 (9.3)</td>
<td>20 (20.4)</td>
<td>22 (21.8)</td>
</tr>
<tr>
<td>Questionable</td>
<td>19 (19.8)</td>
<td>20 (21.3)</td>
<td>17 (17.5)</td>
<td>17 (17.3)</td>
<td>19 (18.8)</td>
</tr>
<tr>
<td>Very mild</td>
<td>45 (46.9)</td>
<td>43 (45.7)</td>
<td>48 (49.5)</td>
<td>41 (41.8)</td>
<td>45 (44.6)</td>
</tr>
<tr>
<td>Mild</td>
<td>15 (15.6)</td>
<td>19 (20.2)</td>
<td>17 (17.5)</td>
<td>16 (16.3)</td>
<td>13 (12.9)</td>
</tr>
<tr>
<td>Moderate</td>
<td>8 (8.3)</td>
<td>6 (6.4)</td>
<td>6 (6.2)</td>
<td>4 (4.1)</td>
<td>1 (1.0)</td>
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<tr>
<td>Severe</td>
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<td>1 (1.0)</td>
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<tr>
<td>CFI</td>
<td>1.13</td>
<td>1.16</td>
<td>1.12</td>
<td>0.95</td>
<td>0.87</td>
</tr>
</tbody>
</table>

* Numbers in parentheses are percentages.

Deans Community Fluorosis Index for the 35- to 44-year-olds was zero. The 17-year-old subjects were born during 1968, the year that the fluoride level in the water supplies was increased to 1.0 ppm, and they and the 15- and 16-year-olds had more among their number with mild and moderate degrees of fluorosis, and fewer who were scored normal, when compared with the 18- to 19-year-olds, who correspondingly had more among their number with normal scores and fewer with the more severe degrees of dental fluorosis. Similarly, the Community Fluorosis Index scores for the 15- to 17-year-old group were higher than for 18- to 19-year-olds.
Table 7. Percentage distribution of survey subjects according to the highest CPITN score.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Number of examinees</th>
<th>No periodontal disease (Code 0)</th>
<th>Bleeding only (Code 1)</th>
<th>Calculus (Code 2)</th>
<th>Shallow pockets (Code 3)</th>
<th>Deep pockets (Code 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 - 19</td>
<td>1231</td>
<td>563</td>
<td>2</td>
<td>2</td>
<td>70</td>
<td>26</td>
</tr>
<tr>
<td>35 - 44</td>
<td>668</td>
<td>668</td>
<td>1</td>
<td>0</td>
<td>28</td>
<td>56</td>
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</tbody>
</table>

Table 8. Mean number of sextants per person according to CPITN-scores and age-group.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Number of examinees</th>
<th>No periodontal disease (Code 0)</th>
<th>Bleeding (Code 1+2+3+4)</th>
<th>Calculus (Code 2+3+4)</th>
<th>Shallow pockets (Code 3+4)</th>
<th>Deep pockets (Code 4)</th>
<th>Excluded less 2 teeth (Code X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 - 19</td>
<td>1231</td>
<td>563</td>
<td>1.1</td>
<td>4.9</td>
<td>4.4</td>
<td>0.5</td>
<td>0.0</td>
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<tr>
<td>35 - 44</td>
<td>668</td>
<td>668</td>
<td>0.4</td>
<td>5.5</td>
<td>5.4</td>
<td>1.8</td>
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Periodontal disease

Very few of the examinees of both age-groups were found to have no clinical signs of periodontal disease as assessed by the CPITN. From Table 7 it can also be observed that 16 per cent of the 35- to 44-year-olds were found to have deep pockets. It should be noted that the total number of persons examined for CPITN was less than the total number of persons examined for dental caries, because the medical history of a small number contra-indicated periodontal probing.

For the teenagers, the majority had calculus as the highest score. Just over one-quarter of them however had shallow pockets as the highest score. Most of these were due to inflammatory swelling of the marginal gingiva and perhaps a reduced resistance to the light probing forces offered by markedly inflamed marginal gingival tissues. Only one per cent was assessed as having deep pockets.

For the 35- to 44-year-old age group over one-half had shallow pockets as the highest score. As in the teenagers, this finding did not always reflect a loss of periodontal attachment. Sixteen per cent of the 35- to 44-year-old age group exhibited deep pockets as the highest score.

Table 8 shows that for the teenage group, a mean of just over one sextant per person was assessed as having neither calculus nor clinical signs of periodontal disease. The mean number of remaining sextants was scored for bleeding or a higher score, a mean of 4.4 sextants per person being scored for calculus or higher but only a mean of 0.5 sextants per person for shallow pockets. Deep pockets were only found in very few individuals among the teenagers.

For the 35- to 44-year-old age group a mean of 5.5 sextants per person was scored for bleeding or a higher score, with a mean of 1.8 sextants being scored for shallow or deep pockets. Only a mean of 0.3 sextants per person was scored for deep pockets. An average of 0.1 sextant per person had less than two teeth present.

Table 9 is a specification of the CPITN-findings with respect to healthy sextants and sextants with deep pockets for the 15- to 19-year-old subjects. The category

Table 9. Frequency distribution of CPITN-scores 0, 4 and X according to number of sextants involved. 15- to 19-year-old survey subjects.

<table>
<thead>
<tr>
<th>No periodontal disease</th>
<th>Deep pockets</th>
<th>Excluded less than 2 teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 sextants scored</td>
<td>250 (44%)</td>
<td>557 (99%)</td>
</tr>
<tr>
<td>1 sextant scored</td>
<td>139 (25%)</td>
<td>5 (1%)</td>
</tr>
<tr>
<td>2 sextants scored</td>
<td>96 (17%)</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>3 sextants scored</td>
<td>30 (5%)</td>
<td></td>
</tr>
<tr>
<td>4 sextants scored</td>
<td>30 (5%)</td>
<td></td>
</tr>
<tr>
<td>5 sextants scored</td>
<td>8 (1%)</td>
<td></td>
</tr>
<tr>
<td>6 sextants scored</td>
<td>10 (2%)</td>
<td></td>
</tr>
</tbody>
</table>

* Numbers in parentheses are percentages of the total number of 15- to 19-year-olds examined.
'No Periodontal Disease' for a particular sextant indicates that no clinical signs of periodontal disease and no calculus were found. From the left hand column it can be deduced that only 10 teenage survey subjects (two per cent) were found to have all six sextants clinically healthy, whereas 250 out of the 563 examinees (44 per cent) were diagnosed as having all sextants with CPITN scores ranging from 1-4. It can be further calculated that 78 teenagers (13 per cent) had three or more sextants scored as healthy. From the right hand column it can be noted that only six teenage survey subjects had sextants with deep pockets, five of these having deep pockets in only one sextant. No teenager had a sextant with less than two teeth.

Table 10 shows the CPITN-findings with respect to healthy sextants, sextants with deep pockets and sextants with less than two teeth for the 35- to 44-year-old subjects. From the left hand column it can be observed that only five of the total number of examinees (one per cent) were found to be without any signs of periodontal disease or calculus. Only 17 (two per cent) had three or more sextants scored as healthy. Of the 668 35- to 44-year-old subjects, 514 (77 per cent) were found to have all sextants with two or more teeth with CPITN scores ranging from 1-4.

From the middle column it can be calculated that deep pockets were found in 16 per cent of the examinees. However, only 36 (five per cent) were found to have deep pockets in more than one sextant and only 16 (two per cent) had more than two sextants in which deep pockets were detected. None was found to have deep pockets in all sextants. Forty subjects (six per cent) had one or more sextants excluded because less than two teeth were present, as can be seen.
from the right hand column. Less than two per cent were found to have more than one sextant with less than two teeth.

According to the criteria established for the CPITN (Ainamo et al., 1982) a subject or a sextant was classified according to periodontal treatment need into one of the following categories:

\[ \begin{align*}
\text{TN} = 0 & \text{ ie No treatment} \\
\text{TN} = 1 & \text{ ie Oral hygiene instruction} \\
\text{TN} = 2 & \text{ ie Oral hygiene instruction and scaling} \\
\text{TN} = 3 & \text{ ie Oral hygiene instruction, scaling and complex treatment}
\end{align*} \]

The data were analysed to show the proportions of persons indicated as having these treatment needs by the CPITN, and are presented as the percentage of persons and the mean number of sextants indicated for the treatment \( TN = 2 \) and \( TN = 3 \).

From Table 11 it can be noted that 96 per cent of the teenagers were found to have an indicated need for oral hygiene instruction and scaling. On average each teenager needed \( TN = 2 \) in 4.4 sextants.

In the 35- to 44-year-old subjects, 99 per cent had an indicated need for oral hygiene instruction and scaling. On average each of this group needed oral hygiene instruction and scaling in 5.4 sextants. It should be noted that the mean number of sextants was derived from the total in each age group.

**Discussion**

The decision about the geographical location of the survey was felt to be judicious for various reasons. First, the vast majority of Chinese live in the urban part of Hong Kong and only a minute fraction of the population resides in what could be called rural areas. Second, the Chinese culture, and especially the diet, has a homogenizing impact on important social class traits relative to oral health. Third, the fact that the whole of the urban area of Hong Kong has had a water fluoridation scheme since 1961. Finally, the generally low level of dental awareness prevalent among the public, the minimal influence exerted previously by the then few dentists, and the almost non-existence of financial schemes which might support demand for dental services. These factors were considered to have a smoothing out effect on the oral disease patterns and the utilization of the existing dental services.

The average number of teeth present both in the 15-19 and the 35- to 44-year-old Hong Kong Chinese was higher than that found in any of the comparable surveys conducted in other countries (Cutress et al., 1979 & 1983; Powell & McEniery, 1984; Arnljot et al., 1985). None of the Chinese survey subjects was edentulous in both jaws and all the 15- to 19-year-old group had 21 or more teeth present. This was also the case for close to 96 per cent of the 35- to 44-year-olds. Compared with the percentage of edentulous survey subjects found in other countries, Hong Kong appears to represent an area with an extremely low tooth mortality.

In a population which had been exposed to water fluoridation for more than 20 years and which had a low per capita consumption of products containing sugar it would be expected to find a low or very low level of dental caries. This
Table 11. Percentage of survey subjects in each treatment need category according to age.

<table>
<thead>
<tr>
<th>Age</th>
<th>Number of examinees</th>
<th>No treatment (TN=0)</th>
<th>Oral hygiene instruction (TN=1)</th>
<th>Oral hygiene and scaling (TN=2)</th>
<th>Oral hygiene scaling and complex treatment (TN=3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 - 19</td>
<td>563</td>
<td>2</td>
<td>98</td>
<td>96 (4.4)</td>
<td>1 (0.0)</td>
</tr>
<tr>
<td>35 - 44</td>
<td>668</td>
<td>1</td>
<td>99</td>
<td>99 (5.4)</td>
<td>16 (0.3)</td>
</tr>
</tbody>
</table>

* Numbers in parentheses are mean numbers of sextants per person.
expectation was confirmed in the present survey and in the previous surveys conducted by the Hong Kong Government.

It can be foreseen that by the year 2000, when water fluoridation has been in operation for 40 years, the average number of DMFT among the 35- to 44-year-olds will be even lower and probably it will be approximately 4-5 DMFT when measured at the level of clinical diagnosis applied in the present survey. The fact that fluoridated toothpastes have been marketed effectively in Hong Kong during the last decade may lead to a further depreciation of the dental caries experience. If the dental caries data are compared with similar survey data gathered by the Joint Working Group of the Federation Dentaires International and the World Health Organization (1985) it appears that the dental caries situation in Hong Kong ranks as one of the most favourable in the World.

Approximately half the Hong Kong survey subjects from both age-groups was found to have no need for any type of dental caries therapy. In countries like New Zealand (Cutress et al., 1979 & 1983) and Australia (Powell & McEniery, 1984) similar proportions of survey subjects having no dental caries treatment need were found, irrespective of marked differences between these countries and Hong Kong in the dental caries situation as a whole. For the Hong Kong population the large proportion having no dental caries treatment need reflected the low level of the disease, whereas the large number of people with no need in New Zealand and Australia reflected the highly developed and easily accessible dental care systems.

Dental caries treatment needs were low in both age-groups both in terms of the percentage in need of specified types of treatment and in terms of the average number of the treatment modalities needed per person. Assessment of the treatment needs in terms of the complexity of the therapy needed demonstrated that though there was some need for complex therapy, most of it was simple in nature. Very few 15- to 19-year-old Hong Kong subjects were found to require pulp treatment and extractions due to caries, and as the average number of teeth in need of these types of treatment was only a small fraction on one tooth (0.1), the absolute number of required treatments for a whole birth cohort in the age-range between 15-19 can be estimated to be small. This trend, though not as marked, was also found for the 35- to 44-year-old Hong Kong Chinese.

Comparing these dental caries treatment needs with data from surveys conducted in other countries or areas, it is justified to assume that the Hong Kong dental caries situation in the run-up to the year 2000, all things being equal, is very favourable and promising.

The data on dental fluorosis appear to reflect the changes made to the fluoride concentration of the water supplies, and it is justifiable to expect that following the reduction in the fluoride concentration from 1.0 to 0.7 ppm in 1978 there will be an increase in the proportion of children with the lesser fluorosis scores.

The presence and the amounts of calculus encountered certainly produced an underscoring of root surface caries. Abundant plaque on root surfaces also probably obscured the presence of many lesions. There was thus a possibility that the found prevalence of 14.5 per cent of persons with at least one tooth with root surface caries was an underestimate.
The present survey did not include the elderly age strata of the Chinese population in Hong Kong and therefore the findings relative to the root surface caries phenomenon were exploratory in nature. The findings that the Chinese people in Hong Kong apparently retain their permanent dentition considerably longer than for similar Western populations indicates that Hong Kong is an exceptionally suitable area for detailed longitudinal epidemiological studies of root surface caries.

