Behavioural Medicine Perspectives for Change and Prediction of Oral Hygiene Behaviour

Development and Evaluation of an Individually Tailored Oral Health Educational Program

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Dissertation presented at Uppsala University to be publicly examined in Universitetshuset, Sal IX, Övre Slottsgatan 2, Uppsala, Friday, February 12, 2010 at 10:00 for the degree of Doctor of Philosophy (Faculty of Medicine). The examination will be conducted in Swedish.

Abstract

This thesis is about a behavioural medicine approach in periodontal treatment and oral hygiene self-care. The aim of this thesis was to develop, describe, and evaluate an individually tailored oral health educational program on oral hygiene behaviour and non-surgical periodontal treatment success, and to determine factors of importance for predicting oral hygiene behaviour.

Two separate studies, both conducted at a specialist clinic for periodontics in a Swedish county council are described. In the first study, the program was developed and described in two experimental single-case studies with multiple baseline designs (Paper I). The second study was a randomised controlled single-blinded trial [n = 113, mean age 51.2, 53% female] in which, the effectiveness of the program was compared with standard treatment on oral hygiene habits, plaque control, and gingivitis (Paper II), periodontal status (Paper III), and attitudes, subjective norms, and self-efficacy (Paper IV). The tailored oral health educational program included a motivational interviewing method and cognitive behavioural techniques, and the individual tailoring for each participant was based on participants’ thoughts and cognitions, intermediate and long-term goals, and oral health status.

Participants in the individually tailored program reported higher frequency of daily interdental cleaning and were more confident about maintaining the attained level of behaviour change, had better oral hygiene, and healthier gingival tissue, particularly interproximally. There was a great reduction in periodontal pocket depth and bleeding on probing scores (BoP) for participants in both programs with a greater reduction in BoP scores in the tailored-treatment group. A lower dental plaque score at treatment start increased the predicted probability of attaining treatment success, and self-efficacy towards interdental cleaning predicted oral hygiene behaviour.

These studies demonstrate an individually tailored oral health education program is preferable to standard program as an oral hygiene behaviour change interventions in non-surgical periodontal treatment.

Keywords: Behavioural medicine, oral health education, Periodontitis, tailored treatment, self-efficacy.

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To Anna and Ida

"Wherever you go, go with all your heart" Konfucius
List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.


All studies were approved by the Ethics Committee of Uppsala University, Sweden (Dnr 2005:314).

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<th>Description</th>
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<tr>
<td>ANOVA</td>
<td>Analysis of variance</td>
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<td>BoP</td>
<td>Bleeding on probing</td>
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<td>GI</td>
<td>Gingival Index</td>
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<td>IC</td>
<td>Interdental cleaning</td>
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<td>ITOHEP</td>
<td>Individually tailored oral health educational program</td>
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<td>LR</td>
<td>Binary logistic regression analysis</td>
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<td>MI</td>
<td>Motivational Interviewing</td>
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<td>NSPT</td>
<td>Non-surgical periodontal treatment</td>
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<td>OR</td>
<td>Odds ratio</td>
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<td>PII</td>
<td>Plaque index</td>
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<td>PPD</td>
<td>Periodontal pocket depth</td>
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<td>RCT</td>
<td>Randomized controlled trial</td>
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<td>SCT</td>
<td>Social Cognitive Theory</td>
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<td>SE</td>
<td>Self-efficacy</td>
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<td>ST</td>
<td>Standard oral health educational program</td>
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<td>SPT</td>
<td>Supported periodontal therapy</td>
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<td>TRA</td>
<td>Theory of Reasoned Action</td>
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<td>TPB</td>
<td>Theory of Planned Behavior</td>
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Introduction

As a dental hygienist, a major task for me is to inspire and guide the patient to adopt and maintain a health behaviour that promotes oral health, prevent diseases, and supports oral health-related quality of life, and when disease occurs, to facilitate successful treatment. During my training there was a tradition and emphasis on the biomedical paradigm in the dialogue with the patient and in treatment. In my daily work treating patients with periodontal disease, there has been an obvious need for a more comprehensive and effective communication with my patients and the use of alternative methods for achieving common treatment objectives and proper long-term oral health behaviour. “Is there another way of working with behavioural matters to achieve proper oral health behaviour for the long-term benefit of the patient?” One challenge in oral health research is how to influence, change and support maintenance to oral health related behaviours. From this clinical perspective, the guiding star of this thesis has been to find appropriate health education methods with a more patient-oriented biopsychosocial perspective that is useful for secondary prevention.

Periodontal disease

The term “periodontal disease” refers to both gingivitis and periodontitis. Gingivitis is an inflammatory condition of the soft tissue surrounding the teeth (the gingiva). Gingivitis is a direct immune response to the plaque accumulation on the teeth (Kinane, 2001). Clinical signs are redness, swelling, and an increased tendency of bleeding on gentle probing. Most people develop clinical signs after 10-20 days of plaque accumulation. Gingivitis is reversible within one to two weeks if the dental plaque is removed by effective oral cleaning (Löe et al., 1965).

Periodontitis are inflammatory diseases affecting the periodontal tissue and the host responses induce tissue destruction that may lead to complete loss of teeth (Kinane, 2001). Both gingivitis and periodontitis are initiated by oral bacteria and the reaction from the inflammatory and immune system is the predominant features. Dental plaque or oral biofilm is the term used to describe the relatively indefinable microbial community associated with a tooth surface. There is a combination of bacterial factors and host response factors that result in tissue destruction. “The pathogenicity of microorganism
relates as much to the individual host’s innate and/or inflammatory and/or immune capability, as to the virulence of the bacteria themselves” (Kinane et al., 2008, p. 285). Periodontitis is mostly of chronic character and are manifested with a variety of signs and symptoms like bleeding gums (gingivitis), increased probing pocket depth, loss of tooth attachment and mobile teeth (Nyman and Lindhe, 1997).

The prevalence of periodontal diseases is high; approximately 40% of adults in a Swedish population have signs of chronic periodontitis, while more severe diseases occur among 7 – 20% (Hugoson and Norderyd, 2008). Hugoson et al. (2005) concluded that even if the general periodontal health was much better, the prevalence of severe periodontal disease for adults (50 years and older) in 2003 had not decreased compared to 1973.

Clinical periodontal examination
The clinical periodontal examination consists of assessment of dental plaque, calculus, tooth mobility, gingival conditions, periodontal probing of pocket depth, loss of attachment, and furcation involvement (Philstrom, 2001). The gingiva is evaluated with the side of the probe to determine whether it is oedematous or fibrotic, and clinical signs of inflammation are evaluated through the presence of bleeding from the gingival crevices (Philstrom, 2001). The amount of plaque is assessed by visual inspection with a mirror, with or without periodontal probe, or after the teeth are dyed with disclosing colour. Two of the most common indices in periodontal research are the gingival index (GI) by Löe & Silness, (1963) and the plaque index (PlI) by Silness & Löe, (1964). In the PlI, only the soft deposit in the gingival area of the tooth is considered, and no attention is paid to the coronal extension of plaque (Löe, 1967). PlI and GI are recorded on buccal, lingual, mesial, and distal tooth surfaces of all teeth. The total sum score for all surfaces is divided into the total number of surfaces measured. The criteria in both indices range between 0 and 3, and the highest mean score for dentition is three. The criteria for both indices are presented in Table 1. These indices are designed to match each other and are highly correlated (Löe, 1967), which is particularly useful when evaluating oral hygiene behaviour. The plaque index reflects the ability to clean teeth at a certain time but does not necessarily demonstrate whether plaque control is performed on a regular basis. The gingival index is more reliable for assessing the long-term performance of oral hygiene (Löe, 1967).
Table 1. Criteria for each score according to plaque index by Silness & Löe, (1964) and gingival index by Löe & Silness, (1963).

<table>
<thead>
<tr>
<th>Score</th>
<th>Plaque index (PII)</th>
<th>Gingival index (GI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Absence of plaque</td>
<td>Absence of inflammation.</td>
</tr>
<tr>
<td>1</td>
<td>A film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may be seen in situ only after application of disclosing solution or by a probe on the tooth surface.</td>
<td>Mild inflammation - change in colour and texture</td>
</tr>
<tr>
<td>2</td>
<td>Moderate accumulation of soft deposits within the gingival pocket or on the tooth and gingival margin that can be seen with the naked eye.</td>
<td>Moderate inflammation – glazing, redness and oedema. Bleeding on pressure.</td>
</tr>
<tr>
<td>3</td>
<td>Abundance of soft matter within the gingival pocket and/or on the tooth and gingival margin.</td>
<td>Severe inflammation – tendency for spontaneous bleeding and ulceration</td>
</tr>
</tbody>
</table>

Non-surgical periodontal treatment and risk factors for progression

The main target with non-surgical periodontal treatment is to keep the supra- and subgingival biofilm under control, at least to a level which maintains a healthy periodontium, thereby avoiding further progression of attachment loss (Cobb, 2002; Drisko, 2001). The patient’s oral self-care and the dental hygienists/dentists skills in removing the oral biofilm and additional retention factors within the non-surgical rootsurface debridement (scaling) are essential to achieve and to maintain periodontal health (Nyman et al., 1975; Rosling, 1983; Westfelt et al., 1998). Wennström et al. (2005) used the term “pocket closure” to describe the main endpoint for treatment success, which means the percentage of all pockets < 5mm. After active periodontal treatment, there is a need for supportive periodontal therapy (SPT) to prevent re-infection and progression of periodontal disease. SPT aims to support the patient’s own efforts in controlling periodontal infection and maintaining healthy dentition (Lang et al., 1997). SPT programs with bi-weekly to 12-week intervals, including systemic evaluation of periodontal status, oral hygiene, and scaling are effective in maintaining periodontal health (Axelsson et al., 2004; Ramfjord et al., 1982; Rosling, 1983; Westfelt et al., 1998).

Biological factors important in risk assessment of patient’s susceptibility to the progression of Periodontitis after treatment include bleeding on probing, residual pockets ≥ 5 mm deep, tooth loss, loss of attachment in relation to age, systemic and genetic factors, and cigarette smoking (Lang and Tonetti, 2003; Philstrom, 2001). Residual pockets with probing depths > 4
mm in conjunction with bleeding on probing represent ecological niches accessible for re-infection. A minimal number of residual pockets could be regarded as periodontal stability (Lang and Tonetti, 2003). Lang et al., (1990) suggest < 10% bleeding on probing as a level associated with a low risk for recurrent disease, and a level of > 25% is associated with high risk.

**Health**

Two commonly used models which describe health and illness, the *biomedical model* and *biopsychosocial model* (Sarafino, 2002). In the *biomedical model*, all diseases are considered being of physical origin and can be explained by disturbance in physiological processes from injury, biochemical imbalances, bacterial or viral infection, which cause change in the body’s structure and balance. In this model it is assumed that the disorder can be repaired or replaced and are separate from psychological and social processes of the mind. If the cause of the disorder is eliminated then the individual will gain health. This model emphasises objective, numerical measurements, and physical data. Health is considered as absence of disease, and has its origins in the 18th and 19th centuries, when knowledge about medicine and science expanded quickly due to the development of the microscope, antiseptic, and anaesthesia. The biomedical models are successful in many areas, for example for many infectious diseases through development of vaccines and antibiotics (Sarafino, 2002). However, many diseases are chronic and have multifactor causes and the risk factor for developing the disease can have both biological and behavioural origins, and some are related to how people live and behave.

A broader perspective of health and illness is the *biopsychosocial model*, which expands the biomedical view by adding the influence of psychological and social factors to biological factors (Engel, 1980). The biological factor includes genetic processes and the person’s physiological functions. The psychological factors are the behavioural or mental processes and involve cognitions, emotions, and motivation. *Cognition* is a mental activity such as perceiving, thinking, remembering, learning, interpreting, believing, and problem solving. *Emotion* is a subjective feeling both affecting and being affected by thoughts, behaviour, and physiology. *Motivation* is a term used for the explanation of why people start some activity, choose its direction, and persist with the activity. Social factors are the interaction of how a person affects and is affected by family, friends, and the society (Sarafino, 2002).
Oral health and periodontal disease

In the treatment of patients with periodontal disease, the biomedical perspective has been the predominant description of oral health, in terms of the presence of bacterial plaque, host response, and local factors on the tooth. The patients' perception of oral health and how periodontal disease affects the patient is not often considered. The importance of considering patient perspective is argued by Rosenberg et al. (1988), if a patient’s functioning and dental care expectations are not considered in the formulation of a treatment plan, compliance and outcome may be negatively affected. In interview studies with individuals diagnosed with periodontal disease, patients describe feelings of fear and anxiety about losing their teeth and how to control the situation, that it can take time before the effect of the disease is fully understood, patients express how the disease affects their life and function (Abrahamsson H et al., 2008; Karlsson et al., 2009). Coulter et al. (1994) advocated for a change in direction towards focusing on the patient, rather than the provider, and to incorporate patients’ assessment of oral health. To do so requires incorporation of a behavioural medicine approach in oral health behavioural research. The approach of behavioural medicine is a perspective of development and integration of psychosocial, behavioural, and biomedical knowledge relevant to health and illness and the application of this knowledge in prevention, diagnosis, treatment, and rehabilitations (International society of behavioral medicine, 2009).

Oral hygiene behaviour

Health behaviour refers to actions of individuals, groups, and organisations, and includes observable, overt actions, mental events, and feelings that can be reported and measured (Glans et al., 2002). Health behaviour is a central concern of health education and a crucial dependent variable in research on the impact of health education intervention strategies. Preventive health behaviour is any activity that a person undertakes in the belief of becoming healthy, for preventing or detecting illness in any asymptomatic state (Glans et al., 2002). Examples of behaviours related to oral health are toothbrushing, interdental cleaning, fluoride rinsing, sugar consumption, and attending to dental health controls. On the other hand, oral hygiene behaviour in this thesis is defined as the frequencies of using various oral hygiene aids or devices, the quality of their use, and endurance of their performance. In addition, plaque index and gingival index is considered as an indirect “measurements” of the quality and endurance of oral hygiene behaviour.
Toothbrushing and interdental cleaning
The daily mechanical removal of supragingival oral biofilm with a toothbrush and interdental cleaning aids is effective for achieving proper plaque control (Iacono et al., 1998; Öhrn and Sanz, 2009). Interproximal cleaning is particularly important, as toothbrush alone is ineffective for reaching the areas that carry a high risk of developing periodontal disease (Claydon, 2008). The most common interdental cleaning devices are dental floss, interdental brushes in various sizes, and triangular wood sticks in different widths. To achieve a high standard of interdental cleaning, the devices or aids should be adapted to the size of the interdental space and the morphology of the proximal tooth surfaces. Furthermore, individual choice and preferences, and dexterity in handling the aids must be considered (Claydon, 2008). Interdental brushes are more effective in removing dental plaque than both dental floss and wood sticks, but wood sticks appear more effective in reduce gingival inflammation (Hoenderdos et al., 2008; Slot et al., 2008).

