MANAGEMENT OF DENTAL CLINICS
BY THE USE OF INFORMATICS

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…about the importance of an overview when managing bits and pieces.
ABSTRACT

The main objective with this project has been to develop a tool for close-to-the-clinic healthcare management, based upon ways of measuring which are interpretable both by professionals as well as by patients. This would be a tool that collects and compiles data related to the dental health situation, permitting an overview of a dental clinic, and thus facilitating the management of dental-health improvements.

This thesis is based upon four different studies. The first study was initiated in a private dental clinic with the aim of creating a system of codes representing a summary of a patient’s dental-health situation. Interviews and discussions with specialists in the field of periodontology and cariology were held. Literature searches were performed as well as different tests in the dental clinic. The result became the HIDEP model (Health Improvement in Dental Practice) a health management tool based upon a preventive and tissue-saving approach. The code consists of the number of intact teeth and total number of teeth, together with a cariological and a periodontal grouping system defining where a patient is found upon a Health–Disease scale.

The second study aimed to develop a dedicated software system, supporting the work according to the model. Both model and software were tested and further developed in dental clinics in Sweden, Germany and the United Kingdom. Questionnaires, interviews and reports concerning the dental-health situation of the clinics were performed. The result became the DentiGroup™ software system. It compiles the codes into a Health profile that presents an overview of the dental-health situation of a dental clinic, from which close-to-the-clinic healthcare planning can start. The software also comprises functions such as risk analysis, automatic suggestions of codes, information leaflets, treatment plans, etc.

A retrospective cohort study was performed on 750 consecutively selected patients during a ten-year period to study if it was possible to follow up the dental-health situation over a longer period of time, as measured by the HIDEP codes. Data accessed from daily work according to the model was continuously registered, compiled and extracted from the software and assembled in a way which focused on the amount of saved dental tissues. 97.1% of the total number of teeth remained and 96.6% of the intact teeth were kept intact. 94.8 % of the patients kept their attachment according to limits of defined periodontal group.

The co-operation of the patients is essential to success in dental healthcare. A fourth study was performed in order to evaluate if work according to the model had any effect on the dental awareness of the patients. A comparative, cross-sectional study, using a questionnaire distributed in a consecutive way to 500 patients of three different types of clinics using either our model or another systematized preventive model, was performed. The result was that there were no differences concerning cariological knowledge between the clinics, but the awareness of periodontal diseases was significantly higher in a clinic using the HIDEP model for several years.

The HIDEP Model and its supporting software DentiGroup™ focuses on the clinical dimension of health–disease but, together with dimensions of economy and well-being, it seems to be a tool for defining outcome of dental healthcare, and as such is also a tool which manages and steers the development within a dental clinic by the support of Informatics.

Key words: management, dental, informatics, computerized, prevention, health, prevention
Målet med detta projekt var att utveckla ett verktyg att användas till en kliniknära vårdplanering baserad på mått som kan förstås av såväl tandvårdare som patienter. Ett verktyg som skulle möjliggöra att tandhälso-data kontinuerligt kunde samlas in och sammanställas för att ge en överblick av mottagnings tandhälso-situation. En överblick som skulle underlätta för tandvårdare och patienter i deras arbete mot målet en god tandhälsa.


En retrospektiv kohort studie utgjorde det tredje delarbetet. Tandhälsan bland 750 konsekutivt valda patienter studerades i en tio års period med syftet att se om det var möjligt att följa upp tandvävnadsbesparingar. Data genererad från det dagliga kliniska arbetet enligt modellen, hämtades från mjukvaran och sammanställdes med fokus på att utvärdera graden av tandvävnadsbesparingar. Det visade sig att under den studerade perioden fanns 97,1% av tänderna kvar och att 96,6% av de intakta tänderna hade förblivit intakta. Dessutom hade 94,8% av patienterna inte förlorat stödjevävnad inom de gränser de parodontala grupperna anger.


LIST OF PUBLICATIONS

This thesis is based on the following papers, which will be referred to in the text by their Roman numerals:

I. Sandberg HC, Fors UG.


III. Sandberg HC, Fors UG.
The HIDEP model - a possible tool for measuring dental-health development in a private dental clinic? In manuscript.

IV. Sandberg HC, Fors UG.
Dental awareness among patients and its possible relation to a management model for prevention. In manuscript.

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1 Introduction

Daily general practice within dentistry comprises a number of decisions, not only purely clinical ones, but also decisions concerning management of the team, patients and economics. All these different items might be comprised in the words close-to-the-clinic healthcare management. A way to steer the activities could be based on quality development and the concept of continuous improvements, but how might the resources of the practice best be used to meet the needs of the patients in the most effective way? This question directly raises several others. What are the needs of the patients, and how should these needs be defined, collected, interpreted, compiled and evaluated from one year to another? Would it be possible to define goals that give both dental professionals and patients an enthusiasm worth striving towards? Is there a common goal that would make the patients partners of the dental team instead of just being customers? How could we improve and move our activities further? These issues require methods of measurement which are interpretable for all parties involved. As W. Edwards Deming said with regard to quality, “if you can’t measure it, you can’t manage it...” [Deming 1982].

The daily work in a dental practice comprises the collection and compilation of clinical findings following a patient examination, the definition of a diagnosis and, in accordance with this, the treatment of the patient. The clinicians are well-acquainted with these steps. By examining each patient, it is also possible to evaluate the outcome of the performed treatment on each separate patient. However, the study of the outcome of the dental practice as an entity for improving oral health soon becomes quite difficult. If this might be achieved in a manageable way in the dental clinic, new possibilities would open up – possibilities that could form the foundation from which an overall evaluation of the outcome could be performed, that is, a foundation for quality development, healthcare planning and management.

As every patient “contains” a lot of information, it is quite impossible to keep more than fifteen to twenty in mind. However, the number of patients within a dental practice often consists of 1000, 2000 or even more patients. To keep track of all these patients by oneself is an intellectual impossibility. Thus, the use of Informatics is needed.

The introduction of Informatics within dentistry has facilitated the gathering of information, as well as increasing the possibilities for communication and exchange of information. This development has also induced a demand for increased efficiency. The concept of evidence-based dentistry seems to grow continuously stronger and will probably involve dental healthcare in a considerable way in the years to come. However, proven clinical experience within the dental team also needs to be taken in to account [White 2003]. There are gaps in knowledge that will need to be bridged, not only between providers and the patients, but also gaps between science and healthcare providers. It seems as a result from a lack of seeing the reality in the same way, probably due to communication problems and goal-setting. Modern information technology could be a way of facilitating future development in bridging these gaps.

In 1987, after seven years of clinical dentistry in my own private practice as well as having been a teacher at the Dental School in Stockholm, I was in a situation where I had to decide whether to focus on the faculty and an academic career, or on making a career of my dental practice and taking care of my investments in money, time and relations. At that time in Sweden there was a surplus of dentists and the competition for patients was intense. Why should patients choose our dental clinic for their dental healthcare? Since 1980 I had been working within the Praktikertjänst company, a company assisting private healthcare providers in Swe-
den. They had during this year produced a poster with the text “Our patients become healthier” to be put up in the clinic’s waiting room. However, how could we do that if we could not show that it was a fact. In 1987, we had also a new dental hygienist in our team. Did we share the same view? How did we define health in respect to disease in our team? It became necessary to find some sort of a common view, as well as a method of communication, not only within the team but also with our patients. Furthermore, that year I received a scholarship permitting me a six-week visit to Japan with the purpose of studying Japanese lifestyle, society, and industry, as well as Japanese dental healthcare. Just before leaving for Japan, I was involved in the organization of a military field hospital in Sweden. Moreover, the end of the 1980s was the dawn of computers within clinical dentistry. All these influences gave me an impetus to focus on my dental practice. Our search for answers to the questions we had, and the different methods we attempted to use, form the base of this thesis.

1.1 Outline of the thesis

The thesis is organized as follows:
The aim of chapter 2, “Background”, is to describe the trends in society and their relation to dentistry at the time this project was started. It was a period when the Industrial Society was successively transformed into the Information Society, when Sweden began to have problems financing the healthcare sector, when the improved oral-health situation among young adults became obvious, and the first software systems were introduced in dental healthcare.

Chapter 3 states the general, as well as the specific aims of the thesis, followed by Chapter 4 which outlines the material and methods used in carrying out the research. In this chapter, the different studies are not described in detail, as they are included at the end as “Original papers”.

Chapter 5 refers to the results, followed by discussions concerning both how the health-management model per se evolved, as well as the supporting software tool, as well as some outcomes concerning effects on the dental-health situation and the impact on dental awareness among patients.

Chapter 6, “General Discussion”, addresses what trends in the society of today can be identified, and what implications this has on dentistry, with a focus on both the possibilities and difficulties which the ideas in this research have revealed.

Chapter 7 includes some conclusions, concerning both specific and general experiences during these years.

Chapter 8 describes thoughts concerning future work within the area of the theme of this thesis that could be of interest.

Chapter 9 contains a long list of persons who, throughout the years have influenced me by both negative and positive criticism, who all inspired me with respect to the work with the model and software.

Chapter 10 contains the references, followed by the original papers.
2 Background

This project started at the end of the 1980s. What was society like and what challenges did we encounter within dentistry at that time? What was the view of patients, concerning how the dental team was organized and what methods were used? Did the introduction of Informatics add something to the field of dentistry?

2.1 Development of society and dentistry

The development of clinical dentistry seems to follow that of society in general [Toffler 1970, SOU 2002, Baelum et al. 2007]. In the Agricultural Era, when production was based on handicraft, dental healthcare was performed by blacksmiths. The treatment most often consisted of pain relief by extracting teeth. The Agricultural Era was followed by the Industrial Society, where mass production became a dominant sign. Within clinical dentistry, the focus moved from extractions to preparations that followed defined rules. Henry Ford said: “You can have any colour you want of your T-Ford so long as it’s black”. Within dentistry, this became: “You can have any filling you like as long it is according to the principles of Black”. Even though the decades of 1940-1970 [Gustafsson 1952, Löe 1963, Ramfjord 1967, Lindhe et al. 1970, Waerhaug 1978, Krasse 1996] showed that the diseases of periodontitis and caries were not inevitable diseases and that preparation didn’t cure cariological disease, technical solutions were still the predominant focus of the clinicians.

It seems that the Information Society started in the mid-1980s, one likely reason being the introduction of personal computers. The concept of Quality and Lean Production became the word of honour focusing on individualized production that economized resources [Krafcik 1988]. Quality assurance and development were facilitated thanks to the support which computers could offer.

It became clear that dentistry was facing three categories of patients [Hugoson 1979, Lundin et al 2005, SOU 2002]. One consisted of young individuals with quite good oral health, with almost no teeth restored at all. Another category, the adults, were most often heavily restored. The third category was the elderly, of which the number of totally edentulous patients diminished successively. For those without teeth, a new treatment was introduced, osseointegrated implants ad modum Brånemark [Brånemark 1972]. Dental healthcare moved towards being a life-long commitment. Twenty to thirty years earlier dental healthcare more or less ended when the patients received their first dentures around the age of their mid-fifties [Hugoson et al 2003].

In Sweden a debate concerning amalgam and its possible toxicity had started [SOU 2003]. This led to discussions about alternative techniques and materials, such as bonding techniques with porcelain and composites. The approach became individualized and tissue-saving preparations and the Principles of Black were abandoned [Tyas et al 2000, Wilson 2004]. The basis of this concept became Minimal Invasive Dentistry [Ericson 2004]. “JIT” – “Just in Time” [Krafcik 1988] – was another concept emanating from the Information Society that seemed capable of being applied to dentistry, as recalls started to become more individualized, thus implying the need of effective risk-assessment [Bader et al. 2003]. Another trait was that mass prophylaxis in terms of fluoride rinses in the schools became discussed, as well as personal responsibility (which stressed home-care and life-style issues) [SOU 2002].
2.2 Three dimensions to be measured

The World Health Organization has defined health as:

"Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" [WHO 1948].

The WHO definition describes two dimensions of health, one is that of well-being and the other concerns the clinical issue, absence of disease. However, it seems that, within society, the concept of health is tightly connected with a third dimension, that of economy.

In Sweden, health developments due to better living conditions and medical advancements have been tremendous during the twentieth century. Science and industry has continuously advanced the limits concerning the possibilities for diagnosis and treatment, although perhaps not always leading to improvements in well-being [SOU 2002]. For the Swedish government, the difficulties in financing the welfare system had started to become obvious, and questions regarding how economical resources should best be used in relation to the needs of the population were raised.

A dental insurance system covering the adult Swedish population was introduced in 1974, but in the 1980s it had started to deteriorate [SOU 2002]. It followed neither the development within dental healthcare, nor the consumer price-index. Even so it had been effective for 15 years, no one could tell what the result had been in terms of dental-health improvements [SOU 2007]. The number of dentists showed a surplus, and discussions of decreasing the number of dental students had started. Instead, the idea was put forward to increase the number of dental hygienists as a better adaptation to the changing needs of the population. [SOU 2002]

![Diagram](image.png)

Figure 1. The definition of health, together with economics, might form three dimensions: Well-being, clinical Disease–Health, and Economy. These dimensions have to be measured, and through this, it is possible make an evaluation over a period of time.