Only negligible proportions in both age groups had no calculus and healthy gingiva. Calculus was found to be virtually omnipresent in both age groups. In a modest number of cases bleeding gingiva surrounding the index teeth was found in the absence of detectable calculus. Twenty-six per cent of the teenage group was found to have shallow pockets. Were this finding to indicate that destructive periodontal disease had already commenced in over one-quarter of the teenagers, this would be a highly significant finding. For the most part however, these shallow pockets were not the result of the loss of periodontal attachment nor were they false pockets surrounding recently erupted teeth, as the second molars were not included as index teeth in the teenagers. Rather these shallow pockets were detected in the examination procedure due to swelling at the gingival margin and a reduced resistance to probing (offered by the highly inflamed marginal gingiva) even using the very light probing forces employed. This finding that 26 per cent of the 15- to 19-year-old age group exhibited some shallow pockets should be taken more as a reflection of the degree of marginal gingival inflammation than as an indicator that destructive inflammation had spread to the deeper tissues of the periodontium. This may, in all probability, also be the case for many of the 56 per cent of the 35- to 44-year-olds exhibiting shallow pockets.

The finding that 16 per cent of the 35- to 44-year-old subjects exhibited deep pockets is noteworthy in as much as deep pockets registered by the CPITN are taken to be an indicator of advanced loss of periodontal attachment.

Recent large surveys conducted in a range of countries using the CPITN-system have indicated that only small proportions of the 35- to 44-year-old groups had deep pockets. In Brisbane, Queensland four per cent of this age group were found to have deep pockets (Powell & McEniery, 1984) and in New Zealand 8 per cent (Cutress et al., 1983). It appears that the prevalence of deep pockets in the 35- to 44-year-old Chinese in Hong Kong as detected in this survey was within the higher range of prevalences found in other studies from non-Asian populations. However, despite the rather high prevalence of deep pockets found in the present survey among the 35- to 44-year-old Hong Kong Chinese as compared to the prevalences reported in non-Asian studies, only ten per cent of the total age-group was found to have one or more deep pocket in only one sextant. The finding of only 5 per cent of the 35- to 44-year-old Chinese with deep pockets in more than one sextant indicates that only this proportion could be considered to have generalized advanced periodontal problems. This is not in accord with the widely held view that generalized advanced periodontal destruction is widespread among adults in Asian countries. Rather this finding indicates that there was, among adult Chinese residing in Hong Kong, surprisingly few individuals in the age-range 35-44 years who appeared to be, or to have been, affected by generalized advanced periodontal destruction.
Conclusions

The clinical findings of the present survey lead to the following conclusions:

Edentulousness and loss of permanent teeth among Hong Kong Chinese below the age of 45 were insignificant oral health problems.

Dental caries prevalence and experience, measured at the clinical diagnostic level applied, were low among the 15- to 19-year-old subjects and moderate among the 35- to 44-year-olds.

The volume of dental caries treatment needs for the vast majority of Hong Kong Chinese below the age of 45 was modest and could be covered by quite simple therapeutic programmes.

Mild forms of dental fluorosis appeared to be rather prevalent among the 15-to 19-year-old subjects who had been exposed to a fluoride concentration of 1.0 ppm from May 1967. It is expected that the lowering of the fluoride concentration to an all-year 0.7 ppm in 1978 will lead to a reduction in the level of fluorosis in future.

Root surface caries was not found to be widespread among the group of 35-to 44-year-old Chinese.

Dental calculus was found to be virtually omnipresent in both age groups and only relatively few persons in both age groups had clinically healthy gingiva.

Deep periodontal pockets were found in only 16 per cent of the 35- to 44-year-olds. Among these persons, few had more than one sextant affected. A small proportion appeared to be, or to have been, affected by generalized advanced periodontal destruction.

Acknowledgements — The survey team gratefully acknowledge the advice and assistance received from staff members of the World Health Organization and the National Institute of Dental Research, Bethesda, Maryland, USA. The Census and Statistics Department in Hong Kong was most helpful during the planning phase. Special thanks are extended to Dr Linda Koo, Dr T.S.C. Chan, Dr C.M. Lo, Mrs I.Chan, Dr P.S.L. Tang and Mr. K.Y. Mak. Last but not least we are indebted to the secretarial staff of the Department of Periodontology and Public Health. The survey was supported financially through a research grant by the Research Committee, Faculty of Dentistry, University of Hong Kong.

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Medical and Health Department (1968): Hong Kong WHO 1968 Survey.


An oral health survey among 15-19 and 35- to 44-year-old Chinese living in Hong Kong was conducted in 1984. A total of 1239 Chinese citizens of both sexes living in a densely populated district of Hong Kong was surveyed using the methods recommended by World Health Organization. All survey subjects were exposed to both a questionnaire inquiry and systematic clinical examinations.

The questionnaire inquiry showed that a large proportion of the adult Chinese population living in Hong Kong had perceptions about their susceptibility to and the preventability of the most prevalent oral diseases which may inhibit positive oral health related behaviour. The inquiry also showed that misconceptions and lack of knowledge about the aetiology and prevention of the most prevalent oral diseases, especially periodontal diseases, were fairly widespread. A unanimous preference for the natural dentition was expressed by the respondents of both age groups. Oral health care at home, such as by toothbrushing with a toothpaste containing fluoride, the use of toothpicks, and mouthrinsing after eating were commonly practised. Consumption of sweet drinks and food was modest and few respondents indulged in frequent between-meal-snacks.

Relatively large proportions of the respondents had experienced toothache, gingival inflammation, or gum bleeding during the last year. More than half the 15- to 19-year-old subjects and 4 out of 10 35- to 44-year-old subjects had not visited a dentist within the last 3 years or had never visited a dentist. Asymptomatic, preventive visits to the dentist were practiced by little more than 20 per cent of the respondents from both age groups. The services of a registered dentist were utilized by the majority of the respondents, but as far as could be discerned unregistered dentists' services were relied upon by a substantial number of low income respondents. The perception of having no dental problem was the most frequent reason given by both age groups for never having visited a dentist. On the basis of the data collected it was recommended that there is an urgent need for an area-wide health education enterprise coupled with modern marketing approaches. Dental health education programmes should be delivered in a form which is culturally acceptable to the people of Hong Kong. Dental health education should be integrated and co-ordinated with general health education as much as possible and the basic principles of the primary health care approach should be followed.

Introduction

An oral health survey of Hong Kong Chinese citizens aged 15-19 and 35- to 44-years was conducted in 1984. The survey included both clinical examinations and a questionnaire inquiry. The sampling procedure has been described in detail in the survey report (Lind et al., 1986) and in the first survey article (Lind et al., 1987). An account of the clinical findings has previously been published (Lind et al., 1987).
Though several dental surveys of Chinese populations have been published only limited information about the oral health related perceptions, knowledge and behaviour of Chinese can be found in the dental literature.

The purpose of the questionnaire inquiry was to collect and analyse socio-cultural data focusing on oral health related perceptions, knowledge and behaviour of the two age-groups. It was also the intention to correlate the clinical findings with the socio-cultural data. The attainment of these purposes was considered to be urgently needed for the planning of an oral health education enterprise in Hong Kong. It was furthermore generally felt, among the dental profession in Hong Kong, that the utilization of the available dental services is low and to a large extent characterized by symptomatic visits to the dentist and a weak dental awareness. With the relatively rapid increase in dental manpower over the next decades it may be necessary to augment the judicious utilization of the increasing dental services by a combination of modern marketing strategies and health education. From a preventive point of view it was also considered of paramount importance to identify perceptions and attitudes with significant bearing on the continuation of the 25-year-old water fluoridation scheme.

Diet and food are of central importance in Chinese culture. A large proportion of income is spent on food, and discussion about food is prominent in everyday conversation. Dining is an important social occasion and the nutritional value of the food is rated in terms consistent with highly sophisticated cultural beliefs, practices, and symbolism.

The adult diet of Hong Kong Chinese is low in calcium but is otherwise nutritionally adequate. It is very rare to find malnourishment. The protein intake is comparable with Australia or the United States of America. The diet consists largely of rice, protein, and green leafy vegetables. Bean curd is a major protein source and poultry, pork, and beef are readily available. Differences in diet across the socio-economic groups are minimal. The main difference is that the more well-to-do have access to the more expensive protein sources. For convenience, rice at breakfast is being replaced by bread or buns. The habit of taking mid-morning and mid-afternoon teabreaks during which snack foods, such as buns or cakes, are consumed is a recent phenomenon here. Nevertheless the per capita use of sugar has remained steady over the last 15 years at about 20 kilograms per person per year, which is approximately 40 per cent of that consumed in the United Kingdom or the United States.

 Practically all toothpaste used in Hong Kong is fluoridated, although one leading brand has only been so since 1983. Water supplies have been fluoridated since 1961.

**Method**

The content of the questionnaire was based on that used for the WHO International Collaborative Study in the 1970's (WHO, 1974) which was conducted in the style of a structured interview. However, due to financial constraints, the questionnaire used for the present study was designed for self-completion. In view of problems concerning the level of literacy of some respondents it was necessary to simplify some sections of the questionnaire, especially that relating to the availability, accessibility, and acceptability of dental services. During the
development of the questionnaire, discussions were held with a medical anthropologist experienced in epidemiological research in Hong Kong. Some questions were introduced to investigate Chinese cultural beliefs and practices relating to oral health. In the section concerning occupation and income, the classifications were consistent with those used by the Department of Census and Statistics, to allow for the testing of the representativeness of the population sample and to provide a basis for inferences concerning the population as a whole.

The final draft was translated into colloquial Cantonese. This was translated back again into English to uncover anomalies. It was then pilot tested and submitted to a final revision before going to press.

When the survey subjects arrived at the Prince Philip Dental Hospital for the clinical examinations they were registered and given the self-completion questionnaire to fill in. When there were problems of literacy, a receptionist was at hand to read the questionnaire to the respondent and record the replies. On completion, all questionnaires were checked to ensure that no sections had been missed.

The results of the clinical examinations were recorded by dental surgery assistants on the clinical examination forms, which bore the same registration number as the corresponding questionnaire. Finally, the survey subjects were given toothbrushes and toothpaste; they attended an oral health education session; and they were given oral hygiene instruction by hygienists.

Data from the questionnaires and clinical examinations were entered and stored on discs at the Centre of Computer Studies and Applications, University of Hong Kong. The analysis was carried out on the UNIVAC SPERRY 1100 Computer using SPSS-X.

Results

The questionnaire inquiry was conducted to investigate the respondents' perceived susceptibility to the most common oral disease phenomena and symptoms. The questionnaire also sought information about their perceptions with regard to the preventability of these possible events.

Information about their preferences relative to natural versus false teeth and their knowledge about the aetiology of gum diseases, dental caries, and tooth loss were also solicited.

A total of 1239 survey subjects were exposed to the questionnaire. For the 15-19 and the 35- to 44-year-old respondents 565 and 676 persons respectively completed it. Only an insignificant number of questionnaires were found to be incomplete to such a degree that they were excluded either totally or partially. With the purpose of simplifying the tables only rounded-off percentages are given and the number of persons in each category is not stated. Socio-economic stratification in Hong Kong is complicated by the fact that two to three generations are sharing the same household and pooling their income. Therefore it is an established convention to use the monthly household income as a socio-economic indicator.

The distribution of the responses to a question about the subjects' perception of their susceptibility to oral disease phenomena such as bleeding gums, a broken tooth, toothache, tooth decay and loose teeth revealed that the majority in both
age-groups forecast that it was likely that they would experience tooth decay, toothache and bleeding gums during the next 5 years (Tables 1 and 2). Around

Table 1. Percentage distribution of the perceptions about susceptibility and preventability of five oral disease phenomena in the 15-19-year-old group according to sex.

<table>
<thead>
<tr>
<th></th>
<th>Susceptibility</th>
<th>Preventability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>It is likely</td>
<td>I can do much</td>
</tr>
<tr>
<td></td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Bleeding gums</td>
<td>53</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>51</td>
<td>38</td>
</tr>
<tr>
<td>Broken teeth</td>
<td>19</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>34</td>
</tr>
<tr>
<td>Toothache</td>
<td>59</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>59</td>
<td>52</td>
</tr>
<tr>
<td>Tooth decay</td>
<td>61</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>62</td>
</tr>
<tr>
<td>Loose teeth</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>32</td>
</tr>
</tbody>
</table>

* Numbers in parentheses are the number of respondents.

Table 2. Percentage distribution of the perceptions about susceptibility and preventability of five oral disease phenomena in the 35-44-year-old group according to sex.

<table>
<thead>
<tr>
<th></th>
<th>Susceptibility</th>
<th>Preventability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>It is likely</td>
<td>I can do much</td>
</tr>
<tr>
<td></td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Bleeding gums</td>
<td>67</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>67</td>
<td>39</td>
</tr>
<tr>
<td>Broken teeth</td>
<td>51</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>55</td>
<td>24</td>
</tr>
<tr>
<td>Toothache</td>
<td>76</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>83</td>
<td>33</td>
</tr>
<tr>
<td>Tooth decay</td>
<td>85</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>81</td>
<td>38</td>
</tr>
<tr>
<td>Loose teeth</td>
<td>51</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>52</td>
<td>20</td>
</tr>
</tbody>
</table>

60 per cent of the teenagers and 82 per cent of the 35- to 44-year-old subjects expected to experience tooth decay and/or toothache. Bleeding gums were expected by about half the teenagers and by two thirds of the 35- to 44-year-old group. Broken teeth and loose teeth were not considered to be a problem within the next 5 years by the teenagers whereas around half of the 35- to 44-year-olds reported that these phenomena were likely. The perception of susceptibility to the five oral symptoms did not appear to be influenced by gender or household income. It is noteworthy that except for tooth decay and toothache many respondents (10 to 25 per cent) gave 'don't know' responses. In general the respondents in both age-groups saw themselves as rather susceptible to periodontal disease, toothache and tooth decay. Tables 1 and 2 also give the responses to the respondents' perceptions of preventability and it can be seen that both the teenagers and the senior respondents had a rather pessimistic perception of
Table 3. Percentage distribution of respondents' beliefs about the causes of gum diseases and tooth decay according to age and sex.

<table>
<thead>
<tr>
<th></th>
<th>Inadequate oral hygiene</th>
<th>Bacteria/infection</th>
<th>Inadequate diet</th>
<th>Chinese explanation</th>
<th>Other explanation</th>
<th>Don't know</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>♀</td>
<td>♂</td>
<td>♀</td>
<td>♂</td>
<td>♀</td>
<td>♂</td>
</tr>
<tr>
<td>15- to 19-year-olds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gum disease</td>
<td>21</td>
<td>23</td>
<td>3</td>
<td>5</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>Tooth decay</td>
<td>43</td>
<td>36</td>
<td>41</td>
<td>39</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>35- to 44-year-olds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gum disease</td>
<td>22</td>
<td>23</td>
<td>4</td>
<td>4</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Tooth decay</td>
<td>48</td>
<td>42</td>
<td>33</td>
<td>29</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
their own abilities in prevention compared with the firm belief in the preventive role of the dentist.

