

Internet Based Platform for Operating Virtual Shared Care and Teleconsultation Networks

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Abstract

A new Internet based system has been developed that will allow healthcare professionals to share medical records and consult with each other in configurable virtual networks over long distances. Actors can search for on-line colleagues on the internet, send and receive patient records and messages, converse on the same medical image using annotations and have a simultaneous chat session. The design phase addressed four main issues, namely network, contact, patient record and communication management issues. The system is expected to eliminate unnecessary repeat investigations and referrals. Healthcare operators can also benefit for better network management and cost containment.

Keywords: Internet Based Medical Network, Shared Care, Teleconsultation, ehealth.

Introduction

Networking is a major need for today's healthcare professionals. Independent practitioners, diagnostic laboratories, pharmacies and hospital specialists form a virtual network often regulated by a private or public operator such as an insurance company.

Various problems arise during this collaborative work for diagnosing and curing a patient. A study by Branger and colleagues indicates that up to 13 percent of laboratory tests are repeated as a result of a lack of coordination or lost results[1]. The Institute of Medicine in the United States has reported similar findings.

Many times a family doctor needs to consult with a specialist before deciding to refer his or her patient. Lack of proper consultation may result in unnecessary referrals that can be otherwise avoided. Similar problems occur when physicians in rural areas refer their patients to experts in urban centers. Many of these referrals are unnecessary and costly.

Consultation is also needed when an on duty doctor in a hospital needs help from a specialist who may be at home. Sometimes patients in developing countries want to have a second opinion from an overseas healthcare institution.

Various issues need to be considered when trying to solve this general problem:

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- a) **Network Management:** A network has to be configured in a way to determine the professionals who can access the network, to assure access security and set usage privileges such as record sharing. The system should be able to produce reports on usage and communication statistics.
- b) **Contact Management:** A professional should be able to search for other professionals in the network according to various criteria. Their offline or online status should also be seen.
- c) **Patient Record Management:** Patient records should be shared for best coordination. Furthermore, the complete patient records folder should be reconstructed at all times. Guvenis and colleagues have developed a strategy to solve this problem [2]. The records are owned by the family doctor and the system automatically reconstructs the records from other doctors seen by the patient. Other approaches exist such as developing a centralized database and use of smart cards. Our platform is able to integrate all of this copy management strategies. It is very important to assure of the privacy of the records.
- d) **Communication Management:** The system should allow for efficient and effective communication between professionals such as the use of messaging, alerting, online chat, medical image transmission and processing capabilities. Data security issues should be addressed.

A number of telemedicine systems have already been developed by various research groups[3-11]. Most of these systems emphasize the communication issues.

In this work, an Internet based platform is developed for operating and managing virtual healthcare networks by addressing all the four types of issues given above[12]. The system can be used by

- a) **Healthcare Operators:** Insurance companies or public healthcare institutions can adapt the system to their needs
- b) **Individual professionals:** They can communicate and form networks similar to general messaging services. For instance a physician may find a partner on the net in order to get a second opinion.

Collaborative Technology

The overall system architecture shown in Figure 1, shows central patient record server repository named ehealth server and relevant ehealth clients(general practitioner) connections.

