# MedView-Design and Adoption of an Interactive System for Oral Medicine

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**Abstract.** MedView is a joint project with participants from oral medicine and computer science. The aim of the project is to build a large database from patient examinations and produce computerised tools to extend, view, and analyse the contents of the database. The contents of the data base is based on a formalisation of health-care processes and clinical knowledge in oral medicine harmonised within the network SOMNET. We give an overview of the current status of the MedView project and discuss background and future directions.

## 1. Introduction

The traditional paper record used in medicine does not store information in a manner that makes it easy to learn from the huge amounts of information collected over time. Not only does it require that someone manually reads and organises the stored information, but even if the records are read the information stored within them is not sufficiently organised and formalised to form a basis for a general analysis. Unfortunately most computerised systems developed today to replace the paper record share the same problem. Systems are designed for storage and transportation of data, and to simplify administrative tasks. To avoid creating computer records sharing most deficiencies of the paper based record simply storing data in a computer instead of on paper is not enough.

This paper describes MedView, a project in which we have tried to create a formalisation of knowledge and to construct computer tools for use within the area of Oral Medicine. The general principles should apply to other areas as well. The aim of the project is to build a large database from patient examinations and produce computerised tools to add to, view, learn from, give decision support for, and analyse the contents of the database.

## 2. The MedView Approach

Diagnostic work and clinical decision-making are central items in every field of medical practice, where clinical experience, knowledge and judgement are the cornerstones of health care management. In order to achieve increased competence, the clinician is confronted with complex information that needs to be analysed. There is considerable evidence that the unassisted human mind is challenged when exposed with multiple sets of data [1]. Therefore, the clinician needs tools in the diagnostic and learning processes that improve storage and analysis.

It is our experience, both from using paper records and current electronic record systems, and from several student projects related to the development of computerised record systems, that neither of these provide tools that really assist the practitioner in the mentioned processes. Instead we have tried to build a system based on knowledge representation techniques with focus on real-world usefulness.

The first step in the diagnostic process consists of gathering and storage of clinical information. In order to be meaningful for interpretation, these data must be recorded in such a way that they can be understood and interpreted in a precise manner by all members of the health care system. This means that a formalised and harmonised health care system is imperative. The word “formalise” in this context means to establish and formally define basic health care activities that can provide an explicit structure for intelligent reasoning. This formalisation is crucial in order to arrive at a correct diagnosis, based on an explicit definition [2]. The term “harmonisation” refers to the process of making the formalised activities adapted within a community [3].

Based on a formal description of the concept “examination” we aim to:

- Provide a formal framework and methodology to be used.
- Formalize the knowledge to be gathered based on this methodology, in a close cooperation between odontologists and computer scientists.
- Develop tools for entering the information gathered at an examination into the database directly in the examination room.
- Develop tools for viewing the contents of the database, both for use in the examination room and later for retrospective studies
- Develop tools for analysing, learning from, and exploring the database and for adding concepts built on top of the basic formal method.

Today the first three steps are essentially finished while the fourth and fifth, of course, are of the kind where there is always more to be done.

## 3. Design

MedView has been developed in an iterative process through close collaboration between experts in oral medicine and computer science, using a mixture of contextual design, user oriented design, and logical analysis of the problem and required knowledge. Essentially, the analysis and design of the system can be divided into two subproblems, knowledge representation and development of applications for gathering and exploring clinical data.

### *3.1. Formalisation and Harmonisation of Knowledge*

The formalisation of knowledge used was developed in close cooperation between participants from oral medicine and computer science, with the purpose of providing a model suited both for oral medicine and computerised storage and reasoning. The model of the health-care activities and medical expertise involved has evolved through collaboration within the Swedish Oral Medicine Network (SOMNET). When elaborating the MedView system, great care was taken to determine what clinical information could be defined as useful and constitute the foundation in the database. The result from these considerations was standardised protocols for input of clinical information. Consequently, case history and all clinical data are entered by use of predefined parameters from these protocols. Through this process a solid base for subsequent analysis and intelligible reasoning of results is obtained. The nomenclature and information structure is thus *formalised* and *harmonised* within the network. The formalised protocols have a logic interpretation, which makes them suitable for automated reasoning in a computerised system. At the same time they are simple enough to have an obvious intuitive reading needing no further explanation.