Between 68 to 82% of individuals brush their teeth twice a day (Ramsay, 2000), and about 73–93% of Swedish respondents report tooth-brushing twice a day (Hugoson et al., 2005). In the age group 50 and 60 years, 40-50% of individuals use toothpicks regularly and about 12% cleaned interproximally with dental floss on a daily basis, for the younger aged groups (20 and 30 years), 30% report daily use of dental floss and less than 15% use toothpicks regularly (Hugoson et al., 2005). It seems to be more difficult to maintain interdental cleaning habits. Johansson et al. (1984) found that approximately 50% of the patients used recommended interdental cleaning aids three years after the advices were provided. Factors such as time wasting and the need for manual dexterity are suggested as explanations for insufficient interproximal cleaning (Cancro and Fishman, 1995).

Compliance, Adherence, Concordance
To describe patients’ engagement in oral hygiene behaviour, two terms are commonly used: compliance and adherence. A third relatively new term, concordance, is increasingly used in pharmacy and medicine with respect to medicine taking, but is rarely used in dentistry.

Compliance can be defined as “The extent to which the patient’s behaviour matches the prescriber’s recommendations” (Horne et al., 2005, p. 12). The term is commonly used in the literature but is criticised as it has negative connotations in terms of clinician-patient relationship. In this description, the role of the care provider is to decide on the appropriate treatment and issues and the role of the patient is to passively follow care providers “orders”. Non-compliance may be interpreted as a person being unable to follow the instructions, or a person with a deviant behaviour (Horne et al.,
Adherence stand for the extent to which a patient’s behaviour (performing life style changes, taking medicine, attend to suggested treatment schedules, homework assignment) corresponds with recommendations from a health care provider or to a mutual agreement with this provider (Sabaté, 2003). Adherence develops the definition of compliance by emphasising the need for agreement and is an attempt to emphasise the patient is free to decide whether to follow the prescriber’s recommendations: failure to do so should not be a reason to blame the patient (Horne et al., 2005). Concordance is defined as “...an agreement reached after negotiation between a patient and a health care professional that respects the beliefs and wishes of the patient in determining whether, when and how medicines are to be taken. Although reciprocal, this is an alliance in which the health care professionals recognise the primacy of the patient’s decisions about taking the recommended medications” (Horne et al., 2005, p. 33) The definition focused on the consultation process in which health care providers and patient agree on therapeutic decisions incorporating their respective views, and support the patient in medicine taking. In concordant consultations, the patient’s beliefs is elicited and is considered of paramount importance (Foster and Hudson, 1998).

Horne (2005) concluded the terms ‘adherence’ and ‘compliance’ reflect different perspectives of the same phenomenon, which is the degree to which patients’ behaviour matches the prescriber’s advice and describes the behaviour of a person. Concordance relates to the interaction between the care provider and the patient and the outcomes in the form of agreement and shared decision-making.

Rydén och Stenström (1994) describe less satisfactory adherence with recommendations concerning preventive care than with curative treatment. Higher complexity and increased treatment time entails the risk of unsatisfactory adherence. Other possible explanatory factors are; lack of stimuli; the duration individuals are recommended to follow the advice; the extent to which individuals believe the treatment is effective; the interplay between the care provider and the patient; and, the personality of the patient. Blinkhorn (1993) considers unsatisfactory adherence often to be explained by inadequate information planning and if the information is irrelevant to the patient.
Health Education

Health education is according to Glans et al., (2002) defined as broad and varied set of strategies to influence both individuals and their social environments aimed to improve health behaviour, and to enhance health and quality of life. Health education includes promotion of optimal health, disease prevention, treatment, rehabilitation and maintenance care. The role of the health professionals and the manner in which the patient education programs are carried out is of crucial importance for the outcome of the treatment. In dental health care as well as general health care health education has traditionally been given in the form of information and advice (Freeman, 1999). The underlying ideas were that by providing information a modification in attitude to certain behaviour would lead to behavioural change. In this approach, the care providers more or less persuade the patients to change their oral hygiene behaviour. The patient may regard the advice as critical or intrusive and this may create a passive patient rather than an active partner. This approach might be successful for some patients but others are less likely to comply with the oral health care provider’s recommendations (Freeman, 1999; Hamman Calley et al., 2000). Traditionally patient education in periodontal care have been described as information about the disease, oral hygiene instructions and teaching of a proper cleaning technique (Nyman et al., 1984; Rylander and Lindhe, 1997). The education program has at least consisted of three sessions at the start of the initial cause related treatment period. Despite that, it is well known that a number of patients have difficulties either to achieve a satisfactory level of self-performed oral hygiene or to maintain a high standard of oral hygiene over time.

A health education program or intervention are claimed to be more beneficial for the patient if it is guided by a theory of health behaviour (Glans et al., 2002). There is increasing evidence that health-relevant behaviour is predominantly determined by cognitions such as prospective beliefs, expectations, and goals. Several psychosocial theories and models of health behaviour includes overlapping constructs but under different names (Bandura, 2004). For example, “perceived behavioural control” in the Theory of Planned Behaviour (Ajzen, 1991) and “perceived self-efficacy” in the Social Cognitive Theory (Bandura, 1997) are similar and mirror-related constructs. Another similarity is between “intention to perform a specific behaviour” and “proximal goals”. According to Bandura (2004) and Ajzen (2002a), the motivation to comply with a desired behaviour is measured by intention or goals that are the predominant predictor if a person will engage in health behaviour. These theories are two of the most commonly used in the research of oral health behaviour and dental hygiene. An outline of the two theories and their use are presented below. Motivational interviewing and goal-setting are other methods assumed to be effective in health education which are presented in next section.
Social Cognitive Theory

Social Cognitive Theory (SCT) is an example of a theoretical framework used for the description and understanding of different factors influencing health behaviour (Bandura, 1997; Baranowski et al., 2002). Within SCT, three components are important in a mutually complex interaction: characteristics of a person; the behaviour of the person; and, the environment within which the behaviour is performed (Figure 1).

![Figure 1. The reciprocal interactions between the person, the behaviour and the environment according to Social Cognitive Theory](image)

Crucial *personal characteristics* include the individual’s capability of symbolising behaviour, anticipating outcome (outcome expectation), learning by observing others, having confidence in performing the behaviour, overcoming the problems in performing the behaviour (self-efficacy), self-determination or self-regulation of the behaviour (goal-setting, self-monitoring of behaviour), and reflecting on and analysing experiences. Self-efficacy helps to determine what people decide to do and that decision is based on their beliefs on capability. Self-regulations help to set, monitor and control goals. *Behaviour* refers to the frequency of a behaviour, the topography of the behaviour i.e how the behaviour is practised, and situation in which the behaviour is performed. *Environment* refers to factors external to the person that can affect the behaviour. Social environment includes family members, friends and peers, and physical environment such as a place or the
availability of a certain product (Bandura, 2004; Baranowski et al., 2002). The understanding that an individual’s behavioural change is affected by personal characteristics and circumstances external to the person and by the behaviour itself is important in the planning of health interventions.

Self-efficacy and its use in oral hygiene behaviour research

In SCT, self-efficacy is considered the cognitive process that is the most important prerequisite for behavioural change. Self-efficacy is how confident a person is in performing a specific behaviour and includes overcoming the barriers to performing that behaviour (Bandura, 1977). Self-efficacy is crucial not only for whether the behaviour will be performed or not, but for how much effort a person will spend on the behaviour, and for how long a person will persist in a specific behaviour during the period they try to change the behaviour (Bandura, 1977). The stronger perceived self-efficacy a person possesses the more active and persistent she or he will be in the effort towards behavioural change. Self-efficacy is related to an action in a specific situation; therefore, a person could not be generally judged to have low or high self-efficacy.

The relation between a person’s self-efficacy and its affect on oral health behaviour has been established. Early positive experiences of oral health behaviour change strengthen a person’s self-efficacy, but negative feelings and unpleasant experiences can debilitate a person’s self-efficacy for oral health behavioural change (Syrjälä et al., 2001). High self-efficacy scores are correlated with high frequencies of tooth brushing and interdental cleaning (Schüz et al., 2006; Stewart et al., 1997; Syrjälä et al., 1999). Self-efficacy appears an important predictive factor for future brushing and flossing behaviour (McCaul et al., 1988; Tedesco et al., 1993).

Social cognitive interventions in oral health prevention research

In oral health prevention, social cognitive interventions have been tested in some experimental studies. Tedesco et al., (1992) determine no differences in self-efficacy and gingival status between patients receiving a cognitive intervention compared to information and instruction alone. In that intervention a contrast microscope was used to emphasise the picture of a healthy mouth and to possess control of wellness and on the patient’s performance achievement in addition to disease information and dental floss instruction. In recent presented experimental studies, patients receiving a cognitive behavioural intervention targeting interdental cleaning including formulating of goals, action and coping plans, self-monitoring, report more frequent interdental cleaning and better oral hygiene than patients receiving only information and instruction (Philippott et al., 2005; Schüz et al., 2006; Sniehotta et al., 2007). These studies concur with the systematic review by Renz et al.,
(2007) suggesting cognitive behavioural interventions are more effective than just information and oral hygiene instructions.

To sum, self-efficacy seems to be important in relation to oral hygiene behaviour. Interventions including self-regularity strategies in oral health education increase oral hygiene performance at least initially. More studies are needed to evaluate its long-term effectiveness and how self-efficacy predicts future oral hygiene behaviour.

**Theory of Reasoned Action and Theory of Planned Behavior**

The theories of Reasoned Action [TRA] (Ajzen and Fishbein, 1980) and Planned Behaviour [TPB] (Ajzen, 1991) focus on interpersonal/individual factors such as attitudes, beliefs, perceived influence from family and friends, and self-confidence. TPB is an extension of TRA and should not be considered as an independent theory (Ajzen, 2002a). TRA was developed to explain the relationship between attitude and behaviour. Ajzen and Fishbein (1980) discuss the rationality of individuals and the term “reasoned action” indicates a person will consider the consequences of a specific behaviour before he/she decides to do it. According to Ajzen (2002a), almost all socially relevant behaviours are guided through active self-control.

Three dimensions in TPB (two in TRA) stipulate the intention to perform a specific behaviour: *attitude*, *subjective norms* (included in TRA) and *perceived behavioural control* (Figure 2).

![Figure 2. Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB).](image-url)
Attitude refer to an evaluation of a certain behaviour, which is determined by the belief the behaviour yields a specific result and an evaluation of whether the results are good or bad. Subjective norms is to what extent a person experiences social pressure from “important others” weighted to the motivation of adapting oneself to social norms. Perceived behavioural control (PBC) is the belief about factors facilitating or impeding performance of the behaviour. In combination, these constructs lead to the formation of intention. Intention to perform a specific behaviour is the dimension best predicting the behaviour. More positive attitudes and subjective norms and a greater perceived behavioural control, will result in a stronger intention to perform the behaviour (Ajzen, 2002a).

Attitudes, subjective norms and behavioural beliefs in oral hygiene research
Constructs from both TRA and TPB have been used in some cross-sectional and longitudinal studies as outcome measures and to investigate the predictability of cognitive variables for oral hygiene behaviour. Theory of Reasoned Action (Syrjälä et al., 2002; Tedesco et al., 1991; Tedesco et al., 1992; Tedesco et al., 1993) and Theory of Planned Behaviour (Sniehotta et al., 2007) variables were highly related to oral hygiene behaviours. The dimensions from TRA (attitude, subjective norms) and TPB (attitude, subjective norms and perceived behavioural control) were related to the intention to perform flossing (Sniehotta et al., 2007; Syrjälä et al., 2002; Tedesco et al., 1991), and flossing behaviour (Sniehotta et al., 2007). The studies demonstrated that individuals with positive cognitions i.e. higher scores for attitude and subjective norms reported a higher intention to perform daily flossing and higher frequencies of flossing. Tedesco et al., (1993) found that TRA variables also could be valuable in predicting clinical variables such as plaque amount and gingival status even if the correlation was lower than for self-reported oral hygiene behaviour.

In sum, intention, attitude, subjective norms and perceived behavioural control seems to be related to oral hygiene behaviour. An integration of these constructs and self-efficacy in the evaluation of oral hygiene interventions are therefore of great interest.

Motivational interviewing
Motivational interviewing (Miller and Rollnick, 2002) encompasses a communication approach that is assumed as helpful in the dialogue with the patient for expressing an individual’s thoughts, cognitions, ambivalences and readiness to change. Some studies in dentistry (Harrison et al., 2007; Stewart et al., 1996) indicate motivational interviewing (MI) is a useful method for
dental care providers in interventions aimed at oral health behaviour changes. Miller and Rollnick (2002, p. 25) claim motivational interviewing can be defined as a “client-centered, directive method, for enhancing intrinsic motivation to change by exploring and resolving ambivalence”. In MI, the clients’ present interest, concerns, and perspectives are in focus. The client-centred perspective is characterised by asking open-ended questions and a reflective listening in an attempt to understand the meaning of the patient’s statements. In addition, it includes steps for clarifying and summarising elusive thoughts in order to facilitate reflection on behaviour change, attitudes, and feelings (Miller and Rollnick, 2002). In this respect, MI can be viewed as a method of communication rather than a set of techniques. MI comprises four general principles:

1. Express empathy. Empathy in MI means “acceptance” of an individual’s behaviour but is not the same as agreement or approval of clients attitude, feelings, or behaviour. Through reflective listening, the counsellor tries to understand the client’s perspective without judging, criticising, or blaming.

2. Develop discrepancy. Is to create a discrepancy between the client’s present behaviour and her or his goals.

3. Roll with resistance. Arguing for change should be avoided, as this is often contra productive and the clients tend to defend themselves instead of considering change. New perspectives should be discussed but not forced and the client is a primary resource for finding solutions.

4. Support of self-efficacy. A person’s confidence and beliefs in carrying out and succeeding with a specific task is a key element in the motivation for behavioural change. Hence, the support of a person’s self-efficacy is essential in the dialogue with the client.

In oral health education, the use of MI could be a valuable communication approach to facilitating dialogue between the care provider and the patient, especially, in the analysis of the individual’s knowledge, self-efficacy, and which oral health and treatment goals the patient has, and in expressing strategies for achieving these goals. One cognitive process that appears to have important inducements for enhancing the effort of attaining explicit goals is the perceived discrepancies between what one does and what one wants to do and perceived self-efficacy (Bandura and Cervone, 1983). Hence, creating discrepancies and supporting self-efficacy is important strategies for empowering individuals to formulate goals for health behaviour.

Goal-setting

Goal setting as a successful strategy for improving different performances has been sporadically described since the end of the 19th century. Explicit
challenging goals enhance the motivation for performing specific behaviours (Latham and Locke, 2007). Personal goals matching or surpassing a personal level create self-satisfaction and may serve as a positive inducement for further pursuit. However, goals that are adopted without knowing how to attain them have low motivational effect, whether they are easy or personally challenging (Bandura and Cervone, 1983).