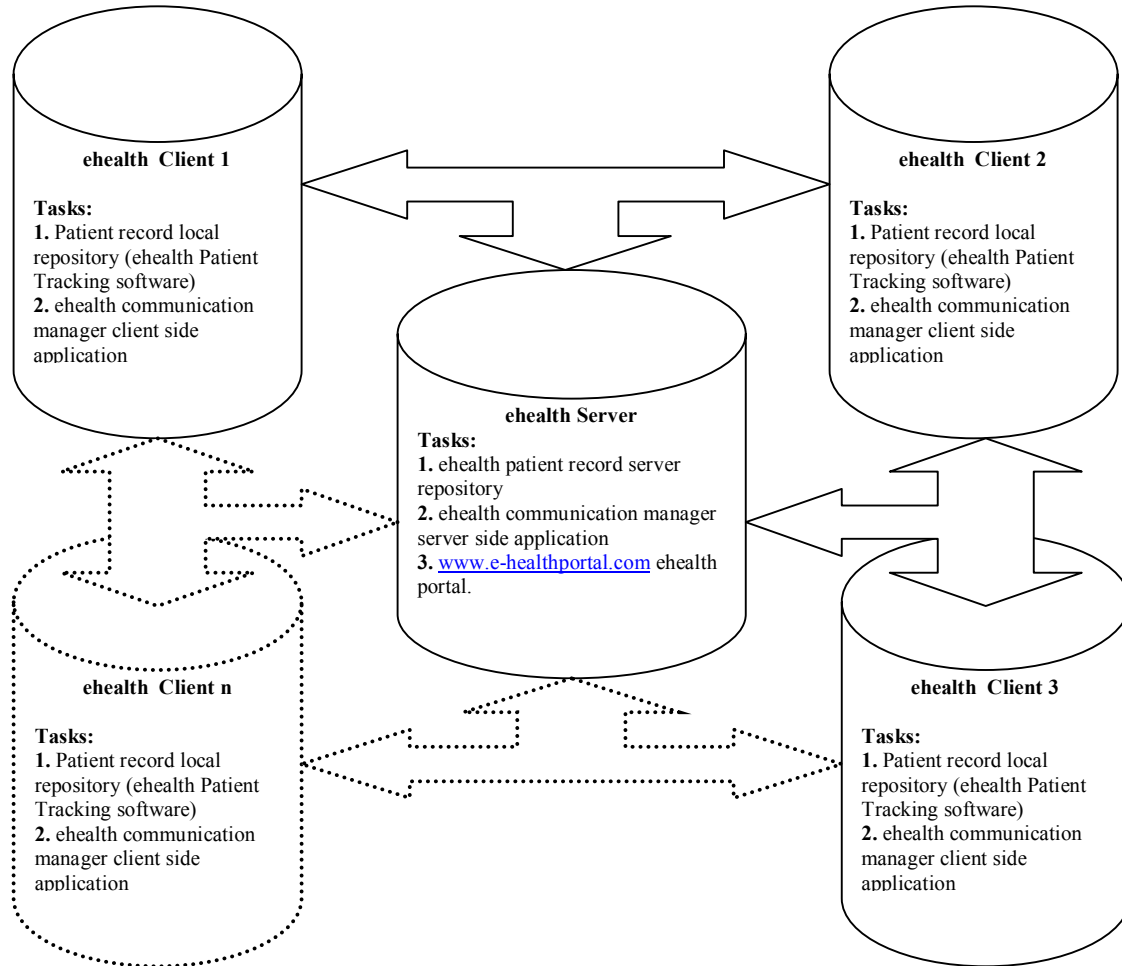


Figure 1 - The overall system architecture

ehealth Communication Manager

In order to get coordination between doctors, e-health Communication Manager software was accomplished. The software is formed of two parts, Client and Server parts. Server part of the Communication Manager is shown in Figure 2. Server Part can log all the chat data. An Administrator of ehealth communication system can join the conversation and disconnect a user. Server side is a Java Application and it coordinates all the conversations between doctors. In this study this Server Application is running on www.e-healthportal.com web server.