The objective becomes to have control of the dimensions shown in Figure 1 over time, and questions raised about cost-benefit, such as:
from a patient’s perspective: “What do I receive for the money I spend”,
from the dental teams: “What are the compensation for the services we deliver?”
from the authorities: “What effect does the money of the tax-payers have upon the outcome of dental healthcare?”

have to be answered.

Having control implies a necessity of having methods of measuring. Furthermore, these measures have to be interpretable by the different parties involved.

The economical dimension is measured by money, and the well-being by interviews and different methods of inquiry [Johansson et al. 2008]. However, what about the measures of the clinical Disease–Health dimension of “good oral health”? If the objective is to have the patients as members of the team as co-workers performing their part in dental healthcare at home, it seems important that the measures used are understandable and interpretable for them also. The agricultural and industrial societies had their methods of measuring, pain relief respectively production of items. The Information Society with the concept of Lean Production and the changing environment provided the necessity for new ways of measuring, and the possibility to communicate and motivate, not only within the dental team, but also involving the patient, as well as giving an answer to the question “What is achieved in terms of oral health for the money spent?”. At the end of the 1980s, there were no answers to this question regarding the adult population, despite the fact that dental healthcare had been financed to a large extent by subsidies from taxpayers ever since 1974. However, some epidemiological studies had been performed [Hugoson & Koch 1979] but there was no data covering the entire adult population of Sweden, as there was no demand upon the dental healthcare sector to report any data to authorities.

2.3 Measuring dental health

In the 1980s the management of dental practices most often was focused on what was done (production in terms of items performed), and less on what was really achieved (outcome in terms of dental health). The main reason for this seems to be difficulties in measurement. Measuring Quantity is much easier than measuring Quality [Deming 1982]. It is much easier to measure production in terms of numbers of root-canal treatments, fillings, crown-restoration, etc. than to measure how many patients have obtained/maintained healthy conditions. This might be seen as a reflection of the Industrial Era, and is not a problem only within dental healthcare, as the same situation exists in general healthcare.

There are several indices and measures within dentistry related to the presence/absence of disease and the most common deal with the Caries and Periodontal diseases. One is the so-called DMFT/S index, Decayed Missing Filled Teeth/Surfaces (DMFT/S) [Klein & Palmer 1937], reflecting caries disease in some respects. Another is the CPI (Community Periodontal Index) [Ainamo et al. 1982, Cutress et al. 1987] that has periodontal diseases as the target. These indices have been criticized. DMFS was constructed at a time when the caries situation was quite different. For example, it does not take into account early signs of demineralisation, when it is possible by non-invasive methods to stop future development [Martens & Sheiham 1993, Lewis 1996]. The CPI was at first criticized because it did not include the marginal bone-level, as well as implicating that Gingivitis was always followed by periodontitis [Miller et al. 1994, Holborow 1998]. It is also said [Baelum et al. 2007] that these and other indices pushed dentistry into a technical method of treating diseases.
As W. E. Deming said, you cannot manage what you cannot measure, and this might be interpreted as the necessity for having methods of measurement for our basic objectives, as well as being interpretable for all parties involved. Much could be accomplished if the involvement of patients could be increased by using methods of measurement which are interpretable by them also, due to the fact that home-care and ways of living are most important for improving oral health [Baelum et al. 2007].

2.4 Management of dental practice by Informatics

In the mid-1980s, the first computers were introduced in dental clinics in Sweden. At this time, they were just tools to keep track of patients’ personal data, invoices and recalls. They gave a support more of an administrative character than that of a tool which could come into use for managing the actions of a dental clinic [Petersen & Johansen 1994]. However, the support from computers continuously became more advanced. Unfortunately, it seemed that this development was based upon how the paper-based record system was constructed. The focus was on input and layout, instead on output. This focus was enforced while legislation regulating the demands upon dental records was based on the paper-based system. This resulted in the digital dental recording systems becoming more or less a digital version of the paper-based record with the same shortcomings concerning output of health-related data, but without the ease of input. The output from dental software systems was mainly based on economics in terms of production of items. In 1987, there was no software directly designed as a tool for the management of a dental practice with the ambition to improve/maintain oral health. Therefore, there was obviously a need for such a system.

3 Aims

3.1 General aims

The general aim of my thesis was to study possible oral-health improvements by the use of some sort of a healthcare management model. An important issue was that the dental team should not have to set aside extra time to register a huge amount of parameters, but instead only to take advantage of the parameters that were already recommended in daily clinical use. Another issue was to facilitate the dental team further by developing an informatic support for the management model.

When it comes to the specific questions under the study, the work was divided into four sub-studies.

3.2 Specific aims

3.2.1 - Study I - The development of the HIDEP Model

The first sub-study aimed to develop and construct a model that could be used to manage both patients and professional healthcare providers toward dental-health improvements. This included finding manageable and adequate measurements of dental health with the aim of using them as a base from which effective close-to-the-clinic healthcare planning could be performed.
This study was published in the paper Sandberg HC, Fors UG. The HIDEP model-a straightforward dental health care model for prevention-based practice management published in Swed Dent J. 2007; 31(4):171-9.

### 3.2.2 Study II - The software support
The aim of this second sub-study included both the development of software, supporting work according to the HIDEP model, as well as pilot tests of the system itself.


### 3.2.3 Study III - The development of the dental-health situation
The aim of this sub-study was to study whether it was possible to follow the dental health of patients attached to a dental clinic through the use of the model and its supporting software for a longer period of time.

The study is described in the manuscript: Sandberg H, Fors U. The HIDEP model, a possible tool for measuring dental-health development in a private dental clinic?

### 3.2.4 Study IV - Effects upon dental awareness among patients
The aim of the fourth sub-study was to study whether the model and its supporting software have any possible effects on the dental awareness among patients attached to dental clinics using the model and its supporting software.

The study is described in the manuscript: Sandberg H, Fors U. Dental awareness among patients and its possible relation to a management model for prevention.
4 Subjects, Materials and Methods

4.1 Study I - The development of the HIDEP Model

The origin of the development started with three specific questions:

- Do the patients become healthier?
- Could it be possible to create a view in common within the dental team?
- Could the motivation and the involvement of the patients increase?

The statement “You can’t manage what you can’t measure”, said by W. E. Deming, does reflect a need of some sort of measurement capable of giving answers to these questions. Without measurements it becomes impossible to evaluate, and if there is no evaluation, actions aiming at continuous improvements cannot be planned [Deming 1982]. The ideas behind the concept of Quality seemed to constitute a good possibility on which to base the research. Within this concept is the production denominated as Lean Production, a production that is individualized and is economical with resources. This seemed to fit within dental healthcare. The end of the 1980s was a period when we started to abandon the preparation principles of Black [Tyas et al 2000, Wilson 2004], and instead started to think in the direction of minimally invasive dentistry [Ericson 2004]. As the objective was to be tissue-saving in the short and long perspective, the bonding technique permitted the carious lesion to define the form of the restoration. Also the concept of “Just in time” (JIT) seemed to be possible to use within dentistry especially concerning individualizing frequency and content of maintenance treatment. However, at this time dental healthcare was very technically oriented despite the knowledge that primary prevention ought to be the foundation of saving tissues. The most important part of the primary prevention was then, and still is, due to the daily home-care performed by the patients and their way of living [Baelum et al. 2007]. Due to this fact, a system used for effective communication with the patients was of interest.

Based on these thoughts a so-called business concept for dental healthcare was formulated as:

**Dental professionals are to promote good oral health and well-being and secure reasonable compensation for the services we provide our patients.**

This statement was reflected in three dimensions: 1, well-being, 2, health, and 3, economy (please see Figure 1). What dental healthcare providers are delivering was defined as, “to promote good oral health and well-being”, and what they are taking as compensation for this work (the economic dimension) was defined as “secure reasonable compensation”. In this way, it also describes a goal that might be common for both healthcare providers and their patients. Both parties might find “good oral health and well-being” worth striving towards.

Concerning “reasonable compensation”, this implies that the patient could find the costs for the services to be reasonable. In other words, the patient has to find the quality of the offered services worth the costs, which is defined within “customer value” [Krafcik 1988].

As one can assume that both healthcare providers and patients are striving towards the same goal, good oral health, the patient might be seen as a partner or a “member of the team”. Healthcare professionals promote good oral health in the clinic, the patient does this in their
homes. However, if the patient is seen instead as a Customer, it might be difficult to fulfil the aims. This is because of the fact that the customer-view demands an obligation of the vendor to fulfil expectations. As the expectation of the population seemed to be that the purpose of dentistry was to repair, it did not correspond to the business concept. These expectations within the population were due to tradition and a lack of knowledge – a knowledge gap that had to be bridged.

The bottom line of dentistry could, by paraphrasing Hippocrates, be formulated as:

- Sometimes to restore tissues loss
- Often to prevent further loss
- Always to increase the patient’s own possibilities to avoid loss of tissues.

The main causes of tissue loss are the diseases Caries and Periodontitis. To define dental health, a system is needed that takes into account both tissues and the diseases. Furthermore, as the patient has their own responsibility for their dental-health situation, it is necessary for the system to facilitate communication with the patient.

To work according to such a philosophy in the dental clinic, it became necessary to find measures that were easy to interpret and to communicate not only within the dental team, but also for use in communication with patients and, in the long run, with authorities and organizations also. The ambition became to establish some sort of a code presenting a summary of an individual patient’s dental-health situation.

Within the concept of quality, the importance of defined processes was also stated [Deming 1982]. If it was possible to define treatment and recall structures within a dental clinic, it might also be possible to evaluate the outcome of the methods used.

Without defined structures, there is a risk of ad hoc decisions that might vary according to time of day and day of the week. Thus, the aim also became to find a more objective decision support, and more strict structures that could link to the different codes describing a patient’s dental-health situation. The positive part of structures could be expressed as:

- Structures make it possible to evaluate the treatments that have come into use
- A structure facilitates a common view and increases objectivity
- Structures allow one to know when exceptions have been made.

Exceptions have to be done as within healthcare we are working with a variety of human individuals. It is important to stress that the ambition was not to define structures that might be seen as a limiting roof instead as a stable platform giving self-confidence to the team and its individuals.

Concerning measurements that where searched, the following three demands were defined:

- They had to be easy to perform
- Clinically objective as possible
- Repeatable as possible.

The first thought became to base the ways of measuring on pocket depths. Deep periodontal pockets, whether they were bleeding or not, were seen as very negative signs at the end of the
1980s. By measuring all pockets of all patients attached to the clinic, it would perhaps result in a sum of, let us say, 675 meters. By adequate professional periodontal treatment combined with appropriate home-care, the sum would hopefully be reduced. Such a method of measurement also seemed possible to communicate to the patients, as well as to be used for evaluation of the periodontal treatment performed. However, the most effective way to eliminate a pocket is by extracting the tooth. The conclusion drawn was that one has to be very cautious concerning what measurements that should be used, as measurements strongly steers how people work [Deming 1982]. Initially, we ended up with a base of measurement where the number of teeth and approximal bone level, together with pocket–depth, became the parameters. Concerning the cariological measures, at first the number of teeth was the basis, together with the number of cavities.

These basic ideas were by chance challenged by Lars Lundin, former head of the Orion Diagnostic company, situated in Trosa. He introduced us to specialists within the fields of cariology and periodontology, but also asked the crucial question, “Why wait until the cavities occur, why not do a risk-estimation and give proper prevention to avoid diseases”. The question to the specialists became, “How should we perform a proper risk-estimation concerning the caries and periodontal diseases?” The recommendation became “Collect as much data as possible about the factors involved in the diseases and you will find out”.

Literature was searched, the most common index used at that time within the cariology field was the DMFS index [Klein & Palmer 1937]. This index did not contain much concerning preventive possibilities. On the periodontal side, there was the recently introduced Community Periodontal Index (CPI) [Ainamo et al. 1982, Cutress et al. 1987]. However, it did not include any parameter that measured the level of supporting tissues, one of the parameters that was thought to be very important. This lack showed that it would be difficult to use in a long-term perspective concerning the evaluation of outcome in terms of dental health. Furthermore, these indices, despite not containing any proactive part, did not seem easy to use for communication and motivation of the patients.

In 1988 the Swedish National Board of Health and Welfare released a framework proposal concerning a dental-health program for the adult population, the so-called RAMVUX [Swedish National Board of Health and Welfare 1988]. Even though this system was also mainly based on symptoms and not on risk, it could with some minor adoptions suit the defined purposes. In addition to the part concerning different levels of disease presented in RAMVUX, was a part added concerning different levels of risk for those patients who did not show any visible symptoms of disease. This system became the so-called HIDEH model (Health Improvement in Dental Practice), in Swedish “Den Nivågrupperade modellen”.