Latham and Locke (2007) mentioned two important factors that affect the goals; the importance of the goal and the self-efficacy i.e. the self-confidence that the goal is attainable. Examples of mediators for goal setting are choice (the individuals own preference), effort, persistence, and strategy. Goal commitment, feedback situational factors (e.g. presence of needed resources) act as moderators. An example of a situational factor in oral health is that the recommended cleaning aids are easily obtainable for the patient.

Gollwitzer (1999) described the differences between goal intention and implementation intentions. Goal intention means a specification of a desired performance or an outcome. People translate their noncommittal desires into binding goals by forming goal intentions. The implementation intentions, subordinate to goal intention, actually answer how the individual will respond when a specific situation occurs. A plan for an implementation strategy that specifies when, where, and how to adapt to a behaviour enhance the intention to succeed with the behaviour and leads to a higher rate of goal attainment.

Bandura (2004) claims that by helping people to see that changed habits are in the person’s self-interest enhances motivation for behavioural changes and to achieve committed goals. Individual long-term goals mirror the person’s ambitions for their future health and treatment. To help people succeed in their effort to achieve long-term goals, it is important to enlist effort and guide action in the ‘here and now’ by forming short-term attainable goals.

The use and development of goal setting is frequently applied in many health care fields. Even if the method has gained increasing interest in dentistry, especially targeting interdental cleaning by forming goals and action plans for when, where, and how to act in daily cleaning (Jönsson et al., 2006; Schüz et al., 2006; Sniehotta et al., 2007), it is not a common strategy in oral health education.

Tailoring of treatment

Tailoring and generic interventions or treatment are two perspectives for arranging and administering behavioural change interventions (Kreuter and Skinner, 2000). A generic intervention to the area of health promotion and prevention means that a health behaviour program is designed to suit all subjects with a specific diagnosis, for example periodontal disease. In dentistry the generic approach has been the dominating perspective in oral health education and treatment and is labelled standard treatment. A tailoring
approach is based on the individuals' perspective i.e. the individuals' personal goals for health and treatment and their specific context for daily living. Individual tailoring of treatment related to individual goals and problems may be more effective in achieving health goals than a generic treatment (Kreuter and Skinner, 2000). Individually tailored treatment programs based on behavioural medicine have been successfully implemented in the treatment of patients with musculoskeletal pain (Sandborgh, 2008; Åsenlöf, 2005) and in physical activity interventions (Marcus et al., 1998); however, web-based individually-tailored physical activity intervention is not more effective than a non-tailored website intervention (Wanner et al., 2009).

Even if the need for individual tailoring of treatment is considered in one study when planning for intervention to different population groups (Sanders et al., 2005), it is infrequently described in dental literature.

Intentions of the present thesis

Even though an integration of psychological and behavioural strategies in oral health interventions appears to improve oral hygiene, there is still a scarcity of scientific evidence for appropriate methods increasing long-term oral hygiene habits. As stated in two systematic reviews by the Swedish Council on Technology Assessment in Health Care (SBU, 2002; 2004), there is little scientific evidence relating to patient behaviour, patient communication, patient education, and methods for supporting patients in developing effective oral self-care habits. This aligns with the Cochrane reviews of Renz et al. (2007) who state there is need for greater methodological rigour in the design of trials in this area. Hardly any of the factors promoting the performance of health behaviour are used in the development of oral health care, especially in the treatment of patients with periodontal disease. Consequently, there is a demand for a greater use of established theory for health education in the development of new interventions for improving oral health (Renz et al., 2007). The dental hygienist has a key role in secondary prevention where patient education is important for the outcome of the treatment. In secondary prevention, the aim is to stop or minimise the progression of early disease while the individual is still largely asymptomatic, and to support patient control over their disease, treatment, and capability of coping with daily living (DiMatteo and Martin, 2002).

This thesis focuses on a need to integrate individual perspective in oral hygiene intervention and treatment of periodontal disease. The assumption was that an effective intervention for behavioural change required an integration of biopsychosocial factors relevant for oral hygiene behaviour in the long-term evaluation of treatment outcome.
The overall aim of this thesis was to develop, describe and evaluate an individually tailored oral health educational program based on behavioural medicine approach in non-surgical treatment of patients with periodontal disease. The thesis includes evaluation of oral hygiene behaviour and non-surgical periodontal treatment success. A further aim was to determine factors of importance for predicting oral hygiene behaviour.

Specific aims:

- To describe and evaluate the effect of an individually tailored oral health educational program based on a behavioural medicine approach for oral hygiene self-care, dental plaque control, gingival and periodontal health and individually long-term goals (Paper I).

- To evaluate the effectiveness of an individually tailored oral health educational program compared with standard treatment of oral hygiene habits, plaque control, and gingivitis (Paper II), on bleeding on probing (BoP) and periodontal pocket depth (Paper III), and on intention, attitudes, subjective norms and self-efficacy (Paper IV).

- To evaluate a clinical significant level of non-surgical periodontal treatment success i.e. plaque scores (PII), BoP scores and pocket closure at 12-month follow-up (Paper III).

- To study how baseline assessments of PII scores, BoP scores, periodontal pocket depth and oral hygiene education programme predict non-surgical treatment success (Paper III).

- To study the predictive value of attitudes, subjective norms, and self-efficacy towards interdental cleaning, for oral hygiene behaviour, plaque control and BoP 12-months after non-surgical periodontal treatment and oral hygiene intervention (Paper IV).
Methods

Design
The project was initiated in 2005 and the 2-year follow-up was completed in October 2009. In the first study, the experimental single case studies with multiple-baseline design included two participants (Paper I). The second study was a randomised, evaluator-blinded, controlled trial testing two different oral health education programs in non-surgical periodontal treatment (Papers II, III, and IV). An overview of the papers and studies are presented in Table 2. The project was approved by the Ethics Committee of Uppsala University, Sweden (Dnr 2005:314).

Table 2. Overview of study design, sample, measurements and statistics.

<table>
<thead>
<tr>
<th>Paper</th>
<th>Design</th>
<th>Sample</th>
<th>Measurements</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Experimental single-case studies with multiple baseline</td>
<td>Two participants with moderate periodontal disease</td>
<td>Clinical measurements, questionnaires</td>
<td>Descriptive</td>
</tr>
<tr>
<td>II, III, IV</td>
<td>Randomised controlled trial</td>
<td>113 patients with moderate to advance Periodontitis</td>
<td>Clinical measurements, questionnaires</td>
<td>Descriptive, t-tests, ANOVA repeated measures, $\chi^2$, and Logistic regression analysis.</td>
</tr>
</tbody>
</table>
Settings, participants and procedures

The studies were conducted at a specialist clinic for periodontics in a Swedish county council with approximately 320,000 inhabitants. Participants were recruited mainly among subjects with moderate to advanced periodontitis, who were referred from both public and private dentistry. The inclusion criteria were: participants clinically diagnosed with chronic periodontitis and scheduled to undergo dental hygiene treatment (i.e. non-surgical periodontal debridement and intervention influencing oral hygiene), aged between 20 and 65, literate in Swedish, and with a plaque index (PlI) according to Silness and Löe (1964) of $\geq 0.3$. The criteria for PlI were set for two reasons. First, a high standard of oral hygiene and a plaque level between 20% and 40% is suggested by Lang and Tonetti (2003) as a level compatible with maintenance of periodontal health and confirmed by Axelsson et al., (2004). Second, as both interventions aimed to improve oral hygiene behaviour, subjects with low plaque scores would have clinical efforts focused on other aspects besides oral hygiene.

Patients were excluded if they knew they could not be available during some part of the study period, suffered from a serious disease that precluded regular sessions, and if explorative periodontal surgery was necessary before the dental hygiene treatment.

Paper I

In this study, the individually tailored oral health educational program was developed and described in four experimental single-case studies. Each participant was studied through a multiple baseline design covering different oral hygiene behaviours. The two oral hygiene behaviours were [1] tooth brushing and [2] interdental cleaning. In the multiple-baseline design, baseline measurements are simultaneously collected for all target behaviours, but the interventions are introduced at different times. Ideally, only the targeted behaviour would be influenced by a specific intervention and the non-targeted baselines should remain unaffected. Provided the dependent variables are stable during the baseline phase (pre intervention), and they only change when the intervention is implemented in each baseline representing the target behaviour, the change is likely to be attributed to the intervention, rather than to extraneous events (Kazdin, 2003).

Four participants were included in the study, three women and one man. As the oral hygiene behaviour changes and periodontal problems were similar for the three women only two participants were presented in Paper I. Participant 1, Mrs A was a 50-year-old woman, with moderate periodontitis, non-smoker, reported good general health and took no medication. Before the referral to the specialist clinic of periodontics, she had visited dental care
irregularly. She had 12 teeth in the maxilla and 11 in the mandible. Her main self-reported problem was sensitive teeth.

Participant 2, Mr B was a 60-year-old man with moderate periodontitis. Smoked 20 cigarettes/day, reported general health as fairly good and took no medication. He visited the dentist regularly but dental hygienist irregularly in later year. He had 11 teeth in the maxilla and 12 in the mandible. He had no problem with his teeth or mouth, but wanted to be informed about present dental status.

The intervention for each case consisted of three different study phases: baseline, intervention, and follow-up/maintenance phases. The intervention phase was separated into two sections: analysis and applied skills, and generalisation. The different phases are presented in Table 1 in Paper I.

Paper II, III and IV

Paper II, III and IV are based on a randomised, evaluator-blinded, controlled trial with two different active treatments. Participants were randomly allocated to an individually tailored oral health educational programme (experimental group) or to a standard oral health educational programme (control group). The randomisation was by blocks of various sizes in a random computer table. Allocation concealment was secured by (i) having a person not involved with the clinic perform the randomisation i.e. neither the examiner nor the dental hygienist could influence the allocation to group and (ii) providing the dental hygienists with sealed consecutively numbered envelopes containing only the assignment for individual subject. The dental hygienist had not met the patient before assignment. The sample was stratified for smoking habits and allocated to the two dental hygienists who performed the treatment.

Participants were recruited among subjects examined during the period of March 2006 to March 2007. Initially the subjects were examined by a specialist in periodontology. After the initial examination patients were given a treatment plan, including preliminary costs for the treatment and maintenance care up to the one-year follow-up visit. When all necessary pre-treatment actions (e.g. tooth extraction and preliminary removable dentures) had been performed, the subjects were invited by the periodontist, to participate in the study. Each patient who accepted to participate received written information about the project and gave their written consent. Participants were included consecutively to the dental hygienists between April 2006 and May 2007. A CONSORT diagram of the participant shows the flow through recruitment, baseline measurement, 3-month follow-up, and 1-year follow-up (Figure 3). Demographic variables and background characteristics are presented in Table 3.
Attrition

During the inclusion period, 141 patients were examined and scheduled to undergo non-surgical periodontal treatment. The main reason for exclusions was the patient had not completed the pre-treatment before May 2007, the deadline for inclusion to the dental hygienist. Finally, 113 subjects were randomly allocated to participate in the study, 57 to the experimental group and 56 to the control group (Figure 3). Six participants (four women and two men) dropped out during the study period. In the experimental group, one participant discontinued treatment due to economic reasons before the intervention started and a further two were lost at the 3-month follow-up, one became seriously ill and one moved temporarily from the county, but came back into the study at the 12-month follow-up. Another two participants dropped out between the 3- and 12-month follow-up. In the control group, one participant discontinued treatment.
Table 3. Baseline characteristics of the participants in the experimental and control group.

<table>
<thead>
<tr>
<th></th>
<th>Experimental group (ITOHEP) (n = 57)</th>
<th>Control group (ST) (n = 56)</th>
<th>Total (n = 113)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean age</strong></td>
<td>52.4 (8.4)</td>
<td>50.1 (10.3)</td>
<td>51.2 (9.4)</td>
</tr>
<tr>
<td><strong>Cigarette smokers</strong></td>
<td>24 (42.1%)</td>
<td>20 (35.7%)</td>
<td>44 (38.9%)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>32 (56.1%)</td>
<td>28 (50.0%)</td>
<td>60 (53.0%)</td>
</tr>
<tr>
<td>Male</td>
<td>25 (43.9%)</td>
<td>28 (50.0%)</td>
<td>53 (47.0%)</td>
</tr>
<tr>
<td><strong>Marital status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married or cohabitants</td>
<td>45 (78.9%)</td>
<td>40 (71.4%)</td>
<td>85 (75.2%)</td>
</tr>
<tr>
<td>Single</td>
<td>12 (21.1%)</td>
<td>16 (28.6%)</td>
<td>28 (24.8%)</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elementary school</td>
<td>14 (24.6%)</td>
<td>13 (23.2%)</td>
<td>27 (23.8%)</td>
</tr>
<tr>
<td>High school</td>
<td>21 (36.8%)</td>
<td>23 (41.1%)</td>
<td>44 (38.9%)</td>
</tr>
<tr>
<td>University</td>
<td>22 (38.6%)</td>
<td>19 (33.9%)</td>
<td>41 (36.2%)</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swedish</td>
<td>46 (80.7%)</td>
<td>50 (89.3%)</td>
<td>96 (84.9%)</td>
</tr>
<tr>
<td>Other</td>
<td>11 (19.3%)</td>
<td>6 (10.7%)</td>
<td>17 (15.1%)</td>
</tr>
<tr>
<td><strong>Previous visits to dentist</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Once a year</td>
<td>37 (64.9%)</td>
<td>37 (66.1%)</td>
<td>74 (65.5%)</td>
</tr>
<tr>
<td>Every second year</td>
<td>10 (17.5%)</td>
<td>10 (17.9%)</td>
<td>20 (17.7%)</td>
</tr>
<tr>
<td>At irregular intervals</td>
<td>10 (17.6%)</td>
<td>9 (16.0%)</td>
<td>19 (16.8%)</td>
</tr>
<tr>
<td><strong>Previous visits to dental hygienist</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Several times per year</td>
<td>20 (35.1%)</td>
<td>20 (35.7%)</td>
<td>40 (35.3%)</td>
</tr>
<tr>
<td>Once a year</td>
<td>11 (19.3%)</td>
<td>21 (37.5%)</td>
<td>32 (28.3%)</td>
</tr>
<tr>
<td>At irregular intervals</td>
<td>25 (43.9%)</td>
<td>15 (26.8%)</td>
<td>40 (35.3%)</td>
</tr>
<tr>
<td><strong>Periodontal diagnosis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slight</td>
<td>2 (4%)</td>
<td>5 (9%)</td>
<td>7 (6%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>23 (40%)</td>
<td>21 (37%)</td>
<td>44 (39%)</td>
</tr>
<tr>
<td>Advanced</td>
<td>32 (56%)</td>
<td>30 (54%)</td>
<td>62 (55%)</td>
</tr>
<tr>
<td><strong>Number of teeth</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>25.3 (3.9)</td>
<td>25.0 (4.6)</td>
<td>25.0 (4.6)</td>
</tr>
<tr>
<td>Treatment start</td>
<td>23.3 (4.0)</td>
<td>23.2 (4.6)</td>
<td>23.2 (4.6)</td>
</tr>
</tbody>
</table>

Note. When numbers in columns do not equal n or 100%, there was an internal dropout in background data. For mean age and number of teeth standard deviation is presented.
Individually tailored oral health educational program (Paper I and experimental group Paper II, III, IV)

The individually tailored oral health educational programme (ITOHEP) was based on the perspective of behavioural medicine i.e. an integration of cognitive behavioural principles (Bandura, 1997; Baranowski et al., 2002) within the non-surgical periodontal treatment. The central theme of the program was tailoring of the treatment to each individual’s problem, capacity, and goals, with subsequent guidance towards appropriate and effective oral hygiene habits. Special emphasis was placed on strategies that would assimilate into every day life. To create a “dynamic dialogue” specific skills in communication were required, therefore, methods from MI were included. In the changing process, individuals are given responsibility for their own actions, thus, becoming capable of taking control and making decisions regarding their problems and what to do about them. The dental hygienists role was to be a resource in this process by providing new and alternative behaviour. When the patient was motivated to change any oral hygiene behaviour, techniques such as goal setting and self-monitoring were used, to further develop behavioural skills.