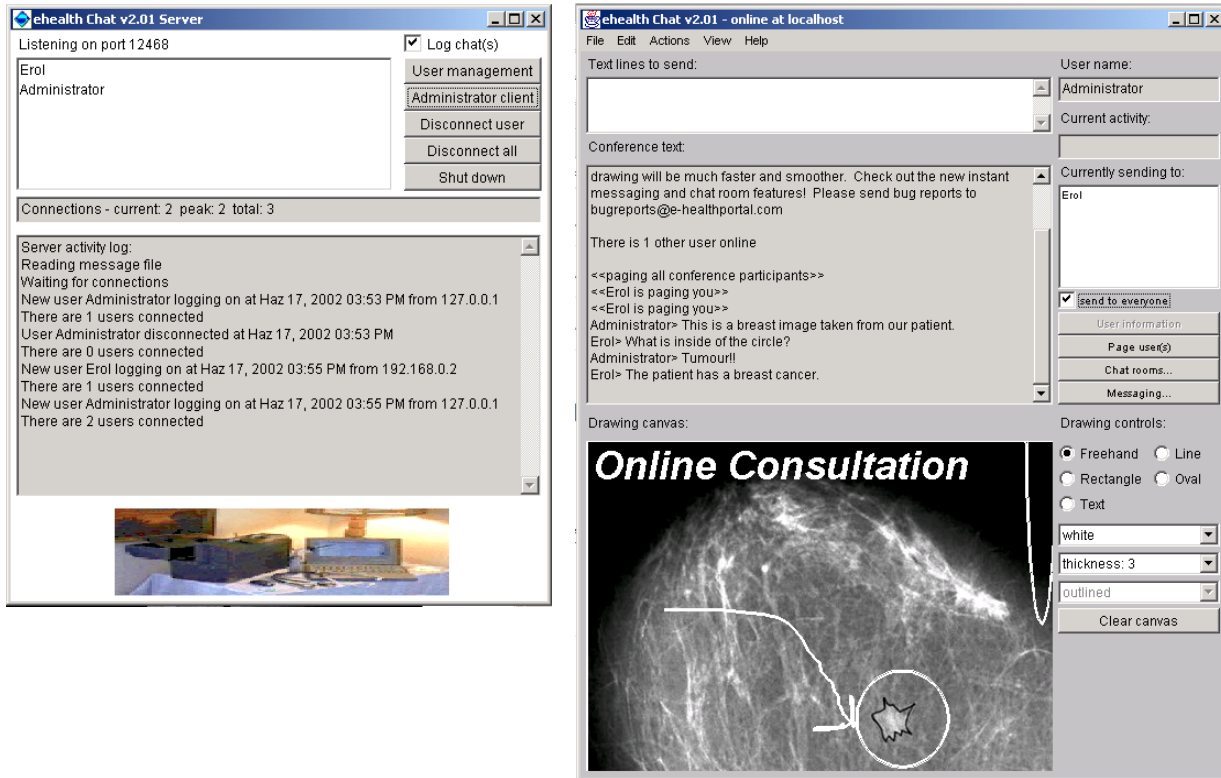


Figure 2 - Server side & Client Side of the Communication Manager

Client Side of the Communication Manager is also shown in Figure 2. Because of this part of the application is an applet, the system is platform independent and a doctor needs just a web browser. It is not important the user's operating system. Only requirement is the web address of this applet which is www.e-healthportal.com/comm

Communication Manager enables doctors to create password protected private rooms. In these rooms, unlimited number of doctors can talk each other and do an online teleconsultation using drawing controls. A doctor can put a jpeg medical image on to drawing canvas. Medical imaging standard DICOM picture files enormously(MB) take place on hard disk drives, for medical image transmitting purposes, a public domain java application named ImageJ in Figure 3 was added to the study. ImageJ was created by National Institutes of Health, USA. It can easily convert 8MB sized a DICOM picture into less than 100KB jpeg picture format without apparent loss. After processing a DICOM image by ImageJ a doctor can use the product jpeg picture file for transmitting to another doctor over ehealth communication network.

