# On the way to a Web Based Hospital Information System: Concepts for the Use of a Medical Data Dictionary to Present Context Sensitive Information in an Intranet Environment

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#### Abstract

Many authors have promoted the www-paradigm to build modern hospital information systems. However currently web-based applications are better suited to information ", browsing" than to build complex data entry features.

This prompted us to start with our first web based developments inside the Gießen University Hospital Information System in the field of pure presentation of stored knowledge and information. This article describes the concepts which will be used in Gießen to convert available information sources to the www paradigm and to implement context-sensitive knowledge presentation mechanisms inside the clinical information system. The approach is based upon a web-based medical data dictionary server. The data dictionary is used to map terms of interest, chosen from the clinical user during work with a HIS-application, to a semantic network of relationships. The dictionary server will follow those semantic links in order to find and display the webpages, which are linked to the subject.

#### Keywords

Knowledge Presentation, WWW, Intranet, Data Dictionary

# Introduction

The terms Internet and World Wide Web are the catchwords of the 90's. More and more authors report on the use of internet technologies also in the closed environment of a hospital network, naming it intranet [1,2,3]. A recent overview of Sittig [3] described 9 examples of routinely used www-based interfaces to access the respective clinical information system. This report concludes, that although many desirable features of a wwwbased interface to a clinical information system are available, current www-technology is much better able to handle "browsing" features for the display of information than to build complex data entry features.

Most clinical sites will develop their web based interfaces on top of an existing clinical information system [2]. The www paradigm offers a variety of advantages, such as thin client applications, executable on any type of workstation, but some of the inherent disadvantages, e.g. underdeveloped security features, or repeated connection buildup have been also described in detail [1]. To overcome some of the problems data are often transferred from hosts to intermediate databases, converting information simultaneously from coded to freetext information. Therefore the ability to provide tight coupling as described by Kohane [2] is lost. Kohane describes tight coupling as the ability of a web based clinical information system, implemented on top of an existing electronic medical record system (EMR) to follow links between departmental systems which would have been provided by messaging or signaling protocols in the legacy EMR. Such features are not only essential for interaction with departments, but also for context-sensitive information display and knowledge based functions which together form a main characteristic of advanced clinical information systems [4].

In this article we present a concept which will provide such coupling mechanisms between the legacy EMR and the web based information sources. The coupling mechanisms will be realized on top of a medical data dictionary (MDD). Inside the dictionary terms delivered from an application will be mapped to context sensitive information stored in webpages.

## **Present Situation at Giessen University Hospital**

#### The Hospital Information System

At Gießen University Hospital, a clinical information system has been developed over the years, which allows for widespread access to clinical patient data as well as to electronic information sources, and to a multitude of linked departmental specific applications e.g. programs for anaesthesists, surgical theatre support or cardiac catheterization units [5,6,7]. Two types of clinical front end workstations allow user access to clinical patient data, e.g. lab results, diagnoses, nursing severity scores, or doctors letters: More than 400 IBM compatible PC's operate with a terminal emulation which accesses data on the Tandem mainframe computer directly [5]. Approximately 400 Macintosh Power PC [6] cooperate in client server fashion with the mainframe on top of the identical centralized patient database and offer a graphical user interface (GUI) to the clinical staff. Access to the clinical information system is provided in all ward offices, all doctor's offices, most theatres and anaesthesia areas, laboratories, pharmacies and departmental offices. Apart from these PC's and MacIntosh machines, several UNIX workstation clusters are operational at the pharmacies, angiology and

Hospital Information Systems

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Figure 1 - The electronic book as web source. The picture shows the drug formulary

pathology departments, which are interfaced to basic functions of the clinical information system such as lab data review or patient demographic data.

#### **The Information Sources**

A variety of commercially available information sources such as drugdex, medline, clinical textbooks, dictionaries and drug formularies have been made available both at the PC's in shape of application switching and at the Macintosh computers inside the Softwindows<sup>TM</sup> emulation respectively as original Macintosh applications [6,7,8,9]. In addition, a large, in house compiled information source called the electronic book has been made available on both platforms. It contains for example guidelines for microbiology sampling and treatment, hygienic guidelines, nursing guidelines and the complete hospital drug formulary. The electronic book is currently based on a collection of generic pascal programs and a variable set of textfiles for each domain, residing on a Novell Server. The electronic versions of drug formulary [10], hygienic guidelines and nursing guidelines have fully replaced the previously used printed books and leaflets.

However, the UNIX workstation clusters, which are operational at the pharmacies, angiology and pathology departments, are not able to access the commercial or in house compiled information systems at all, so that, if needed, an additional PC has to be provided for information review.

#### The Use of the Medical Data Dictionary

Medical data dictionaries (MDD) have been used in Hospital Information Systems (HIS) for some time to map descriptive information with codes. They have been reported to be essential in structured data capture and they allow to implement knowledge based functions [11,12,13].