The program comprised seven separate components with different tactics for tailoring each individual’s personal goals regarding oral health and dental hygiene habits.

The seven components of the program

1. Initiation and analysis of knowledge, expectations, and motivation
   Initially, an interview with open-ended questions (an interview guide, created for this study, was used) ascertained the patient’s knowledge of periodontal disease, self-care habits, and attitude toward oral hygiene, as well as outcome expectations and experiences from earlier treatment. The extent to which information about dental diseases was provided depended on each patient’s prior knowledge. The patient formulated (in writing) three to five personal general long-term goals related to oral health that were important to them.

2. Analysis of oral hygiene behaviour
   Based on the above data, the dental hygienist made recommendations related to self-care interventions that were discussed with the patient. Disclosing solution was used to illustrate any current oral biofilm and to initiate a discussion related to oral hygiene aids that might support the patient’s oral health goal. The patient’s motivation to use various oral hygiene aids was explored. A guiding principle was to introduce only one oral hygiene aid at each session, which allowed the patient to use the chosen aid properly and at the desired frequencies, before any new and alternative aids were introduced.
3. Practise of manual dexterity for oral hygiene aids
The practise of manual dexterity was introduced when the patient’s oral hygiene aid was chosen. Instruction sessions on “what to do” and how to do it” were conducted at a wash basin in front of a mirror to make the circumstances as close to a home routine environment as possible.

4. Individual goals for oral hygiene behaviour
At the end of each session, the patient’s self-efficacy and readiness to change an oral hygiene habit was explored through direct questioning. Subsequently, the oral hygiene procedures of how, when, and where to use the desired oral hygiene aid or aids, and which area should be given particular attention until the next session, were discussed and agreed. The action plan for oral self-care until the next session was formulated in writing. Patients were encouraged to start using the oral hygiene aid they considered having the best chance of being successful in attaining the intermediate goal.

5. Continuous self-monitoring
A short structured diary was introduced for the patients to keep records on their self-care between sessions. Recordings included which aids used, frequency and when they were used, as well as associated factors that facilitated use or created barriers for use. The diary was discussed and analysed at the next appointment. Positive experiences were encouraged, problems identified, and possible solutions to the problems were discussed.

6. Generalisation of behaviour
When all self-care aids had been introduced and practised, they had to be coordinated to function together. The individuals’ preference, knowledge, and capacity to adapt to necessary oral hygiene aids differed between aids. The dental hygienist allowed the self-care process to develop in a way that supported individuals to proceed at their own pace.

7. Maintenance of oral hygiene behaviour and prevention of relapse
The patient was informed that relapses are common during behavioural change (Wilson, 1992). Strategies were discussed for maintaining goals for oral hygiene that had already been achieved. Specific risk situations for interdental cleaning relapse were identified (e.g. summer holiday, periods of work-overload), and problem-solving strategies discussed. The discussions focused on situations in which oral hygiene was facilitated and how to find solutions to problems the patient encountered. If difficult/demanding situations were identified, a plan aimed to prepare the patient how to handle these situations was designed. If there were signs of a relapse to previous oral hygiene habits, disadvantages and advantages were discussed.

The components of the program related to the treatment sessions are presented in Table 4.
Table 4. Components in the individually tailored oral health education program and clinical strategies at each session

<table>
<thead>
<tr>
<th>Sessions</th>
<th>Components in the experimental intervention</th>
</tr>
</thead>
</table>
| 1        | Initiation and establishment
          | Interview.                                  |
| 2        | Formulations of the most important long-term goals to fulfil in relation to oral health. |
|          | Analysis of oral hygiene habits
          | Frequency of behaviour.                    |
| All sessions | Present oral hygiene status discussed and motivation for using various oral-cleaning aids was explored. |
| All sessions if necessary | Practise of manual dexterity
          | Instruction on “what to do” and how to do it” |
| All sessions | Individual goals for oral hygiene behaviour
          | How, when and where to use the desired oral hygiene aid or aids, and which area should be given particular attention to were decided. |
| During the initial dental hygiene treatment (1-5) | Continuous self-monitoring
          | Diary including the aids used frequency and when they were used. |
| 3,4 or 5 | Generalisation of behaviour
          | When all self-care aids had been introduced and practised, they had to be co-ordinated to function together |
| Last session in the initial treatment and during maintenance | Prevention of relapse
          | High-risk situations were identified and problem-solving strategies for how to handle those situations are discussed. |
Program development and training
The individually tailored oral health educational program was designed by a dental hygienist in co-operation with a psychologist. The dental hygienist then tested and further developed the intervention in four experimental single case studies, of which two are presented in Paper I. Some steps were supervised by the psychologist when the intervention was first implemented. In the randomised controlled group study, two experienced dental hygienists provided both interventions, including the non-surgical debridement for both the experimental and control groups (Paper II, III, IV). Before and during the experimental intervention the second dental hygienist received special training from the project leader. The training included three 8-hour sessions covering education in MI method and the philosophy behind the use of cognitive behavioural strategies. Principles and strategies for implementation of the different components in the intervention were described in a manual. Before the study started, components from the intervention were tested on three subjects at the clinic. Video recordings monitored how well the intervention was followed. Some video recordings were discussed with a psychologist at the start of the study, and strategies for implementations of goals and homework assessment and how to handle different situations were considered. Clinic-based supervision was performed during the course of the study.

Standard oral health preventive programme
(control group Paper II-IV)
The programme corresponded to the description by Nyman et al. (1984) and Rylander and Lindhe (1997). The programme (labelled as individual educational programme) has been tested on young adults with satisfactory results (Hugoson et al., 2007). The components in this routine preventive programme at each session are presented in Table 5.

The standard treatment programme (defined as ST in Papers III & IV) was in concordance with the dental hygienists professional competence, and no special training was given. A treatment manual covering what to do in each session and illustrated information material were used to provide the same information about periodontal disease to all subjects in the control group.
Table 5. Components of the standard oral health preventive programme at each session

<table>
<thead>
<tr>
<th>Sessions</th>
<th>Components in the control intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>• Periodontal status was demonstrated and discussed.</td>
</tr>
<tr>
<td></td>
<td>• Structured information was provided about periodontal disease, its consequences, the role of careful</td>
</tr>
<tr>
<td></td>
<td>and correct brushing twice a day and interdental cleaning once a day.</td>
</tr>
<tr>
<td></td>
<td>• Oral hygiene instructions after use of disclosing solution.</td>
</tr>
<tr>
<td></td>
<td>• The dental hygienist decided and gave prescriptions on which oral hygiene aids the subjects should use</td>
</tr>
<tr>
<td></td>
<td>and encourages the patient to do interdental cleaning before tooth brushing, preferably in the evening.</td>
</tr>
<tr>
<td></td>
<td>• The subjects were asked to demonstrate and practise the cleaning technique in their own mouth.</td>
</tr>
<tr>
<td></td>
<td>• The subjects were informed their own engagement is crucial for successful treatment outcome.</td>
</tr>
<tr>
<td>Second and following sessions</td>
<td>• Oral hygiene status was checked with disclosure solution.</td>
</tr>
<tr>
<td></td>
<td>• New instructions and adjustments of aids and technique was discussed and demonstrated if necessary.</td>
</tr>
<tr>
<td></td>
<td>• New information was given if the dental hygienist considers it necessary or if the subjects ask</td>
</tr>
<tr>
<td></td>
<td>questions about periodontal disease or oral hygiene.</td>
</tr>
</tbody>
</table>

Non-surgical treatment and supportive periodontal care (Paper I-IV)

Throughout the project, the different oral cleaning devices were recommended on an individual bases. The decision on which interdental cleaning aids was the most appropriate depended on the size of the interdental space and the morphology of the proximal tooth surfaces. Dental floss was recommended for narrow interdental space and in the maxilla anterior teeth with intact papillae. Triangular woodsticks were recommended for open interdental spaces. Interdental brushes with a handle were recommended for wide interdental spaces. A woodstick in combination with one or two interdental brushes, 0.8 mm or larger, was the most common recommendation.

The number of sessions in the RCT depended on individual needs for scaling treatment (i.e. severity of the periodontitis or amount of calculus), and was assumed to vary between four and six sessions. In both groups, the participants visited the dental hygienist weekly until scaling treatment was
finished. After one month, an oral hygiene control was performed for both groups.

In the RCT, non-surgical debridement was integrated into both programmes during the initial dental hygiene treatment, mainly performed with hand instruments (LM® Gracys, curette of 5 various designs and LM® Svärdström 1/3 & 2/4, Turku, Finland). In the experimental single-case study, the scaling procedure was during the generalisation phase. In both studies, there was supplementary scaling after the 3-month follow-up and during supportive maintenance care. Supportive maintenance care was scheduled every third month after initial dental hygiene treatment i.e. three and six months after the 3-month follow-up. The supportive maintenance care sessions included checking oral hygiene status with disclosure solutions, and if necessary, re-instruction. For the experimental group, these sessions included relapse prevention procedures and, when needed, new goals for oral hygiene practise were discussed.

Treatment integrity (Paper II-IV)

To increase the chance the treatment was implemented as intended, several strategies was applied (Perepletchikova and Kazdin, 2005). Random video recording of sessions verified the content of the intervention in both groups and corresponded with the study protocol. Data were collected to estimate the extent participants in the experimental group formulated long-term goals and the goals for oral hygiene practise, and completed the diary. The working sheets from the experimental group revealed all participants formulated long-term and intermediate goals (action plans) and 47 out of 56 (84%) completed the diary in accordance with the study protocol. Data from a questionnaire, covering questions about the content of the both interventions, revealed over 90% of participants in the experimental group claimed they had formulated goals for oral hygiene procedures in writing, completed the diary, and formulated long-term goals. In the control group, almost all reported no goal had been set and no diary was used. The above data indicated both programs were implemented in accordance with the instructions.

Measurements

An experienced periodontist performed all clinical measurements throughout the study. Initially, health history including general health status, medication, smoking habits, and socio-economical status was collected. In the RCT, the examiner was blind to group belonging (Papers II, III, IV).
Oral hygiene behaviour (Paper I-IV)

Gingivitis was the main outcome to evaluate oral hygiene behaviour. Plaque and self-reported oral hygiene practice were selected as secondary outcomes. The presence of gingival inflammation was recorded according to criteria for the gingival index (GI) from Löe and Silness (1963) and the presence of plaque was recorded according to Silness and Löe (1964) plaque index (PlI). In the present studies, criteria 2 and 3 were combined, i.e. all visible plaque was judged as the same amount. Clinical experience from patients treated for periodontal disease at the clinic indicated few patients had spontaneous bleeding and ulcerations; therefore criteria 2 and 3 were considered equally severe. Thus, the highest score for both PlI and GI was 2. As both the GI and PlI are established in the clinical practice of the examiner, there was no calibration before the study. However, to secure intra-observer reliability, five tests on plaque and gingival score were conducted throughout the RCT study period. Four of the five measurements disclosed an almost perfect agreement (Cohen’s Kappa 0.84-0.86), and one test revealed a moderate agreement (Cohen’s Kappa 0.51). However, the percentage agreement was high, as only 3 of 24 measures differed.

In Paper III, all plaque scores of 1 and above were considered a positive indicator of plaque, and the surface was registered as positive: the index was calculated as percentage of all sites in the dentition that scored ≥ 1.

In the experimental single case studies (Paper I), PlI and GI calculated for buccal- and lingual surfaces reflected tooth-brushing behaviour, and interproximal tooth surfaces reflected interproximal cleaning behaviour.

Oral hygiene practice was assessed by questionnaires covering oral self-care habits such as frequency of tooth brushing and interdental cleaning, type of toothbrush and interdental cleaning aid, and time and place for oral cleaning. Toothbrushing and interdental cleaning was classified into two categories; brushing at least twice a day/less often and; cleaning proximal surfaces once a day/less often.

Participant rating of global improvement and treatment satisfaction (Paper II)

To evaluate the participants’ opinion about the interventions and satisfaction with treatment, six questions were posed at 12 month follow-ups;
(1) performance of oral self-care (much better, better, no difference, worse) compared to before treatment;
(2) satisfaction with oral health (much more satisfied, more satisfied, no difference, worse) compared to before treatment;
(3) compliance with skills obtained during the treatment (daily, several times a week, a couple of times during a month, seldom/never);
(4) likelihood to maintain new habits (very likely, likely, fairly likely, not likely);
(5) satisfaction with care given by the dental hygienist (very satisfied, satisfied, fairly unsatisfied, very unsatisfied) and;
(6) whether the treatment had been worthwhile (time and cost) (yes, absolutely, yes, to some extent, it’s neither nor, no).

Periodontal measurements (Paper III)
The periodontal examination consisted of probing pocket depth (PPD), measured at six surfaces on each tooth, and bleeding on probing (BoP), measured as presence/absence of bleeding within 15s after pocket probing. PPD and BoP were assessed with a mirror and a periodontal probe (CC Williams Probe1-2-3-5-7-8-9-10, Hu-Fridy®, Chicago, IL, USA).

Preset criteria for treatment success
To conclude whether both interventions had a clinically significant effect i.e. reaching a level of non-surgical treatment success at the 12-month re-examination, criteria for the outcomes PlI, BoP, and pocket closure were formulated in advance. To attain success level for non-surgical periodontal treatment (successful-NSPT) a classification based on three classes for the three outcomes was established (Table 6). For each individual to be classified as “successful-NSPT”, at least two of the three outcomes had to be in class I, but none in class III. It was assumed all participants would improve after treatment; therefore, the individuals not fulfilling the criteria for “successful-NSPT” were classified into the group, “incomplete-NSPT”. All participants were classified as either “successful-NSPT” or “incomplete-NSPT”.