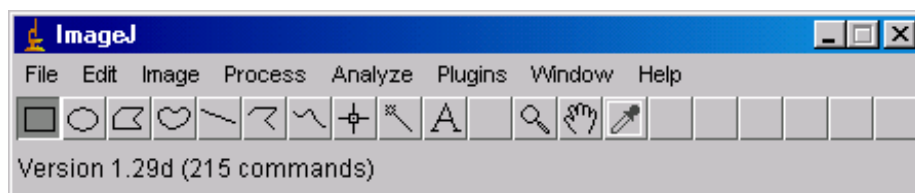


Figure 3 ImageJ, created by National Institutes of Health, USA

ehealth Patient Tracking System

ehealth patient tracking system is shown in Figure 4. When application starts, ehealth Communication Manager also starts and forces the doctor to connect to ehealth communication server. This part of the project is responsible for storing and manipulating patient records locally. It is also responsible to send the patient records to relevant doctor(s) via ehealth communication manager. ehealth Patient tracking system can be used both General Practitioners and especially Family Doctors.

The screenshot displays the ehealth Patient Tracking System interface. The main window is titled "ehealth Patient" and contains a menu bar with "File" and "Help". Below the menu bar are several tabs: "Patient Demographic Data", "Patient Visits", "Patient Appointments", "Patient Prescriptions", "Patient Record Communication Manager", "Patient Diseases", "Patient Vaccine Info", and "Patient Specific Conditions". The "Patient Demographic Data" tab is active, showing a form with the following fields:

Patient ID	1	Entered Date	05.09.1989	Company	
Name	ZEHLIYA	Find	pld	Work Phone	
Surname	GUNCER	Record Owner	Dr. Mehmet	Work Address	
Birthdate	17.04.1960	Birthplace	Mardin	Home Address	
Height	1.65	Weight	57	Home Address 1	
Gender	F	Marital Status	Single	Explanation	
Citizen	TC	Social Security	E		
Blood Type	ARH+	Blood Pressure	NORMAL		
Education	Master				
Home Phone	212 232 32 42	Mobile	535 456 45 45		
Relative	Erden Saglam	Relative Phone	532 345 45 68		

At the bottom of the main window, there are five tabs: "Family Info", "Family Health Info", "Family Birth Info", "Patient Nutrition Info", and "Patient Growth Info". The status bar at the bottom left shows "Record 1 of 26".

Overlaid on the main window is a smaller window titled "ehealth Communication Manager v1.09 - online at e-he...". This window has a menu bar with "File", "Edit", "Actions", "View", "Help", and "Patient Records". It contains a "Text lines to send:" field with the text "Welcome to ehealth Chat version 1.09. You are the first user online. <<New user 'Dr. Ahmet Keskin' connected>> Patient Record has been sent to the active userPatient Record has been sent to the active userPatient Record has been sent to the active user". To the right of this text is a "User name:" field with "Dr. Ersan Yüce" and a "Currently sending to:" field with "Dr. Ahmet Keskin". There is a checked checkbox for "send to everyone" and buttons for "User information", "Page user(s)", "Chat rooms...", and "Messaging...".

Figure 4 ehealth patient tracking system

ehealth Patient Record Communication Manager

Doctors who use ehealth patient system for patient tracking purposes can send patient data each other using ehealth communication manager. In figure 5 the user interface for “Patient Record Communication Manager” is shown.