4.2 Study II - The software support

The so-called HIDEH code developed in Study I contains the parameters of number of teeth, number of intact teeth, and a cariological and a periodontal group. From the beginning, these codes were registered in the paper-based record of every patient in the clinic. At one glance, they gave a rough summary of the specific patient’s dental-health situation. However, it became a hard work to compile all patients’ codes in order to have some sort of overview of the clinic’s health situation, as it was based on paper. As the mission within dental healthcare is to promote good oral health among patients and not to produce paperwork, the need for a dedicated software system became obvious.
At that time in 1988, software was in use in the clinic which assisted the team with invoicing of patients and with keeping track of recalls. This software also became used for handling data resulting from the HIDEPE model. The fields “Phone Home” and “Phone Work” in the patient register-form of the software were sufficiently large and were subsequently used to register the HIDEPE codes. Age-divided telephone lists were printed out regularly. Codes were compiled by hand and health profiles giving an overview of the dental-health situation of patients attached to the clinic were constructed by hand.

At the end of the 1980s, it was rare for dentists to know anything about the support from Informatics, but I had the luck to know a colleague, who knew about computer systems and programming. Together with this colleague, a software that permitted us to enter the codes in different age-groups and to compile a health-profile diagram automatically was developed. This was the first step towards a dedicated software supporting work according to the HIDEPE management model.

The working strategy was to create a software from, so to speak, “the other way around”, beginning with defining what questions we wanted to have answers to. Instead of having a focus on Input, the codes were already established, the focus became on Output. What were the questions that had to be answered? The main question was still “Do our patients become healthier?” the second followed naturally “What shall we do to move towards our goals continuously?”, and finally “How much does this cost in terms of time and money spent?”

The development continued and 1992 the first version of the software system DentiGroup™ was developed and also offered as a commercial product. At this time, we had created, through our network of contacts, a platform from which we could perform different clinical tests with the model as well as the software among not only Swedish healthcare providers, but also clinicians in the United Kingdom and Germany.

The clinical tests included different steps.

- Was the philosophy comprehensible in different clinical environments and in different countries despite different insurance schemes?
- Was the translation correct, especially with respect to the special patient information leaflets?
- How accurate were clinicians in respect to giving an adequate HIDEPE code to a patient?
- Did the suggested treatment plans seem to be realistic and adequate?
- Was the software user-friendly enough? What functions could be improved?
- How long a period would elapse before a clinic had enough data to establish an overview, a Health profile that showed a relevant picture of the entire clientele of a specific clinic?
- Could this Health profile be used to form the basis from which close-to-the-clinic healthcare planning could take a start in the clinic?
- How could the system be implemented in best possible way in a clinic?

In Sweden, we had at the beginning of the 1990s close contacts with the Folktandvården, the Swedish Dental Health Service, in the counties of Södermanland, Västernorrland and Värmeland. A connection between DentiGroup™ and the digital dental recording system that was in use in Sörmland became a reality. Abroad we had contacts with Ivoclar UK and in Germany with Vivacare, a subdivision of the Vivadent-Ivoclar company. The software was continu-
ously updated with an appropriate language, as well as the treatment plans and patient-information leaflets. In Sweden, we had different test groups comprising fifty teams, in the UK we had a test group of nine dental teams and in Germany fifteen. A second period of tests in the second half of the 1990s was performed in Germany in close co-operation with Zahnärztekammer Nordrhein, including fifty clinics, and at the beginning of the 2000 in the UK in a collaboration with the British Dental Association (BDA), as well as with a group of private dentists in Stockholm, “Privata Munhälsan”.

The software and model was also presented within the organization of International Healthcare Foundation (IHCF), an organization that involved clinicians and scientists within cariology as well as periodontology. In addition, an exchange of ideas was made with dental insurance companies in North America, such as Northwest Delta Dental in Seattle, Washington, and the Knowell Company in Montreal, Canada. Close contact was also established with the late Dr. Hans Sundberg, head of the dental department of the Swedish National Board of Health and Welfare [Sundberg 1992].

The clinical tests started with a full-day lecture introducing the philosophy and content of the HIDEP model and hands-on training with the most recent version (at that specific time) of the DentiGroup™ software. All personnel of the dental teams were invited to these sessions. To increase the reliability, the attendants were trained in assigning adequate HIDEP codes using predefined cases.

Throughout the different tests, questions that arose were continuously answered and support was given, at that time mostly by fax and phone. The test teams had to fill in enquiries and were interviewed concerning user-friendliness and proposals for improvements. They also had to report the oral health situation of their respectively clinics regularly. At the end of the different tests, a summary was made and distributed either in a final meeting or in written form to the different teams.

The input from the tests gave valuable ideas concerning improvements for the software. New versions were continuously developed and further tested. These tests gave a considerable knowledge base, not only concerning the development of the software, but also input concerning new ways of profiting from the basic ideas and philosophy of the model.

During these years, there was a rapid development of Information Technology in society. The introduction of the personal computer occurred at the end of the 1970s, but it took until the mid-1980s before it started to grow stronger. Since then, one can say that the speed of the processors and the memory has been multiplied by a factor of a hundred. The speed of the processors moved from 20 MHz to 2 GHz and the memory from 20 MB to 200 GB on computers used at home. More data could be handled faster.

The DentiGroup™ system was initially (version 1.x and 2.x) developed using a database programming system named Superbase (Software Publishing Corporation, USA). To furnish necessary graphical functions, graph data functions were implemented using the Graphics Server (Bits Per Second Ltd., England) system. The version 3.0 of the DentiGroup™ system was based upon MS-Access 97 (Microsoft Corporation, USA) and Graphics Server 5.0, enabling a MS-Windows 95, 98 and NT compatible system. The current version (4.1.1) was developed in MS-Visual Basic and Visual Basic for Applications (VBA) and released in 2003.
As the performance of computers and software increased, it became possible to improve the usability of the DentiGroup™ continuously in terms of layout and functions according to the demands of the users. The software evolved toward more user-friendliness, both concerning layout and interactivity. Functions were added, but the basic concept remained unchanged.

4.3 Study III - The development of the dental-health situation

To test if it was possible to measure the dental-health situation of the patients in a dental clinic and to follow the development over time by the use of the HIDEP codes, a retrospective cohort study on consecutively chosen patients was performed. It was decided to look at the situation during the year 2005 and to compare it with the situation 10 years earlier.

The HIDEP model is based upon the assumption that a patient could, in a clinical point of view, be either in Health or have symptoms of Disease. If in Health (being inactive), there are five levels of risk: 0S, 1S, 2S, 3S and 4S. From very low (0S) to very high (4S) risk of attracting disease. The “S” stands for Support/maintenance treatment. Concerning Disease, there are four groups: 1, 2, 3 and 4 corresponding to severity of symptoms. This goes both for caries as well as for the periodontal diseases, and gives the codes:

C0S, C1S, C2S, C3S and C4S describing different cariological risk groups.

P0S, P1S, P2S, P3S and P4S describing different periodontal risk groups.

C1, C2, C3, and C4 and P1, P2, P3, and P4 corresponding to severity of symptoms of caries respectively periodontal diseases.

In summary, a HIDEP code consists of four parameters, which are:
- Total number of teeth
- Number of intact teeth
- A cariological code
- A periodontal code,
altogether describing where the patient could be found upon a Health–Disease scale.

The HIDEP codes were used in this study to evaluate the dental-health development concerning the ability of the dental team, together with their patients, to save tissues measured in terms of number of teeth and number of intact teeth, as well as loss of supporting tissues in terms of approximal bone level [Norderyd et al 1999, Paulander et al 2004]. Two other issues of interest for study were whether it was possible to identify some age group that presented a higher degree of risk-attracting symptoms of the caries disease, but also whether the patients in a periodontal aspect had kept their periodontal situation or even improved it [Axelsson et al 2004].

Data in terms of HIDEP codes from 2005 and 1995 respectively was extracted from the DentiGroup™ software of those patients that fulfilled the inclusion criteria. These were: patients within the 20-79 age range in the year 1995, being active within the recall system of the specific dental team during these ten years. In order to evaluate the long-term outcome of the periodontal situation, the periodontal groups were transformed to represent approximal bone levels in this way:
• Groups P0S + P1S + P1 formed the category **No loss of attachment** (= approximal bone level less than 4 mm from cemento-enamel junction).

• Groups P2S + P2 formed the category **Moderate loss of attachment** (= horizontal approximal bone loss less than 1/3 of the root length).

• Groups P3S + P3 + P4S + P4 formed the category **Advanced loss of attachment** (= a horizontal loss more than 1/3 of the root length (P3S and P3), but also including patients with vertical bone-pockets, and/or furcation involvement (P4S and P4)).

The long-term effects of caries disease were measured by the number of intact teeth and the total number of teeth.

It was also decided to study whether any age groups could be identified in which the cariological risks increased, as well as whether there had been any changes concerning the relation of the number of patients with Inactive disease compared with those being Active in a periodontal perspective.

**The clinic under study**

The private clinic under study is situated in Trosa, a small town in the countryside about 75 kilometres south of Stockholm. The number of inhabitants is around 4500; the mean age, as well as the socio-economic standard, is above the average of Sweden. Many of the inhabitants commute to other cities in the vicinity. In this specific private general dental clinic, adult patients, 20 years or older, are treated. The dental team consists of one dentist, one dental hygienist and two dental assistants. The HIDE model has been in use in the clinic since the end of the 80s to steer the activities of the clinic.

**Data processing and statistics**

All data was processed in the software DentiGroup™ in order to collect and study the overall health profiles, to assist in calculation of HIDE codes and to select patients. Box plots of medical values, quartiles and 10-90 percentiles have been calculated using the Statistica software package, version 7.0. The change in caries risk scores and the change in the number of patients with active periodontal disease were analyzed by a generalized-estimating-equations (GEE) model with the GENMOD procedure in SAS®. Additional figures and graphs have been produced by MS-Excel. A senior medical statistician supervised all statistical operations. The regional research ethics committee in Stockholm approved the study.

**4.5 Study IV - Effects upon dental awareness of patients**

As stated at the beginning, oral health development is strongly due to the home-care of the patients, as well as their way of living [Baelum et al. 2007]. Dental healthcare providers can be as technically skilled as possible, but as long as the patients do not perform their part of the work, dental healthcare will not succeed in the long run. Sometimes the question has been raised whether dental healthcare providers have anything to do with oral-health improvements as, in places where health care providers are rare rather than where there is an abundance of dentists, oral health is sometimes better counted in terms of number of teeth.
It seems that an important mission of the modern dental healthcare team is to be some sort of a knowledge broker or a so-called infomediary, a person who helps a client to make better investment or purchase decision. In that way, the dental team could have a function of collecting information and extracting useful knowledge that should be transferred in a comprehensible way to the patient. [Abrahamsson et al 2008]

The question of whether the HIDEP model could assist as a tool in this knowledge transfer was raised. It was decided to perform a comparative study in different clinics – those that had been using the ideas and software for several years, with those that were new HIDEP-model users and with clinics that did not use the HIDEP model, but instead, used another healthcare-model system. The study was based upon an enquiry that was consecutively distributed to 100 patients in each dental clinic. The aim of the different items within the enquiry was to measure the level of knowledge, interest, motivation and desires concerning dental health.

The aim of this study was to investigate whether the HIDEP model and its supporting software is facilitating the communication of the broad message of the model and its preventive measures to the patients.

The three different clinical settings were:

- **Category I**: Clinics using a model of a systematized preventive approach other than the HIDEP model.
- **Category II**: Clinics that had been working according to the HIDEP model for about one year.
- **Category III**: A clinic that had been working according the HIDEP model for more than ten years.

The clinics were chosen to, in some respects, represent smaller communities as well as larger cities. The questionnaire consisted of 12 different items in a Likert-type scale, as well as questions about background data such as gender, age, educational level, but also a question about how long the patient had been within the clinic.

The enquiries that were sent back by post were compiled and statistically analyzed in MS Excel and Statistica (version 7.0) in collaboration with a medical statistician. The main methods were basic descriptive statistics and Kruskall-Wallis ANOVA by ranks. The regional research ethics committee in Stockholm approved the study.
5 Results and Discussions

During the last 20 years changes within society and the dental healthcare sector together with progress of science, and close contacts with specialists, clinicians and patients have formed the HIDEP model and its supporting software DentiGroup™. In the following the model and software are presented, as they appear today in 2009. Accordingly, the presentation of Study I and Study II will be more comprehensive than it is in the published articles. Study III “Development of the dental-health situation” and Study IV “Effects upon dental awareness among patients” are, on the other hand, presented less extensively, but two manuscripts are to be found in the section “Original papers” at the end of this thesis.

5.1.1 Results of Study I - The HIDEP Model

The model developed at the end of the 1980s was given the Swedish name “Den nivågrupperade modellen”. In English this would be “The level-grouped model” or, as we usually call it today, the HIDEP model.