<table>
<thead>
<tr>
<th>Class</th>
<th>% Closed pocket</th>
<th>% Bleeding on Probing</th>
<th>% Plaque index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>&gt; 75%</td>
<td>≤ 15%</td>
<td>≤ 20%</td>
</tr>
<tr>
<td>Class II</td>
<td>≥ 65%</td>
<td>≤ 25%</td>
<td>≤ 29%</td>
</tr>
<tr>
<td>Class III</td>
<td>&lt; 65%</td>
<td>&gt;25%</td>
<td>&gt;29%</td>
</tr>
</tbody>
</table>

Note. For attaining a “successful-NSPT” level, the participant must fulfil at least two of the three criteria for Class I but none in Class III.

For clinically significant improvement on a group level i.e attaining “successful-NSPT”, the mean percentage of BoP (for all calculated tooth surfaces) should be reduced to a level of ≤ 15% (Lang and Tonetti, 2003), and
for high-quality oral hygiene, the mean percentage of PII should be reduced to a level < 20% (Htoon et al., 2007). For clinically significant successful scaling, a mean level of ≥ 75% of the periodontal pockets that are > 4mm at baseline should be closed at the 12-month re-examination.

Individual characteristics (Paper IV)

An instrument by Tedesco et al (1991) was used for assessing intention to interdental cleaning, attitude and behavior beliefs for interdental cleaning and subjective norms and normative beliefs. All items were scored from 1 (unlikely, bad, harmful, unhealthy, unpleasant, unimportant), to 7 (likely, good, beneficial, healthy, pleasant, important). A mean value >5 indicates positive cognitions. Self-efficacy of interdental cleaning was assessed by a modified version of Self-efficacy (SE) scale by Syrjälä et al. (1999). A six-point scale was used with scores from 0 (completely confident not to) to 5 (completely confident). A mean value > 3 indicates fair to high confidence in performing daily interdental cleaning. The items from the two original forms (Syrjälä et al., 1999; Tedesco et al., 1991) were translated by the first author and backwards translated to English by a professional translator. Chronbach’s Alpha for the Attitude scale was 0.73, for the Subjective norms scale 0.59, and for self-efficacy scale 0.89.

Statistical models and data analyses

Paper I

In the experimental studies, Microsoft Office Excel 2003 for Windows was used for the descriptive statistics. To determine whether the intervention programme had a clinically significant effect, criteria for improvement were formulated in advance. The mean PII (for all calculated tooth surfaces) should be reduced to a mean level close to 0.20 (Lang and Tonetti, 2003). For clinically significant periodontal improvement, the mean BoP index should be below 20% of the total number of tooth surfaces (Joss et al., 1994; Lang and Tonetti, 2003). Visual inspection of the changes in mean, level, trend, and latency of change across the different phases was applied for judgement on the intervention effect (Kazdin, 2003).

Paper II, III and IV

All statistical analyses were performed with SPSS software package (SPSS for Windows, version 15.0, SPSS Inc., Chicago, IL, USA).

Complete baseline data were available for all randomised participants in both groups. Intentions to treat analyses were applied where the missing values were imputed with a linear interpolation imputation method (accord-
ing to SPSS 15.0) for GI (Paper II), PlI (Paper II & III), BoP (Paper III), and Pocket closure (Paper III). Missing data on oral hygiene behaviour (Paper II & IV), self-reported oral health (Paper III) and attitudes, subjective norms and self-efficacy variables (Paper IV) was imputed through last value carried forward method (Twisk and de Wente, 2002). Data for “participant rating of global improvement and treatment satisfaction” per protocol analyses are presented, including all participants who completed the questionnaire at the 12-month follow-up (Paper II).

The main outcome variables of GI (Paper II) and the secondary outcome variables of PlI (Paper II), BoP (Paper III) and individual characteristics (Paper IV) were analysed with separate 2 (experimental group/control group) \times 3 (baseline/3-month post treatment/1-year follow-up) repeated measures analyses of variance (ANOVA repeated measure) and subsequent Bonferroni Post Hoc tests. The mean differences in GI and PlI between baseline and at 3-month follow-up (post treatment), between 3-month and 12-month follow-up (maintenance period) and between baseline to 12-month follow-up (study period) were analysed by Independent groups t-test (Paper II). In addition, percentage of closed pocket, PlI, and BoP at the 3- and 12-month follow-up between experimental and control groups, and between “successful-NSPT” and “incomplete-NSPT” groups (Paper III) were also analysed by Independent groups t-test.

In Paper III a binary logistic regression analysis was applied to examine variables of importance for reaching treatment success of non-surgical periodontal treatment i.e. “successful-NSPT”. The self-reported oral hygiene behaviour and satisfaction with the treatment (Paper II) and validation of “successful-NSPT” on periodontal diagnosis, demographic variables, and reported oral health (Paper III), were described and analysed by cross-tabulation and \( \chi^2 \) tests.

Pearsons correlation was used in Paper IV to examine relations between individual characteristics and self-reported interdental cleaning (IC) at the baseline assessment. A binary logistic regression (LR) analysis was conducted (Paper IV) in order to examine the predictive value of baseline scores for attitude, subjective norms and self-efficacy at the 12-month follow-up with regard to daily IC cleaning, an interproximal plaque (PlI) level of \( \leq 20\% \) and an interproximal bleeding on probing (BoP) level of \( \leq 20\% \). The cut-off level between the categories for PlI and BoP were based on suggestions from Lang and Tonetti (2003) and Htoon et al., (2007). For attitude and subjective norms: (a) a mean < 5 indicating a negative attitude or low influences from significant others, and (b) a mean \( \geq 5 \) indicating a positive attitude or high influences from significant others. For self-efficacy: (a) \( \leq 3 \) indicating a low confidence in performing daily IC, and (b) > 3 indicating a high confidence in performing daily IC.

An alpha level of 0.05 or below was considered statistically significant.
Results

Paper I: Description and evaluation of the effect of an individually tailored oral hygiene treatment

Both participants changed their oral hygiene behaviour during the intervention and the new habits were maintained during the study period. The mean rate of PII and GI, measured on the buccal and lingual surfaces for toothbrushing and inter-proximal surfaces for interdental cleaning, changed from phase to phase in the expected direction in both cases, Mrs A and Mr B. During baseline, a visual inspection of the index for buccal/lingual surfaces and inter-proximal surfaces revealed no trend in either direction for plaque and gingival indices (Figure 4a and b). When the intervention was introduced (a new tooth brushing technique was introduced and brushing skills were practised), a rapid decrease in both PII and GI occurred for the buccal and lingual surfaces (Figure 4a, Mr B). During the weeks when interdental cleaning aids were introduced, a rapid decrease in PII occurred from 1.1 to 0.3 for Mrs A and 1.5 to 0.6 for Mr B. The change in PII and GI interproximally for Mr B is illustrated in Figure 4b.

As expected, there was a delay in the decrease in GI, but it closely followed the PII. The baseline levels for inter-proximal surfaces were not affected by tooth brushing alone and did not change until the interdental cleaning aids were introduced. The decrease for both buccal/lingual surfaces and inter-proximal surfaces was maintained throughout the study.

Both participants attained the pre-decided criteria for clinical significance level of plaque (average value: Mrs A, 0.18; Mr B 0.13) and bleeding on probing (average value: Mrs A, 11%; Mr B, 13%). Reductions in periodontal probing depth were attained. The positive results remained stable throughout the 2-year study period (for more detailed descriptions see Paper I).
Figure 4 a & b. Results showing Mr. B’s plaque and gingival indices in relation to toothbrushing (TB), and to interdental cleaning (toothpicks, TP and interdental-brushes, IDB). Indices related to toothbrushing are records from the buccal/lingual surfaces (4 a) and interdental cleaning are records from the inter-proximal surfaces (4 b). Low scores indicate low amounts of plaque and healthy gum.

Paper II: The effectiveness of an individually tailored treatment on oral hygiene behaviour

Treatment effect on gingival status
The $2 \times 3$ ANOVA repeated measures had a significant time × group interaction for Global GI, $F(2, 222) = 29.5, p < 0.001$, and for Proximal GI, $F(2, 222) = 47.9, p < 0.001$, demonstrating the groups developed differently over time, in favour of the experimental group. Post hoc analysis revealed statistically significant mean differences between both baseline and 3-month follow-up (global GI, $p < 0.001$; proximal GI, $p < 0.001$), and baseline and 12-month follow-up (global GI, $p < 0.001$; proximal GI, $p < 0.001$), in favour of the experimental group. There was no statistically significant mean score
difference between the 3- and 12-month follow-up, i.e. both groups retained the achieved gingival standard during the maintenance period. Mean values and standard deviations are presented in Table 7.

| Table 7. Global GI and Proximal GI at baseline, 3-and 12-months follow-up. |
|---|---|---|
| | Baseline | 3-month follow-up | 12-month follow-up |
| | Mean (SD) | Mean (SD) | Mean (SD) |
| GI Global  |  |  |  |
| Experimental | 0.92 (0.28) | 0.27 (0.14)* | 0.21 (0.16)* |
| Control | 0.92 (0.23) | 0.52 (0.20) | 0.50 (0.17) |
| GI Proximal  |  |  |  |
| Experimental | 1.14 (0.27) | 0.37 (0.17)* | 0.28 (0.20)* |
| Control | 1.13 (0.23) | 0.72 (0.21) | 0.69 (0.20) |

* = Independent groups t-test at the 3-month follow-up ($t = 8.20, p < 0.001$; $t = 9.50, p < 0.001$), and at 12-month follow-up ($t = 9.61, p < 0.001$; $t = 10.7, p < 0.001$).

**Note.** Experimental group n = 57, Control group n = 56.

Abbreviations: SD, standard deviation. GI, Gingival Index (0-2), low scores indicate low gingival inflammation.

**Treatment effect on oral hygiene**

The $2 \times 3$ ANOVA repeated measures test had a significant time × group interaction for Global PI ($F(2, 222) = 8.91, p < 0.001$) and for Proximal PI ($F(2, 222) = 14.0, p < 0.001$), demonstrating the groups developed differently over time in favour of the experimental group. Post hoc analysis revealed significant gain-score differences between both baseline to 3-month follow-up ($p = 0.003$), and baseline to 12-month follow-up ($p < 0.001$), in favour of the experimental group. There was no significant gain-score difference between the 3-month and 12-month follow-up for Global PI, i.e. both groups retained the achieved oral hygiene standard. For Proximal PI, there were significant mean gain differences between the groups at all three intervals i.e. baseline to 3-month ($p = 0.001$), 3-month to 12 month ($p = 0.013$) and baseline to 12-month follow-up ($p < 0.001$): the experimental group had a larger plaque reduction than the control group. Mean values and standard deviations are presented in Table 8.
Table 8. Plaque indices for full mouth (Global) and interproximal surfaces at baseline 3-, and 12-months follow-up.

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>3-month follow-up</th>
<th>12-month follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>PlI Global</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>0.74 (0.34)</td>
<td>0.17 (0.11)*</td>
<td>0.14 (0.13)*</td>
</tr>
<tr>
<td>Control</td>
<td>0.73 (0.31)</td>
<td>0.32 (0.22)</td>
<td>0.31 (0.16)</td>
</tr>
<tr>
<td>PlI Proximal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>1.01 (0.37)</td>
<td>0.29 (0.18)*</td>
<td>0.23 (0.19)*</td>
</tr>
<tr>
<td>Control</td>
<td>0.99 (0.35)</td>
<td>0.48 (0.28)</td>
<td>0.49 (0.22)</td>
</tr>
</tbody>
</table>

Note. Experimental group n = 57, Control group n = 56. Abbreviations: SD, standard deviation. PlI, Plaque Index (0-2), low score indicate high standard of oral hygiene performance. * = Independent groups t-test at the 3-month follow-up \(t = 4.36, p < 0.001; t = 4.26, p < 0.001\) and at 12-month follow-up \(t = 6.07, p < 0.001; t = 6.87, p < 0.001\).

Treatment effect on oral hygiene habits

Approximately 90% of participants in both groups reported toothbrushing twice a day at baseline, and the frequency was consistent throughout the study period.

At baseline, 26 (46%) of the participants in the experimental group and 21 (38%) in the control group reported daily interdental cleaning. After dental hygiene treatment at the 3-month follow-up, both groups increased use of interdental cleaning: 45 (79%) of participants in the experimental group and 37 (67%) in the control group reported interdental cleaning once a day. There were no statistically significant differences between the groups either at baseline \(\chi^2 (df 1, n = 113) = 0.76, p = 0.382\) or at the 3-month follow-up \(\chi^2 (df 1, n = 113) = 1.94, p = 0.163\). More participants in the experimental group [45 (79%)] reported daily interdental cleaning than in the control group [33 (59%)] at the 12-month follow-up, \(\chi^2 (df 1, n = 107) = 5.29, p = 0.021\).

Participant rating of global improvement and treatment satisfaction

A higher proportion of individuals in the experimental group estimated they were able to perform oral self-care much better after treatment (12-month follow-up) than in the control group \(\chi^2 (df 1, n = 105) = 5.02, p = 0.024\), although both groups estimated better performance. More participants in the experimental group reported daily practise with skills obtained during the treatment \(\chi^2 (df 2, n = 105) = 8.76, p = 0.025\) and estimated higher likeli-
hood of maintaining new habits than individuals in the control group did $[\chi^2 (df 1, n = 106) = 5.97, p = 0.015]$. The analysis of satisfaction with care given by dental hygienist revealed no significant differences between the groups $[\chi^2 (df 1, n = 105) = 1.23, p = 0.266]$. Most participants, irrespective of group, considered the treatment was valuable: for more information see table 6 in Paper II.

**Paper III: Evaluation of an individually tailored oral hygiene programs’ effect on periodontal health**

**Treatment effect on Bleeding on Probing (BoP)**

After the oral hygiene intervention and periodontal debridement, a marked reduction of both full-mouth and proximal scores was observed in both treatment groups and the supportive periodontal treatment resulted in a further reduction of BoP scores (Figure 5).

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**Figure 5.** The experimental group (ITOHEP) had lower full-mouth BoP scores at both the 3-month re-examination (CI 95%: 4-15; $p < 0.001$) and the 12-month post treatment examination (CI 95%: 5-15; $p < 0.001$) than the control group (ST) ($p$-value marked with stars in the Figure). For the interproximal sites, the experimental group had lower BoP at both 3-month post treatment (CI 95%: 4-18; $p = 0.002$) and 12-month post treatment examination (CI 95%: 7-21; $p < 0.001$).
The repeated measures ANOVA with subsequent Bonferroni post hoc test revealed a significant time × group interaction for both full-mouth BoP [F (2) = 11.9; p < 0.001] and proximal BoP [F (2) = 12.6; p < 0.001], indicating the groups developed differently over time. Post hoc analyses revealed mean differences between groups over time for both full-mouth BoP (mean difference 8.24%; 95% CI: 3.5-12.9; p = 0.001), and proximal BoP (mean difference 9.65%; 95% CI: 4.25-15.0; p = 0.001).