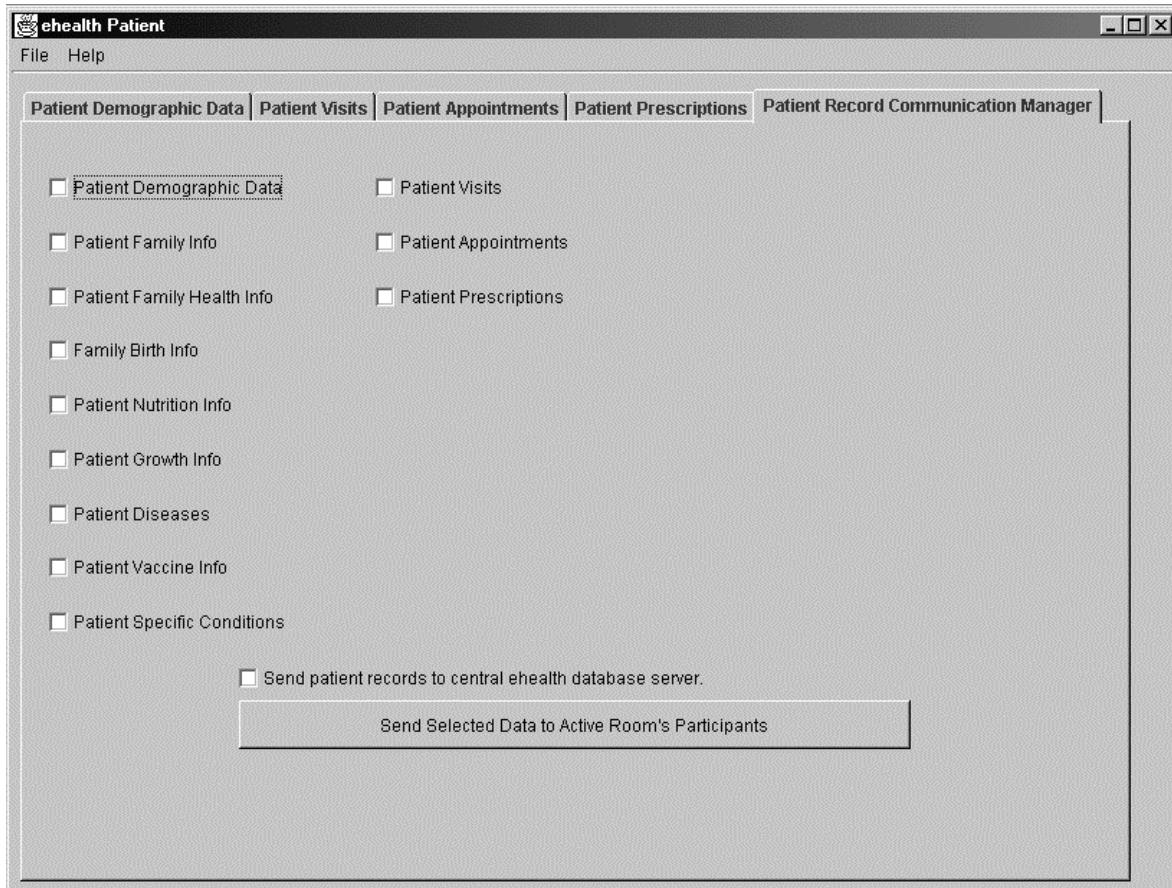


Figure 5 ehealth patient record communication manager

When a doctor click “Send Selected Data to Active Room’s Participants” button the doctor at the other node sees a warning message which states that the received new patient record from on his/her screen. The related screen shot is taken and shown in Figure 6. When a patient record received from a remote node, ehealth patient tracking system automatically activates the related user interface and paste the received data into edit boxes. At that moment in order to insert received data into local database, local system user has to give consent. When “Send patient records to central ehealth database server” check box is selected the data are also sent to ehealth server database.