The HIDEP model has as a basis a coding system that makes it possible to identify where the patient might be found upon a dental Health–Disease scale. The different codes form a summary of the oral-health status of each specific patient. To these codes, different treatment plans as well as proposals of maintenance schemes, content and interval of recall are attached. When compiling the codes of all patients connected to a dental clinic, it forms a “Health profile” of the specific clinic. This health profile gives an overview of the patient clientele, an overview that gives a basis from which close-to-the-clinic healthcare planning could take a start. The profile is also useful for evaluations of the performed healthcare, as well as for motivation of team and patients. Some adequate data can be extracted and given a basis from which epidemiological surveys can be performed.

5.1.1.1 The basis of the HIDEP Model

The HIDEP Model is build upon three cornerstones:

- **RAMVUX**, a proposal for an adult dental healthcare program, launched by the Swedish National Board of Health and Welfare [Swedish National Board of Health and Welfare 1988].
- **FPU**, an acronym for the Swedish words for Simplified Periodontal Examination, described by Drs Ericsson and Jacobsson [Jacobsson 1979, Ericsson 1983]. FPU is very similar and could easily be adapted to, for example, the PSR, Periodontal Screening and Recording system [Nasi 1994, Charles & Charles 1994].
- **Risk assessment** based on clinical findings and professional judgement.

5.1.1.2 The variables used

To define an appropriate HIDEP code for a patient, the issue becomes to define the “amount” of tissues and to judge if the patient is in health or if she/he has signs of disease activity.
The different parameters that are used within the HIDEP Model are:

**Related to Tissue:**
- Number of intact teeth (that is, sound teeth without either cavities or restorations)
- Total number of teeth
- Marginal bone level

**Related to Disease activity:**
- Carious lesions, type and progression rate
- Bleeding on Probing, pocket depth

**Professional risk estimation:**
- Based on risk factors from social, behavioural and demographic, as well as biological point of views.

The values of these parameters form the HIDEP code and it defines where a patient is situated on a Health–Disease scale, a scale from very low risk of attracting disease to very severe symptoms of disease.

### 5.1.1.3 The HIDEP Health–Disease scale

![HIDEP Scale](image)

*Figure 2. In a clinical aspect, either a person can have symptoms of disease or is in health, there is no in-between. One can have fewer or more symptoms of disease (1 - 4) but can hardly be more or less healthy. However, being in health you then have less or more risk of attracting disease (0 - 4). People with symptoms of disease need treatment to become healthy. The more symptoms, the more extensive the treatment will be. On the other hand, a person with no signs of disease needs different intervals and type of Support treatment (recall) to remain healthy, dependant upon individual risk.*

As the main diseases threatening oral tissues are Caries and Periodontitis, there is within the HIDEP Model nine different cariological codes (from low risk of attracting cavities, “C0S” (S stands for Support), to severe symptoms of caries disease, “C4”, and nine different periodontal codes (from low risk of loosening of teeth, “P0S”, to severe symptoms of periodontitis “P4”).

Those patients that do not have any natural teeth at all receive the code “CD”, standing for Complete Denture. Osseous integrated implants are not regarded as natural teeth. Even if implants have given new possibilities to many patients, they are not evidence of successful preventive dental healthcare.

All patients will end up with a code after an examination, corresponding to the actual dental status. This code presents condensed information about the actual patient’s oral health condition. Here are some examples.
22/28 C0S P1. This describes a patient with 22 intact teeth and 28 teeth in total. This patient has a very low risk of attracting cavities, but is slightly ill from a periodontal point of view (Gingivitis without loss of attachment).

4/25 C4 P0S. This is a patient with 25 teeth in total, of which 4 are intact. Has severe symptoms of caries disease, but very low risk for loosening of teeth. No loss of attachment and no Gingivitis.

0/12 C4S P3S. This shows a patient with a very high risk of attracting cavities, as well as loosening of teeth. No teeth are intact, in total this patient has 12 teeth. This patient will need intense support treatment in both a periodontal as well as a cariological aspect.

0/0 CD CD. This code describes a patient with no natural teeth at all. CD stands for Complete Denture. This patient no longer has any risk of attracting cavities, but in case of implants, has risks of attracting mucositis or implantitis.

In the case of osseous integrated implants, they are not regarded as natural teeth. This means that a patient who only has implants will also receive the 0/0 CD CD code.

5.1.1.4 The clinical examination

The clinical examination proposed within the HIDEP Model should mainly be seen as a screening, with the main objective to “sort out” the healthy patients. Those that do not pass this screening have to be submitted to a more thorough examination. What could be seen as appropriate for inclusion in the screening examination are:

- Total number of teeth and number of intact teeth (the two most basic quality measurements for dental healthcare)
- Number, type and location of possible caries lesions
- Oral hygiene, and pocket screening revealing active Gingivitis or Periodontitis
- Level of approximal bone seen on radiographs together with
- General health issues, as well as possible use of tobacco and
- A professional risk estimation including frequency of sugar input and use of fluorides.


After the examination, the different values of the parameters are compiled; the result will give an assumption about where the patient should be placed on the Health–Disease scale. If all results are excellent, the adequate group codes should then naturally be “C0S P0S”. If, on the other hand, all results are extremely poor the adequate grouping should be “C4 P4”. There could naturally also be mixes between different cariological and periodontal groups. Together with number of intact teeth and total number of teeth, and with the CD code, it becomes possible to use numerous different code combinations when describing the dental-health situation of the patients.

All examinations of patients consist of collecting data. This already starts when the patient steps into the dental clinic: is the patient man or woman, young or old? It continues in the operatory, general health conditions, special desires and demands, followed by the examina-
tion of the mouth and surrounding tissues. Are there many or few teeth, many or few restora-
tions? How is the standard of oral hygiene? Are there any cavities? How are the supporting
tissues, etc. All examinations end up with a summary of the actual patient’s condition. Some-
where in the head of the clinician all impressions are compiled from which future actions are
planned. The HIDEP codes just form a tangible summary.

From a HIDEP code, one could also go the other way round. For example, with the code 
24/30 K1S P3, what type of patient might that represent? Twenty-four teeth are intact and 
there are 30 teeth in total. It is probably a pair of wisdom teeth that are missing. Twenty-four 
teeth that are intact show that 6 teeth are restored. Most probably those restorations consist of 
Class I or Class II fillings on posterior teeth. Is it a young or an elderly patient? – probably a 
quite young person with a low risk of attracting cavities. But, how is that this patient has a 
severe periodontal problem? The patient could be a smoker with bad oral hygiene, have a 
stressful life or have parents who have lost their teeth. A man or a woman? Colour of the hair? 
Shoe size? The answers to these last questions depend upon the clinicians’ experience.

5.1.1.5 Recall and treatment plans

Behind each code used within the HIDEP Model, guidelines exist concerning recall, as well 
as treatment plans. From the very beginning, these were based upon Textbook of Clinical Pe-
riodontontology [Lindhe 1985] and from the textbook “Kariologiska principer” [Ericsson 1980] 
concerning the cariological part. These structured plans have had to be adapted to the re-
sources which a specific clinic presents.

![Figure 3. Periodontal treatment plans. Examples of structured periodontal treatment plans. The plan on the left shows the plan that was followed during the 1990s. The plan on the right presents the most recent plan including the step when a patient chooses appropriate tools, but also when tissue re-generation could be considered.](image-url)
If a patient at the screening examination is considered to have symptoms of disease activity, then the patient needs some sort of treatment. Before this treatment starts, a more thorough examination has to be performed.

A patient that does not have any symptoms of the diseases is considered healthy, inactive. However, when healthy, there is always more or less of a risk of disease. These risks vary from very low “0S” to very high “4S”. The higher the risk is, the more often does the patient have to come to the clinic [Bader et al. 2003, Beirne et al. 2005, Mettes et al. 2007, 2008]. If a patient is found to be at high risk, then a more thorough examination is performed. The recall treatment should be directed towards factors that are found to be most unfavourable in the specific patients’ situation.

The number of teeth and number of intact teeth that are used within the code system, together with the cariological and periodontal codes, gives an idea about how long the visit for a recall should be. A person with a code 0/32 C0S P4 must naturally have more time set aside than a patient with a code 0/4 C0S P4.

The structured periodontal plans indicate, for example, when the use of antibiotics could be considered. If this is defined within a structure, it becomes more easy to evaluate how effective different treatments methods have been.

The step “Let the patient choose adequate tool” is within the concept of seeing the patient as a co-worker. It seems, according to our experience, that the involvement of the patient increases when she/he is given more responsibility. A well-educated patient understands that the red colouration stains the plaque that has to be removed. Instead of telling the patient what to do and how to do it, the dental hygienist gives the patient the responsibility for making the decision of what dental-care product she/he thinks would be the most appropriate. The result of this will most often be that the patient has a desire to show us that she/he had made the right decision. The patient will work hard to prove it. The next visit includes a new colouration of the plaque. If there are surfaces that still show plaque, the patient is given a new chance to pick another product. Certainly, the dental hygienist could recommend the most adequate tool from the very beginning. That would perhaps be less time-consuming, but it seems in most patient cases, the result might not be as good.

5.1.1.6 The health profile of the clinic

As each patient of the clinic receives a code, determined by the number of intact teeth, total number of teeth, and adequate cariological and periodontal code, this permits not only the compiling of the age profile of the practice, but also the health profile of its patients.

The health profile diagram shown in the Figure 4 diagram can be used for four different purposes, namely:

- Motivation of the patients.
- Close-to-the-clinic healthcare planning.
- Quality assurance and development.
- Marketing.
Figure 4. The periodontal health profile of a clinic, presenting an overview of the clinic’s periodontal situation according to the HIDEP model. The figure shows a so-called age-distributed health profile. To the right you find the different, periodontal groups. On the x-axis, the different age intervals, and on the y-axis, the number of patients is presented. In each bar, you will find those patients with best oral health status at the bottom and those with poorest dental health at the top.

5.1.1.7 Motivation of the patient

When patients are classified into different groups that are simple and easy for them to understand, they will get a clearer picture of their own oral-health situation, and this facilitates communication and motivation. With some guidance from the dental healthcare provider, this will permit the patients themselves to discover what group they belong to. Thus, more or less, the patient determines where the “starting line” is. By using, for example, the bar diagrams, the patient can see where they are on the scale, and what point they can reach after successful treatment. In other words, a goal could be visualized. By using the treatment plan associated with the patient’s group, it can be shown how the race to better oral health is planned; where they have to “run uphill” - where they need to make an effort - and where they can “run downhill” and accomplish things with less effort. The demands upon the patient are clear, as well as the demands upon the healthcare provider.

By “integrating” patients in the work, the awareness of the importance of good oral health seems to increase. When dental care is target-oriented, it seems to provide a good base for increasing the dental awareness of patients. A clinic presenting a serious, target-oriented dental-care approach seems to have an opportunity for promoting and “marketing” itself.

The information given to the patient at his/her visit in the clinic is followed up with one or more printed information leaflets, which deal only with the problems that the actual patient presents. Such a leaflet has an important function of re-enforcing the effect of the verbal in-
formation given by the health-care provider, as well as defining what the dental team can do and what the patient has to do. The dental healthcare providers does the work in the clinic, the patients do the work in their homes. Everyone works towards the same goals. Patients are no longer customers - they become partners of the team.

Figure 5. An example of a patient information leaflet explaining periodontal disease, and an example of information directed towards a factor that could be improved.

5.1.1.8 Close-to-the-clinic healthcare planning

When organizing a clinic according to the HIDEP model, it becomes possible to set goals more than that of the clinic’s economical performance - goals concerning oral health can also be set. This gives data for controlling and managing the operations in order to improve the performance steadily and run the business on a long-term basis. The system utilizing treatment and recall plans for different groups also seems to simplify communication between team members, and the HIDEP codes give a summary of a patient’s dental-health situation.

Based on the human resources of the clinic - that is, the competence and working hours of the different personnel categories and the number and needs of the patients - as well as the clinic’s physical resources - that is, number of treatment rooms, type of equipment, etc. – appropriate treatment programs, as well as recall programs, could be established.

The treatment plans should not provide detailed instructions for carrying out treatment. Instead, they should provide a platform for reaching the goal – healthy patients. When the different members of the team agree upon criteria, treatment plans, etc., there will be less risk “of making mistakes” and losing face. The team members will feel more secure, and with this an increased possibility might follow of influencing the patients in the right direction. The
firm structure of the clinic does not limit the performance; instead, it should provide a stable platform, from which the different team members could act.

Delegation should not mean, “Give tasks to perform”, but instead it means giving goals to reach. Thus, all team members must be aware of the clinic’s goals, and use these goals as a base. Each one of them have the possibility of influencing their own situation – the team’s as well as the patient’s situation.

With strict criteria, a more objective view of the dental-care needs can be established, continuously reducing the risk of administering too much, or too little, treatment. This can facilitate the team in providing the right care within the right time.

The handling of patient appointments might also be more efficient, since the HIDEP model gives an indication of what to do, when and by whom. The time reserved for the person administering the treatment can be adapted to suit the needs of the patient.