For both the responses to the susceptibility and preventability there appears to be only insignificant differences between the sexes. When the data were analysed according to monthly household income and educational attainment only few and insignificant differences were found.

When the subjects in both age-groups were asked their opinion about false teeth versus natural teeth more than 90 per cent thought that natural teeth were better.

As can be seen from Table 3, which shows the responses to two open-ended questions, respondents from both age-groups declared that they knew nothing about the cause of gum diseases whereas they appeared better informed about the aetiology of tooth decay. Chinese explanations were not given for the cause of tooth decay whereas a few (six per cent) gave Chinese explanations for gum diseases. Asked about the role of tooth decay, gum diseases, broken teeth and tooth loss in old age more than 80 per cent of the respondents in both age-groups declared that old age was an important cause. Tooth decay was claimed by around 70 per cent as leading to tooth loss whereas the role of gum diseases received the greatest number of 'don't know' responses. When the replies to the questions about the causes of gum diseases and tooth decay were analysed according to monthly household income the economically less privileged had significantly more 'don't know' responses than the more privileged groups.

The older generation appears to be more inclined than the teenagers to utilize Chinese cures (Table 4). It should be noted, however, that the formulation of

<table>
<thead>
<tr>
<th></th>
<th>15 - 19</th>
<th>35 - 44</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>♂</td>
<td>♀</td>
</tr>
<tr>
<td>'Sour' feeling in tooth</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Toothache</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>Gum problems</td>
<td>24</td>
<td>15</td>
</tr>
</tbody>
</table>

Table 4. Percentage distribution of affirmative responses to the use of 'cooling teas or herbal medicine' for the cure of oral disease symptoms according to age and sex.
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medicine were analysed according to educational level a rather strong trend was
found; the higher the educational level the less cooling teas and herbal medicine
were used as a cure for toothache and gum problems.

The percentage distribution of the responses concerning the nature of oral
hygiene measures that the survey subjects had performed the day before the
inquiry clearly demonstrated that toothbrushing was practiced by the vast
majority (Table 5). The use of toothpicks to clean the teeth was prevalent among

Table 5. Percentage distribution of the subjects’ personal oral health care practices according
to age and sex.

<table>
<thead>
<tr>
<th></th>
<th>15- to 19-year-olds</th>
<th>35- to 44-year-olds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Φ</td>
<td>Φ</td>
</tr>
<tr>
<td>Yesterday I used</td>
<td>(282)</td>
<td>(275)</td>
</tr>
<tr>
<td>Toothbrush</td>
<td>99</td>
<td>96</td>
</tr>
<tr>
<td>Toothpick</td>
<td>40</td>
<td>52</td>
</tr>
<tr>
<td>Dental floss</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Disclosing tablets</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Mouthwash</td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td>Rinsing after eating</td>
<td>48</td>
<td>40</td>
</tr>
<tr>
<td>Toothpaste containing fluoride</td>
<td>88</td>
<td>88</td>
</tr>
<tr>
<td>Other measures</td>
<td>13</td>
<td>16</td>
</tr>
</tbody>
</table>

the senior respondents whereas it was less common among the teenagers. Rinsing
after eating was also a rather common practice. The inquiry did not probe into
the reasoning behind these hygiene habits. Between 73 and 88 per cent of the
respondents from both age-groups reported that they used a toothpaste contain­ing
fluoride. It was found that only a negligible number did not possess a toothbrush
and that for the vast majority the toothbrush was purchased less than 1
year ago. Household income and the level of educational attainment appeared to
influence the use of dental floss, disclosing tablets and fluoridated toothpaste
rather strongly among the 35- to 44-year-old subjects. Nine out of ten teenagers
had heard of fluoride whereas one quarter of the 35- to 44-year-old group re­
ported their ignorance about it. Both household income and the level of educa­
tional attainment were found to be significant factors influencing the knowledge
about fluoride in this older group.

Tables 6 and 7 show the responses to questions about the consumption of
sweet drinks, sweet food and between-meal-snacking. This appears to be more
frequent among the 15- to 19-year-old subjects. More than half the senior sub­
jects did not have any between-meal-snacks the day before the query. The eating
of sweet desserts at meal times does not appear to be a common habit; more
than two thirds of the subjects, irrespective of age and sex, did not eat a sweet
dessert the day before. An analysis of the data according to household income
and level of educational attainment showed an almost identical pattern among
the teenagers whereas statistically significant differences were found in the older
group. The higher the income and the educational level the more common was
the consumption of sweet foods between-meal-snacking.
Table 6. Percentage distribution of the consumption of sweet drinks and food in the 15- to 19-year-old group according to sex.

<table>
<thead>
<tr>
<th>Sweet drink between the three daily meals</th>
<th>Between-meal snacks</th>
<th>Sweet dessert at meal times</th>
</tr>
</thead>
<tbody>
<tr>
<td>❋  ❇</td>
<td>❋  ❇</td>
<td>❋  ❇</td>
</tr>
<tr>
<td>(282) (274) (283) (273) (283) (275)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

None     20  16  32  46  65  71
Once     33  27  29  23  25  18
Twice    27  27  22  15  8   7
Three times 8  10  7  5   1   2
> Three times 12  19  11  11  1   2

Table 7. Percentage distribution of the consumption of sweet drinks and food in the 35- to 44-year-old group according to sex.

<table>
<thead>
<tr>
<th>Sweet drink between the three daily meals</th>
<th>Between-meal snacks</th>
<th>Sweet dessert at meal times</th>
</tr>
</thead>
<tbody>
<tr>
<td>❋  ❇</td>
<td>❋  ❇</td>
<td>❋  ❇</td>
</tr>
<tr>
<td>(336) (334) (335) (335) (335) (336)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

None     38  31  53  53  70  64
Once     40  35  29  36  26  30
Twice    17  22  15  10  3   5
Three    4   6   3  1   1   1
> Three times 2  6   2  1   0   1

As can be seen from Table 8 about half the respondents from both age-groups declared that they were satisfied with the condition of their gums whereas considerably fewer were satisfied with the condition and appearance of their teeth.

Table 8. Percentage distribution of the survey subjects' satisfaction with the condition of gums, teeth and the appearance of their teeth according to age and sex.

<table>
<thead>
<tr>
<th>I am satisfied with</th>
<th>15- to 19-years-old</th>
<th>35- to 44-years-old</th>
</tr>
</thead>
<tbody>
<tr>
<td>❋  ❇</td>
<td>(279) (273)</td>
<td>(326) (329)</td>
</tr>
</tbody>
</table>

The condition of my gums 50  53  50  44
The condition of my teeth 29  35  31  24
The appearance of my teeth 23  23  47  34

For both age-groups it was found that the higher the monthly income the higher was the number of respondents who were satisfied with the appearance of their teeth.
teeth. Neither household income nor level of educational attainment appeared to influence the self-assessment of the respondents' satisfaction with the condition of their gums and teeth. The responses to the question: 'Please indicate when you last visited the dentist, show that relatively few persons in both age-groups visited the dentist within the last year and that one third of the teenagers had never visited the dentist or did not recall ever having been to the dentist during childhood or adolescence (Table 9). Monthly household income exerted a statistically significant influence on the visiting behaviour of both age-groups and for the economically less privileged teenagers almost four out of ten had never visited a dentist or did not remember having done so (Table 10). Asymptomatic visits to the dentist, measured by the percentage of persons who went for a check-up at their last visit, were only made by relatively few people in both age-groups and again monthly household income was a significant factor influencing these preventive visits (Table 10). The most frequently given reasons for visiting the dentist on the last occasion were toothache, a broken tooth and tooth extraction, whereas problems with the gums was only mentioned by relatively few in both age-groups.

More than half of both age-groups reported that they consulted a licensed dentist in private practice at their last visit (Table 11). However, visits to unlicensed (illegal) dentists were paid by quite a few subjects. Whilst the monthly household income and the level of educational attainment did not influence the choice of dentist among the teenagers both indicators did for the 35- to 44-year-old group; the unlicensed dentist was chosen by a significantly larger number of the less economically and educationally privileged groups. Only respondents from the lower income groups were found to have consulted dentists practicing in the People's Republic of China.

The subjects in both age groups who reported that they never visited a dentist (Table 9) were asked about the reasons for this and the percentage distribution of their responses is given in Table 12. The most frequent reason given in both age groups was: 'I have no dental problem.' Close to half of the teenagers stated that they had had no dental problems up to the time of the inquiry whereas almost three out of four females aged 35-44 and more than half the males aged 35-44 stated they had had no dental problems.

Approximately one third of the teenagers and the senior respondents felt that cost of the dental services may have acted as a barrier to their seeking dental care. There appears to have been some concern, by respondents from both age
Table 10. Percentage distribution of subjects' last visit to the dentist according to monthly household income and age.

<table>
<thead>
<tr>
<th>Monthly household income (HK dollars)</th>
<th>15- to 19-years-old</th>
<th>35- to 44-years-old</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 - 3999</td>
<td>4000 - 7999</td>
</tr>
<tr>
<td>Within the last year</td>
<td>(123)</td>
<td>(209)</td>
</tr>
<tr>
<td>Never or don't remember</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td>I went for a check-up</td>
<td>39</td>
<td>34</td>
</tr>
</tbody>
</table>


Table 11. Percentage distribution of the type of dentist visited by the respondents on the last occasion according to age and sex.

<table>
<thead>
<tr>
<th>The last visit to the dentist was</th>
<th>15- to 19-years-old</th>
<th>35- to 44-years-old</th>
</tr>
</thead>
<tbody>
<tr>
<td>At the dental hospital</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>At a government clinic</td>
<td>17</td>
<td>11</td>
</tr>
<tr>
<td>A licensed dentist in private practice</td>
<td>58</td>
<td>63</td>
</tr>
<tr>
<td>An unlicensed dentist</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Other or Don't know</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 12. Percentage distribution of the subjects' reasons for never having visited the dentist according to age and sex.

<table>
<thead>
<tr>
<th>I never visited the dentist because</th>
<th>15- to 19-years-old</th>
<th>35- to 44-years-old</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have no dental problem</td>
<td>47</td>
<td>72</td>
</tr>
<tr>
<td>I'm afraid of the pain</td>
<td>27</td>
<td>22</td>
</tr>
<tr>
<td>I'm afraid of the dentist</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>It is too expensive</td>
<td>34</td>
<td>31</td>
</tr>
<tr>
<td>It is too far to go</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>I haven't time</td>
<td>14</td>
<td>39</td>
</tr>
<tr>
<td>I'm unable to get off work</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Waiting time to see dentist is too long</td>
<td>26</td>
<td>29</td>
</tr>
<tr>
<td>A dentist cannot help my dental problems</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Other reasons</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

groups, that the 'waiting time to see the dentist is too long'. More than one third of the 35- to 44-year-olds indicated that they did not have time available to see the dentist.

Fear of pain and fear of the dentist were not important factors in preventing the male respondents in both age groups from seeking dental treatment. However, fear of pain was more common among the females of both age groups, and reached 27 and 22 per cent for the teenagers and the 35- to 44-year-old subjects respectively.

Household income, as an economic indicator, did not have a significant effect on the distribution of responses about reasons for not visiting the dentist.
Discussion

The Chinese culture is a very strong common denominator, having a deep and forceful impact on the health related beliefs and behaviour of Chinese. It permeates all strata of the social system, even in an area like Hong Kong which is strongly exposed to Western culture. Traditional Chinese medicine plays an important role among modern Chinese. In Hong Kong traditional Chinese medicine and Western medicine co-exist and complement each other.

The questionnaires used in the international collaborative studies (WHO) were constructed with the Western health care consumer in mind and in some respects this approach is not appropriate for the Chinese living in Hong Kong. The holistic approach by the Chinese in the development and maintenance of a functional body equilibrium, seeking to ensure optimal health in their daily life, determines health care practices at home and the uptake of Westernized health care services to a large extent. An example of these cultural aspects is the paramount importance of the Chinese diet and the dietary habits. The Chinese diet serves many purposes, and among these the curative and the health promotion values have a conspicuous bearing on the most prevalent dental diseases. With these cultural determinants in mind, the survey questionnaire was modified and supplemented following advice by a Chinese cultural anthropologist.

It is important to realize that lack of knowledge among Chinese about the aetiology, prevention, and cure of the major dental diseases, in terms of the Western medical philosophy, is very often compensated by Chinese medical interpretation of the pathological phenomena.

The respondents' reactions to questions related to their knowledge about the causes of the major oral diseases and their perceived susceptibility and preventability clearly revealed that some of the important objectives of health education will be in the dissemination of knowledge about the aetiology, pathogenesis, prevention, and therapy of the diseases. Widespread misconceptions and ignorance about oral diseases and oral health exist in the adult population in Hong Kong. Within the tenets of the Health Belief Model (Rosenstock, 1966) widespread misconceptions about the cause of the common major dental disorders would certainly reduce the effectiveness of any planned educational initiatives aimed at improving the oral health status of a community. One half of all respondents in the present survey indicated that they did not know what the causes of gum bleeding actually are. Furthermore between 82 per cent and 89 per cent of all respondents considered old age to be a cause of tooth loss. From these findings it can be concluded that the promotion of a more scientific orientation to the understanding of the causes of periodontal disease and tooth loss should be initiated without delay.

It is important to note that generally the respondents were rather pessimistic about their own capabilities in the prevention of dental caries, bleeding gums, and toothache, whereas they had a greater confidence in the dentist's capability to prevent these phenomena with the exception of the treatment of loose teeth. Their pessimistic view of their own capabilities may also be explained by differences in culturally defined concepts. There is good reason to believe that a potent contribution towards the shaping of attitudes in the Hong Kong population regarding oral health care is the information promulgated by those deliver-
ing this care. Perhaps a lack of confidence in the professions' ability to manage advanced periodontal disease signals a need for the dissemination of more accurate information through the members of the dental profession.

A unanimously strong preference for natural teeth was found among Hong Kong Chinese. This was found to be prevalent, irrespective of economic, sex, and age group status.