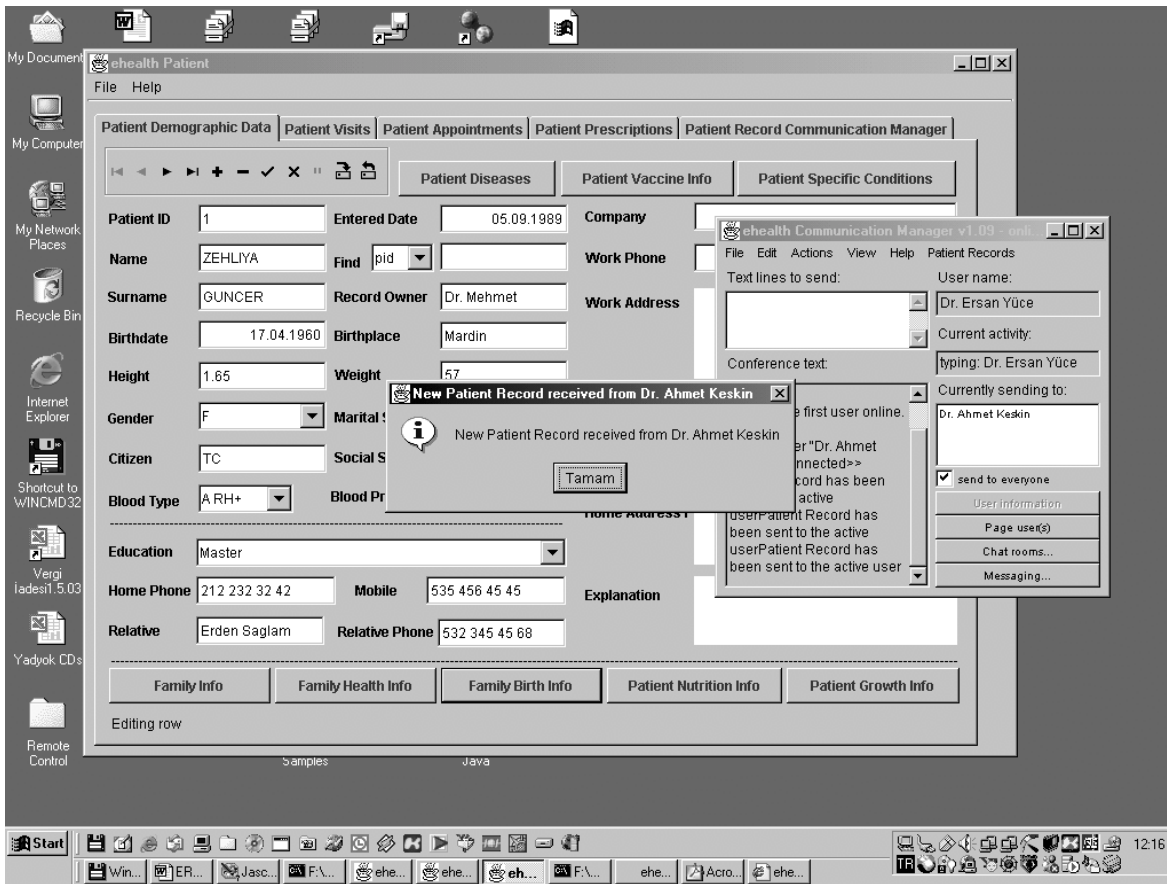


Figure 6 “New Patient Record received from Dr. Ahmet Keskin”

Exchanging Patient Records

The technology used in exchanging patient records is XML technology. A customized XML DTD(Document Type Definition) and encrypted XML files were generated in this study. Root element named “Patient” DFD structure is shown below as plain text:

```
<?xml version="1.0" encoding="UTF-8"?>
```

```
<!ELEMENT Patient (name, surname, gender, birthdate, birthplace, height, weight, marital_status, citizen, education, mobile, phone, company, work_address, work_phone, relative, relative_phone, department, blood_type, blood_pressure, handicap, film_date, film_open, entered_date, last_reg_date, address1, address2, explanation, social_security)>
```

System Repositories

Database system consists of two parts, local and server parts. Doctors who use the ehealth patient tracking system will have locally Access database. This database will be used for storing patient data purposes.

Server part of the database is SQL Server 2000 based. Table structure of the server database is quite similar to local database structure. If a doctor who is in an active communication with another doctor with ehealth communication manager and want to send a medical record to the other one, a check box will ask whether the doctor give a consent for storing this data in ehealth database server or not. In this way, server database will collect medical records in one node and authenticated patients of www.e-healthportal.com web site can reach their medical data whenever they want(Figure 7 and Figure 8).