Gießen embarked on a data dictionary approach for its hospital information system in an early phase of HIS development, prompted by experiences with the HELP system. In its first version, the GMDD, being fully integrated into the HIS, supported hierarchical and polyhierachical relationships [14]. The second and more modern version has been employed for a drug order entry application inside the Gießen HIS and supports all kinds of semantic relationships [15,16]. It is based on the principles of a relational database and portable across platforms.

# **The Future**

#### **The Information Sources**

As a first step we designed a set of programs which allow the setup of a web-based electronic book. This allows to convert each of our internal information sources on demand into an intranet application. Figure 1 shows an example from our in house drug formulary. The programs generate the chapters of each book in shape of links (left side of page) and reconstruct the search index (Top of page). The textfiles are displayed on the right side of the page.

Construction of such a converter program proved essential, since for some time we will have to support both applications, the old DOS-based and the new web-based electronic book in parallel in order to allow access for all clinical users. Having such a converter, we can allow the clinical personnel in charge of the respective sources, e.g. the pharmacist or staff of the microbiology department, to maintain their data in the DOS based electronic book. The web version is then generated by the converter.

The internet based electronic book has been taken into routine use in July 1997 and is increasingly used. More than 5000 requests have been answered until now. It includes today all 6 information sources which were available in the previous DOSbased version mentioned above. The equivalent of more than 2 megabytes of textual data containing hospital intern guidelines and procedures has thus been made available on the intranet of our hospital. Parallel to this, a secure mirroring process has been set up, which copies all information provided by Gießen university hospital departments for the internet into our intranet as well.

#### The Data Dictionary Server

So far most data dictionaries have been fully integrated into the HIS as a backbone application [11,14]. Only few data dictionaries can also offer support in a distributed environment, and to our knowledge only one of them can be used in the www [17]. Our aim is to construct a concept where medical data dictionaries play an important role in the new distributed intranet environment of the future. Figure 2 shows how the data dictionary will be used.

The application will post a message containing the search term via a web browser to the dictionary server, a web based application which connects to the data dictionary database. The dictionary server will resolve the term, follow its semantic relationships and point to the appropriate webpages containing information relevant to the term. The web browser which has been invoked from the application to post the term, will receive a dynamically constructed webpage which presents the semantic relationships and the first related webpage immediately, and which offers dynamic links to all other related webpages in a frame based environmen.



Figure 2 - A dictionary server performs context sensitive mapping of web-based information resources

How does the server know which semantic links to follow ? Information about the search paths for certain types of information will be stored in the dictionary itself. This information will be read from the dictionary server and the pathways will then be followed automatically for the given term. Those semantic navigation steps will be displayed dynamically in the top of a frame based answer page. All the dynamically displayed links to webpages will be highlighted, so that the user can choose another one. The information itself will be displayed at the bottom of the web-page.

#### **Context Sensitive Information Retrieval**

Few examples of successfully integrated context sensitive help functions have been reported from other sources. Cimino has implemented context sensitive information in shape of a medline button which opens medline and immediately starts a search with the chosen search terms in order to retrieve the relevant literature for a given term [1].

For the future we intend to offer full context sensitive help to the clinicians working in the Macintosh version of our HIS in a similar way. The user should just have to highlight the appropriate term and press one single info button in any of the clinical applications.

This feature will be constructed in a modular fashion in C-language, the programming language used for the HIS-client interface on Macintosh PC's. It can thus be added to any of the HISfunctions on that platform. In any HIS function the working mechanism, posting a message to a web browser, will be identical. Within the Macintosh HIS environment, features exist already to either start a new web browser or to call the last active browser from background. By bringing the browser window in the foreground one can then make the dynamically created webpage visible at once.

## What do we gain ?

The University Hospital Gießen currently operates a closed intranet and will continue doing so for the near future to avoid security risks. Already many relevant clinical information sources can be searched in the web (see for example [18,19]) and they can be mirrored in a secure way to the intranet in the near future. In a first stage we have successfully mirrored the

external webpages of the medical department to our intranet. More and more commercial information sources can be expected to be available in a web-compatible version in the near future. All Macintosh PC's have been equipped with a web browser. Using the proposed pathway we will be able to present such new information sources easily to our users.

Moreover we have had complaints from our clinical users about the time needed to switch applications in order to retrieve e.g. drug information from our in house drug formulary during review of specific patient results. In such situations the context sensitive presentation of the relevant knowledge can result in a major advantage for the users. American Universities for example undertake huge efforts to make different information sources available on the physicians workstation and to implement an integrated workspace for physicians, researchers and other clinical staff within the IAIMS programme [20].

With the proposed concept we will be able to map diverse kinds of information sources just by maintaining simple database entries in our medical data dictionary. As soon as this has been performed, the sources will be available for context sensitive information browsing inside of applications.

Based on top of the presented concept, the changes to the clinical application programs in order to integrate such context sensitive information can be kept to an absolute minimum. Only two things have to be provided: A webbroser application must either run in background or it must be started from the application. The application must be able to convey a specific selected term or expression to this browser application.

The data dictionary server assures that all requests will be handled by an identical piece of software, enabled and governed only by knowledge stored inside the data dictionary itself.

We think that the concept will enable us to supply new applications with minimum effort with context sensitive information functions.

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