The older generation of respondents in the present survey appeared to be more inclined to use 'cooling teas' and herbal medicine to cure toothache and gum problems. Though the use of traditional Chinese cures was quite prevalent among the 35- to 44-year-old Chinese it appeared that both educational attainment and household income had a differential effect. The higher the educational level and the more economically privileged the respondents were, the less they were inclined to use traditional Chinese cures. The use of these cures is an area of study which deserves much more attention than that given in the present survey. The possibility that their use might be a factor leading to delay in seeking advice and treatment needs further investigation. From a Western point of view, the traditional Chinese cures are often measures which 'cure' symptoms, whereas the Chinese see them as potent in re-establishing functional bodily equilibrium. Without a deeper understanding of the traditional Chinese cures and how they can be incorporated into the management of disease problems, the Western orientated health educator will be in a weak position to change health and disease behaviour by culturally acceptable methods.

For both the 15-19 and the 35- to 44-year-old Chinese, toothbrushing was practiced by more than 98 per cent, as indicated by the positive reaction to the question about what they did yesterday. More than three quarters of the respondents used a fluoride dentifrice, and the use of toothpicks and mouthrinsing after eating were more prevalent among Chinese living in Hong Kong than found in many of the other survey populations exposed to similar questions. However, the degree to which these oral hygiene practices were oral health orientated or based on other motivations was not investigated in the present survey.

Bearing in mind that Hong Kong's public water supplies have been fluoridated since 1961, and because of intensive television advertising of fluoride toothpastes, it was not surprising that nine out of ten 15- to 19-year-olds and two thirds of the senior age group in the present survey knew about fluoride.

The eating of between-meal-snacks was considerably less frequent among the 15- to 19-year-old Hong Kong Chinese than found in comparable surveys from other countries. For the 35- to 44-year-old Chinese, it was found to be even less frequent than for the teenagers. Around 40 per cent of the 15-19 and 50 per cent of the 35- to 44-year-old subjects had no between-meal-snacks the day before the inquiry. The same trend, though somewhat weaker, was found for both age groups concerning the intake of sweet drinks between the three daily meals. Asked about having a sweet dessert at meal times the day before, more than two thirds of the respondents in both age groups reported that they did not. It is difficult to compare the data from the present survey concerning the timing of the last dental visit, the reasons for the visit and the services received with similar data from comparable surveys conducted in other countries (Cutress et al., 1979, 1983; Arnljot et al., 1985; Powell & McEniery, 1985), and conclusions should be made with caution. A direct comparison indicated that the Hong
Kong Chinese consumers of dental services were very different from the consumers in the other survey countries. Less than one quarter of the Hong Kong teenagers visited a dentist in the past 12 months whereas more than two thirds of the teenagers from the other countries did. Likewise the percentage of the 35- to 44-year-old Chinese who visited the dentist in the past twelve months was markedly lower than that in the other countries surveyed. Also more than half the Chinese teenagers had never visited a dentist, had not done so in the last three years, or did not remember, and the proportion was only slightly greater for the senior survey subjects. It was found in the present survey that household income was a strong factor influencing visiting behaviour.

The major reasons reported for never having visited the dentist were; no dental problem, lack of time, and the perception that dental treatment is too expensive. 'I have no dental problem', was claimed by about two thirds of the teenagers and about one half of the 35- to 44-year-old group. An internal analysis showed that those who indicated that they had no dental problem usually had very low dental caries score; 0.4 and 1.5 DMF-T for the 15-19 and 35- to 44-year-old subjects respectively, compared with 1.7 and 7.3 DMF-T for the total groups.

Asymptomatic reasons for the last visit to the dentist were reported by around one fifth of the Chinese aged 15-19 and 35-44 respectively. For the teenagers, this is an extremely low proportion in comparison with the findings of the majority of surveys mentioned earlier. But for the 35- to 44-year-olds this lower percentage was similar to that found in the comparable studies conducted in Poland, USA, and Japan. Household income was found to be a rather strong factor in the decision by the Hong Kong Chinese to make asymptomatic visits to the dentist.

From the questionnaire data collected and analysed it appears that a well-conceptualized dental health education initiative is of paramount importance in Hong Kong. The survey report (Lind et al., 1986) made the following recommendations related to health education:

- expansion of the school dental services should lead to the development of a systematic oral health care delivery system for children from 3-16 years of age. This future system should be founded on health education and prevention. With the long-term purpose of improving the periodontal health status of the adult population, heavy emphasis should be placed on effective oral hygiene. The health education programme should be firmly organized and systematic, both in strategy and tactics, according to modern health education principles and methods,

- an area-wide health education enterprise coupled with modern marketing approaches should be implemented as a co-operative government-dental profession initiative,

- dental health education programmes should be delivered in a form which is culturally acceptable to the people of Hong Kong,

- dental health education should be integrated and co-ordinated with the general health education as much as possible and the basic principles of primary health care approach should be followed.
References


SEX DIFFERENCES IN THE PERIODONTAL STATUS OF HONG KONG ADULTS AGED 35–44 YEARS

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Epidemiological studies on periodontal diseases conducted in many countries employing different indices have generally shown advanced periodontal destruction to be more prevalent in adult males than in adult females.

The 1984 Hong Kong survey of adult oral health, using the Community Periodontal Index of Treatment Needs (CPITN) to determine periodontal status, revealed that in males aged 35 to 44 years the prevalence of deep pockets was 23 per cent, compared with 9 per cent in females ($P < 0.01$). Males had a mean of 0.4 sextants with deep pockets whereas females had a mean of only 0.1 sextants so affected ($P < 0.01$). Females were found to have a significantly larger proportion of healthy sextants ($P < 0.01$). The observed sex difference in disease prevalence may have been influenced by the fact that fewer teeth were present in the females, but it could not be explained by differences in reported oral hygiene measures and practices.

Introduction

Since the advent of descriptive epidemiological indices for periodontal disease, many epidemiological investigations have shown differences in the prevalence and severity of periodontal destruction between adult males and females.

A number of epidemiological investigations of periodontal disease in adults which employed the Periodontal Index (P.I.) (Russell, 1956) has been conducted in industrialized nations. Among these are the studies reported by Russell (1957), Jamison (1960), Moeley & Smith (1963), National Centre for Health Statistics: Kelley & van Kirk (1965), Douglass et al. (1983), Hughes et al. (1982), which were all performed in the United States of America. In Europe there are, among others, Lövdal et al. (1958), Ainamo & Alvesalo (1968) and Sheiham (1969). Freitas et al. (1983) have reported on the periodontal status of adults also measured by the P.I. Taken as a group, these investigations can be interpreted as having shown that the periodontal status of females aged 30 years and above was better than that of males of comparable age. A similar pattern has also been shown to occur in some developing countries, such as Uganda (Skougaard et al., 1969), in various ethnic groups in Israel (Rosenzweig & Smith, 1966), and in South Vietnam (Russell et al., 1965).

The World Health Organization international collaborative study of oral health care systems, employing a modified Periodontal Index, has shown the same trend for better periodontal conditions in females aged 35–44 years than in males; it was evident in all urban and rural areas in the ten industrialized countries studied (Arnljot et al., 1985).
In contrast however, Waerhaug (1966, 67), using the P.I., reported that in Ceylon, now Sri Lanka, the periodontal condition of females was worse than that of males after the age of 20 years. The suggested explanation for this pattern was that it resulted from frequent childbirth and poor nutrition in females (Waerhaug, 1971).

Employing measures of loss of periodontal attachment, Cutress et al. (1982) in Tonga and Western Samoa, and Baelum et al. (1986) in Tanzania, have shown loss of periodontal attachment to have a greater prevalence in adult males than in adult females. MacGreggor & Sheiham (1974) reported that Western Nigerian males over the age of 30 years had a higher percentage of teeth with pocketing than females. Furthermore, an epidemiological survey of periodontal disease in Dutch adults has shown a greater percentage of 35–44 year-old males to have pockets, with a greater average number of pockets per person, than females of the same age range (Plasschaert et al., 1978).

Studies based on the Periodontal Treatment Needs System (PTNS) (Johansen et al., 1975) conducted in Scandinavian countries by Bellini & Gjermo (1973), Markkanen et al. (1983), and Christensen et al. (1984) have confirmed this trend and generally shown males to be in need of more periodontal treatment than females. Similar findings have been reported from studies based on clinical criteria as recommended in Technical Report Series No. 621 (WHO 1978), by Srikandi & Clarke (1982) and Beck et al. (1984).

This generality, that females have a better periodontal status, has been ascribed to the better oral hygiene status generally found among females (Waerhaug, 1966). It has also been suggested that females may make more frequent visits to dental care providers than males (Löe, 1963), and that this might influence the periodontal status. In the report of a study by Ainamo & Alvesalo (1968), it was suggested that the observed sex difference in periodontal status may also have been an indirect consequence of the higher frequency of tooth loss in the females than in the males.

The 1984 Hong Kong survey of adult oral health (Lind et al., 1987) recorded the periodontal status of examinees using the Community Periodontal Index of Treatment Needs (Ainamo et al., 1982). This present analysis of the data collected during the survey was undertaken to assess if the previously reported trend for less severe periodontal destruction in females than in males appertains in Hong Kong for adults aged 35–44. Furthermore, this analysis investigated whether any sex differences in periodontal status was related to the oral hygiene practices claimed to be performed by the study subjects.

Materials and methods

The Hong Kong survey of adult oral health 1984 employed a cluster sampling method within a selected area of urban Hong Kong. All 35–44 year old persons from selected living quarters were invited to attend for a dental examination. At the hospital each examinee was subjected to both a questionnaire interview and a clinical examination. The questionnaire was a self-completion type and sought information on, amongst many other topics, the oral hygiene practices of the respondent, the time interval since the last visit of the respondent to the dentist, the reasons for that visit and the treatment received on that occasion. The
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clinical examination, conducted with the benefit of overhead dental lights in a standard clinic in the dental teaching hospital, included the recording of missing teeth and the application of the CPITN (Ainamo et al., 1982), probing each index tooth at six sites. Prior to the survey the three examiners, EFC, CJH, and WIRD, were trained to probe with a force not exceeding 0.25 N by means of an electronic pressure sensitive probe (Vine Valley Research Corp.). In addition examiners undertook a calibration exercise before the survey. Between and within examiners consistencies were monitored throughout the survey. The data were stored on a Sperry-Univac 1100 Computer and subsequent statistical analysis was performed on an IBM-XT microcomputer using SPSS-PC+. Student's t-test was used to compare differences between group mean values. The Chi-square test was used for comparison between proportions, as was, using an auxiliary computer program, the test for critical differences between proportions. The differences were considered significant when $P < 0.05$.

Results

668 persons aged 35–44, both completed the questionnaire interview and were subjected to a CPITN examination. 337 of these were female.

Table 1. Percentage distribution of the subjects examined according to the highest CPITN score by sex.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age</th>
<th>Number of examiners</th>
<th>No periodontal disease (code 0)</th>
<th>Bleeding only (code 1)</th>
<th>Calculus (code 2)</th>
<th>Shallow pockets (code 3)</th>
<th>Deep pockets (code 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>668</td>
<td>337</td>
<td>1</td>
<td>0</td>
<td>34</td>
<td>56</td>
</tr>
<tr>
<td>♀</td>
<td>35–44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>♂</td>
<td>35–44</td>
<td></td>
<td>331</td>
<td>0</td>
<td>0</td>
<td>21</td>
<td>55</td>
</tr>
</tbody>
</table>

$P < 0.01$

Only a small proportion of both males and females exhibited no periodontal disease as assessed by CPITN criteria (Table 1). Males were however found to have a significantly higher prevalence of deep pockets than females as determined by the highest CPITN score ($P < 0.01$).

The mean number of 0.4 sextants with deep pockets in males was significantly greater ($P < 0.01$) than the mean number of 0.1 sextants in females (Fig. 1).

Table 2 shows the differences in the percentage distribution of the subjects according to the number (0 to 6) of sextants scored as healthy, for males and females. Although healthy sextants were infrequent, females were found to have a significantly larger proportion of them ($P < 0.01$). Five per cent of females had three or more healthy sextants compared with only 1 per cent for males ($P < 0.01$).

Males had a greater proportion of sextants with deep pockets ($P < 0.01$). However, most of the males with deep pockets were, like the females, found to have only one sextant involved. There was no significant difference between the mean number of sextants with deep pockets in those individuals registering a CPITN score of 4, this being 1.6 sextants for males and 1.5 sextants for females.

Although the proportions were very small, twice as many females as males had one or more sextants excluded, due to inadequate numbers of teeth, in
accordance with the criteria for CPITN scoring. This difference was not statistically significant. However the mean number of sextants excluded in females was double that for males \((P < 0.05)\) (Fig. 1). An analysis of missing index teeth by sex (Table 3), failed to show any significant differences with the exception of tooth 11, which was more often missing in females. Moreover, the mean number of missing teeth, including third molars, was not significantly greater for females (3.2) than for males (2.7).

Plaque scores were not recorded, but responses to questions on oral hygiene measures and practices were analyzed. This failed to reveal any significant differences between males and females. Very little difference could be discerned between the sexes in their reports on both the recency of the last visit to a dentist and the reasons for that visit, with none of these differences reaching statistical significance.
Table 3. Numbers and percentages of missing index teeth by sex.

<table>
<thead>
<tr>
<th>Tooth</th>
<th>No. missing</th>
<th>% missing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td>17</td>
<td>30</td>
<td>28</td>
</tr>
<tr>
<td>16</td>
<td>55</td>
<td>53</td>
</tr>
<tr>
<td>11</td>
<td>44</td>
<td>24</td>
</tr>
<tr>
<td>26</td>
<td>60</td>
<td>47</td>
</tr>
<tr>
<td>27</td>
<td>33</td>
<td>26</td>
</tr>
<tr>
<td>37</td>
<td>51</td>
<td>51</td>
</tr>
<tr>
<td>36</td>
<td>128</td>
<td>116</td>
</tr>
<tr>
<td>31</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>46</td>
<td>127</td>
<td>116</td>
</tr>
<tr>
<td>47</td>
<td>49</td>
<td>47</td>
</tr>
</tbody>
</table>

Discussion

This survey in Hong Kong, using the CPITN to record the periodontal status, has confirmed a trend for advanced periodontal destruction to be more prevalent in adult males than in adult females. This is consistent with the findings of investigations employing this and other indices performed elsewhere. Although an index of treatment needs, it appears as though the CPITN does allow for the assessment of periodontal status to a certain extent (Barmes & Leous, 1986). One other study also employing the CPITN has similarly shown that the periodontal condition of females was consistently better than males (Powell & McEniry, 1985).