Periodontal pocket assessment
At baseline examination, the mean percentage (all sites) varied between 31-32% for PPD 4-5 mm and between 9.2-9.3% for PPD >5 mm. For interproximal sites, the mean percentage of PPD >4 mm varied between 25-28%. At the 3-month re-examination, the mean percentage for PPD 4-5 mm was reduced to 12% in the experimental group (ITOHEP) and to 14% in the control group (ST), and for PPD >5 mm the mean percentage reduced to 1.6% to 1.7% for both groups. The mean percentage of interproximal sites with PPD >4 mm reduced to 6.7% in both groups at the 3-month re-examination. At the 12-month re-examination, there was further reduction in PPD in both groups, especially for the interproximal sites and PPD 4-5 mm. No statistically significant differences between the two groups at any of the examination intervals were determined.

The initial treatment phase i.e. oral health education and scaling treatment, resulted in “pocket closure” with a mean frequency of 69% for the experimental group and 66% for the control group: for the interproximal sites, the “pocket closure” was 68% (ITOHEP group) and 67% (ST group). After some re-scaling during the maintenance period, the mean percentage of closed pockets increased to 75% for the experimental group and between 76%-77% for the control group. No statistically significant difference between the two groups was observed at any of the examination intervals.

Treatment success and factors influencing treatment success (“successful-NSPT”)
At 12-month re-examination, the “successful-NSPT” level, based on the variables PlI, BoP, and pocket closure for each participant was 54 (47.8%) individuals: the remaining 59 (52.2%) were classified as “incomplete-NSPT”. For mean values of the treatment success outcome variables between the two groups (“successful-NSPT” /“incomplete-NSPT”) see Paper III.

The selected variables in the logistic regression analysis were oral health educational treatment groups, PlI, and BoP at baseline examination; although, instead of closed pocket, the percentage PPD >5 mm was used. In the binary logistic regression model, the odds ratio (OR) of attaining “suc-
cessful-NSPT” in subjects with a lower plaque score at baseline [OR, 0.95; 95% CI; 0.92-0.97; \( p < 0.001 \)] was higher. Similarly, the OR of attaining “successful-NSPT” in subjects treated with the ITOHEP intervention (experimental) (OR, 4.22; 95% CI; 1.77-10.1, \( p = 0.001 \)) was higher than with ST intervention (control). No significant relations for percentage of PPD > 5 mm or levels of BoP at baseline examination were identified.

The percentage predictability of attaining “successful-NSPT” level 12-month post-treatment in relation to PII at baseline for the different treatment groups (ITOHEP v.s ST) is illustrated in Figure 6. A PII score of about 30% at baseline increased the predicted probability of “successful-NSPT” to 75-90%: a PII over 80% gave predicted probability of 10-35%. A PII score of 60% at baseline gave a predicted probability of 30% for “successful-NSPT” level when treated with ST intervention and over 60% with the experimental (ITOHEP) intervention.

![Figure 6](image)

Figure 6. Predicted probability of attaining a “successful-NSPT” level 12-months post-treatment for both treatment groups in relation to PII scores at baseline. The curve with PII scores before treatment and type of therapy as explanatory variables is constructed from the regression coefficient in the regression analyses.
Paper IV: Evaluation of an individually tailored treatment on individual characteristics

**Intervention effects on intention, attitude, subjective norms and self-efficacy**

No statistically significant difference between groups on attitude, subjective norms and self-efficacy before the interventions were introduced, with all $p > 0.43$, indicating successful randomization.

Mean scores, standard deviations and group mean differences between baseline and 12-month follow-up are presented in Table 9. There were differences between groups in *intention* to perform daily IC at the 12-month follow-up [$t(111) = 2.57; p = 0.011$], but not in *attitudes, subjective norms*, or *self-efficacy*, either at the 3- or at the 12-month follow-ups.

Table 9. Mean scores, standard deviation at baseline, 3- and 12-month follow-up.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Baseline Mean (SD)</th>
<th>3-month follow-up Mean (SD)</th>
<th>12-month follow-up Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Attitude towards IC</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITOHEP group</td>
<td>5.9 (0.68)</td>
<td>6.2 (0.56)</td>
<td>6.3 (0.62)</td>
</tr>
<tr>
<td>ST group</td>
<td>5.9 (0.58)</td>
<td>6.2 (0.57)</td>
<td>6.2 (0.59)</td>
</tr>
<tr>
<td><em>Subjective norms</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITOHEP group</td>
<td>5.7 (0.90)</td>
<td>5.9 (0.81)</td>
<td>5.9 (0.84)</td>
</tr>
<tr>
<td>ST group</td>
<td>5.6 (0.87)</td>
<td>5.8 (0.85)</td>
<td>5.7 (0.88)</td>
</tr>
<tr>
<td><em>Self-efficacy towards IC</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITOHEP group</td>
<td>3.5 (1.01)</td>
<td>3.8 (0.91)</td>
<td>3.7 (1.01)</td>
</tr>
<tr>
<td>ST group</td>
<td>3.4 (0.93)</td>
<td>3.8 (0.99)</td>
<td>3.7 (0.92)</td>
</tr>
<tr>
<td><em>Intention to daily IC</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITOHEP group</td>
<td>6.4 (0.80)</td>
<td>6.7 (0.49)</td>
<td>6.8 (0.42)</td>
</tr>
<tr>
<td>ST group</td>
<td>6.4 (0.60)</td>
<td>6.6 (0.62)</td>
<td>6.4 (0.97)</td>
</tr>
</tbody>
</table>

*range 1-7; † range 0-5. Abbreviations: ITOHEP = individually tailored oral health educational programme. ST = standard oral hygiene education. IC = interdental cleaning.

The repeated measures ANOVA revealed both interventions had impact on *intentions* [$F(2) = 4.89, p = 0.040, \eta^2 0.03$], *attitude* [$F(2) = 21.4, p < 0.001, \eta^2 0.16$], *Subjective norms* [$F(2) = 4.77, p = 0.009, \eta^2 0.04$], and *self-efficacy* [$F(2) = 11.8, p < 0.001, \eta^2 0.09$], over time. The partial eta squared ($\eta^2$) indicated a small to medium intervention effect size. Post hoc analyses revealed differences between baseline and 12-month follow-up for *attitudes* (mean difference 0.28, 95% CI: 0.13-0.43), and for *self-efficacy* (mean difference 0.26, 95% CI: 0.05-0.47).
Relationship between attitudes, subjective norms and self-efficacy, intention and interdental cleaning at baseline

Positive attitude ($r=0.21$, $p=0.05$) and subjective norms ($r=0.19$, $p=0.05$), and high self-efficacy ($r=0.44$, $p=0.01$) were related to high intention to perform daily interdental cleaning (IC). High intention ($r=0.27$, $p=0.01$) was then related to high frequencies of IC. Both attitude ($r=0.28$, $p=0.01$) and self-efficacy ($r=0.40$, $p=0.01$) were related to high frequencies of IC.

Prediction of oral hygiene behaviour, plaque control and bleeding on probing

The predictive value of attitude, subjective norms and self-efficacy for daily IC, interproximal PlI score and interproximal BoP scores at 12-months post-treatment follow-up are presented in Table 2 in Paper IV. A higher odds ratio of performing daily IC and attaining a plaque score $\leq 0.20$ was observed for subjects with higher self-efficacy score at baseline. No significant relations were observed for attitude, subjective norms, and self-efficacy on BoP scores. When attitude and subjective norms were removed from the model, and treatment groups (ITOHEP vs. ST) were introduced, the predicted probability of performing daily IC and attaining an interproximal PlI score level $\leq 20\%$ was higher in the ITOHEP and with self-efficacy score $\geq 3$ at baseline, than with ST treatment (Table 10).

Table 10. The predicted probability of performing daily interdental cleaning and attaining a PlI score level $\leq 20\%$, 12-month follow-up.

<table>
<thead>
<tr>
<th>Predicted probability to perform daily interdental cleaning at 12-month after treatment</th>
<th>Treatment with ITOHEP-intervention</th>
<th>Treatment with ST-intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-efficacy mean score $&lt; 3$ at baseline</td>
<td>65%</td>
<td>41%</td>
</tr>
<tr>
<td>Self-efficacy mean score $\geq 3$ at baseline</td>
<td>88%</td>
<td>74%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Predicted probability to reach a PlI score level $\leq 20%$ at 12-month after treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-efficacy mean score $&lt; 3$ at baseline</td>
</tr>
<tr>
<td>Self-efficacy mean score $\geq 3$ at baseline</td>
</tr>
</tbody>
</table>

Abbreviations: ITOHEP = individually tailored oral health educational programme; ST = standard oral hygiene education; PlI = plaque index. The table were constructed from the regression coefficient in the regression analyzes, with SE scores before treatment and type of therapy as explanatory variables.
Discussion

The first step in this project (Paper I) was to develop and test if a program including both motivational interviewing method and cognitive behavioural techniques was effective in oral hygiene education and feasible for a dental hygienist to perform. The second step was to test the new program in comparison with a standard oral hygiene education programme, to evaluate which program, if any, was superior for improving oral hygiene behaviour (Paper II). In addition, the evaluation of treatment outcome on periodontitis in terms of bleeding on probing and periodontal pocket depth was important and also to identify a clinical significant level of treatment success: these findings are presented in Paper III. Finally, in Paper IV, factors of importance for predicting oral hygiene behaviour are described; thus, all aims for the thesis were fulfilled.

The main findings in this thesis were that an individually tailored oral health educational programme based on a behavioural medicine approach could successfully be implemented within a periodontal non-surgical treatment intervention (Paper I). The tailored oral health educational programme was superior to a standard oral health educational programme. Individuals treated with the experimental intervention reported higher frequency of daily interdental cleaning and were more certain to maintain the attained level of behaviour change, had better oral hygiene, and healthier gingival tissue, particularly interproximally (Paper II). After the non-surgical periodontal treatment a great reduction in periodontal pocket depth and bleeding on probing scores were shown in both groups, with greater reduction in BoP scores for individuals in the tailored treatment group. A lower dental plaque score at treatment start increased the predicted probability of attaining treatment success (Paper III), and self-efficacy towards interdental cleaning was an important factor in predicting oral hygiene behaviour (Paper IV).

Tailored treatment in oral health education (Paper I & II)

As discussed in this thesis the patient’s engagement in her or his own oral self-care is crucial for successful periodontal treatment, which implies oral health education is vital in the treatment process. There is limited research in the area of oral health education, especially in terms of intervention studies with rigorous designs (i.e. randomised controlled trials) and incorporating
theories and models from the field of psychology and sociology in the treatment procedures (Renz et al., 2007; SBU, 2004). Dental hygienists and dentists have had little support from the field of oral health education research in treatment planning, as there is lack of scientific evidence for which oral health education programmes should be recommended in the treatment of patients with periodontal disease.

In the experimental single-case study, the tailored health educational programme was successfully applied in the two study participants (Paper I). Both participants improved their brushing and interdental cleaning performance and attained clinically significant improvement for plaque and the pre-decided criteria for bleeding on probing, indicating the intervention was effective for changing oral hygiene behaviour. Thus, the intervention could be tested in a randomised controlled trial aimed at testing effectiveness in comparison with a standard oral hygiene educational programme.

In the randomised controlled trial, it was hypothesised both interventions should have positive effects, but the individually tailored oral health educational programme would be more effective in reducing gingivitis. The reduction in gingivitis and improvement in oral hygiene was largest at the 3-month follow-up for both groups, i.e. immediately after the intervention was introduced and scaling treatment was performed. The improvement was maintained at almost the same level up to the 12-month follow-up but there was a marked difference in reduction of GI between the groups, in favour of the experimental group. Hence, the hypothesis for the study was confirmed. These findings were in accordance with other behavioural interventions studies of patients with periodontal disease (Jönsson et al., 2006; Philippott et al., 2005; Renz et al., 2007) and strengthened the hypothesis that interventions including psychosocial strategies are more effective for oral hygiene behavioural change than standard treatments.

The differences between groups for both GI and PI were most pronounced for the proximal sites. These differences were further validated by participants’ global rating of interdental cleaning frequencies, use of skills learned during the treatment and maintaining of behavioural change (Paper II). To achieve a high standard of interproximal plaque control is important as these sites often have deeper periodontal pockets (Kim et al., 2007) and are most likely to exhibit residual plaque and calculus after scaling treatment (Cobb, 2002). If areas with insufficient plaque control correspond with sites where periodontal problems are most pronounced, it may result in poorer healing of the periodontal pocket and less pronounced reduction of gingival inflammation (Tomasi et al., 2007). There were no differences in toothbrushing frequencies mainly due to the fact that most participants already at study start brushed their teeth twice a day.

Plaque and gingival indices were used as outcome measures to evaluate short- and long-term oral hygiene behaviour change in combination with self-reported oral hygiene habits. However, the level of plaque control for
maintaining healthy gingival tissue is not clearly defined, although a total
plaque score (all sites) around 25% might be tolerable for most individuals
with periodontal disease (Htoon et al., 2007; Lang and Tonetti, 2003). The
participants in both groups reached a low level of total plaque scores and
were even lower compared to the plaque level reported in other oral hygiene
intervention studies (Renz et al., 2007).

A tailored oral health education programme where the goals for oral hy-
giene performance and oral health are agreed between the patient and dental
hygienist appears possible to implement in clinical practice. The shift from
an oral health care provider perspective, i.e. what is best for the patient, to-
wards a more patient-centred perspective, where the patients cognitions,
beliefs, motivation, and daily life are considered in the treatment, was suc-
cessful. The individual patient sometimes preferred different routines for
her/his oral hygiene practice than the dental hygienist thought was the best.
For example, many patients in the experimental group choose to use tooth-
picks and interdental brushes at times other than in connection with tooth
brushing, and they altered the routine depending on where they resided e.g.
at home, on holiday, or travelling on business.

Components in the individually tailored treatment compared to
standard treatment
Traditionally in dentistry the main perspective of oral health education ema-
nate from the biomedical perspective in which the main aim is to inform the
patient about the disease and give advice to the patient what to do (Freeman,
1999; Hamman Calley et al., 2000). The focus is to remove the cause of the
disease without a thorough consideration of which factors influence the per-
son’s action and persistence in changing behaviour. When conducting oral
health educational programs, it is important they have an empirical and theo-
retical basis as this increases the likelihood of constructing effective pro-
grams that are related to behavioural change (McCaul et al., 1985). In the
experimental intervention described in this thesis, the guiding principles
originated from the framework of Social Cognitive Theory (Bandura, 1997),
and individual perspective, oral hygiene behaviour itself, and the environ-
ment in which the individual existed were incorporated into the program.
The seven components of the program and the flow through the different
components was influenced by the client self-care commitment model used
in a previous study (Jönsson et al., 2006) and the structure of an intervention
for patients with persistent musculoskeletal pain designed and developed by
Äsenlöff (2005).