The protocols defined for collection of data are rather extensive, including detailed interviews of disease history and protocols for clinical examinations. Existing mucosal lesions are described in terms of localisation and clinical appearance. Mucosal lesions are also documented with digital video technique. This technique offers the advantage that the digitised images are immediately accessible in the database, both for analysis and distant consultations. Results from biopsies, laboratory tests and other invasive or non-invasive investigations are included, as are diagnoses, treatment modalities and clinical outcomes of

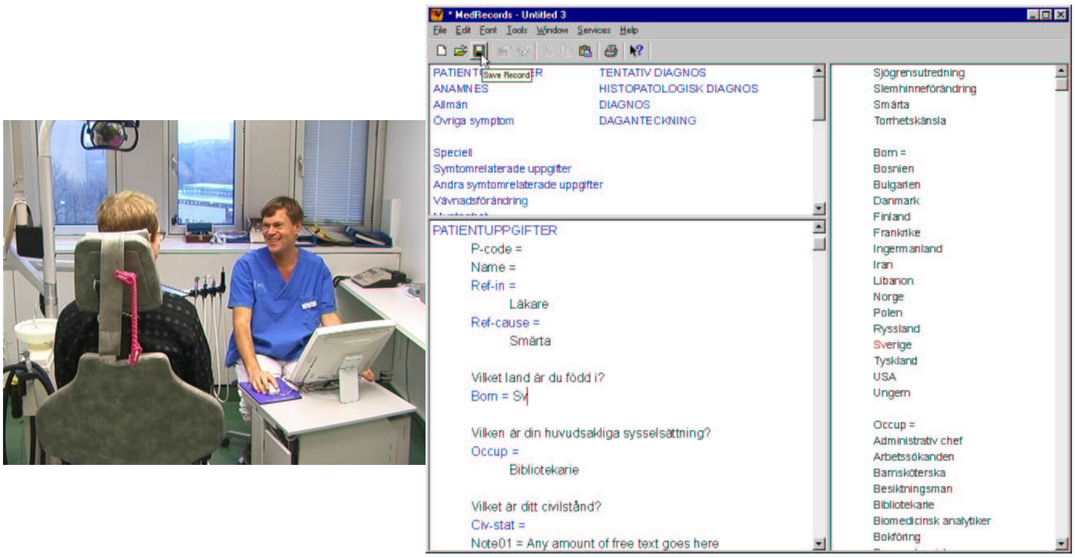


**Figure 1:** Left: Clinician working with MedView. Right: MedRecords main window.

performed therapies. Additional information not included in the protocols but relevant for the present patient can be included as text.

The formal model of the database used is that of a collection of definitions, where each definition describes one medical examination. Each such definition can be viewed as a collection of equations:

occup = dentist
civ-stat = married
colour = white
pattern = erytem.

Reasoning is performed using a theory of definitions [4]. The formal model used in MedView is such that the currently used formalisation can be easily extended and modified over time. The protocols used can be seen as a first approximation of the needed knowledge structures. When we learn more we can extend the protocols to collect more information and describe harmonised nomenclature for a larger part of oral medicine. The model also makes it easy to introduce more complex concepts based on the basic data collected through the common protocols. For instance concepts that group together a number of possible values, or a diagnosis expressed in terms of common observations from a number of cases.

### *3.2. Entering Information*

A basic assumption underlying the design of MedView is that of separating the activities of entering information and viewing or otherwise using the entered information. The rationale behind this is that the cognitive tasks involved are very different. Thus, specialised applications have been developed for each task.