5.1.1.9 Quality-assurance and development

The health profile diagrams consist of different red and green sectors. The fields that correspond to patients without disease activity are green, and those corresponding to patients with ongoing disease are red. Concerning quality development within dental practice, it could simply be stated like this: “Our goal is continuously to make the diagram less red”.

The aged-distributed health profile diagram might be used as a rough basis to start studying how it looks in a clinic. What is the need among the patients? Do special risk ages exist? Who are the special-risk patients? What are the resources of the clinic? Where should the focus be in order to have best results in improving dental health among the patients? How did the diagram look last year, how does it look this year and what are the goals and desires in the years to come?

By yearly compilations of the clinic’s health profile, it will be possible to evaluate not only the efforts the clinic has made, but also to give a hint of what direction the clinic has to pursue in its work toward better oral health among the patients.

5.1.1.10 Health-economy

Within the HIDEP model, quality development represents all measurements that are planned and systematically performed with the goal of continuously increasing the gains concerning oral health and economy in a long-term perspective for all parties involved [Sundberg 1992].

This statement involves both health and economy, and could be expressed with a health-economic diagram.

By extracting some key numbers, such as number of patients, costs and incomes of the clinic, as well as health data extracted from it, it is possible to achieve a health-economic diagram that will form a summary of what a practice has achieved in terms of promoting the function “good oral health”, as well as improvement in the economic function, that of “reasonable compensations” from time to time.
5.1.1.11 Marketing

It is a well-known fact that good marketing is that of delivering a good treatment to the already existing patient. A further step in that direction could be to inform the patients about what has been achieved concerning the results of the clinic’s efforts in oral-health improvements among all the patients of the clinic. If the patients are seen as members of the dental healthcare team, they also have to be treated as members as, for example, by giving them information about what is achieved by the team.

As a member of a team, one could expect that you are interested to see and hear how your team is performing, but also to know to what extent your own contributions have affected the result. This is because we all have a more or less expressed desire to be recognized as “being someone”.

The close involvement of the patient starts even before the new patient comes to the clinic. The main objective will be to make this new patient a devoted team member as soon as possible. Within the HIDEP model, it is suggested to send a welcome letter to the new patient. This letter describes where the practice is situated, the names of the different staff members, but also the most important information: what will happen at her/his first visit in the clinic. The letter also includes a health declaration form, which the patient could calmly fill in at home, and then bring to the practice when it is time for the first examination. Such a welcome letter will diminish the uncertainty of the patient, thus increasing the possibility of establishing a good base for the first contact with the team and for future contacts to come.

The examination itself is also a kind of marketing, while the active involvement of the patient is a demand. As mentioned earlier, the ideal situation is when the patient herself/himself could suggest the correct coding corresponding to her/his oral-health status. The examination might also be seen as the introduction of a new member to the team.

To further strengthen the feeling of involvement and the membership of a team one could, for example, once a year give information to the patients attached to the clinic. In an comprehensible way, the results which the clinic has achieved together with the patients concerning improvements of oral health are described.

So, marketing can be seen as working together with the patient as a team member, she/he does the work in their home, the professional does the work in the practice. Everybody is working towards the same goals, those of “good oral health” and “reasonable compensations”. A good way to succeed in making the patient a devoted team member seems to be to communicate these facts in an effective way to all patients.

5.1.1.12 Summary of the results

As the HIDEP Model covers many parts of management within a dental clinic, it can be described as shown by Figure 6. The examination will end up by giving the individual patient a code describing a summary of the oral-health situation of that specific patient. If the patient has active disease, treatment plans, as well as patient information, are proposed. If the patient is in health, the healthcare provider will receive a suggestion of how often and with what content the recall will be.
Regular compilations of the codes of all patients attached to the clinic form the health profile of the clinic, a profile from which quality development, healthcare planning, motivation and marketing could start. Furthermore, all data received will facilitate analysis of risk factors, patients’ at risk, as well as outcome of treatment. Finally, data could be used for epidemiological and benchmarking purposes. If information is given, the clinics should then expect a feedback concerning, for example, evidence-based methods.

Figure 6. This figure shows different steps within health management supported by the HIDEP model. The right half of the circle shows the features where the model assists in managing the patient. The left half shows the different steps that come into use when managing the clinic. In the upper left the connection with the “outside” of the clinic is described. The clinic could furnish data to be used in quality registers and for benchmarking. Here the clinic could also receive information concerning, for example, effective methods and expert decision support.

5.1.2 Discussion of the results from Study I

As mentioned, the work started with a search for models that was not primarily based on treating diseases, but instead had a part of proactivity, a part of risk assessment. The indices and models encountered did not fulfil the requests, and this was the reason why RAMVUX [Swedish National Board of Health and Welfare 1988] was taken as a basis, though expanded with a part based on risk assessment. When specialists were interviewed, they suggested the inclusion of as many factors as possible to determine risk. As both caries disease and periodontal diseases are multi-factorial, this gave numerous parameters that were involved in the process of defining the risk of a patient.

The HIDEP model is not using any new risk-estimation techniques, but is combining a number of already available examination methods, risk-estimation systems and treatment suggestions into an entity.

Even if both Caries and Periodontitis are two tissue-consuming diseases, the view with the Health–Disease scale will give some problems. A patient with extremely severe symptoms of
caries disease, C4, could by proper treatment successively move towards less and less risk. A C4 patient can become a C4S, C3S, C2S, C1S or a C0S, due to the fact that the risk estimation is not based on the “scars” of the disease, the restorations. This “walk” between different risk levels is not possible when it comes to the periodontal HIDEP groups while these are based upon the scars of the disease, marginal bone level. A patient with severe periodontitis, vertical bone-pockets, furcation involvements, described by the group P4, cannot move to any other risk level than P4S, with less than most affected teeth extracted or submitted to treatments such as tissue regeneration. This fact gives problems concerning, for example, giving adequate recall intervals, but can be solved if some sort of system with points is used.

The differences between the grouping-system of cariological and periodontal diseases are also reflected in the health-profile diagrams. The cariological health profile has very few red sectors as these only represent those patients with untreated active caries lesions. As soon as the cavities have been restored, the red group (C1, C2, C3 or C4) is changed into an adequate green group (C0S, C1S, C2S, C3S or C4S). The restoration does not mean that the disease is cured, even if the group is changed. It is only the symptoms of the disease that have vanished.

Originally [Sandberg & Fors 1990] the cariological group Very Low Risk (C0S) presented a person with a stimulated Saliva flow above 1.0 ml/min, Lactobacilla counts < 100 000 ml, Strep Mutans counts < 1 million/ml, Buffering capacity > 6.0. Sugar frequency index [Söderholm 1988] = 0 DMFS Low. The C4S group corresponded to the worst situation.

To perform saliva tests on all patients was far from being cost-effective when determining a risk level. Furthermore, the use of fluoride and oral hygiene were not included from the beginning. Quite early the risk assessment was re-arranged towards performing saliva tests on new patients in order to collect as much data as possible of this unknown new person, as well as those showing caries activity or presenting high risk of attracting cavities. The risk assessment of today is based on questions to the patient concerning use of fluoride, frequency of sugar input, medication, and dryness of mouth, but also general health and level of well-being. These issues are combined with clinical findings like status of the restorations concerning their number, activity and locations together with oral hygiene conditions. The data is compiled and, together with our own experience, a level of risk is defined. This level defines the frequency of recall, but also what the focus of the maintenance care should be. If something has been missed in the assessment the patient has to be re-coded. In some cases that means that the intervals of recall can be longer and in others shorter. It seems that this way is according to evidence that we have today. [SBU 2007]

When working in an environment where most people are in good dental health, it seems that a screening that permits one to “sort out” the patients in good health is the best strategy. Those who are not passing this screening as being in health or at low risk are submitted to a more thorough examination. A patient who shows symptoms of disease, for example, decay, has passed the level of risk; the patient has symptoms of disease. Certainly, conclusions can be drawn concerning the speed/activity of the caries disease as it starts on the posterior teeth and, according to the intensity of the activity, moves forward. In addition, the number, type, size, colour and consistency of the carious lesions, gives us information about the activity. However, in the case of a patient who shows only one lesion (C1) on a molar at the examination, is this a patient at low risk for future decay? That is not certain, because something might have happened recently. For example, it could be that a patient has just started medication that reduces the saliva flow, giving the patient a dry mouth that the patient treats regularly with sour candy, corresponding to an elevated risk (C3S or even C4S). On the other hand a patient with
lots of cavities (C4), could perhaps tell us that she/he has just terminated a period of depression and heavy medication and now seems to be in a good condition, interested in having the teeth restored, corresponding to a lower risk (C1S or C2S). To conclude, the type and location of the cavities could give us valuable information concerning risk for future cavities most of the time, but not always. When a patient shows activity, some sort of risk assessment has to be performed to give the patient adequate assistance in order to avoid future cavities. This is also a question about ethics. The prognosis of heart surgery on smokers is poor. Despite this, surgery shall be performed according to ethical standards within Swedish healthcare, but the patients must be fully informed and in consent concerning the dubious outcome. Should teeth with cavities be restored on patients with a high frequency of sugar input? Yes certainly, but the patients have to be informed about the bad prognosis. This example shows that dentistry based solely on treating symptoms and not informing about the risk factors might not be seen as being ethical.

Smoking was, at the end of the 1980s, seen as an aggravating factor. At that time, being a low consumer meant smoking less than 15 cigarettes a day. Today it seems that the limit is much less [Norderyd et al. 1999, Paulander et al. 2004, Kunzel et al 2006]. The dental hygienist of the clinic performed a tobacco survey in 1994 upon the patients she treated, based upon the HIDEF-model coding. For 500 patients that were consecutively selected, not only dental-health status but also the use of tobacco in terms of smoking and snuffing (Swedish wet tobacco) were registered. Frequency, duration and whether the patient had stopped using tobacco was registered as well. The tobacco use was studied in relation to the patients’ dental-health status given by the HIDEF codes. When the dental hygienist herself discovered the relation between the use of tobacco and the difficulties in curing periodontal diseases, she became an excellent person to wean patients from tobacco.

At the end of the 1980s, hereditary factors were not seen as predominant factors involved in common periodontal disease. There was also a belief among clinicians that gingivitis always led to periodontitis. Today we know that this was not the fact [Armitage 1999]. The risk assessment was difficult. The advice received from periodontal specialists was “Focus on early detection. A patient who shows loss of attachment is also showing that he/she is prone to periodontitis.” The HIDEF model has stuck to this concept through the years. It is because of this that the different P groups are based upon level of approximal bone. The depths of the pockets and bleeding/pus determine whether the patients are active or inactive in their disease. We have discussed as follows: a patient that has lost attachment shows that this is a patient prone to periodontitis. The more that is lost, the higher the risk becomes for losing the teeth in case of an exacerbation. The higher the risk, the more frequent the recall visits become. To each of the risk groups P0S, P1S, P2S, P3S and P4S, suggestions are attached concerning the frequency of recall. However, this frequency is just a rough suggestion. If we have a 25-year-old patient presenting P2S (horizontal loss less than 1/3 of the root length), this patient is seen as being at a higher risk compared with a patient at 65 with the same P2S group defining-level of approximal bone [Persson 2004]. The frequency of recall becomes more intense for the 25-year-old patient compared with the 65-year-old. The same goes for smokers and those patients with general diseases related to periodontal disease, such as diabetes and osteoporosis as well as obesity.

The limit of 10% of the most affected teeth was set to define the periodontal group. The limit concerning Active or Inactive also became 10%. If the screening examination reveals pocket depths in the range of 3.5 - 5.5 mm or more with bleeding/pus in 10% or more of measured pockets, the patient was described as being Active. Through the years, it has been noticed that
these limits were perhaps a little too hard and have probably led to a slight over-registration of disease. Another thing important to mention is that the level of attachment can vary within the different groups, from this it follows that the approximal bone level of a patient can decrease without the patient changing periodontal HIDEP group. Certainly if we had measured the decrease in millimetres, the model would be more refined but considerably more time-consuming for use in daily clinical work as a screening method.

In the end of 1990s [Armitage 1999], it was decided by periodontologists to review the denomination of periodontal diseases. From our perspective, we thought that the HIDEP grouping system was easier to use clinically, as treatment plans and suggestions of recall intervals could be attached to each defined group. Accordingly, the criteria for the periodontal grouping system was not changed.

From the start the suggested treatment plans were presented in a textbook of periodontology by Prof. Lindhe which was included in the model [Lindhe 1985]. However, after ten years of work according to the HIDEP model, it was discovered that the outcome of the treatment became less and less good in the test clinic.

Accordingly, the treatment plans were changed towards the concept of Full Mouth Disinfection and the results improved. It might be the fact that it was not due to the methods per se, but more due to an increased enthusiasm within the dental team, because it seems that an enthusiastic team has better possibilities to motivate a patient than an unenthusiastic team. [Farman 2008, Axelsson 2004].

It seems that the model with its grouping system can furnish the dental clinics with data concerning the long-term evaluation of a tissue-saving approach. The indicators used for this purpose are total number of teeth together with number of intact teeth and approximal bone level.