The reasons for this sex difference in the clinical manifestations of periodontal destruction have not as yet been fully elucidated. The most commonly cited reason is that the oral hygiene status of females is, in general, better than that of males (for review see Waerhaug, 1966). This seems perfectly reasonable. Some caution should be exercised when comparing epidemiological findings from one population group with another, however. Some more recent investigations in developing countries (Cutress et al., 1982; Reddy et al., 1985; Loe et al., 1986; Baelum et al., 1986) have suggested a need for circumspection in relating levels of oral hygiene, as determined in these studies, directly to the severity of periodontal destruction. Nonetheless it is noteworthy that in two of these studies there was a clear trend for generally poorer oral hygiene and calculus status to be coincident with poorer periodontal conditions in males (Cutress et al., 1982, Baelum et al., 1986).
The CPITN, which was designed primarily as an indicator of treatment needs in populations, does not include scoring for dental plaque, as this was considered less important than the assessment of its consequences, gingival bleeding and pocket formation (Ainamo et al., 1982). It is not known if a difference existed in oral hygiene status between the males and females examined in the present study, because plaque levels were not measured. However, the reported oral hygiene practices on the day prior to examination did not differ significantly between the males and females. This however should not be interpreted as suggesting that the difference in prevalence of more advanced periodontal conditions between the sexes could not in part be explained by differences between the oral hygiene status of males and females.

The possibility that the greater tooth loss sometimes encountered in females could contribute to the difference in the prevalence of more advanced periodontal conditions, as suggested by Ainamo & Alvesalo (1968), may also have influenced the results in this survey. In the females, there was a significantly greater number of sextants excluded from examination of the periodontal status due to inadequate numbers of teeth. Furthermore, although differences were small, there was a trend towards the presence of fewer teeth in females. The greater number of sextants excluded, coupled with the greater loss of all teeth in females may have been of sufficient magnitude to have had a bearing on the results of the CPITN but these factors are unlikely to explain the difference in the prevalence of deep pockets.

That these females may enjoy greater periodontal health partly as a result of more frequent dental visits, as suggested by Loe (1963), was not confirmed in this present investigation; the responses concerning the last dental visit did not differ between males and females. It has previously been pointed out by Rosenzweig & Smith (1966) that this suggested reason for the existence of a sex difference in periodontal status may not be applicable in all countries. Societal perceptions of the position of females and their consequent health behaviours are clearly not the same in every part of the world.

The questionnaire did not ask about tobacco-smoking habits, which may influence periodontal status (Ismail et al., 1983). For the year 1982 it was reported that 54 per cent of Hong Kong males aged 35 to 44 years then regularly smoked, compared with only 6 per cent of females of the same age range (Hong Kong Central Health Education Unit). It is suggested that future oral health directed questionnaires should ask about the use of tobacco products.

This analysis of the clinical findings and the sociological data from the 1984 Hong Kong survey of adult oral health has not adequately explained the reasons for the observed sex difference in the prevalence of advanced periodontal destruction. Social and behavioural factors, in addition to those which may affect oral cleanliness, must be investigated in order to help to elucidate the matter.

Acknowledgements – Special thanks are extended to Dr T.S.C. Chan, Dental Data Processing Unit, University of Hong Kong for his assistance in data analysis.
The survey was supported financially through a research grant provided by the Research Committee, Faculty of Dentistry, University of Hong Kong.

References


The hierarchy within the CPITN's scoring method has been tested in a Scandinavian population wherein it gave a correct estimate of the prevalence of gingival bleeding except for the score for calculus on mandibular incisors (1). In a Japanese population, however, bleeding was absent in 47.5% of sextants with a score for calculus (2). This present analysis was undertaken to examine the relationship between periodontal parameters and CPITN scores on index teeth in Hong Kong Chinese.

In the 1984 Hong Kong Survey of Adult Oral Health, the sampling methods and examination procedures of which have been previously described (3), 563 15-19-yr-old and 668 35-44-yr-old subjects were examined. Three calibrated examiners, using the CPITN, probed each index tooth at six sites, and the findings of shallow or deep pockets, calculus and bleeding were each recorded separately. Examiner reliability was generally in the range considered to be good to excellent as assessed by Kappa statistic (4).

In the 15-19 group, of the 3265 index teeth examined, 2377 had calculus or a higher score. Of these 88.5% had calculus without pockets and 11.4% had shallow pockets. 23.2% of index teeth with low pockets. 23.2% of index teeth with calculus and no pockets exhibited bleeding, this finding being most marked for lower incisors; but the majority of index teeth with pockets, as for the younger group, were associated with both bleeding and calculus (Table 2).

Our finding of calculus without bleeding and this being most marked for index teeth with pockets, as for the younger group, were associated with both bleeding and calculus (Table 2).

Table 1. Relationship between periodontal parameters and CPITN scores on index teeth in percentages for 15-19-yr group

<table>
<thead>
<tr>
<th>CPITN score</th>
<th>Combinations of parameters</th>
<th>Index teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>-P + C + B</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>-P + C + B</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>-P + C + B</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>-P + C + B</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>-P + C + B</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>-P + C + B</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>-P + C + B</td>
<td>all</td>
</tr>
<tr>
<td>Total (n)</td>
<td>(378)</td>
<td>(223)</td>
</tr>
<tr>
<td></td>
<td>(403)</td>
<td>(369)</td>
</tr>
<tr>
<td></td>
<td>(346)</td>
<td>(379)</td>
</tr>
<tr>
<td>P = pocket (shallow or deep); P1 = pocket 5.5-5.5 mm; C = calculus; B = bleeding</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

% only six subjects had scores of Code 4, therefore no data are reported.

Table 2. Relationship between periodontal parameters and CPITN scores on index teeth in percentages for 35-44-yr group

<table>
<thead>
<tr>
<th>CPITN score</th>
<th>Combinations of parameters</th>
<th>Index teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>-P + C + B</td>
<td>17.16</td>
</tr>
<tr>
<td></td>
<td>-P + C + B</td>
<td>11.10</td>
</tr>
<tr>
<td></td>
<td>-P + C + B</td>
<td>26.27</td>
</tr>
<tr>
<td></td>
<td>-P + C + B</td>
<td>46.36</td>
</tr>
<tr>
<td></td>
<td>-P + C + B</td>
<td>31.31</td>
</tr>
<tr>
<td></td>
<td>-P + C + B</td>
<td>36.36</td>
</tr>
<tr>
<td></td>
<td>-P + C + B</td>
<td>all</td>
</tr>
<tr>
<td>Total (n)</td>
<td>(505)</td>
<td>(391)</td>
</tr>
<tr>
<td></td>
<td>(761)</td>
<td>(553)</td>
</tr>
<tr>
<td></td>
<td>(526)</td>
<td>(604)</td>
</tr>
<tr>
<td>P = pocket (shallow or deep); P1 = pocket 5.5-5.5 mm; C = calculus; B = bleeding</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the 15-19 group, of the 3265 index teeth examined, 2377 had calculus or a higher score. Of these 88.5% had calculus without pockets and 11.4% had shallow pockets. 23.2% of index teeth with low pockets. 23.2% of index teeth with calculus and no pockets exhibited bleeding, this finding being most marked for lower incisors; but the majority of index teeth with pockets, as for the younger group, were associated with both bleeding and calculus (Table 2).

Our finding of calculus without bleeding and this being most marked for index teeth with pockets, as for the younger group, were associated with both bleeding and calculus (Table 2).

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Esmonde F. Corbet
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Key words: calculus; CPITN; periodontal epidemiology; periodontal treatment needs

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Accepted for publication 21 April 1980

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of calculus (5). There is thus further
doubt about the basis for CPITN indicat­
ing scaling for all teeth with calculus.

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The Hong Kong Adult Oral Health Survey – 1991: background, study population, and methods


Abstract - This second adult oral health survey was conducted with the following main aims: 1) to describe the oral health conditions and to analyse the oral health care needs and demands of 65–74-yr-olds in Hong Kong, and to propose appropriate strategies for meeting their needs in the light of societal obligations; 2) to describe the oral health conditions and to analyse the oral health care needs and demands of 35–44-yr-olds in Hong Kong with special emphasis on assessment of changes in this age group since 1984 (when the first adult oral health survey was conducted); 3) to assess the impact of sociodemographic and dental care system factors on the oral health status of selected adult age groups; and 4) to utilize survey data to refine curriculum development and research strategies in the Faculty of Dentistry, as well as in the proposal of appropriate action to governmental committees on dental health policy. For enhanced comparability with the previous study, the 35–44-yr-olds were selected from the same geographic areas of Hong Kong Island. Multistage cluster sampling was used to recruit the study population, defined geographic units and addresses being used as the starting-point. A sample of 398 subjects was selected, of whom 93% were both interviewed and clinically examined. The 65–74-yr-olds were recruited from housing estates in all principal areas of Hong Kong, yielding a sample of 559 subjects, of whom 96% were both interviewed and clinically examined. The analysis of the data was based on the model used by the International Collaborative Study II, from which other methodologic guidance had been sought. The definitions of selected sociodemographic variables such as occupation, income, Family Material Possession Index, family support, and dental anxiety, which are relevant to the whole study, are given here.

Key words: aged; dental health surveys; health services research; oral health; research design

In 1986, the Department of Periodontology and Public Health of the University of Hong Kong published the report of its first adult oral health study, which had been conducted in 1984, covering two age groups, 15–19- and the 35–44-yr-olds (1). One of the recommendations in that report was that "planned research studies should be conducted with the purpose of designing cost-effective programmes for the delivery of oral health care to all population groups, including those with special needs, such as the handicapped and the elderly." The commitment to fulfill, among others, this recommendation has been borne out partly by annual departmental Community Health Projects, which have immensely added to our knowledge of the oral health situation in many different groups in Hong Kong society (2), and partly by the ensuing report on the second adult oral health study.

Although epidemiologists have some doubt as to the feasibility of directly translating survey data into treatment need and resource guidelines (3), there is no doubt about the usefulness of mapping out the actual oral health situation in selected population groups. Thus, the World Health Organization (WHO) (4–6) has consistently advocated epidemiologic studies as the major component of a nation’s planning for and evaluation of its oral health care services, and this advice has been heeded by many countries,
in terms of international collaborative studies (7), major stand-alone surveys (8-12), and repeated studies with regular intervals (13-16). The decision to undertake this oral health survey in Hong Kong was based on the wish to monitor oral health development in one central adult age group (35-44-yr-olds) and on the realization that very little was known about another increasingly important age group (65-74-yr-olds). Before further description of the study details, it seems relevant to give a brief description of the society in which the study took place, and the dental care available to the population.

The setting
Hong Kong is situated on the southern coast of mainland China. It became a British Crown colony in 1842, and now has a total land area of about 1052 sq. km. Ever since the establishment of the People's Republic of China on the mainland in 1949, Hong Kong has been undergoing rapid demographic, social, and economic transformations. Primarily because of the great influx of refugees from China, Hong Kong's population has grown from fewer than 1 million in 1945 to 5.7 million in 1991. Over 98% of the population are Chinese, and although around 60% of the present population were born in Hong Kong, most families originated from the southernmost province of China, Guangdong.

Concomitant with population growth has been the rapid modernization of Hong Kong's technology and institutions, as shown by large increases in a number of indicators such as the proportion of the population engaged in manufacturing, energy consumption, the number of private cars, government per capita expenditure, and the proportion of the population receiving postsecondary education. In terms of health status, the development has been similar to that of many developed countries, i.e., reduced incidence of various infectious diseases and decline in infant and maternal mortality rates, while chronic diseases, such as malignant neoplasms and heart disease, have become the major causes of death. Government expenditure on medical and health services accounted for about 10% of total expenditure in 1988 (17, 18).

The most conspicuous initiatives in the field of oral health were the fluoridation of water in 1961 (19), the establishment of a school dental service for primary schoolchildren in 1980 based on school dental therapists, and the establishment of a Faculty of Dentistry at the University of Hong Kong in 1982. The objective of this establishment laid down by the government was the production of graduates with a dental degree which met the requirements set by the General Dental Council of the UK (20). No specific reference was made to the needs of the local population who were eventually to be served by the dental profession. A few years after the first local dentists graduated from the university, fears of imminent overproduction of dentists led to a reduction in the dental student intake from 60 to 50 per year. By 1991, around 1300 dentists were registered in Hong Kong, corresponding to a dentist to population ratio of 1.4400. But in spite of the limited area, this ratio varied between 1:500 and 1:20000 in different areas in Hong Kong. In response to recent recommendations by a governmental committee (21), attempts are now being made to emphasize preventive dentistry in pre-schoolchildren and to establish a bridge between the school dental care service and the private dental practitioners. However, no special activities are planned concerning the dental care of adults in general or the elderly.

Aims of the study
The overall aims of the study were defined as follows:

1. to describe the oral health conditions and analyse the oral health care needs and demands of 65-74-yr-olds in Hong Kong, and to propose appropriate strategies for meeting these needs in the light of societal obligations toward these age groups;

2. to describe the oral health conditions and analyse the oral health care needs and demands of 35-44-yr-olds in Hong Kong with special emphasis on assessment of changes in these cohorts since the 1984 survey of adult oral health;

3. to assess the impact of sociodemographic and dental care system factors on the oral health status of selected adult age groups;

4. to utilize survey data to refine curriculum development and research strategies in the university department, as well as in the proposal of appropriate action to governmental committees on dental health policy.

Objectives relating to different parts of

Fig 1. Map of Hong Kong Island and part of Kowloon and New Territories with study areas indicated.
the study are referred to in the following individual papers.

Study population and methods
The study was planned to follow the guidelines for the International Collaborative Study II (WHO, personal communication), although it was impossible to join the preparatory stages of that study. The ICS II works on a model which postulates that the socioenvironmental characteristics of the society, the oral health care system, and the individual's characteristics influence oral health behaviour and, consequently, oral health status and consumer satisfaction (22, 23). Information on these aspects is then gathered through extensive social surveys among dental care providers and in the population, and by epidemiologic survey of selected population samples. In the following discussion, the background and a detailed description of the sampling procedures of this study are given together with population characteristics. Next, the details of the data analysis are laid down. Clinical criteria were based on internationally accepted standards as described by WHO (24), but further details are provided in the relevant papers. It was decided not to survey dental care providers because of other survey activities involving this group.