Data is collected in a critical situation, namely during examinations, see Fig. 1. For each examination, values for many different attributes describing an examination must be given. An application for entering data called MedRecords (MR) is used for this task. MR was designed as an alternative to the form-based interfaces commonly used in applications, which consist of a number of boxes, text-fields, pull-down lists etc. Compared to such, MR provides a very space-efficient technique for entering data. A protocol with a hundred different attributes can easily be handled on one screen.

The user interface consists of three areas. At the top left is a navigation area, below is the input view where data is entered, and, finally, to the right is list of commonly used values. The user navigates to the appropriate part of the input form by selecting a link in the navigation area. The input view works as a specialised text-editor, with links to the value lists to the right. Digitised images may be included by dropping them on the input view.

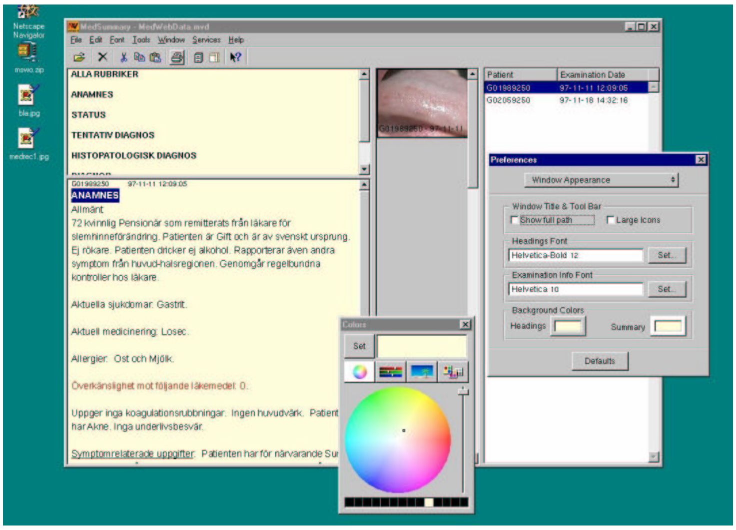


**Figure 2:** MedSummary main and preferences windows. Different texts may be generated by selecting from the headings at the top left. Clicking on a minimized image will show it full-sized in a separate window.

### *3.3. Viewers*

We can discern between two categories of viewers. First we have viewers simplifying the daily work in the examination room, second, viewers for analysis, exploration, and learning.

The first, and so far most used, viewer is MedSummary (MS). MS is used in conjunction with MR in the examination room, but also to display detailed information during analysis. The database view given by MS is that of a textual summary of one or more examination records, together with any associated images (Fig. 2). The purpose is to display in a format suitable for viewing the information collected in MR. Instead of showing the form or screen used to collect data, we use Natural Language Generation (NLG) to synthesise from the collected data a comprehensible summary of all, or parts of the examination(s).

As mentioned above, we make a clear distinction between input application(s) and viewers. In the examination room new data is entered with MR, the contents of existing examination data is viewed using MS. The main window of MS shown in Fig. 2 contains a listing of selected examinations to the right, thumbnails of images in the middle and a synthesised summary to the left. Clicking on a thumbnail image will show it full-sized in a separate window. Selecting between the headings at the top left generates different texts. When a patient comes back, the user can create a suitable background text by selecting the desired previous examinations, and then click on a heading to view a summary with images.

The most used visualisation of the database for analysis so far is called The Cube. The Cube provides a view of the database aimed at analysis with respect to finding patterns in the material. The application enables a three-dimensional display of a multivariate analysis, which may be rotated and viewed from different angles by the examiner, see Fig. 3. Each plane represents one parameter chosen by the user. Any number of parameters (planes) can be used. The individual plane offers a display of values for the chosen parameter. Each patient subjected to analysis is represented by a line connecting the individual values for each parameter. If the patient material is homogenous from the aspect of parameters chosen the lines will appear parallel to each other within the cube. Heterogeneities in the patient material for a certain parameter will cause the lines to diverge from each other in the corresponding slide. The user can select a number of lines and perform operations on them. Among the available operations are removing the selected lines from the display and launch MS to view details. MS will show a summary as described above, including images. The clinical information associated with any line in the display is thus available to the user.