5.2.1 Results of Study II - The DentiGroup™ software

Even though the clinical situations differed between the countries, the basic philosophy of the HIDEP model was well accepted by the test clinics. The different insurance schemes in Sweden, the United Kingdom and Germany were mainly driven by production of items and not by the promotion of prevention. Especially in the UK and Germany, the dental teams reported that the HIDEP model gave them an opportunity to attract patients that had an interest and were willing to pay for preventive dentistry, as preventive dentistry was poorly paid within the insurance systems [Widström & Eaton 2004]. Proposed treatment plans and intervals of recall, as well as content of patient information leaflets, were well-accepted as it was possible to adapt them to the individual needs and resources of each clinic.

Reliability tests were performed in connection with the introductory lectures aiming at a calibration of the dental teams. The test was based upon five different patient cases described on paper and with radiographs. It was shown that 80% of the participants, no matter which country, gave the same HIDEP code. 20% gave a code that was only one step away. This discrepancy was mainly concerning the cariological risk estimation. If the majority of the attendants wrote C3S (high risk), there were others who wrote C4S (very high risk), but very few stated C2S (clear risk). However, no one wrote C0S (very low risk) or C1S (low risk). Concerning the groups corresponding to active periodontal or active cariological groups, the agreement
was almost 100%. However, as these tests were not performed or evaluated in a strict scientific setting, the results can only be interpreted as indicative.

Also the user friendliness was rated highly. However, tests revealed a great desire among the clinicians to have a computer support that furnished them with proposals of adequate HIDEP codes automatically. The risk analysis and different searches were also items that the test clinics desired to be more easy to perform.

The clinical tests also revealed that, after two months of continuing registrations of all patients visiting a clinic for examination, a preliminary health profile of the clinic was shown – a preliminary health profile that significantly (p < 0.05) corresponded to the health situation of the health profile received after one year covering the whole population of patients within a clinic.

Several of the dentists said that the health profile furnished them with new and valuable information. “I didn’t have any clue that our clinic had such a good cariological situation, but on the other hand there are so many patients with periodontal problems in the age interval of 45-65”, and similar comments. It was the first time that they had received an overview concerning the dental-health situation of their clinics.

The different tests also gave us information about how the implementation of the HIDEP model and its supporting software could be performed stepwise following the Plan-Do-Check-Act (PDCA) cycle described by Deming [Deming1982].

- **Plan**, means that all members of the team have to have a common view upon the criteria of the different cariological and periodontal codes.
- **Do**, is a two-month period when registration of the HIDEP codes of all patients visiting the clinic is performed.
- **Check.** A first health profile is compiled and, based upon this, preliminary close-to-the-clinic healthcare planning is performed. Identifying the needs of the patients and how the resources of the clinic could be adapted to these needs in the best way. Is there any age group that presents more cariological or periodontal problems than another? Where should we place our focus in the year to come? Are the suggested treatment plans adequate concerning improving the situation, does our team present competence in relation to the situation of the patients? What methods shall we choose and how often should we see the patients in our recall system?
- **Act**, the last step of the implementation means Action, involving the patients as team members in the process towards health improvements.

After some months, evaluation has to be performed leading to a new cycle of PDCA with the aim of continuous improvements.

During, as well as after, the different tests, the software system was updated and new versions were continuously released and further tested. It became quite an amount of work not only to update, but also to support several versions of the software in different languages. However, at the end of the 1990s there was a version (3.0) available in the English, German and Swedish languages.

The results of the different tests show that the DentiGroup™ system might be used in both private, as well as public, dental practices, in Sweden and abroad. DentiGroup™ XL was de-
signed to co-operate and be integrated with other administrative dental systems, but might also be used as a stand-alone tool. In the following DentiGroup™ XL is presented as a stand-alone product. To more easily adapt the program to the specific clinics’ resources and needs, as well as to the progress of science, the program contains different possibilities for its own editing concerning recall intervals, risk evaluation, etc.

The DentiGroup™ XL software program gives, among other things, automatic suggestions of adequate group codes. However, within a normal distribution of patients in a clinic, the healthcare providers could directly define an adequate HIDEP code of a patient and manually register it in the software, this could be done without using the function included in the software which assists with an automatically proposed HIDEP code. However if the automatic function is used, the program automatically gives suggestions of adequate cariological and periodontal codes, as well as suggestions of treatment plans and patient information leaflets based upon what findings are negative. It is also possible to note for every patient the use of tobacco, medication, and diseases, but also self-defined risk factors.

Compilations of health profiles, print-outs of information letters and treatment plans also give the possibility of doing risk analyses and searches for specific patients. In version 3.0 there a function dealing with health-economics of the dental practice was also included.

Print-outs
- Print-outs can be achieved for single patient or a list of all patients, sorted according to age or name. These printouts could be done for different teams, if several teams are working within the clinic.
- Adequate treatment/recall plans for a specific patient.
- Patient information leaflets, Welcome letters, Health declaration form, Recall information.
- Diagrams, forms, etc.

Statistics
- Unlimited history for a specific patient, concerning the development of the HIDEP codes.
- Statistics for all HIDEP codes of the patients, mean age, mean number of teeth and intact teeth.
- Statistics can be derived from specific teams, and before/after certain dates.
- Health-economic diagrams, where only the monthly income/costs of the clinic have to be added. This function is within version 3.0 but not in 4.0.

Risk analyses
- The possibility of studying how different risk factors influence oral health.
- To perform searches of specific patients at risk.
- Searches of persons in specific age-intervals with specific codes.

Diagrams
- Easy interpretable diagrams concerning the patients’ cariological and gingival/periodontal health status.
- Age-related cariological and gingival/periodontal health profiles.
- Risk diagrams for initial analyses of risk factors.
- Unlimited historical functions.
Figure 7. Some examples of the software functions. 1) An input form for clinical findings that could be registered by clicking on the respective risk factor and its corresponding value. Information leaflets and treatment plans based upon the findings are then proposed. 2) Output in terms of the health profile covering all patients of a clinic. 3) When analyzing and searching individual patients or risk factors, this or similar forms can be used. 4) Results of such searches can be presented by diagrams or by numerical tables.

Own editing
- Possibilities for defining price for different intervals of recall per year.
- The welcome letter could be edited with the specific practice address, personnel, etc.
- Define own risk levels as well as recall intervals.
- Define own weighting of the different parameters’ values.
- Free editing of all treatment plans and patient information letters.

5.2.2 Discussion of the results from Study II

One issue that became clear during all the different tests, was that the users had expectations of Informatics that was beyond technical possibilities. Computers are still seen as complements to humans, they are good at handling large amounts of data, compiling and structuring, however they are not smarter than the way in which they are programmed and the amount of data they are furnished with. Humans can by just a glance start to make reasonable assumptions based upon experience and imagination, a normal health informatic system lacks this
ability [Coeira 2003]. If you give a computer just a glance of a patient, the computer will just report a stupid guess. It soon became quite obvious that to reach some sort of relevance it was necessary to furnish the software with a large quantity of data in order to receive a suggestion close to that of the clinician. In clinical settings this situation becomes unrealistic. It seems to be more efficient to use the proven experience of the clinician based upon some objective facts that the examination reveals.

Within the DentiGroup™ software, a function assists the clinician to find an adequate HIDE-P code, but to do that it will require that data of 12 different parameters be registered. It was found empirically that within a normal recall clientele, about 90% of the patients could be given a HIDE-P code directly without any assistance from the software. On the other hand, for the remaining 10%, the function that gives suggestions becomes useful while it gives the clinician, as well as the patient, information about not only code but also what items could be changed and what impact it would have on the codes. Another advantage is that the software gives proposals of written information directed to the patient, dependant upon what specific problem the patient has, and suggestions to the healthcare provider about how the treatment should be performed.

Within this function of giving automatic suggestions, each different criterion presents a number. The higher degree of severity, the higher the points become. As we are not specialists in the fields of cariology or periodontology, the point system has permitted the user to self-set a number behind every criterion according to his or her own beliefs and advancements of science. The Cariogram software [Bratthall 1996, Petersson & Bratthall 2000 Hänsel Petersson et al. 2003] presents a more biological form of calculation including synergistic effects, giving a more dynamic functionality. The Cariogram program contains an algorithm that presents a “weighted” analysis of the input data, mainly biological factors. Due to this, the Cariogram is included in version 4.0 of the DentiGroup™ XL software. The green field in Cariogram corresponding to “the actual chance to avoid new cavities” is given in percentages. This percentage might be translated into the HIDE-P systems corresponding to the different cariological risk groups described in the model. With such connection in between the software’s it might be possible to take advantage of the algorithm of Cariogram, and Cariogram might take advantage of the database within DentiGroup™, giving possibilities for different analysis of the patient clientele as well as the storage of data.

The use of dedicated software such as DentiGroup™ might open up new horizons, not only on the individual patient level, but also especially on the clinical level giving an overview of the entire clientele within a dental clinic. The philosophy within the HIDE-P model is that all patients attached to a clinic should receive a code presenting a summary of their dental-health situation. To determine such a code the system has to be simple to use and has to have the daily clinical work as a basis. The clinicians’ experience is important to use when defining an adequate code for each patient, but this experience has to walk hand in hand with what science continuously discovers concerning what is seen as evidence-based [SBU 2004, 2007]. On the market, there is other software assisting clinicians with decision support, and Cariogram is already mentioned as a good example. Concerning periodontal diseases Previser [Page et al. 2002, 2003, 2005 ] presents another good example. However, both these types of software do not aim to give a code to each and every one of the patients within a clinic, just being a decision support in cases of patients presenting signs of disease or high risk of attracting disease.
5.3.1 Results of Study III - Development of the dental-health situation

In order to evaluate the appropriateness of the model to measure the dental-health situation a long-term follow-up study was performed. The overall result was that it seems to be possible to distribute the patients within a dental clinic according to their dental-health situation and follow it over the years with the aid of the HIDEP codes.

750 patients (335 men, 45%, and 415 women, 55%) were found to fulfil the inclusion criteria of being patients in the age interval of 20-79 in the year 1995 and during a ten-year period were within the recall system of the clinic. The average age in 2005 was 61 years.

![Sex and age distribution 2005](image)

**Figure 8. The gender and age distribution of the cohort in the year 2005**

The result of the study has been divided according to different areas of interest - number of teeth, number of intact teeth, and level of supporting tissues measured as approximal bone level within the intervals which the HIDEP grouping systems indicate. The caries risk in relation to age was also studied, as well as changes in the number of patients with active or inactive periodontitis.

**Number of teeth**
During the ten years which elapsed, there were 75-80% among the individuals within the age interval of 20-49 who did not lose any teeth at all. About 10% of the patients who were in the age group of 50-59 in the year 1995 had lost three or more teeth. This percentage is doubled in the age interval of 60-69. The only statistical significance is that the age group of 60-69 lost more teeth compared with age groups beneath 49 years.
Out of the cohort of 750 patients, 524 patients did not lose any teeth at all. 114 patients lost one tooth. In addition, 112 lost two or more teeth. 14% of the patients stood for 79% of all teeth lost.

The figure shows a wide spread between the patients, and this spread increases throughout the ages, especially from the age group of 50-59 in 1995 (born in the period 1936–1945). However, counting all teeth lost in the cohort, it became 564 (2.9%) out of 19 445 teeth. In other words 97.1% of the teeth were kept. Even if the material is small especially in the younger and older age groups, it seems that the majority of the patients are keeping their teeth.
Intact teeth
The results concerning intact teeth show a similar development as the total number of teeth. When comparing age groups in 1995 with the same age groups in 2005 there are about four more teeth that are intact in the age interval of 30-59. The age interval of 60-79 shows only minor changes. In total, the loss of intact teeth has been 3.4%. It is not possible from our material to present the exact number of how many intact teeth have been extracted or filled.

Caries risk
Within this study, one of the aims was also to study whether there was any age group that presented a higher risk of attracting symptoms of caries disease. The odds of having an increased caries risk in 2005 compared with 1995 was 1.2-1.5 in the age span of 20-59. The odds for an increased caries risk increased – for those at 60-69 it became 2.2 (p < 0.004) and for those above 70 years the odds became 4.7 (p < 0.0001).

![Caries risk odds](image)

*Figure 11. The odds in 1995 of having an increased caries risk in 2005.*

Active or inactive periodontal disease
In general terms, the number of patients with active periodontal disease (P1, P2, P3 and P4) in 1995 sank during the ten-year period. There was a positive and statistically significant (p < 0.001) change towards the HIDEP groups describing inactive disease (P0S, P1S, P2S, P3S and P4S). The odds for activity is lower in 2005 compared with 1995 (OR=0.60, 95% C.I. 0.45 – 0.81).

Measuring the tissue-saving function: Attachment
During the ten-year period about 39 (5.2%) patients moved to a higher periodontal HIDEP group indicating that they had a decrease of the level of approximal bone. 75 patients (10%) have reached a better periodontal group. The year 1995 100 patients (13%) showed an advanced loss of bone level > 1/3 loss (P3S, P3, P4S or P4). Ten years later this number was 112 (16%). However there was no statistical significance (P=0.92) concerning changes of periodontal groups.