The differences and the similarities between the experimental condition
(ITOHEP) and control condition (ST) are discussed from the perspective of
tailoring programme strategy versus standard/generic program strategy.
Information

One main difference between the programs is how the information is presented to the patient. In a standard treatment program, patients receive standardised information about the causes of periodontitis, the risk of smoking (if the patient smokes), treatment opportunities, and that the patients own engagement is crucial for successful treatment outcome. In principle, the patient’s knowledge, earlier experience, and what he/she wants to know are not considered. The information is supplied from the dental hygienists perspective i.e. what is best for the patient. This is a standard or generic strategy (i.e. the information is designed to suit all people with a specific diagnose) to increase knowledge and to motivate people to take action into a specific behaviour. An individually tailored programme is initiated through an interview with open-ended questions that explore the patients’ knowledge, earlier experiences, wishes, and expectations. The dental hygienist asks if the patient would like further information and encourages the patient to take an active role by questioning and eliciting an expression of the patient’s opinions. In this approach, the information is always supplied from the individual patients’ perceived needs i.e. tailoring strategies.

Analysis of oral hygiene behaviour

To explore which oral hygiene aid or aids the individual patient need an analysis of oral hygiene habit is included in both programs. However, the programs differ in how different oral hygiene devices are introduced to the patients. In standard treatment, all oral hygiene aids assumed as needed are implemented in the first session; additional aids are introduced if the patient fails to clean properly. All patients are requested to brush twice a day (morning and before going to bed in the evening), and to use interdental cleaning aids in connection with tooth brushing, preferable in the evening. This is a generic health education strategy assuming that all patients with periodontal disease have the same needs, and the consulting process is focused on persuading the patient to adhere to the dental hygienists instructions. If the patient fails to follow the dental hygienists advice, he or she is considered non-complier.

In contrast, the guiding principle of the individually tailored program is to introduce only one cleaning aid at each session, and if possible to start with the one that the patient already uses and is supposed to have the best chance of being used successfully. For example, if there is insufficient cleaning on the lingual and/or buccal surfaces, the oral hygiene instruction should preferable start with tooth brushing alone and the interproximal cleaning instructions are postponed to the next session, even if her/his main periodontal problems are located in these areas. Here, instruction is tailored to the individual patients’ capacity, knowledge, and self-efficacy expectations and are given accordingly.
**Instruction**

In both programs, disclosing solution was used to display oral biofilm and as a guide for the oral hygiene instructions. In the individually tailored programme, disclosing solution was used to illustrate to the patient where he/she was successful and areas for improvement, and to give feedback on homework assignments. The use of assignments meant that the patient expressed and formulated in writing which specific areas were important to work on until the next session, the decision was made in concordance with the dental hygienist. In the standard treatment program, the disclosing solution was used to highlight where the patient failed in removing plaque and to indicate how he/she should avoid future failure. In both programs, the patient was instructed how to clean with toothbrush and different interdental cleaning devices. In the individually tailored programme the emphasis was on exercises in front of a mirror at a wash basin to make the circumstances as near to a home routine environment as possible, so the patient knew “what to do” and “how to do it”.

**Goal-setting**

In the individually tailored programme, both long-term oral health goals (formulated in the second session) and intermediate goals of oral hygiene behaviour (formulated at the end of each session) were central. The participants chose long-term goals that were related to both periodontal status and that reflected other objectives (Paper I). For instance, goals such as achieving good cleaning technique and avoiding anxiety related to bad breath reflected behaviourally and psychologically relevant areas, rather than biomedical goals. The participants’ individual long-term goals reflected the ambitions for their future oral health and treatment. According to Latham and Locke (2007), goals contribute to the enhancement of the individuals’ motivation for performance provided they find the goals important and attainable, and patients should be confident and knowledgeable about how to achieve the goals. One objective with the intermediate goals was to allow the patient to explore and devise an action plan for when, where, and how the oral hygiene practise was to take place. Before the patient formulated the intermediate goals, there was discussion, and sometimes negotiation, between the patient and the dental hygienist about appropriate frequencies and preferable oral hygiene aids, although ultimately, the patients own requirements were acknowledged. In this consultation process, the focus was on the dental hygienist and the patient agreeing on therapeutic decisions and incorporating their respective views, i.e. the decision was made in agreement. The dental hygienist’s role was to support the patient in their oral hygiene performance.

The standard treatment programme included goals such as interdental cleaning once a day, and attaining a plaque and bleeding on probing level
beneath 20%. However, these goals were decided from the dental hygienist and dentists’ perspective and assumed as the best for a patient with periodontal disease: the patient’s own goals for oral hygiene and oral health were not explicitly expressed. If the patient failed to reach the goal, he or she was seen as a non-complier. In the individually tailored programme, if a patient failed to achieve a goal, the long-term goals for oral hygiene and health were discussed in relation to what the patient had already achieved, and if necessary new goals were formulated.

**Self-monitoring and relapse prevention**

Monitoring behaviour according to self-care assignments and identifying risk situations were also central features of the individually tailored programme. By completing the diary between each session, the patient could assess how he or she managed to follow the action plan, and the positive and negative experiences they had during the week. The regular (weekly) structural and consequent follow-up of the diary and oral hygiene procedures presented opportunity to reformulate the intermediate goal. This procedure combined with the discussion of strategies and coping plans for managing difficult situations was one of the strengths of the individually tailored programme which resulted in the patient willingly took an active role in their own oral self-care.

However, both educational programs appeared to have a positive impact on the patients, as almost all participants were satisfied with the dental hygiene treatment and reported the treatment was worth the time and treatment costs (Paper II). There was a small difference between the two groups concerning time required for the treatment, with more time required for the experimental group.

**Periodontal outcome (Paper III)**

The treatment effect of the two different oral hygiene educational programs on periodontitis, measured as a reduction in bleeding on probing and periodontal pocket depth, was evaluated and described in Paper III. In addition a cut-off level for non-surgical treatment success based on a maximum mean for “Pocket closure”, BoP- and PII scores was introduced. There were minor differences between the two programs for bleeding on probing but no difference in the percentage of pocket closure after treatment, which indicated the scaling and root planning procedures were sufficient. The individually tailored treatment group had lower BoP scores than the standard treatment group, both for global- and proximal sites. There are few comparable studies with the same number of participants and the same design; however, the BoP score for the standard treatment group was similar to other studies that use a standard oral hygiene program (Wennström et al., 2005; Westfelt et al.,
The results for “pocket closure” were almost identical to the results from Wennström et al., (2005), and the percentage of PPD reduction was similar to the results reported by Westfeldt et al., (1998).

To evaluate the clinical significance of the programs, preset criteria for treatment success after non-surgical periodontal treatment were determined. These criteria were based on previous studies (Htoon et al., 2007; Lang and Tonetti, 2003; Wennström et al., 2005). The individuals were classified into two groups based on data from 12-month follow-up: “successful-NSPT” and “incomplete-NSPT”. The Individuals in the “successful-NSPT” were classified healthier and reported a higher level of self-rated oral health, indicating the improvement for these individuals was clinically significant. However, individuals within the “successful-NSPT” group differed, as some were fully recovered and some individuals and specific sites still required complementary treatment, such as periodontal surgery. Therefore, “successful-NSPT” should only be considered as the actual endpoint of non-surgical periodontal treatment. In a study by Lundgren et al., (2001), 52% fulfilled the criteria for treatment success, although only four sites per patient were studied and periodontal surgery was included in the treatment. In the present study, almost half of the participants attained clinically significant levels of treatment success. Whether the preset criteria were appropriate (too rigorous/too gentle) requires validation in further longitudinally studies and over a longer study period, when change in attachment level also are included. More individuals in the tailored health education group attained “successful-NSPT” level than individuals in standard treatment group.

Lower initial PlI scores and group assignment (ITOHEP) were associated with a higher probability of attaining “successful-NSPT” level. There was about 30% higher predicted probability of an individual with a plaque score around 60% at baseline of attaining a successful level of non-surgical periodontal treatment, if treated with an individually tailored oral health educational programme rather than a standard treatment programme.

The periodontal health gained with the individually tailored intervention in this project was beneficial, but the acquired authorisation for active participation was probably just as important for the individual patient. The experience from the present project was that a more thorough exploration of the patients preferences facilitated the process of supporting the patient in their effort to improve oral health. As far as possible, dental health care should be designed and accomplished in concordance with the patient, as is stated in the Swedish Dental Act (SFS 2008:149) in § 3.

Even if an individually tailored programme may initially be more time-consuming than standard oral health education, the individually tailored programme is assumed cost-effective in the long term. As more individuals in the individually tailored programme had lower plaque and gingival scores, and more attained treatment success, there might be need for less frequent supportive periodontal treatment, or at least, less time during appointments.
Factors to predict oral hygiene behaviour (Paper IV)

The general construct intention, attitude and subjective norms from the Theory of Reasoned Action and self-efficacy from the Social Cognitive Theory were used to guide the selection of predictor variables of oral hygiene behaviour and bleeding on probing presented in Paper IV. The tailored treatment group increased intention to perform daily interdental cleaning during the study period, whereas standard treatment group did not. One reason for the differences might be the formulation of goals which was a central part of the tailored education programme. According to Gollwitzer (1999) an implementation plan which specifies when, where, and how to adopt a specific behaviour enhance the intention and lead to a higher rate of goal attainment.

There were no differences between the groups for the three dimensions attitude, subjective norms, and confidence in performing interdental cleaning. These results are similar to findings reported by Tedesco et al., (1992), but contrasted with the findings of Stewart et al., (1996) who reported change in self-efficacy for individuals receiving a psychological intervention. Both interventions affected attitude and self-efficacy towards interdental cleaning, but the changes were small. One reason was that the participants initially reported attitudes and subjective norms highly, and had high intentions, therefore, limiting the possibility of improvement due to a ceiling effect.

According to Social Cognitive Theory, self-efficacy is an important motivational factor for intention to behavioural change, and according to Theory of Reasoned Action, attitudes and subjective norms precede intention. The results from this thesis supported this assumption as intention correlated with these constructs and interdental cleaning practise. Higher confidence, more positive attitude, and subjective norms were related to the level of intention and interdental cleaning practise. Similar findings in previous studies suggest some individual factors related to intention to perform daily flossing and self-reported flossing behaviour (Schüz et al., 2006; Sniehotta et al., 2007; Syrjälä et al., 2002; Tedesco et al., 1991).

The only individual factor examined in this thesis which appeared to have an impact on future oral hygiene behaviour and plaque control was self-efficacy toward interdental cleaning at the start of the treatment. This suggested that it is necessary to pay special attention to individuals presenting low confidence in performing daily interdental cleaning at the start of the treatment. These individuals appeared to have higher probabilities of attaining sufficient oral hygiene after a cognitive behavioural intervention than with standard intervention. Therefore, assessment of self-efficacy should be a natural part in the analysis of oral hygiene behaviour and in the planning of oral hygiene interventions.
Methodological considerations

Internal Validity

Experimental single-case studies (Paper I)
The four participants (two described in Paper I) included in the experimental single-case study were chosen to mirror a typical patient referred to the clinic with moderate periodontitis. Three females and one male, aged between 48 and 60 years with different background characteristics such as smoking habits, education, civil status, and ethnicity were included. For all four the intervention and treatment resulted in an improvement according to the preset criteria. For the three women, the implementation of the intervention in the different phases was similar; therefore, only one of them was presented in Paper I.

In the assessment of the individually tailored treatment, a multiple-baseline design was used to test the intervention, as it was not possible to fully withdraw the intervention (i.e. knowledge, cognitive strategies) once it was introduced. The plaque and gingivitis scores remained virtually unchanged during both baseline (buccal/lingual and inter-proximal surfaces) measures, and the outcome did not alter until the intervention was introduced. The rapid change of the slope and level supported a functional relationship between intervention and outcome. This change is probably attributed to the intervention rather than to factors such as maturation and history (Kazdin, 2003): maturation being something within the individuals that influences the result and changes over time e.g. getting older, wiser, more tired, and history refers to events in the individuals’ daily life that affect the outcome of the intervention.

Experimental single-case studies are well suited to the development of new treatment programs and testing their efficacy (Kazdin, 2003), and are specifically useful for understanding when, how, and under what conditions an intervention is effective and in providing opportunity for refinement of the intervention before being applied to a larger group study (Bockardt et al., 2008). In experimental single case studies, inferences about the effect of the intervention are made by comparing different conditions presented to the same case. This means the person under study serves as her or his own control. The rigorous control over the studied cases (baseline assessment, continuous assessment during the study and use of different phases) makes it possibly to rule out threats to the internal validity and thereby causal inference about each individual case can be drawn (Bockardt et al., 2008; Kazdin, 2003).

In this thesis the replication of the four single-case studies were conducted by using a randomized controlled group study design upon which Paper II-IV are based.
Randomised controlled trial (Papers II-IV)

The major strength in the group study (Papers II-IV) was the randomised design and the large sample, which minimised systemic differences between the groups before the interventions were introduced. Another strength was the low attrition rate during the study period; therefore, the change in mean values after treatment and the differences between groups could be interpreted as an effect of the interventions rather than differences in means due to characteristics for the dropouts. In this thesis, intention to treat analysis was applied and all randomised participants in both groups were included in the statistical analysis: these preclusions strengthened internal validity and that the differences in the results were due to the intervention (ST or ITO-HEP) rather than other external factors or influences.

The control intervention was designed to correspond to the best-described standard oral health educational program in the area of non-surgical periodontal treatment, and was according to the recommendation described by Rylander and Lindhe (1997) and commonly used in periodontal treatment (Axelsson et al., 2004; Hugoson et al., 2007). The standard educational program was familiar to both dental hygienists; however, the individually tailored treatment was not familiar and may have been more difficult to carry out. Several precautions were taken to increase treatment integrity to ensure the interventions were implemented as intended for both groups.

To increase adherence to the study protocol, both interventions were described in manuals; for the experimental intervention, copies of long-term goals, intermediate goals, and diaries were saved in a personal file. Video recordings were taken to verify if the content of the intervention in both groups corresponded with the study protocol. All data confirmed the objectives were fulfilled by the two interventions and that the interventions followed the study protocol. The diary was the only component in the experimental conditions not completed by all participants. There could be several explanations for this, such as the dental hygienist failed to distribute the diary, the patient forgot the diary at home, or did not complete it. Few participants (n = 9) did not complete the diary between all session, and there was no reason to believe that it influenced on the results. Both study groups improving as expected and the differences between and within groups being similar for both dental hygienists strengthened that both interventions were implemented as intended.