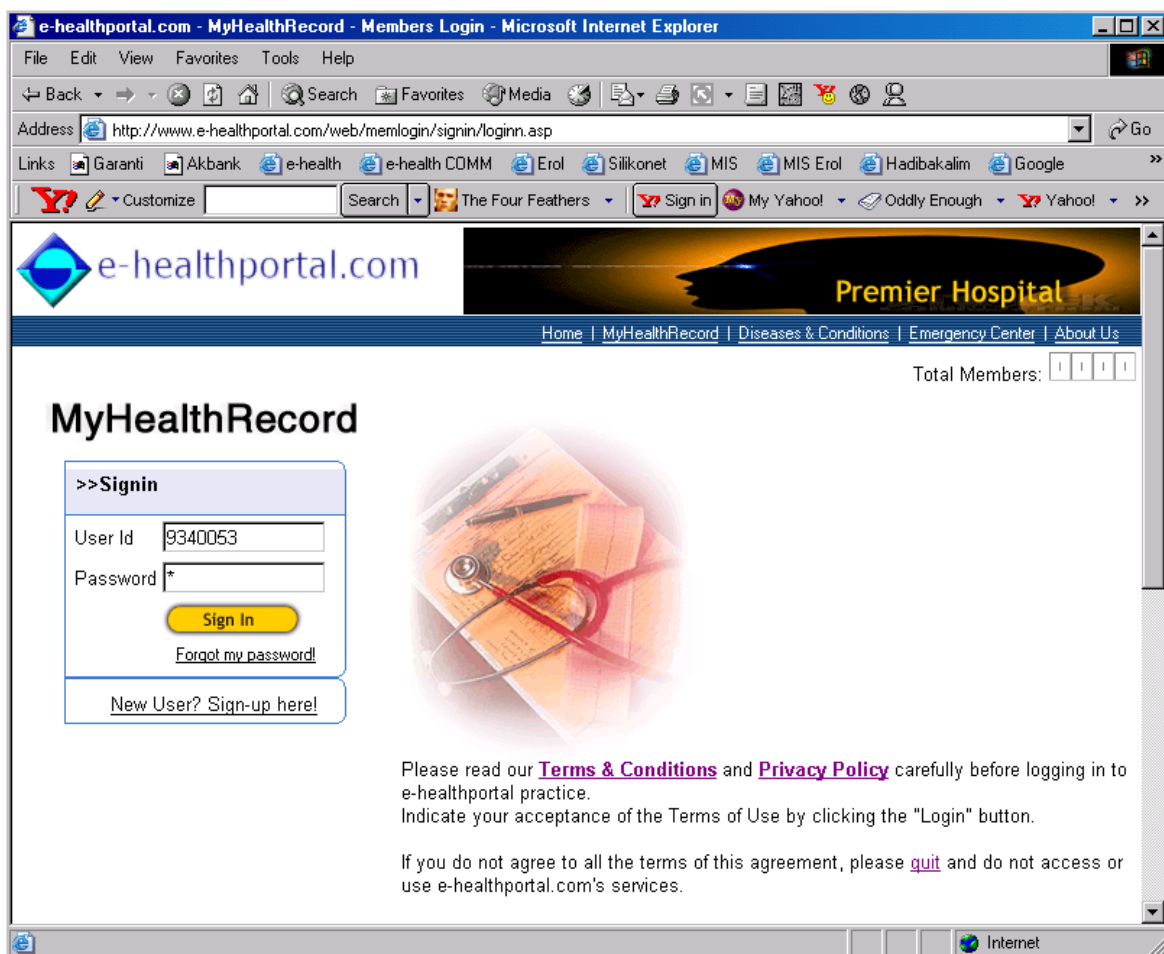


Figure 7 MyHealth Record Login Screen

e-healthportal.com - MyHealthRecord - Members Login - Microsoft Internet Explorer