The HIDEP code combinations
Studying the different combinations of the HIDEP codes concerning relation of cariological and periodontal groups, one can notice that patients, when affected, are most often affected with one of the diseases, but rarely with both at the same time. From the total number of 750 patients in the cohort in the year 2005, there were 52 patients with an approximal bone level
corresponding to P4 and P4S, only four of them had severe cariological problems (C4, C4S). Concerning patients with caries problems, there were 90 patients with an elevated caries risk corresponding to clear (C2S), or high (C3S) or very high (C4S) cariological risk, only 10 of these also had serious periodontal problems (P4, P4S).

5.3.2 Discussion of the results from Study III

In 1995, there were 1353 patients within the studied clinic’s recall system. During the ten years studied, 148 patients became deceased and 114 moved from the clinic. Additionally, 331 patients were transferred to a new dentist that started in the clinic. This is the main reason why only 750 of the original 1353 patients were included in this study. Of course, the 1353 patients from 1995 could be compared with all the 1519 patients of 2005, but then there had been about as many new patients (769) as those who had been introduced into the HIDEF model (750), which has made this follow-up study of possible effects of the model complicated.

The situation within a dental clinic is dynamic because of this, and it is important to understand that the two samples from spring of 1995 and spring of 2005 do not reflect the exact situation at exactly these periods. This is because that the risk-related recall system in this clinic indicates recall intervals from very short intervals for high-risk patients and longer intervals for the low-risk patients. However, all patients visited the clinic (dentist or hygienist) within a period not exceeding 12 months previously. Concerning the necessary radiographs to determine the attachment level, all were taken within a period not exceeding 24 months.

A dental insurance reform specially aimed at people above the age of 65 was introduced in the year 2002, which was during our test period. This reform gave large subventions when more extensive prosthodontic treatment was needed. One effect of this reform was that people waited with such treatment until they reached the age of 65. It might be possible that this reform to some extent was reflected in our results. Also the introduction of fluoridated toothpastes in the 1960s, as well as the change of “when to drill” in the 1980s, might be reflected in the data presented [Gabre et al. 2006].

We think that this study, despite all shortcomings, still shows that it is possible to distribute all patients of a clinic according to their dental-health situation by the use of the grouping system presented within the HIDEF model, even if there can be variations of the bone levels within the limits defined by the periodontal groups. Results from several clinics using similar criteria could give a broad base from which statistically significant data could be extracted permitting, for example, benchmarking concerning evaluations of methods used.

5.4.1 Results of Study IV - Effects upon dental awareness among patients

As mentioned earlier the daily healthcare and way of living are important parts in achieving improved oral health [Baelum et al. 2007]. The dental professionals have an important role to motivate and transfer knowledge [Eaton 1998, Abrahamsson et al. 2008]. This specific study focused on the abilities of the HIDEF model to increase the dental awareness among patients. The different clinics that were compared had been using the HIDEF model either for a longer or shorter time or had been using another model also based on ideas about prevention. The response rate from the different clinics varied from 72% to 88%.
The inclusion criteria were thus patients within the recall system of clinics that had a systematic preventive approach. The clinics should represent similar types of teams concerning age and staff, and include dentists, dental hygienists and dental assistants. Finally, an effort was made to select clinics established in larger cities, as well as smaller communities.

Statistical analysis did not reveal any significant socio-economic differences between the three different clinic categories in terms of age, gender or educational level.

The questionnaire consisted of 12 items reflecting awareness and interest, together with questions concerning background data, such as gender, age or educational level. The enquiry revealed that there were statistically significant differences between the different clinics on some of the items.

**Figure 12. Effects on dental awareness among patients.**

**Category I:** Clinics using a model of a systematized preventive approach other than the HIDEP model. **Category II:** Clinics that had been working according to the HIDEP model for about one year. **Category III:** A clinic that had been working according the HIDEP model for more than ten years.

**Item 3)** “I know what my risk is for loosening of the teeth.” **Item 5)** “I know how my dental-health situation is compared with others of my age group.” **Item 6)** “I have received increased knowledge about what is affecting my oral health since I started in this clinic”, **Item 9)** “I receive direct information about my dental situation.”

Questions that one could assume were common knowledge, for example, how to avoid decay, almost all patients knew. There were no differences between the clinics. However, some of the questions showed statistical significances, especially these items:

**Item 3)** “I know what my risk is for loosening of the teeth.” 98.8 % of the patients from Category III, answered: “I completely agree” or “I agree to a large extent”. Corresponding figures for Categories I and II were lower; see Figure 12. There was a significant difference between clinics I & III (p < 0.0001) and II & III (p < 0.0001) respectively.

**Item 5)** “I know how my dental-health situation is compared with others of my age group.” In Categories I and II, less than 50% of the patients answered “I completely agree” or “I agree to a large extent”. In Category III the corresponding number was 90%; see Figure 12.. There was a significant difference between clinics I & III (p < 0.0001) and II & III (p < 0.0001) respectively.
Item 6) “I have received increased knowledge about what is affecting my oral health since I started in this clinic”, and Item 9) “I receive direct information about my dental situation.” Category III shows a considerably higher rate for “I completely agree” compared with the answers from Categories I and II; see Figure 12. There was a significant difference for Item 6 between clinics I & III (p < 0.0001) and II & III (p < 0.0001) respectively. For Item 9, the differences between clinics I and III (p < 0.001) and II & III (p < 0.05) were less significant.

5.4.2 Discussion of the results from Study IV

The over-all response rate was remarkably good, ranging between 72%-88%, indicating that the patients of the different clinics showed an interest in the subject and in participating in the study.

Item 3) “I know what my risk is for loosening of the teeth”, is a knowledge that is not as widespread as that of the risk of incurring cavities. Here, our assumption is that knowledge concerning periodontitis is mainly spread by dental professionals themselves [Abrahamsson et al. 2008]. Periodontal risk assessment is more difficult compared with caries risk assessment [Lang & Tonetti, 1996, 2003]. The grouping systems within the HIDEP model concerning the clinical findings of periodontitis are based upon rather straightforward measures, such as the bone level, pocket depths, and bleeding (signs of ongoing disease), which might facilitate communication with the patients.

Item 5) “I know how my dental-health situation is, compared with others of my age group.” This item did also show a clear statistical significance. In Sweden, we do not have any national, and only some regional, epidemiological data covering the adult population, so this question normally is impossible to answer with “I completely agree”. Within the model, one important feature is the dental-health overview of the clinic that permits the professional to show the oral-health situation of a specific patient and relate it to the rest of the clinic. This function is one of the tools that is used to motivate patients, and might be one of the explanations why clinic III had better results than the others.

Item 6) “I have received increased knowledge about what is affecting my oral health since I started in this clinic”, and Item 9) “I receive direct information about my dental situation.” These two statements might to some extent reflect abilities in communication and degree of knowledge-transfer in the clinic. The differences between the clinics on both of these items could perhaps be explained through the grouping system used within the HIDEP model, where every patient receives a clear code describing where the patient is upon the disease (active) – health (inactive) scale. Thus, it is easy to show where a specific patient is situated, the reasons for this, and what the possibilities for the patient to reach a better position are.
6 General Discussion

This project started at the end of the 1980s, an 20 years have passed. What has happened since? How has society and dentistry changed? Have patients, dental healthcare and methods changed or is it the same? How has the national dental support evolved? What influence have the introduction of Informatics been on dentistry?

6.1 Developments in society and dentistry

It seems that both society and dentistry are moving towards something that has become known as the Knowledge Society.[Toffler 1990]. The introduction of the personal computer was probably one reason for the shift from the Industrial Society to the Information Society. This, made it possible to collect and save huge amounts of data that could be compiled and analyzed. In addition, Information Technology has given huge possibilities to exchange this information. The introduction of, for example, mobile phones and Internet has changed daily life. However, it seems that this accessibility to information has also made it less easy to hide, to be anonymous, as almost everyone within modern society is more or less “on-line” all the time. This situation has led to an increased demand upon companies, enterprises and different sectors of society to become more transparent [Thompson 2007].

One of the problems in the Information Society is just that of information, as there is an overflow of information. The PC and Internet gave us an abundance of easily achievable information. This development was already foreseen in 1970 by [Toffler 1970] as techno-stress. It seems that one of the tokens within the knowledge society is to collect, compile and evaluate information with the aim to extract knowledge. This has lead to a new profession, the so-called information intermediary or knowledge broker. Defined as a “Trusted third-party reseller or provider of advice on selection of goods or services, competitor information, or research data”. There are examples of knowledge brokers within our own area, namely the Swedish Council on Technology Assessment in Healthcare (SBU, Statens beredning för medicinsk utvärdering) in Sweden and, internationally, the Cochrane collaboration.

Our patients are also evolving, as both they and we are integrated in the development of the society, from being subjects with an authoritarian belief in the dentist in the Industrial Society, to becoming customers within the Information Society. With an increasing knowledge, they might become something else in the Knowledge Society, perhaps co-workers who would like to have transparency, appraisal and feedback. This development could also be compared with the ideas behind the concept of Customer Relationship Marketing (CRM) where the ambition is to move people from the lowest level of being a Prospect via Customer further upwards to the top, being a devoted Partner.

Transparency, Informatics and fast communications have led in society to continuously increased competition. The competitors are no longer within a defined community, instead they are found around the world. An example from the field of dentistry are the dental technicians who are now working in East Asia doing crowns and bridges for patients around the world.

The competition is about price and quality, in other words, customer value [Krafcik 1988]. Despite what price a person is paying for a product or a service, she/he wishes to have as much as possible for the money spent. It seems that one could expect an increasing competi-
tion within dental healthcare based upon price and quality. It seems to be necessary to show, in terms of health related data, what the patients receive for their money spent. Pain relief or number of restorations produced will not be enough in a competing environment. Despite being a society with an abundance of information, there are gaps concerning levels of knowledge, such as those between professionals and patients, as well as between professionals and science. It seems to be a useful tool to be able to bridge these gaps in the competition.

6.2 Three dimensions to be measured

In health-economic discussions, we have to have ways of measuring the three dimensions of well-being, economy and health–disease in order to find the most beneficial methods for the future. In Sweden a Consensus conference was held on these subjects in the year 2002. One of the conclusions was to reach the highest possible health in most cost effective way [Hugoson et al. 2003].

A recurrent study is performed in Sweden, the so-called Quality index [SKI 2008] rating the Swedish inhabitants’ view upon different services within society. Dentistry is the most appreciated sector among Swedes. What is measured? – degree of satisfaction, that is how well people found the personnel and their services. It was not a question about what has been achieved in terms of oral-health outcome. In the light of all criticism that dental healthcare has received concerning the high cost for dental healthcare, the result was astonishing. [SOU 2007]. To conclude that, despite high costs for services, patients put dental healthcare as the sector best appreciated. But what has been achieved for the money spent has not been measured among the adult population, yet.

In dental healthcare, as well as in other sectors of society, there is at this moment an increasing demand for cost-effectiveness [Widström 2004], and questions such as ‘What is achieved for the money spent?’ are formulated. The ultimate goal of Minimal Invasive Dentistry must be that of “being not invasive”, which also results in questions regarding knowledge of how to achieve such goals.

A new state dental-care financial support system was introduced in Sweden in 1 July 2008 [SOU 2007]. The development of this new system has induced several other projects within Swedish dental healthcare. One is the development of a national dental quality register, “Svensk Kvalitets register för Karies och Parodontit” (SKaPa), while another is the Dental-health Register within the Swedish National Board of Health and Welfare. It is supposed to collect, compile and analyze information from dental clinics about the outcome of performed dental healthcare.

Quality indicators for periodontal and caries diseases to be used in dental clinics were defined at a consensus conference in 2007 involving specialists in the fields of cariology and periodontology [SKaPa 2008]. Another project within the Swedish National Board of Health and Welfare is performed together with the Swedish Council on Technology Assessment in Healthcare (SBU). The aim is to identify and approve methods that are, as much as possible, evidence–based, to be used as national guidelines. The idea is that the state dental-care financial support system is to be used as the steering tool, since methods not approved will not be re-funded.
The state financial support system has been based on the Internet in order to be able to manage it. All dental healthcare providers that would like to be within the system have to have access to the Internet, either on-line or via a website, to send information about what is performed on what indications and on whom. There is also a demand for reporting the number of teeth and intact teeth. This is because the government wants to know about what is achieved for the tax money spent.