Validity and reliability of the measurements

The clinical measurements used in this project are established in dentistry and periodontal research and the examiner who performed the clinical measurements was familiar with all periodontal outcome measures. However, all indices are based on a subjective judgement by the person performing the assessment, therefore, there is always a risk judgement differs between as-
sessments for the same patient. Thus, precautions were taken to strengthen the internal validity. First, the person who performed all clinical measurements was blind to group allocation. Second, to ensure intra-observer reliability, test-retest on PI and GI were conducted during the study, which revealed good reliability.

In the statistical analyses, both PI and GI in Paper II and the individual factors in Paper IV were analysed with parametric statistical models, even though the scales were on an interval level and non-parametric models might have been more appropriate. However, non-parametric analyses were conducted and the results for both within and between groups were similar for both methods. Mean values are often more illustrative than rank-sums and for PI and GI, mean values are always used in dentistry.

The preset criteria for clinical significant level in Paper III was aimed to be individually related and understandable, and to correspond with professional skill (i.e. scaling performance), patient adherence (i.e. educational program), and reduced risk for disease progression and serve as guidance for the clinician for treatment success in non-surgical periodontal treatment. The proportion of plaque scores provides information on individual self-care (and skills) and measures such as gingival inflammation and probing pocket depth provide information on current periodontal condition (Renvert and Persson, 2004) and a low BoP score indicates periodontal stability (Cobb, 2002; Lang et al., 1986). In an attempt to identify the success rate of treatment, Lundgren et al. (2001) propose an evaluation criteria staircase based on site level, with the highest level of success being PPD ≤4 mm, no signs of gingival inflammation or BoP, and no further loss of clinical attachment or alveolar bone loss. However, in a clinical setting, these criteria might not attainable for all sites. In this project PI, BoP, and “Pocket closure” were chosen because of clinical relevance on an individual basis rather than at site level, and indication that success level also included a quality related component was verified by individuals self-rating of oral health.

The two instruments used to evaluate social cognitive outcomes in Paper IV are established (Syrjälä et al., 1999; Tedesco et al., 1991), but were used in their Swedish version for the first time. The Cronbach α for attitude and self-efficacy was moderate to high indicating an acceptable reliability of the measures, but was somewhat lower for subjective norms. The instrument constructed by Tedesco et al., (1991) followed the instruction by Ajzen (2002b) and are assumed to mirror the different constructs in the Theory of Reasoned Action. To assess self-efficacy towards interdental cleaning, an instrument assessing interdental cleaning self-efficacy by Syrjälä et al., (1999) was used. The instrument had only four respondent scale steps but that was considered too few for detecting changes, thus, two additional steps were added. This did not appear to affect item reliability for the homogeneity of the scale, as the Cronbach α was high.
No suitable instrument was found to measure participants’ opinion about interventions and satisfaction with treatment. Therefore a study-specific instrument was developed. The items used were influenced from an instrument used in a study in physiotherapy evaluating two interventions (Åsenlöf et al., 2005a). Prior to the RCT the relevance of the items were tested on the participants in the single-case study and three other patients treated at the clinic.

The items used for assessing oral hygiene habits were designed for this study but were similar to those used in epidemiological studies in Sweden (Uhrbom and Bjerner, 1993; 2003) Before the dental hygiene treatment started, about 40% of the participants reported interdental cleaning once a day; however, from the baseline plaque scores, there were no differences between the participants who reported frequent use of interdental cleaning aids and those who did not. There are several explanations for this, for example, overestimating the frequencies of use, starting to clean more regularly after periodontal examination and pre-treatment actions, insufficient cleaning technique, and/or inappropriate cleaning aids. However, the analysis of oral hygiene behaviour inferred several patients reported use of interdental cleaning aids such as wood-sticks regularly, but as a device to remove food-impaction rather than removing plaque. Hitherto the gingival and the plaque indices are used as a surrogate outcome measure for oral hygiene behaviour but a more valid instrument would be beneficial to assess individual’s oral hygiene behaviour both in terms of quantity and endurance.

External validity and generalisation of experimental intervention

The project was conducted at a specialist clinic for periodontics with experienced dental hygienists and dentist and according to the protocols for treating patients with moderate to severe periodontitis. In the experimental single-case study, Paper I, the aim was not to generalise the result to a larger group but to test if a cognitive behavioural intervention was effective before it was implemented to any large group study: this is important from both an ethical and an economic perspective. Experimental single-case studies are used to some extent in health care, especially when developing new treatment strategies (Johansson and Lindberg, 2001; Söderlund and Lindberg, 2001; van Kouli et al., 2008; Åsenlöf et al., 2005b), but to our knowledge not described in the area of oral health research.

This was the first time an individually tailored oral health educational programme was tested and evaluated in a RCT. Even if the care-provider requires understanding and training in cognitive/behavioural principles and techniques and must learn and practise the MI method, this study highlighted it was possible to use the program in a dental clinic setting by a dental hygienist. The population consisted of patients with periodontal disease referred to the clinic and examined during one year (March 2006 to March 2007), and the mean age, gender, and smoking habits corresponded to epi-
demographic data on personal characteristics of patients previously referred to the clinic. Therefore, the participants in this study could be assumed as mirroring a population undergoing non-surgical periodontal treatment at the clinic. Furthermore, to be comparable with general practice, all remaining teeth were included i.e. no exclusion of molars or third molars. Even if the treatment in this thesis was conducted with experienced dental hygienists who were trained in the individually tailored programme, it is a reasonable assumption that the program could be applied in other similar clinical settings and in general dental care.

Clinical implications

The findings of this thesis favour the individually tailored programme and the program was well accepted by the study participants. To implement an individually tailored oral health education program by dental hygienists or dentists in similar clinical settings, or in general dental care, requires complementary training. The use of cognitive behavioural techniques such as implementation plans/goals for when, where, and how to adapt the behaviour change (Gollwitzer, 1999), and self-monitoring of how well the plan is followed could facilitate behaviour change. A positive attitude and high intention to change behaviour was insufficient for attaining a level of proper oral hygiene behaviour and low plaque- and gingival scores (Paper IV). The development of skills for performing the new behaviour, having a plan for overcoming obstacles for behavioural change, and reinforcement situations are necessary for facilitating the change. Therefore, comprehensive education for dental hygienists and dentists for incorporating the use of cognitive behavioural strategies into their clinical work is necessary. Motivational interviewing could be a useful method for facilitating dialog between oral health care providers and patients. Hence, the behavioural medicine perspective should be the basis for preventive strategies in the undergraduate education of dental hygienists and dentists. For successful clinical implementation, a person with competence in applied behaviour analyses, including teaching through direct supervision or analysis of video recordings, are essential.

The pre-set criteria for clinical significant level of treatment success are described in Paper III. These levels could be useful in research comparing different treatments and their effect in non-surgical periodontal treatment and could also be used as a guide for the clinician in dialogue with patient’s when discussing treatment goals. If the treatment fails to reach the pre-set level for plaque, oral hygiene behaviour change may has been insufficient, which requires analysis of how the oral health education is implemented or provided. A more careful analysis of the debridement procedure and the need for surgery must be considered if the pre-set criteria for pocket closure or bleeding on probing are not achieved.
Conclusions

- Cognitive behavioural strategies and motivational interviewing communication methods are applicable and can be performed by trained dental hygienists in a clinical setting.
- The individually tailored oral health educational program is effective in oral hygiene behavioural change. Participants attained a higher level of oral hygiene practise and improved gingival health more than participants receiving standard treatment: the differences were most pronounced for interproximal sites.
- Individuals in the individually tailored oral health educational programme group had lower bleeding on probing scores than standard treatment group, but there were no differences for periodontal pocket depth.
- With the preset criteria for clinically significant treatment success i.e. maximum mean for PII, BoP, and pocket closure, more individuals in the individually tailored oral health educational programme achieve treatment success (“successful-NSPT”) than with standard treatment.
- A lower level of plaque at the start of the non-surgical periodontal treatment and individually tailored health educational programme increases the probability of attaining clinically significant treatment success, “successful-NSPT”.
- An individually tailored oral health educational programme influences intention to perform daily interdental cleaning.
- High Self-efficacy scores at baseline predict daily interdental cleaning and PII scores ≤ 20%, one year after treatment.
- Individuals with low self-efficacy have a higher probability of a successful level of oral hygiene behaviour if treated with cognitive behavioural intervention rather than standard treatment.

These studies demonstrate an individually tailored oral health education program is preferable to standard program as an oral hygiene behaviour change intervention in non-surgical periodontal treatment.

Further research

This thesis highlights the need of further knowledge in some aspects. The positive effect of the individually tailored program must be considered in terms of its cost-effectiveness. A patient-related outcome such as oral health related quality of life before and after non-surgical periodontal treatment also requires evaluation. To validate the accuracy of the pre-set criteria for plaque score, bleeding on probing and pocket closure, described as treatment
success, long-term evaluation is necessary. Furthermore, there is a need to study how the education of the individually tailored program could be implemented into daily practice for dental hygienists and dentists. There is also a demand for further research on how this program could be implemented into general dental practice and to include patients with less severe periodontal problems and patients who maybe less motivated to collaborate for economic reasons. One possible application would be to confirm if an individually tailored program could be successfully applied in the treatment of individuals with active caries or individuals considered at high risk for caries.

Little is known about how patients experience the treatment, organise their oral hygiene practise, or which strategies they use to facilitate behavioural change. Such knowledge is preferable gained in qualitative studies. Further research in investigating the components in interventions that contribute to change and the moderators such as individual- and contextual variables that influence the change may serve as guidelines for dental hygienists and dentists in their determination of which patient would benefit from a particular intervention.

Syftet med avhandlingen var att utveckla, beskriva och utvärdera ett individuellt skräddarsytt munhälso- undervisningsprogram integrerat med den icke-kirurgiska behandlingen av patienter med parodontit med avseende på munhygienbeteende. Ett ytterligare syfte var att utvärdera programmets effekt på parodontal hälsa och att studera faktorer av betydelse för att förutsäga munhygienbeteenden. Två separata studier ingår i avhandlingen, båda utförda på en specialisttandklinik i ett svenskt län. I den första studien (delarbete I) utvecklades och prövades undervisningsprogrammet genom två experimentella fallstudier med två separata baslinjemätningar, en för tandborstning och en för approximal rengöring. Programmet har utvecklats med utgångspunkt i kognitiva beteende tekniker för att organisera olika beteendeförändringsstrategier i interventionen och rådgivningsprocessen är inspirerat av och strukturerat enligt Motiverande samtalsmetod. Sju steg ingår i programmet; (1) individuell analys av kunskap, motivation och förväntningar samt formulering av långsiktiga munhälsmål; (2) Analys av munhygienvanor och munhygieninstruktion; (3) Individuell träning av valda munhygieniska hjälpmedel; (4) Individuellt utformade delmål för munhygienbeteende; (5) självkontroll av valt munhygieniskt hjälpmedel genom dag-
bok; (6) Samträning av valda munhygieniska hjälpmedel; (7) Återfallsprevention. Behandlingen är skräddarsydd utifrån den enskilde individens kunskaper, motivation till förändring, tilltro till egenförmåga, långsiktiga mål och delmål, samt parodontalstatus. I den andra studien (delarbete II-IV), en randomiserad kontrollerad enkel-blind studie \([n = 113, \text{medel ålder 51.2 (SD 9.4; range: 25-65), 53 % kvinnor}]\) testades effektiviteten av den individuellt skräddarsydda munhälsoundervisningen jämfört med en standardiserad munhälsoundervisning. Urvalet bestod av patienter med moderat till grav parodontit remitterade till specialistkliniken. I delarbete II jämförs de båda programmens effektivitet för att förändra munhygienenbeteende. Munhygienbeteende är i denna avhandling definerat som: \(\textit{frekvens} \) dvs. hur ofta som olika munhygieniska hjälpmedel används, \(\textit{kvalitet} \) som innefattar hur de används och \(\textit{varaktighet} \) vilket är hur de används i ett längre tidsperspektiv. Plack- och gingivalindex används som ett indirekt mått på kvalitet respektive varaktighet av munhygienenbeteendet.


Resultat från delstudie två visade att individerna i det individuellt skräddarsydda programmet rapporterade mer frekvent användande av daglig approximal rengöring och var mer säker på att upprätthålla den uppnådda beteendeförändringen jämfört med dem som fick en standard behandling. Resultatet visade också att individerna i det individuellt skräddarsydda programmet hade en bättre munhygien och en friskare gingiva (lågt plack- och gingivalindex). Den största skillnaden noterades approximalt. I delarbete III utvärderades den parodontala hälsan mätt som procentuell reduktion av fördjupade tandköttsfickor och blödning vid sondering. Vidare utvärderades utifrån fastställda kriterier för plackindex, blödning vid sondering och procentuellt andel utläkta fördjupade tandköttsfickor (< 5 mm) en kliniskt signifikant nivå för ett lyckat behandlingsutfall av den icke-kirurgiska behandlingen vid uppföljning 12-månader efter behandling. Individerna i studien delades in i två grupper beroende på hur de uppfyllde de i förväg uppsatta kriterierna för en lyckad icke-kirurgisk parodontalbehandling. Resultat från delarbete III, visade att individerna i det individuellt skräddarsydda programmet hade mindre blödning vid sondering jämfört med dem som erhöll en standardiserad munhälsoundervisning. Båda grupperna förbättrade sig lika mycket med avseende på procentuell andel utläkta tandköttsfickor. Fler individer i det individuellt skräddarsydda programmet uppfyllde kriterierna för en kliniskt signifikant nivå för ett lyckat behandlingsutfall av den icke-
kirurgiska parodontalbehandlingen. I delarbete IV utvärderades båda programmen med avseende på individernas intention till daglig approximal rengöring, attityd, subjektiva normer och självtillit till approximal rengöring och om det var möjligt att använda dessa karaktäristika för att förutsäga ett munhygiensbeteende 12 månader efter avslutad icke-kirurgisk behandling. Individerna i det individuellt skräddarsydda programmet ökade sin intention till daglig approximal rengöring. Hög självtillit till daglig approximal rengöring vid behandlingen start predicerade både själv-rapporterad daglig approximal rengöring och att uppnå ett plackvärde ≤ 20 % 12 månader efter behandling. Ett högre odds för att förändra sitt munhygienbeteende noterades för individer som hade låg självtillit till approximal rengöring vid behandlingens start om de behandlades med det individuellt skräddarsydda behandlingsprogrammet.

Slutsatser: Studierna visar att ett individuellt skräddarsytt munhälsoundervisningsprogram är att föredra framför ett standardiserat munhälsooundervisningsprogram i en intervention med avsikt att förändra munhygienbeteende i samband med parodontalbehandling. Självtillit till daglig approximal rengöring predicerar munhygienvänor och plackkontroll 12 månader efter avslutad behandling.
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