Recruitment of the 35-44-yr-old age group
For enhanced comparability between the planned study and the 1984 study, it was decided to select the study population from essentially the same areas of Hong Kong as 7 years before. Some modifications were deemed advisable on the basis of field experience in the previous study; thus, four study areas which yielded very limited results were excluded, and another area was included because of its mix of housing (public and private), which was perceived to be of greater relevance to the study. The selection process was a modified, multistage cluster sampling including the following stages:

1. Geographic areas to be investigated were defined by selecting relevant tertiary planning units (TPUs), which are the smallest administrative areas obtainable from public registers, from maps in the Department of Census and Statistics.

2. TPUs in western and southwestern Hong Kong Island were selected.

3. A random sample of 576 permanent residential addresses in the defined TPUs was drawn from the Department of Census and Statistics housing-quarter frame.

4. Study subjects were selected. The study area is illustrated in Fig. 1. The sequence of the subject recruitment process is illustrated in Fig. 2. University undergraduate students were recruited to visit the sampled homes in order to introduce the survey and to secure appointments with suitable study subjects for the interview proper and clinical examination. The home visits took place when the subjects were expected to be at home after work, i.e., in the evenings on weekdays, and on weekends. Because previous surveys had revealed that not many households in Hong Kong have members in the age group 35-44 yr, the sampled addresses were used as starting addresses for the recruitment process, and substitutions were made in cases of recruitment failure. The flat next to the one sampled was approached as a substi-

---

**Fig. 2. Activity flow chart of subject recruitment.**
Table 1. Outcome of subject recruitment (35-44-yr-olds)

<table>
<thead>
<tr>
<th>A. Sample of addresses</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of addresses selected</td>
<td>576</td>
<td>100</td>
</tr>
<tr>
<td>Inaccessible addresses</td>
<td>42</td>
<td>7</td>
</tr>
<tr>
<td>Accessible addresses</td>
<td>534</td>
<td>93</td>
</tr>
<tr>
<td>Mean number of households visited per address</td>
<td>8.2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Sample of households</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of households visited</td>
<td>4389</td>
<td>100</td>
</tr>
<tr>
<td>Noncontacts</td>
<td>1153</td>
<td>26</td>
</tr>
<tr>
<td>Households without 35-44-yr-old members</td>
<td>2045</td>
<td>47</td>
</tr>
<tr>
<td>Households with 35-44-yr-old members</td>
<td>1191</td>
<td>27</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C. Households with eligible members</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households with eligible members</td>
<td>1191</td>
<td>100</td>
</tr>
<tr>
<td>Refused to participate</td>
<td>729</td>
<td>61</td>
</tr>
<tr>
<td>Agreed to participate</td>
<td>462</td>
<td>39</td>
</tr>
<tr>
<td>Mean number of eligible persons per household</td>
<td>1.33</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D. Respondents</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of persons invited</td>
<td>616</td>
<td>100</td>
</tr>
<tr>
<td>Number of persons who failed to attend survey</td>
<td>218</td>
<td>35</td>
</tr>
<tr>
<td>Number of persons interviewed only</td>
<td>26</td>
<td>5</td>
</tr>
<tr>
<td>Number of persons interviewed and examined</td>
<td>372</td>
<td>60</td>
</tr>
<tr>
<td>Study population</td>
<td>398</td>
<td>65</td>
</tr>
</tbody>
</table>

Table 2. Selected demographic characteristics of survey subjects and Hong Kong population (percentages)

<table>
<thead>
<tr>
<th>35-44-yr-olds</th>
<th>Population 1991</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>n=398</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>45</td>
</tr>
<tr>
<td>F</td>
<td>55</td>
</tr>
<tr>
<td>Civil status</td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>91</td>
</tr>
<tr>
<td>Single, divorced, widowed</td>
<td>9</td>
</tr>
<tr>
<td>Education level</td>
<td></td>
</tr>
<tr>
<td>No schooling</td>
<td>1</td>
</tr>
<tr>
<td>Primary</td>
<td>20</td>
</tr>
<tr>
<td>Lower secondary</td>
<td>30</td>
</tr>
<tr>
<td>Upper secondary</td>
<td>36</td>
</tr>
<tr>
<td>Tertiary</td>
<td>9</td>
</tr>
<tr>
<td>Social class</td>
<td></td>
</tr>
<tr>
<td>Professional, administrative</td>
<td>20</td>
</tr>
<tr>
<td>Clerical</td>
<td>18</td>
</tr>
<tr>
<td>Sales/service worker</td>
<td>18</td>
</tr>
<tr>
<td>Production worker</td>
<td>22</td>
</tr>
<tr>
<td>Housewife</td>
<td>23</td>
</tr>
<tr>
<td>Household income (Hong Kong dollars)</td>
<td></td>
</tr>
<tr>
<td>&lt;$5000</td>
<td>13</td>
</tr>
<tr>
<td>$5000-$9999</td>
<td>34</td>
</tr>
<tr>
<td>$10000-$14999</td>
<td>18</td>
</tr>
<tr>
<td>$15000+</td>
<td>27</td>
</tr>
<tr>
<td>Did not know</td>
<td>8</td>
</tr>
</tbody>
</table>

Recruitment of the 65-74-yr-old age group

Initially, it was planned to employ the same subject recruitment procedures for both the middle-aged and the elderly. However, after a very short run-in phase, it became obvious that the "home visitation" method was not feasible for the 65-74-yr-olds, because they did not let the interviewers in, a difficulty which has been described previously (26). Thus, the selection of the elderly had to be completely replanned.
Table 3. Selected characteristics of 65–74-yr-old participants and nonparticipants (percentages)

<table>
<thead>
<tr>
<th></th>
<th>Participants n=559</th>
<th>Nonparticipants n=160</th>
<th>Significance (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>27</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>73</td>
<td>84</td>
<td>0.01</td>
</tr>
<tr>
<td>Denture prevalence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxillary</td>
<td>51</td>
<td>59</td>
<td>NS</td>
</tr>
<tr>
<td>Mandibular</td>
<td>43</td>
<td>54</td>
<td>0.02</td>
</tr>
<tr>
<td>Self-reported teeth no.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20+</td>
<td>28</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>10–19</td>
<td>32</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>1–9</td>
<td>27</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>14</td>
<td>27</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Last dental visit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within 1 yr</td>
<td>23</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>1–2 yr</td>
<td>16</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>2–3 yr</td>
<td>10</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>3–5 yr</td>
<td>14</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>5+ yr</td>
<td>37</td>
<td>48</td>
<td>0.03</td>
</tr>
<tr>
<td>Main reason for nonparticipation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not know of survey</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forgot to come</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No natural teeth</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No dental problems</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not want check-up</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Too busy, could not come</td>
<td>36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The table shows the differences in characteristics between participants and nonparticipants, with significance levels indicated by P-values. The higher percentage of participants who were mandibular dentures, more edentulous subjects, and more subjects who had not seen a dentist for more than 5 yr. There was a higher percentage of women among the survey subjects than the Hong Kong elderly population in general, but the civil status and education level of the two groups were similar (Table 2).

This method of sampling the elderly population resembled that of the National Survey of Oral Health of US Adults in 1985, in which about 5600 Americans 65 yr old and older were examined in senior citizen centres throughout the country. As noted by Le (27), it excluded the housebound, the institutionalized, and those who had chosen not to attend senior citizen centres.

This observation, without doubt, is also true of the present study, and other recruitment methods must be chosen to overcome this imbalance. The uneven female: male ratio could be seen partly as a result of more women frequenting the centres for the elderly, partly as an expression of less reluctance among women to participate. In other studies of the elderly, similar female: male ratios were found, with a 61:39 ratio reported by both Yu (28) and Ch & LEE (29).

Data analysis

The guide for the data analysis was provided by the analytic model used by the ICS II (22), which is conceptually close to the model for individual determinants of health care use suggested by ANDERSEN & NEWMAN (23). Because the dental care delivery system and the dental care providers were not surveyed in this study, these components of the model were disregarded, but selected outcome measures were incorporated. KYAK's modified model (30) was then used to order the...
variables appropriately, as illustrated in Table 4. Except for the need variables, need for treatment, DMFT, and CPITN, information was based on the structured interviews conducted. The analysis presented in the various papers also comprised a detailed description of these variables particular to each paper. However, operational definitions of some of the background variables are given here.

For the categorization of education and occupation, the official statistics were used (25). Education was measured as the educational level at which the respondent left the education system (e.g., no schooling but primary school, tertiary education, etc).

Occupation was measured as the main occupation of the respondent (e.g., professional, service worker, etc). Housewives were categorized separately, and those unemployed or retired were categorized separately according to their previous occupation. In the specific analyses, some regroupings were made to facilitate statistical requirements or interpretation of the analysis.

Income was measured as the size of the total household income in Hong Kong dollars and grouped according to official categories. Especially for the elderly who might be living with their families, this measure did not have much relevance. A second question was therefore used to reveal the source of the income (e.g., salary, family support, etc).

Because of the lack of a generally accepted composite measure for socioeconomic status in Hong Kong (besides the traditional measures of education, income, occupation, living conditions, etc), it was decided to use an alternative socioeconomic indicator, the Family Material Possession Index (FMPI). This index was devised and used by Ng (31) in several youth social surveys in Hong Kong, in which relevant socioeconomic information was difficult to obtain. No stated, first, that material possessions obviously reflect the availability and disposability of economic resources, and, second, that material possessions indicate a lifestyle that is dependent not only on economic resources but also on a person's values and preferences, which, in turn, are shaped by educational attainment, occupational subculture, and social network. The question on material possessions was as follows: "Different families would have different kinds of possessions and facilities in their homes. Are the following objects or facilities present in your home?" The question was accompanied by a list of 18 objects (e.g., air-conditioner, high-fidelity sound system, oven, television, etc) and four facilities (bath-tub, storeroom, built-in closets, and wooden floor), for which the respondent indicated possession or not. Furthermore, when calculating the FMPI, two dimensions were considered to be important in addition to possession, value and rarity. Value referred to the relative monetary value of the object and rarity to the extent to which an object was possessed by the group of people in question, and the standards for these concepts were defined through special studies comprising representative panels of people. Finally, a weight was applied to televisions, air-conditioners, and cameras for "extra quantities", e.g., three or more cameras. If all items on the list were selected, and if televisions, cameras, and air-conditioners were present in the maximum quantity, the total index score would reach 100; the minimum score was 0.

Family support was measured for the elderly in order to determine their dependence status, both socially and economically. This took into account the traditional living arrangements in Chinese families, elderly parents often living with children or grandchildren (29, 32). The support variable comprised marital status (married or widowed/single) in combination with whether or not the elderly respondent was living with family, thus forming four groups, each representing different levels of dependency.

Dental anxiety was measured by the four standard questions of Corah's Dental Anxiety Scale (33), and respondents were grouped according to their DAS score, which shows values between 4 and 20.

The description and analysis of the individual variables and their interrelationships are given in subsequent papers, the sequence of which follows the model depicted in Table 4. Any variable not described in detail above will be described in the paper where it first appears.

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Periodontal conditions among the middle-aged and the elderly in Hong Kong


Abstract - The aim of this study was to describe the periodontal conditions in 372 35-44-yr-old and 537 noninstitutionalized 65-74-yr-old Hong Kong Chinese who were examined clinically for loss of attachment, recession, probing depth, calculus, and bleeding after probing. Community Periodontal Index (CPI) data and treatment need indications were compiled from index teeth or their substitutes. The prevalence of loss of attachment varied considerably in both cohorts according to the definition of the threshold (≥6, ≥9, and ≥12 mm, respectively). The mean numbers of teeth with loss of attachment at the ≥6-mm threshold and at higher thresholds were small; in both age cohorts, about one-fifth of subjects had probing depths ≥6-mm, while at the ≥9-mm threshold only 2–3% were so affected. Although recession was an important component of loss of attachment in the younger cohort, in the older cohort the prevalence and extent of recession were greater than for probing depths at thresholds ≥4 mm. All subjects had one or more teeth with calculus, bleeding, or both, most teeth being so affected. Eighty-four of the 537 65-74-yr-old subjects were excluded either because of edentulousness or because extractions indicated for the remaining teeth would have rendered the subjects edentulous. The distribution of subjects according to their highest CPI score was remarkably similar for the two cohorts. No subjects in either age group were assessed as "healthy" (CPI code 0) or had "bleeding only" (code 1) as their highest score. While most subjects scored CPI code 2 or 3 as their highest score, only 17% of the younger and 15% of the older cohort scored Community Periodontal Index of Treatment Needs (CPI TN) code 4. Differences in the mean number of sextants affected by CPI codes between the two cohorts were mainly due to a greater number of excluded sextants in the older cohort. CPI findings for 35-44-yr-olds differed little from those reported in 1984. 

Key words: aged; Community Periodontal index of Treatment Needs; dental health surveys; epidemiology; health service needs and demand; oral health; periodontal diseases

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Accepted for publication 1 January 1994

Clinical findings of an oral health survey of Hong Kong adults aged 15-19 and 35-44 yr conducted in 1984 have been published previously (1, 2). The periodontal findings, being based on the Community Periodontal Index (CPI), were consistent with most CPI-based surveys for these two cohorts (3-5) in that few survey subjects had healthy periodontal conditions and that only a moderate proportion of the older cohort (16%) had severe periodontal disease as evidenced by probing depths of 6 mm or more. Calculus was found to be omnipresent although an interesting finding was that for a modest number of teeth, calculus was not always associated with gingival bleeding after probing (6). However, the periodontal conditions described, being based upon CPI criteria (7), did not include loss of attachment data; therefore, a description of the lifetime experience of periodontal disease in terms of total loss of attachment was not feasible. In addition, only limited information has previously been available on periodontal conditions for older Hong Kong adults and none for the 65-74-yr-old cohort.

The aim of this study was therefore to describe the prevalence, severity, and extent of periodontal disease in 35-44-yr-old and 65-74-yr-old Hong Kong Chinese.