The real treasure of MedView is the database being built. The number of possible viewers is limited only by our imagination. Knowledge is there to explore in a well-documented format. A simple web-based viewer for finding images matching criteria taken from any of the attributes in the data base is shown in Fig. 3.

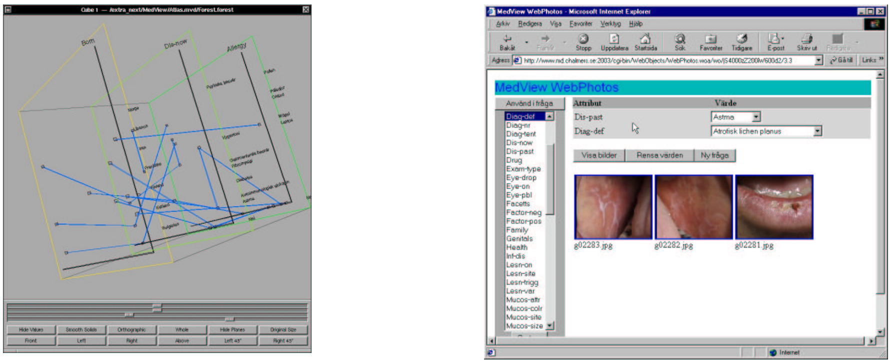


**Figure 3:** Left The Cube. Right: Searching for images over the web.

## 4. Clinical Implementation

MedView has been implemented within SOMNET in a common effort to collect data in oral medicine and improve working routines. The system is currently in daily use in eight examination rooms at four different clinics. Currently (January 2000) the MedView database contains approximately 1500 records. The average growth rate is 20 new patients and 30 visits by previously examined patients a week.

The content of the database is used in mainly two ways. First, in the examination room to display the history of the patient under examination, second, to perform analysis, learn from, and search for patterns in the database. Also, seminars are held regularly within the network, discussing cases taken from the database.

## 5. Conclusions and Future Work

So far much of the effort put in to the MedView project has been to provide foundations for formalisation of medical knowledge, and to build tools for systematically collecting medical knowledge at clinical examinations. Tools that have been put to the test at about 1500 examinations have been developed and proven useful. Some analysis tools are in use, although in a smaller circle. Now, with these foundations in place there are many different future and ongoing projects to pursue further.

We need more work on knowledge representation theory, for instance how various concepts can be described on top of the basic data base model. We will also continue working on providing better analysis and visualisation tools. We are also planning application to new areas: the Brånemark Clinic is world leading in teeth implants, we plan to apply MedView in an international project evaluating new treatment methods. Another interesting project is development of an Internet Textbook in oral medicine together with the Eastman Dental Institute based on cases from the MedView database. Yet another is data mining: as the database grows searching for patterns in it becomes more and more relevant. Finally, improved support for distant consultations, currently patient information is sent via email. A better approach would be to build tools for real-time communications using audio/video so that the expert asked can view and interact with the patient directly.

## References


[1] J. Merz, M. Small and P. Fishbeck. Measuring decision sensivity: a combined Monte Carlo logistic regression approach. Med Decis Making 1992:12(3), pp. 189-196.

[2] Goossen WT, Epping PJ, Abraham IL, Classification systems in nursing formalizing nursing knowledge and implications for nursing information systems. Methods Inf Med 1996;35(1)59-71.

[3] Peteresen PE, Christensen LB, Moller IJ, Johansen KS. Continous improvement of oral health in Europe. J Ir Dent Assoc 1994;40(4)105-107.

[4] L. Hallnäs, Partial Inductive Definitions.TCS 87(1):115-142, 1991.