A Web-based system for medical teleconsultation: 
First results

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Abstract

Medical consultations between ambulances in rural areas and large medical centers are necessary for high quality health care. In particular, medical consultations between Croatian islands of Cres and Losinj and mainland medical centers in Rijeka and Zagreb are necessary for several reasons. Often, patient transport is not acceptable due to a high risk for the patient. In addition, transport generates additional expense and is often impossible in winter months due to weather and sea conditions, not to mention discomfort to the patient. In this paper, we describe a concept of a web-based system for medical teleconsultation. The system will be applied to communication between the islands of Cres, Losinj, and neighboring islands and university hospitals in Zagreb and Rijeka. The system consists of a teleconsultation module and a electronic Internet-based health record module. User interface is implemented in HTML and Phyton languages. WWW access to the system ensures platform independence, i.e. the system can be accessed using an ordinary Internet browser from any computer platform. The system is currently under development.

Keywords: telemedicine, medical consultation, teleconsultation, electronic health record, Internet-based health record

1. Introduction

Rural areas have always presented challenging tasks in providing health care services. Rural medical centers are typically smaller and do not have medical specialists available locally. The reason for this is that specialist practices are not self-sustainable in such areas with low concentration of population. For this reason it is necessary to conduct medical consultations with large medical centers. An example of such rural areas are islands, and in fact east coast of Adriatic sea is characterized by a large number of islands requiring consultation services from large medical centers. In particular, medical consultations between Croatian islands of Cres and Losinj and mainland medical centers in Rijeka and Zagreb are necessary for several reasons. One problem is high risk for the patients in critical condition. Second, transport generates additional travel expenses. Finally, is sometimes impossible to travel in winter months due to weather and sea conditions, not to mention discomfort to the patient. This serves as a motivation for development of a medical teleconsultation system.
Internet has become a very powerful tool for a wide range of applications. In particular, medical uses of Internet pose many challenges. Web-based consultations has shown to be a logical application of WWW to medical field [1]. In this paper, we describe a web-based system for teleconsultations between physicians. The system is currently under development. In Section 2, we describe the concept of the system. Security aspect is discussed in Section 3. Finally, a conclusion is presented.

2. System concept

The system is based on web technologies in order to be more universal when it comes to accessibility and usability. In this way, user access the system over the Internet or an intranet. The system consists of two modules: a teleconsultation module and an electronic health-record module.

The consultation module provides mechanism for exchange of multimedia medical information between referring physician and a specialist. The referring physician sends request to the one or several specialists over the web server. The request is formed by picking the electronic health record of the patient in question and adding a request note. This data is stored in the database and a request for teleconsultation is sent to the specialist by e-mail and by GSM SMS (short message service) notification to ensure prompt response. The specialist accesses the web server and gives his opinion in the form of response that is also stored in the database. The referring physician is notified of the response by e-mail and by GSM SMS message. The referring physician may then add new information to the electronic health record of the patient.

The electronic health record module is used to maintain medical history of the patient[2]. The information about the patient is stored in the database. The database consists of two parts. The first part stores teleconsultation data while the second part contains electronic health record data. The database contains: physician information, audit information (user identity, actions taken), teleconsultation requests, and electronic patient record data.

Electronic patient data includes personal information, immunizations, medications, allergies, laboratory results, problem list, and hospital visits. The patient information is recorded through time, so a common attribute of all mentioned data is date and time. A block diagram of the system is shown in Figure 1.

![Figure 1. An outline of the WWW-based consultation system](image-url)
3. Implementation

The system consists of a web server and a database server. Web server provides interface to users who access the system over the web. A database is used to store all information in the system. The system is implemented on Linux platform.

We have used Apache web server \cite{1} extended with modules for secure authentication and data encryption. Web page formatting is handled by XML and XSLT (XSL Transformations). This way, web page design is separated from the content. Dynamic page content is implemented using the Python scripting language. PostgreSQL \cite{2} is used as a database server. It is interfaced to Python via the built-in python module.

To access the system it is necessary to perform authentication. The user can then use teleconsultation module or electronic health record module. Teleconsultation module is accessed through the teleconsultation web page, i.e. by visiting links to send request for consultation, or to view received consultation response (specialist's opinion). The main teleconsultation page is shown in Figure 2.

![Figure 2 Teleconsultation web page.](image)

Information about patients is entered to the system by means of electronic health record module. Using this module it is possible to add, edit, and delete patient records. However, all actions are logged for security purpose and it is not possible to change certain fields in the patient record. The main electronic health record page is shown in Figure 3.

![Figure 3. Electronic health record web page](image)
4. Security aspects

Security is a very important aspect in many applications of Internet today such as e-commerce and e-medicine. The proposed system employs many techniques for protecting patient privacy. These techniques include data encryption, user authentication, audit procedures, and database integrity protection. The developed system provides a high level of security.

User authentication is performed by entering username/password information under the SSL (Secure Socket Layer) session encryption. The system provides different privileges for different users. System administrator is required to have physical access to the system.

Database transactions are logged so that the database can be restored in case of a system crash due to any reason. Additional security measure is that the database is located on a separate machine which is not connected to Internet but only contacted by the WWW server machine. The WWW server acts as a firewall to protect the database server. Regular backup schedule is used to enable restoration of the system after a crash.

5. Conclusion

We have presented a web-based system for medical consultations and Internet-based health record. The system is originally developed for medical teleconsultation Croatian islands and the mainland medical centers, but it can be used for any medical teleconsultation applications. The system reduces risk to patients who cannot be transported due to medical problems and also helps health insurance system by reducing of travel expenses. Future work will include experimental use of the system and redesign of some parts.

Practical testing of the system will provide more information about the financial aspect of the use of telemedicine and will also raise awareness of these new technologies. We also hope that such applications will foster development of appropriate legal instruments that regulate this kind of medical practice.

Literature