Material and methods

As part of the Adult Oral Health Survey of Hong Kong conducted in 1991, 372...
Periodontal conditions

Table 1. Interexaminer reproducibility according to cohort and examiner combination for periodontal variables expressed as percent agreement and kappa statistic (k)

<table>
<thead>
<tr>
<th>Age cohort (yr)</th>
<th>Examiners</th>
<th>Attachment loss</th>
<th>Probing depth</th>
<th>Recession</th>
<th>Calculus</th>
<th>Bleeding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% agree</td>
<td>% agree</td>
<td>% agree</td>
<td>% agree</td>
<td>% agree</td>
<td>% agree</td>
</tr>
<tr>
<td>35-44</td>
<td>1-2</td>
<td>68</td>
<td>87</td>
<td>65</td>
<td>85</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.38</td>
<td>0.67</td>
<td>0.38</td>
<td>0.24</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>1-3</td>
<td>66</td>
<td>74</td>
<td>55</td>
<td>81</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.53</td>
<td>0.47</td>
<td>0.26</td>
<td>0.22</td>
<td>0.47</td>
</tr>
<tr>
<td></td>
<td>2-3</td>
<td>70</td>
<td>73</td>
<td>72</td>
<td>83</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.46</td>
<td>0.45</td>
<td>0.56</td>
<td>0.32</td>
<td>0.58</td>
</tr>
<tr>
<td>65-74</td>
<td>1-2</td>
<td>66</td>
<td>84</td>
<td>67</td>
<td>95</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.40</td>
<td>0.52</td>
<td>0.49</td>
<td>0.20</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>1-3</td>
<td>68</td>
<td>84</td>
<td>68</td>
<td>99</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.46</td>
<td>0.52</td>
<td>0.49</td>
<td>0.30</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>2-3</td>
<td>76</td>
<td>89</td>
<td>64</td>
<td>99</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.55</td>
<td>0.64</td>
<td>0.49</td>
<td>0.30</td>
<td>0.34</td>
</tr>
</tbody>
</table>

Table 2. Prevalence and severity of attachment loss, probing depth, and recession according to severity threshold for Hong Kong adults aged 35–44 and 65–74 yr (extent of each clinical variable refers to mean number of teeth affected in subjects)

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>Clinical variable</th>
<th>n</th>
<th>≥4 mm</th>
<th>≥6 mm</th>
<th>≥9 mm</th>
<th>≥12 mm</th>
<th>Indeterminate</th>
</tr>
</thead>
<tbody>
<tr>
<td>35-44</td>
<td>Attachment loss</td>
<td>372</td>
<td>74</td>
<td>33</td>
<td>3.3</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Probing depth</td>
<td>372</td>
<td>81</td>
<td>7.3</td>
<td>20</td>
<td>2.8</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Recession</td>
<td>372</td>
<td>22</td>
<td>4.1</td>
<td>3</td>
<td>2.2</td>
<td>0</td>
</tr>
<tr>
<td>65-74</td>
<td>Attachment loss</td>
<td>461</td>
<td>96</td>
<td>9.5</td>
<td>69</td>
<td>3.7</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Probing depth</td>
<td>461</td>
<td>75</td>
<td>4.5</td>
<td>21</td>
<td>1.7</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Recession</td>
<td>461</td>
<td>69</td>
<td>3.7</td>
<td>26</td>
<td>1.7</td>
<td>6</td>
</tr>
</tbody>
</table>
probing depth between examiners 1 and 2 in both age groups and between examiners 2 and 3 in the older group. The lower level of reproducibility between examiners 1 and 3 for attachment loss and recession in the 35-44-yr age group, expressed as proportion of agreement, was similarly reflected in the kappa statistic. The lowest kappa-statistic values were found in the scoring of calculus for both age groups and bleeding in the older group, most of these showing only “fair” agreement (κ=0.21-0.40); however, all of these clinical variables had an interexaminer proportion of agreement of over 80%.

Loss of attachment – Loss of attachment of \( \geq 4 \) mm at one or more teeth was detected in over 74% of the 35-44-yr-old and 96% of the 65-74-yr-old cohorts (Table 2). The extent of this loss of attachment at this severity threshold in those so affected was a mean of 8.0 teeth in the younger and 9.5 teeth in the older age cohort. Reductions in the prevalence of attachment loss were observed with increasing severity threshold; thus, at the \( \geq 6 \) mm threshold, 33% of the younger and 69% of the older cohort had one or more teeth so affected. The extent of loss of attachment was also reduced at this severity threshold, being limited to a mean of only 3.3 teeth in the younger and 3.7 teeth in the older cohort.

The most noteworthy reductions in the prevalence of loss of attachment were observed between the \( \geq 6 \) mm and \( \geq 9 \) mm thresholds in the younger and between the \( \geq 9 \) mm and \( \geq 12 \) mm thresholds in the older cohort. Thus, for the younger cohort, the prevalence of attachment loss at the \( \geq 9 \) mm threshold was only 7% with a mean of 2.2 teeth so affected, while in the older cohort the prevalence was 5% at the \( \geq 12 \) mm threshold with a mean of 1.2 teeth so affected. Only 2% of the younger cohort showed loss of attachment \( \geq 12 \) mm. The mean number of teeth so affected was correspondingly small.

Probing depth – In the younger cohort, 81% of subjects had a probing depth \( \geq 4 \) mm with a mean of 7.3 teeth so affected, while, in the older cohort, 75% of subjects with a mean of 4.5 teeth were so affected (Table 2). An increase in the severity threshold to \( \geq 6 \) mm substantially reduced the prevalence of subjects so affected to 20% and 21% for the younger and older cohorts, the mean number of teeth also falling to 2.8 and 1.7, respectively.

The percentage of subjects affected at probing-depth-severity thresholds of \( \geq 6 \) mm and \( \geq 9 \) mm in the younger cohort was very similar to those seen for the older cohort. Thus, at the \( \geq 6 \) mm threshold, the percentages of subjects so affected in the younger and older cohorts were 20% and 21%, respectively, while at the \( \geq 9 \) mm threshold, the percentages were 2% and 3%, respectively. The trend for the older cohort to have a somewhat smaller mean number of teeth affected by a particular severity threshold than the younger cohort was also found at probing-depth thresholds of \( \geq 6 \) mm and \( \geq 9 \) mm.

At the \( \geq 12 \) mm threshold, only 1% of the younger cohort and a negligible proportion of the older cohort were so affected. In the former, a mean of 1.3 teeth had probing depths \( \geq 12 \) mm.

Recession – In the younger cohort, the prevalence and extent of recession were smaller than for probing depths. Con-
which was present on almost all teeth. The generally low kappa-statistic values found with the scoring of calculus is interesting because the highest inter-examiner proportion of agreement was found for this variable. This apparent incongruity highlights potential problems with the interpretation of the kappa statistic for the assessment of inter-examiner reproducibility and may occur with dichotomous scoring systems in which most scores fall within one cell in the two-way contingency table.

Few studies have reported on loss of attachment in populations in the South-East Asia region. Studies by Ramfjord et al. (12) and Wang et al. (13) in Chinese populations using Ramfjord's Periodontal Disease Index (PDI) are not directly comparable, the PDI being based on part-mouth scoring. It is interesting to note in the latter study of factory workers from Tianjin in the People's Republic of China that the prevalence of PDI scores of 5 (a gingival sulcus extending apically to 3–6 mm from the cementoenamel junction) in subjects aged 18–50 yr was 12.5%, while the prevalence of PDI scores of 6 (the gingival sulcus extending more than 6 mm apically from the cementoenamel junction) was 0.9%. Thus, the prevalence of attachment loss in Wang et al.'s study was much lower than that found in either of the two cohorts in this present study and can most probably be explained by differences in clinical criteria. More recently, in a Japanese population, Okamoto et al. (14) reported that at the 24-mm-attachment-loss threshold, 51% of 30–39-yr-olds and 79% of 40–49-yr-olds had loss of attachment, while at the ≥6-mm threshold, 14% and 35%, respectively, were affected. These results are largely consistent with the findings in this present study for the Hong Kong 35–44-yr cohort.

When considering loss of attachment in older cohorts, Barlum et al. (15) found that in 60–80-yr-old Chinese from the Beijing area, 50% of subjects had loss of attachment ≥4 mm, while 10–30% had loss of attachment of ≥7 mm. In older Japanese age groups, Okamoto et al. (14) reported that 50% of 60–69-yr-olds and 96% of 70–79-yr-olds had loss of attachment ≥4 mm, while 68% of both age groups had loss of attachment at the ≥6-mm threshold. Once again, these results, taking into account slight differences in age ranges and attachment-loss threshold levels, are comparable with those found in Hong Kong for the older cohort.

In the definition of severe attachment loss, some consideration must be given to the age of the subjects under consideration. With this in mind, an attachment loss threshold of ≥6 mm in subjects aged 35–44-yr might be considered to be severe, but this would not necessarily be so for subjects aged 65–74 yr, in whom a threshold of ≥9 mm might be more appropriate. Thus, using these admittedly arbitrary thresholds, it could be said that approximately one-third of 35–44-yr-olds and just over one-quarter of 65–74-yr-olds in this Hong Kong sample had experienced severe periodontal attachment loss.

With respect to probing depths, few data are available from countries within the South-East Asia region with the exception of those derived from the application of the CPI. As this index relies on part-mouth scoring, results pertaining to the CPI will be discussed later. However, Barlum et al. (16) do refer to unpublished work by Chen et al. in which the prevalence of pockets ≥4 mm in a Chinese population was 30–51% for 30–39-yr-olds and 51–62% for 40–49-yr-olds. This is somewhat smaller than the 81% prevalence of 35–44-yr-olds who had probing depths ≥4 mm in the present study. However, in elderly Chinese, Barlum et al. (15) did report trends which were similar to that of the Hong Kong Chinese in that, while most subjects had probing depths ≥4 mm, the percentage of subjects with probing depths at greater thresholds was much smaller. It is interesting to note in this present study that, at the ≥6-mm threshold for probing depths, similar proportions of both the younger and older cohorts were so affected. This must be viewed against the finding that over twice as many of the older cohort were affected with attachment loss at this threshold level as in the younger cohort. This concurs with other studies which show that, for the most part, at ages above 35 yr, probing depth as an indicator of severity of attachment loss becomes less reliable as recession becomes more extensive (16, 17). There is supporting evidence of this observation from Okamoto et al. (14), who noted that in the older Japanese cohorts, many sites with advanced attachment loss did not exhibit deep pockets, but did show recession of the gingival margin. Thus, it would appear that, above a probing depth threshold of ≥6 mm, the number of persons affected by deep probing depths is small because recession makes an important contribution to total loss of attachment. This can be seen in the present study of Hong Kong Chinese, which finds that recession has become more prevalent in the older cohort than in the 35–44-yr-olds. At the ≥6-mm threshold, 22% of the younger cohort had recession, while 69% of the older cohort were so affected. The disparity between the younger and older cohorts was even more noticeable at the ≥8-mm threshold; only 3% of the younger cohort had recession, while 26% of the older cohort had it.

All subjects in both age groups had calculus and gingival bleeding affecting most of their teeth. Few studies within the region have reported solely on calculus and bleeding although these two clinical criteria are components of the CPI's hierarchical scoring system (see below). However, Barlum et al. (15) reported that in elderly Chinese more than 45% of tooth surfaces examined had calculus, suggesting that calculus was widespread. With respect to bleeding, Okamoto et al. (14) reported that the proportion of sites so affected increased with increasing age; thus, in the 60–69- and 70–79-yr-old cohorts, approximately 60–65% of sites exhibited bleeding. Thus, based on the available data, the results from Hong Kong Chinese on prevalence and extent of calculus and bleeding are unremarkable in the context of the South-East Asia region.

A comparison between the distribution of subjects according to the percentage of teeth with calculus (Fig. 1) and the distribution with gingival bleeding (Fig. 2) indicate that more teeth were affected by calculus than bleeding. This finding agrees with the findings from the 1984 Hong Kong survey of adult oral health, in which teeth with calculus were not always associated with gingival bleeding (6), and warrants further examination.

Little discernible difference was found between the CPI results from the 1984 Hong Kong survey of adult oral health for 35–44-yr-olds (1) and those obtained for the same cohort in this survey 7 yr later. Possible explanations for this find-
ing might be either that there have been no changes in the periodontal status in this cohort of Hong Kong adults or that the CPI is insufficiently sensitive to discern changes which might have taken place. In studies in which responses to periodontal treatment have been monitored in clinical practice (18-21), changes in the CPI have been discernible. Moreover, in community studies, detectable changes in the CPI have been shown, particularly after scaling (22). In Hong Kong, even though the dentist-to-population ratio has improved dramatically over 7 yr from 1:6000 in 1984 to 1:4000 in 1991, delivery of dental treatment has, at best, been on an ad hoc basis. These points taken into account would therefore suggest that if any changes have taken place in periodontal conditions in this age cohort they are likely to have been only minimal.

The CPI findings for Hong Kong 35-44-yr-olds, as compared with surveys of the same age range in the People's Republic of China (23, 24) and other countries in the Western Pacific region (5), reveal that the percentage of subjects and mean number of sextants with deep pockets (code 4) in Hong Kong subjects are somewhat greater than in many studies conducted elsewhere in the region with the exception of Australia and Japan (one study). Furthermore, it is interesting to observe that, unlike most studies conducted in the region, no subjects in this age cohort were assessed as "healthy" (code 0) or had only "bleeding" (code 1) as their highest score. It is particularly noteworthy that there were only small differences among the younger and older cohorts in the percentage distribution of subjects according to the highest CPI score. This finding can largely be explained because the expected increased periodontal destruction with increased age occurs largely at reversion and is thus not detected by the CPI, which is based on probing depths. In addition, tooth loss in this older cohort might have had an influence on the prevalence of various CPI scores because a mean of 1.8 sextants were excluded for having fewer than two teeth in a sextant.

In an elderly, institutionalized Japanese population, Miyazaki et al. (25) reported that the prevalence of deep pockets (code 4) decreased with each increasing 10-yr cohort from 55 to 84 yr, while the mean number of excluded sextants increased. Conversely, Hu et al. (26), reporting on an elderly population of Chinese in Shanghai, found that for each 5-yr cohort from 60 to 79 there was a trend for an increased proportion of both subjects and sextants scoring CPI code 4 (deep pockets) despite an increase in the mean number of excluded sextants. Moreover, CPI surveys specifically for the 65-74-yr cohorts have been reviewed by Pilot et al. (27), and they show marked variations in both the percentage of persons and the mean number of sextants with deep pockets or deep CPI scores (2-3 or 4, respectively). These differences in CPI results among different studies in the region could reflect genuine differences in patterns of disease in different populations exposed to different health care delivery systems, but they might also be due to variations in the application of the CPI method, as suggested by Pilot et al. (27). Furthermore, the extent to which tooth loss affects the CPI results remains to be determined.