In Sweden there have been tendencies in the last 15 years in organizations and within politics to turn towards a capitation system based on a positive economic outcome for healthcare providers, with the unquestionable goal of promoting good oral health [SOU 2002]. These ideas started when the changed dental-health situation of children and young adults became obvious. Today it is used mainly within the Swedish Dental Health Service, aiming most often at the younger part of the population. This concept might be of interest if it will induce increased dental awareness and ameliorate the situation of the individual patient. A problem in introducing a capitation service covering the whole population is the inequalities in dental-health status between the younger and older parts of the population. Certainly such a system would be from a taxpayer’s perspective ideal, while a fixed price could be defined for the money spent per year, instead of the situation of today when the costs are related to fee for services [SOU 2007]. On the other hand, as the use of Informatics are now introduced to support this system, it becomes more easy to identify levels as individually as possible. Finally, it will come down to giving a defined price to each patient – in other words, exactly as it is within the fee for service/item system. The result is the same if you as patient perform an adequate home-care – the costs for dental healthcare will be reduced. To me, how we should increase the knowledge among our patients seems more important than how the payment for these services is managed. However, it seems that most of treatment performed is due to a repair of earlier restorations, so it is clear that a system that makes fillings more profitable rather than preventing them is not sustainable in the long run.

6.3 Measuring dental health

Today Minimal Invasive Dentistry is the overwhelming trend within modern dentistry. But to be as minimal as possible one should be: non-invasive, that is, to base the work upon the bottom line of dentistry, to save the original parts, the tissues.

The dental-health situation in western countries has shown a development better than expected, and as this will force dentistry in new directions, one expects to be cosmetic dentistry another general health issues [BDA 2007, Baelum et al. 2007]. The shift also implies other ways of measuring. The DMF system was developed in a different reality than we are facing now. That system seems not to be useful for epidemiological purposes in daily dental healthcare [Marcenes & Sheiham 1993]. The caries incidence has decreased and there has been a shift in diagnosing [Gabre 2006]. We are moving toward a view of Manifest or Initial and Active or Inactive. Concerning periodontal diseases, it seems that the view “Active-Inactive” could be used in the same way [SKaPa 2007]. These views formed the basis from which the HIDEP model was developed.

The measurements of number of intact teeth and total number of teeth seems to be good quality indicators [SOU 2007, SKaPa 2007]. This is mainly due to our basic issue of saving tissues intact, but is also due to the fact that caries disease starts in the back of the mouth and moves forward, dependant upon the strength of the activity. The more intense the activity is,
the more destruction will occur and the more forward the cavities will occur. A quote of 22/32 implies filling/cavities in molars of class I or II. For a quote of 6/10 one could imagine that the lower front is intact and that this patient has some sort of prosthodontics.

Certainly we also need quality indicators concerning the quality of our restorations, root-fillings and implants, but these indicators form “the second line” when tissues are already lost. The materials and methods used to restore lost tissues must also be preventive in the aspect of not inducing further tissue losses. If the technical part of dental healthcare has a low quality, it will sooner or later also be reflected in tissue-based measures.

These are all signs showing in what directions we might be heading. The urge for transparency and increased competition seems to be forcing dental clinics to market themselves based upon their abilities to improve the dental-health situation and well-being of their patients in the most cost-efficient way. The results will be to a large extent dependent upon well-educated patients showing a good proportion of dental awareness and by seeing themselves as co-workers.

6.4 Management of dental practice by Informatics

One can conclude that the IT support within dentistry has not followed the same pace as IT development in society. Why?

In the 1980s, the developers of the first systems was not acquainted with dental healthcare, and dental healthcare personnel were not acquainted with the possibilities which this new digital technique could offer.

It seems that the primary reason to take advantage of IT within dental healthcare was due to problems related to different insurance systems. The more difficult these were, the greater the need became for software systems. This could perhaps be an explanation of why digital dental systems grew much more quickly at the end of the 1980s and 1990s in Germany than in Sweden.

The first softwares within dentistry had economy as the main core. From this basis dental recording systems then developed. The demands for records within healthcare were legally defined as based upon the paper-based record system with a focus on input. As the first digital dental-record systems had to fulfil this law, they became more or less just a digitalized version of the paper-based record, with the same limited possibilities concerning output, but without the ease of input. The paper-based dental-record system was quick and easy to use, only paper and pen were needed. The digital-recording system could not compete and it seems that, in Sweden, the reason to digitalize the clinic became just a question more or less of being an up-to-date dentist.

In the middle of the 1990s national demands upon quality assurance appeared within healthcare but this had no impact on the digital-recording systems. As the need for IT support in Sweden was small, there were also a limited number of users. This gave a small customer base and a very tight economic sphere for further developments in IT support.

The new state dental-care financial support system that was introduced on 1 July 2008 was not only complicated, but also demanded fast communication between dental practices and
Försäkringskassan (Social Insurance offices). The dental-care financial support system is supposed to be furnished with 5.9 billion SEK of the Swedish taxpayers money yearly – money transferred to dental healthcare with the clear purpose of maintaining/improving the dental status of the Swedish population. To “get hold” of this money, it became a necessity for dental healthcare providers to communicate with Försäkringskassan over the Internet. There is also a demand upon them to give an answer to the question: “What is achieved for the taxpayers money spent?” In the previous national dental insurance system, this question was not raised, but it was in this new system. The output, outcome of dental healthcare, has now to be answered.

It seems that the introduction of the new state dental-care financial support system has been the most important impetus concerning the digitalizing of Swedish dental healthcare. The same year as the system was introduced, new laws also became effective, which regulated the digital records within healthcare with a focus upon patient safety, their rights and their accessibility to the records. These laws, together with the new state dental-care financial support system, seems to have a considerable impact upon the development of the future digital systems.

The development of dental-recording systems, as well as increased communication, seems to have moved dental healthcare towards the Knowledge Society with an aim of closing the gaps of knowledge, not only between patients and professionals but also between professionals, producers, science and authorities.

There seems to be three major areas that might be improved, all of them based on the possibilities of bridging knowledge gaps:

- Knowledge gap between professionals and patients
- Knowledge gap within the dental healthcare team
- Knowledge gap between healthcare providers and producers/science/authorities.

Knowledge gap between professionals and patients
In Sweden, we are facing a future where the number of older patients is increasing considerably. This is happening simultaneously with the number of dentists decreasing. In order to maintain good oral health, it is necessary to refocus, rearrange and reorganize dentistry. The patients themselves have to take a higher responsibility for their own oral health in order to do that, they have to have adequate knowledge.

In order to re-orientate the activities and decrease the knowledge gap, it becomes necessary to increase the knowledge of the patients. This means that it might be necessary to abandon the concept of seeing the patient as a customer, because the customer-view leads to a situation where the dental healthcare provider has to fulfil the expectations of the customer. As long as the expectation and knowledge of many people is still that the daily work in dental clinics is to repair teeth, it becomes difficult to adopt new ideas in which retaining health, rather than repairing, is the predominant issue.

New digital dental-recording systems will be constructed in a way which makes it possible for the patient to access information about their oral-health situation. Increased patient friendliness and increased interactivity, as well as increased interpretability, will most probably be seen. Instead of numbers and tables which are difficult to understand, there will be easily in-
interpretable charts, diagrams, pictures, photos, 3D images, etc. Surveys will be online. Questions will be answered.

Knowledge gap within the dental healthcare team
Future IT support seems to give the possibility for evaluating the dental healthcare performed, to identify risk patients and to see patterns. For example, the use of statistical processing seems to have the possibility of automatically giving information to be used for effective quality development. One could also foresee more support from so-called expert systems. It will be much easier to have a common view and to set goals [Coiera 2003].

Knowledge gap between healthcare providers and science/producers/authorities
One important issue in the years to come is to combine clinically proven experience with scientifically proven facts. The use of Informatics will facilitate this development. Information from clinics can be sent to quality registers where conclusions concerning effectiveness in treatment can be drawn. Methods and material that has been scientifically proven can be more easily spread to dental clinics, and the results of these methods and material can be reported back [Coiera 2003]

For the years to come, it seems that we as professionals in our daily work not only have to take into account available scientific evidence, but also to collect information in our clinics in a systematic way in order to obtain knowledge about our outcomes. This objective, together with an effective knowledge transfer between the parties involved, will probably comprise the two most important features of dentistry when entering the Knowledge Society. To facilitate this, ways of measuring interpretable for all parties involved, as well as the support of dedicated softwares, will be prerequisites.

Enhanced communication, increased demands from patients/society concerning health economy, changing needs and a new way of looking at healthcare will induce new types of dental-recording systems.

Instead of having clinic-based systems with software installed on servers, it seems that the trend is moving towards systems based on the Internet. Instead of re-arranging existing dental-recording systems that sprang from a time quite different to today, it seems to be more feasible and more effective to develop new systems that are giving answers to our questions, using the Internet as a platform. This probably will facilitate integration of different systems as add-on modules to the digital dental-recording systems, that are more oriented towards odontology, permitting one to extract knowledge to be used for continuous improvements of not purely economical issues as before, but instead of issues of cost-effectiveness concerning methods and materials. What materials works in our hands, what is the latest within science? What can we bring into our clinics? What is the result of our efforts, what can we report back? Within these different issues patients, professionals, industry, science and authorities have an interest. The use of Informatics will enhance the possibilities for managing dental healthcare more effectively.
7 Conclusions

- The foundation of dental healthcare is prevention, that is, to save tissues as teeth and their attachment. The patients themselves by their home-care and ways of living perform a large part of this prevention. To increase their involvement they can be seen as co-workers striving towards common goals with dental healthcare providers.

- A common goal “Good oral health” demands measures interpretable by all parties. There are three dimensions to be measured: well-being, economy and the clinical dimension of health–disease.

- The clinical dimension of health–disease can be measured by viewing the major threats, periodontal and caries diseases, as being Inactive or Active. If inactive, there are different risks in becoming active. If active, there are different degrees of symptoms.

- Total number of teeth, number of intact teeth and approximal bone level are indicators that could be used on a long-term basis for evaluating the outcome of the dimension health–disease. Inactivity–Activity can be used to evaluate outcome in a shorter time perspective.

- Total number of teeth, number of intact teeth and approximal bone level, together with defining Activity or Inactivity, are items that could be assembled in a code describing a summary of the dental-health situation of a specific patient within the clinic.

- Compilations of all codes give an overview, a health profile of the dental clinic. This overview is used as a basis from which quality development and healthcare planning could start.

- Structured treatment plans and maintenance schemes to be used in the dental clinic can be established on the basis of scientific evidence, clinical experience and the resources of the clinic and the needs of their patients.

- These different items mentioned above are included in a healthcare management model (HIDEP model) supported by a dedicated software (DentiGroup™), permitting the abovementioned actions, as well as different forms of analysis.

- The model and its supporting software can follow the development of dental health among patients within a dental clinic over time and, by this, permit evaluation of the clinical dimension of health–disease aimed at continuous improvements.

- A work according to the model facilitates communication and motivation of patients by increasing their involvement and dental awareness. Communication within the dental team and with science and authorities is facilitated. Thus, a step towards bridging the knowledge gaps between the parties involved in Swedish dental healthcare has been taken.
8 Future work

The performed research emanated from the question “Do our patients become healthier?” in 1987. In finding an answer to that question, several other questions arose. What do we mean by health? Who is responsible? How can it be measured? How could we continuously improve? At that time it seems that society was leaving the Industrial Society and entering the Information Society. Personal computers came and made it possible to handle large amounts of data. The concept of quality with an individualized production economizing resources and the issue of continuous improvements grew stronger.

It seems that development within dentistry in the years to come will be primarily within the field of Dental Informatics. New revolutionary materials or methods like, for example, genet-technology does not seem likely to change dentistry in the near future as much as Information Technology is likely to do. In Sweden the new state dental-care financial support system will have a large impact on Swedish dentistry. Other issues that will have an impact are questions about evidence-based dentistry and cost-effectiveness, but also new laws concerning the digital dental-record system and the rights and safety of the patients.

It seems that the future of Dental Informatics will be based on the Web. This gives new possibilities not only concerning accessibility for patients and healthcare providers, but also possibilities concerning quality registers and spreading methods that are evidence-based. The major advantages will be decreased knowledge gaps between science-providers-patients and authorities. Within this, it seems that it will be a necessity to use or at least translate data in a way comprehensible for all parties involved. Such a system will, because of its accessibility, also facilitate the compilation of information into knowledge. In the years to come, it seems that the ideas that were the impetus to this thesis could come into use when developing Informatics targeted at management of dental clinics with the aim of continuous improvements of health.

This research has focused on the dimension of Health–Disease, and in the future, it might be important to try to integrate the dimensions of well-being and economy, with the aim to cover more thoroughly the management of oral health, as described at the consensus conference in Mullsjö, Sweden [Hugoson 2003].

Important work that should be performed in the future includes:

- Further testing and improvements of the HIDEP model and its corresponding software, especially long-term studies of possible health outcomes using the HIDEP model or similar tools.

- Creation of new and possibly also, Web-based, dental-record systems permitting a decrease of the knowledge gaps between patients, healthcare providers, authorities, science, industry, dental schools, etc. Such record systems should allow methods like the HIDEP model to be used.

- Development and studies of new methods for measuring oral health that combine the three dimensions of Health; Well-being, clinical Disease–Health, and Economy.

- The inclusion of the general health data of the patients within this panorama as there is a close linkage between the oral and the general health situation of a patient.
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