File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media Print Copy Paste

Home | MyHealthRecord | Diseases & Conditions | Emergency Center | About Us

MyHealthRecord

Name	GOKHAN
Surname	GUNCER
Type	20
Gender	M
Birthdate	17.04.1971
Phone	(212) 345 45 45
Blood Type	B RH+
Blood Pressure	HIGH
Entered Date	05.09.1989
Last Reg. Date	05.09.1994
Address	Atilay Sok. Saral Apt. No:17/5 81040 Feneryolu - Istanbul
Social Security	H

[Update Your Demographic Data?](#)

My Visits

Date	Diagnose	Doctor	Note1	Note2
01.03.1994	KULAK-BURUN-BODAZ	SUNA SAYAR	BURUN DAMLASI VERILECEK	

Done Internet

Figure 8 MyHealth Record Screen

Conclusions

An Internet based system has been developed that will allow a number of virtual healthcare networks to function, enabling healthcare operators to manage their groups and professionals to share medical records and consult with each other over long distances. The system design addressed four main issues, namely network, contact, patient record and communication management issues. JAVA and XML technologies have been used for software platform independent operation and patient data exchange standardization. Both Access and SQL server 2000 have been used for database functions.

The system is expected to lower healthcare costs while improving quality by eliminating unnecessary repeat investigations and referrals, as well as improving knowledge sharing among professionals.

ehealth communication manager and patient tracking system is now being evaluated between 4 doctors in a polyclinic and medical image lab in Istanbul.

A number of refinements are being carried out at the present for the testing of the full scale version.

References

1. Branger, P.J., A. Van't Hooft, J.C. Van der Wouden and J. Van der Lei, "Laboratory Services Utilization: A survey of Repeat Investigations in Ambulatory Care," *Netherlands Journal of Medicine* 47, pp. 208-213, 1995.
2. Guvenis, A., Ayan, Z., Serin Ö., "Copy Management in a Shared Care Environment using the Internet", *Topics in Health Information Management*, Vol 18, No:2, pp. 39-45, 1997
3. D.G. Kilman, D.W. Forslund, Virtual patient records, *Commun. ACM* 40 (8) 111–117, 1997
4. F.L. Kitson, T. Malzbender, V. Bhaskaran, Opportunities for visual computing in healthcare, *IEEE Multimedia* 4 (2) 46–57, 1997
5. R. Simon, D. Krieger, T. Znati, R. Lofink, R.J. Scabassi, *Multimedia MedNet*, *IEEE Comp.* 5 65–73, 1995
6. L. Kleinhoiz, Supporting cooperative medicine: The Bermed Project, *IEEE Multimedia* 1 (4) 44–53, 1994
7. A.P. Scalfani, C. Heneghan, J. Ginsburg, P. Sabini, J. Stem, J.N. Dolitsky, Teleconsultation in otolaryngology: live versus store and forward consultations, *Proceedings of the Annual Meeting of the American Academy of Otolaryngology–Head and Neck Surgery*, San Francisco, CA, September 7–10, pp. 62–72., 1997
8. D.B. Blakeslee, W.E. Grist, M.E. Starchura, et al., Practice of otolaryngology via telemedicine, *Laryngoscope* 108 17, 1998
9. W.J. Crump, B. Driscoll, An application of telemedicine, *Tech. Otorhinolaryngol. Diag.* 106 595–598, 1996
10. S. Pederson, G. Hartvisen, D. Haga, et al., Teleconsultation of patients with otorhinolaryngologic conditions, a telendoscopic pilot study, *Arch. Otolaryngol. Head Neck Surg.* 120 133–136, 1994
11. D.A. Perendia, A. Allen, Telemedicine technology and clinical applications, *J. Am. Med. Assoc.* 273 483–488, 1995
12. Fazlıoğlu, A. Erol, Internet Based Communication Network Between Doctors, Boğaziçi University, Biomedical Engineering Institute, Master Thesis 2002.