References

Oral health care needs among the middle-aged and the elderly in Hong Kong


Abstract - A sample of 372 35-44-yr-olds and 537 noninstitutionalized 65-74-yr-olds were clinically examined in an oral health survey of Hong Kong Chinese conducted in 1991. The examination procedures and diagnostic criteria for assessing restorative and extraction treatment need followed those recommended by the World Health Organization. The Community Periodontal Index-based periodontal treatment needs involving index teeth or their replacements were computed from separate clinic scores for maximum probing depth, presence of calculus, and bleeding after probing. A set of criteria for assessing prosthodontic treatment need was specially laid down for this survey. Examiners were calibrated before the survey, and the interexaminer reliability was found to be generally good. Besides reporting the various individual normative treatment need items in the traditional way, the present analysis used some holistic treatment-need categories which may have manpower-requirement implications for the classification of subjects. All dentate subjects surveyed required some treatment. Only 6% of the elderly, all edentulous, required denture work only. Of the 35-44-yr-olds, 42% needed scaling and oral hygiene instruction only, which could be provided by dental hygienists. The treatment needs of the vast majority of the middle-aged and the elderly (mainly scaling; simple fillings; and extractions, dentures, or both) could be easily handled by general dentists. Only about one-fifth of the subjects in both age groups required some complex care such as endodontics, crowns, and advanced periodontal treatment, which could be delivered by senior dentists or dentists with specialist training.

Key words: aged; dental health surveys; dental care; dental prostheses; dental restoration; health services needs and demand

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Accepted for publication 1 January 1994
been described in a preceding paper (4).

In summary, the populations comprised 372 35-44-yr-old and 337 65-74-yr-old Hong Kong Chinese who had undergone an interview and a clinical examination. There was an overrepresentation of women in both age groups.

Two examiners assessed the tooth and denture status of the 65-74-yr-olds, and one more examiner was recruited for the 35-44-yr-olds. Three examiners assessed the periodontal conditions. Examiners were calibrated before the survey, and examiner reliability was assessed by duplicate examinations of people in the same age group at the end of the survey. Cohen's kappa statistic was used to measure interexaminer reliability.

The same examiner who assessed the tooth condition and denture status of an examinee also assessed the tooth-based treatment need and denture treatment need. The clinical procedures and diagnostic criteria for assessing the tooth and root status have been described previously (5). Immediately after recording the tooth status and before proceeding to the next tooth space, the examiner recorded the type of treatment required, if any. The treatment-need assessment basically followed those recommended by the World Health Organization (WHO) (6).

The treatments considered included those relating to the removal of caries and restoration of lost tissue, endodontics, replacement of existing restoration, and tooth extraction.

The assessment of prosthodontic treatment need followed the assessment of the denture status. Because the need for fixed prosthesis, i.e., a bridge, was not recorded separately, examinees with an indication for replacement of any missing teeth were recorded as needing dentures. Any irreparably broken denture was assessed as being in need of replacement. All existing dentures were assessed for stability, retention, and occlusion, and complete dentures were assessed for vertical height (7). Any dentures found to be defective in two or more of these features were assessed as being in need of replacement. A prosthodontic treatment need was indicated for examinees with an existing denture if there were, or, as indicated by assessed need for extraction, there were going to be, fewer than 20 teeth (pontics of bridges being counted as teeth); if there were, or were to be, tooth spaces anterior to the second premolars, or a tooth space anterior to the first premolar; or if any existing bridge was fractured or otherwise rendered useless, or if a bridge abutment was indicated for extraction. A complete denture was indicated for an arch with only one or two adjacent teeth remaining. Denture repair was indicated for easily repairable denture defects, such as a denture missing one denture tooth.

The assessment of the periodontal conditions has been described in a preceding paper (8). Community Periodontal Index (CPI)-based periodontal treatment needs involving index teeth or their replacements were computed from the separate clinical scores for maximum probing depth, presence of calculus, and bleeding after periodontal probing. Teeth that had been assessed as requiring extraction for any reason were excluded from this assessment of periodontal treatment needs.

For an overview of the different types of treatment that the examinees needed, a holistic approach was used to categorize examinees into one of the following six categories according to the various types of treatment that they needed: 1) no treatment need; 2) denture only; 3) scaling only; 4) fillings and scaling only; 5) fillings and scaling plus extractions, dentures, or both, but no complex restoration or advanced periodontal treatment; and 6) simple treatment plus complex restoration, advanced periodontal treatment (root-planing, surgery or both), or both.

Table 1. Percentage distribution of survey subjects and mean number of teeth (in parentheses) according to type of treatment need and age group

<table>
<thead>
<tr>
<th>Type of treatment</th>
<th>1984 35-44-yr-olds</th>
<th>1991 65-74-yr-olds</th>
</tr>
</thead>
<tbody>
<tr>
<td>No need for restoration or extraction</td>
<td>50</td>
<td>49</td>
</tr>
<tr>
<td>One-surface filling</td>
<td>30 (0.5)</td>
<td>29 (0.5)</td>
</tr>
<tr>
<td>&gt;2 surface filling</td>
<td>28 (0.4)</td>
<td>21 (0.3)</td>
</tr>
<tr>
<td>Crowns</td>
<td>3 (0.1)</td>
<td>4 (0.1)</td>
</tr>
<tr>
<td>Endodontics</td>
<td>3 (0.1)</td>
<td>3 (0.1)</td>
</tr>
<tr>
<td>Extraction - caries*</td>
<td>16 (0.3)</td>
<td>29 (0.7)</td>
</tr>
<tr>
<td>Extraction - periodontal</td>
<td>1 (0.1)</td>
<td>8 (0.1)</td>
</tr>
<tr>
<td>Extraction - others</td>
<td>7 (0.1)</td>
<td>6 (0.1)</td>
</tr>
</tbody>
</table>

* Includes extractions for other reasons in the 1984 survey.
Table 2. Normative denture-treatment needs in 35-44-yr-olds. Percentage of subjects accepting treatment-need recommendations by arch

<table>
<thead>
<tr>
<th>Arch</th>
<th>Partial</th>
<th>Complete</th>
<th>Repair</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Upper arch</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partial</td>
<td>0.5</td>
<td>1</td>
<td>-</td>
<td>1.3</td>
</tr>
<tr>
<td>Complete</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>1</td>
</tr>
<tr>
<td><strong>Lower arch</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partial</td>
<td>0.3</td>
<td>-</td>
<td>-</td>
<td>0.3</td>
</tr>
<tr>
<td>Repair</td>
<td>0.3</td>
<td>-</td>
<td>-</td>
<td>0.3</td>
</tr>
<tr>
<td>None</td>
<td>0.3</td>
<td>1</td>
<td>92</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Normative denture-treatment needs in 65-74-yr-olds. Percentage of subjects accepting and refusing treatment-need recommendations by arch

<table>
<thead>
<tr>
<th>Arch</th>
<th>Partial</th>
<th>Complete</th>
<th>Repair</th>
<th>None</th>
<th>Refused</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Upper arch</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partial</td>
<td>6</td>
<td>0.2</td>
<td>0.6</td>
<td>5</td>
<td>0.2</td>
</tr>
<tr>
<td>Complete</td>
<td>1</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td><strong>Lower arch</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partial</td>
<td>0.4</td>
<td>0.2</td>
<td>0.4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Repair</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>2</td>
<td>1</td>
<td>49</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Refused</td>
<td>0.4</td>
<td>0.2</td>
<td>8</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Percentage distribution of dentate survey subjects and mean number of sextants (in parentheses) in each periodontal treatment-need category according to age group

<table>
<thead>
<tr>
<th>Year</th>
<th>35-44-yr-olds</th>
<th>65-74-yr-olds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n=668)</td>
<td>(n=453)</td>
</tr>
<tr>
<td>1984</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No periodontal treatment need</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>OHI only</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>OHI and scaling</td>
<td>99</td>
<td>100</td>
</tr>
<tr>
<td>Complex care</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>Fillings and scaling only</td>
<td>(3.4)</td>
<td>(5.5)</td>
</tr>
<tr>
<td>Extraction, denture, or both; no complex treatment</td>
<td>(0.3)</td>
<td>(0.3)</td>
</tr>
</tbody>
</table>

Table 5. Percentage distribution of survey subjects according to treatment-need category and age group

<table>
<thead>
<tr>
<th>Age group</th>
<th>35-44-yr-olds</th>
<th>65-74-yr-olds</th>
</tr>
</thead>
<tbody>
<tr>
<td>No treatment need</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Denture only</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>OHI and scaling only</td>
<td>42</td>
<td>13</td>
</tr>
<tr>
<td>Extraction, denture, or both; no complex treatment</td>
<td>21</td>
<td>11</td>
</tr>
<tr>
<td>Complex care</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

they would not accept the indicated treatment. Slightly less than half of the 65-74-yr-olds would not accept the indicated treatment in either one arch or both arches. New partial dentures in either one arch or both arches were the most common normative denture treatment need indicated.

Periodontal treatment needs as indicated by Community Periodontal Index (CPI) – The CPI and indicated periodontal treatment needs were computed for all 372 35-44-yr-olds who received a clinical examination. However, of the 537 65-74-yr-olds, 84 were excluded from the CPI computations either because of edentulousness or because extractions indicated for remaining teeth would have rendered the subjects edentulous and therefore devoid of periodontal treatment needs. In the latter group, 125 were male and 328 were female. The indications for periodontal treatment need based upon the CPI were very similar for the two age groups (Table 4). Oral hygiene instruction and scaling were indicated for all subjects; however, a smaller mean number of sextants was indicated for scaling in the older age group. Complex care which might involve root planing and periodontal surgery was indicated for 17% of the younger and 15% of the older group.

Holistic treatment categories – Table 5 shows the percentage distribution of the survey subjects in the various treatment-need categories when all the normative treatment needs were considered together. Although all of the 35-44-yr-olds needed some treatment, most of them needed scaling only (42%) or scaling and simple fillings (21%). Complex care which might include endodontics, crowns, advanced periodontal treatment, or all three was indicated for one-fifth of this age group.

The 65-74-yr-olds who did not need normative treatment (7% of the group) were edentulous subjects wearing satisfactory complete dentures. A small proportion (6%) of the elderly needed denture work only, and they were all edentulous. Most of the other elderly needed extraction, dentures, or both, together with other simple treatments such as scaling or filling. Complex dental treatments were indicated for only 19% of the elderly, a percentage close to that of the younger group.

Discussion

Little change in the pattern of tooth-based treatment need and periodontal treatment need was found in the 35-44-yr-olds between 1984 and 1991. At first, this may seem slightly surprising because the number of dentists in Hong Kong had increased significantly, as had the proportion of subjects who had visited a dentist once a year (10) over the same time period. However, the problem-oriented dental-visit behaviour of most adults (10) and the curative-oriented dental care services delivered by the dentists in Hong Kong (11) may partly explain why little change in the disease levels and the associated treatment needs had taken place. The importance of prevention was not appreciated. The
amount of normative treatment need found in the two age groups in the present study was in line with that found in 45–64-year-old Chinese public housing residents studied in 1988 (12, 13). The finding that dental caries was the major indication for extractions in both age groups agrees with a previous study by Corbett & Davies (14).

In the assessment of denture-treatment need, specific criteria had been formulated for assessing incomplete dentition and for assessing existing dentures. The criteria for the assessment of incomplete dentition were loosely based on the concepts of function in older adults with shortened dental arches proposed by Kaye & Witter (15), which assumed that fewer than 20 teeth would not provide adequate function, and that missing anterior teeth would not allow for the possibility of a shortened dental arch and would thus indicate a prostho­dentic treatment need. These criteria were laid down to obviate the examiners having to make subjective assessments about whether the incompleteness of a dentition had affected its ability to function. The criteria for the assessment of existing dentures were based on those of Bergman et al. (16), Rius (17), and World Health Organization (18).

In the 1984 survey (1), the criteria for assessing prosthetic dental treatment need were less refined. A denture was indicated when an arch was edentulous and no denture was worn, or when the remaining dentition was, in the opinion of the examiner, sufficiently incomplete with edentulous space or spaces anterior to the first molar, or when an existing denture was unsatisfactory in function. That a smaller percentage of 35–44-year-olds, according to the refined criteria, were found to need denture treatment in 1991 than in 1984 probably indicates that no favourable change in denture-treatment needs within the population had occurred.

In the present study, 45% of those with a normative denture-treatment need responded, on questioning, that they would not accept the indicated treatment. This may reflect a lack of awareness of the potential benefits of modern prosthodontic care, the implied financial consequences of accepting the treatment need, or both. In planning for the provision of prosthetic care, it is important to be aware that not all normative treatment needs would be accepted and that there may be a large discrepancy between the normative and perceived treatment needs (19, 20).

The periodontal treatment needs indicated by the CPI results suggest that a massive commitment of oral health care services should be directed largely toward the provision of oral hygiene and scaling. Such inordinate demands on resources are disproportionate to the public health importance of periodontal diseases in this population in which, although one in three subjects had experienced some form of severe periodontal attachment loss (8), this, for the most part, was limited to a few teeth. Thus, the prevention of periodontal diseases in this population must be based primarily on self-reliance and personal oral hygiene, supported by specialist care for those persons and groups found to be at high risk of appreciable tooth loss through periodontal attachment loss (21).

For oral health care planning and estimation of manpower requirements, not only is it important to know the amount of various types of treatment required, but information on the proportion of people with various combinations of treatment needs is also needed. However, classification of subjects into different treatment-need categories is rarely reported in oral health surveys. The present analysis attempts to use some treatment-need categories which may have manpower-requirement implications for the classification. All the dentate subjects surveyed in the present study required some treatment. Because only a small proportion of the edentulous elderly required denture work only, the establishment of a class of dental auxiliary specialized in making dentures, such as those in other countries, seems not to be required in Hong Kong. As discussed above, a massive commitment of resources to the provision of oral hygiene and scaling may not be appropriate because most of the 35–44-year-olds in Hong Kong needed only the type of dental care that can be provided by dental hygienists, who require less training than dentists. The treatment needs of the vast majority of the middle-aged and elderly surveyed can be easily met by general dentists. Only about one-fifth of the subjects in both age groups required some complex care such as endodontics, crowns, and advanced periodontal treatment. These treatments can be delivered by senior dentists or dentists with specialist training.

References


