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A Web-Based Electronic Medical Records and Hospital Information System for Developing Countries^{*}

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Abstract. We researched the infrastructure and current medical data management systems in Vietnam and designed an electronic medical record keeping system to acquire, process, store and share health information in a fully automated computer network-based system. The modules in the system have automated data acquisition from Ultrasound, Digital Radiography, CT scanner, MRI and Laboratory stations, and manage pharmacy and financial information and other related activities in the hospital. Database servers currently store personal information along with text data, image data and will store video data in the future. The system will allow the patient to login and review online their medical records at home. The system was tested in the Biomedical Informatics Laboratory at the Hanoi University of Science and Technology and implemented in Khanh Luong hospital in Hanoi, Vietnam. It meets the needs for healthcare in developing countries with low investment cost, ease of implementation, and convenience for doctors and medical staff.

1. Introduction

According to statistics from the Ministry of Health MoH-Vietnam, in 2008 Vietnam had about 1,000 public and private hospitals with a total of 200,000 beds. With a total population of about 86 million people, every year the hospital treated about 8 million patients. The total number of doctors, nurses and medical staff in the hospitals is about 500,000 people.¹ The MoH-Vietnam estimates that about 100% of the central or provincial hospitals and 30% of suburban hospitals have Local Area Network (LAN), high speed Internet connection and their own website.² The World Economic Forum reports, in Vietnam the number of people using computers is 9.51/100, Internet users are 20.45/100, broadband Internet subscribers are 1.48/100, subscribers using cell phones are 27.16/100, land-line telephones are 32.65/100 (2007), secure Internet servers are 0.6/million (2007), and International Internet bandwidth (MB/s) is

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1.44/10,000.³ The Vietnam Report predicts that by 2012, in Vietnam the number of Internet users will be 36/100, broadband Internet subscribers will be 3.5/100 and cell phone

subscribers will be 120/100.⁴ Thus, with the current infrastructure of information technology (IT), in Vietnam, there is a strong trend towards the application of IT and communications to develop hospital information management, especially for electronic medical records (EMRs) management and remote medical services to patients (e-hospital).^{1,2} Also Vietnam ranks 16th in the E-Participation Index which assesses the quality, relevance, usefulness, and willingness of government websites for providing online information and participatory tools and services to the people (2008).³ We have studied the features of the EMRs and compared them to paper-based methods using different criteria. We expect individual hospitals in Vietnam to: save \$86,400 in five working years,⁵ decrease error activity by 17.4%, and reduce patient total time per visit by 22%.⁶ With the economic development of Vietnam, more and more high tech medical equipment is being purchased by hospitals for patient treatment. Thus increasing data in the form of diagnostic images, test results as well as information from examinations, doctor's diagnoses and therapeutic methods are generated and currently stored in the form of films and paper in booklets. This has caused difficulties in archiving, management, and searching, especially for patient health information sharing in healthcare facilities in Vietnam.^{1,7} Using research results, we analyzed and designed a model based on a distributed control web-server, capturing, managing, storing and sharing electronic medical records for application and conditions in developing countries such as Vietnam.

2. Background

2.1. Analysis of healthcare in Vietnamese hospitals

We researched hospitals in Vietnam and studied patient medical information storage, management and the available IT facilities. We found that most of the hospitals used manual methods for information storage and management, consisting of papers and films in booklets. Some hospitals also used personal computers to manage and print the patient data in a simple and discrete way. Currently there are systems available to network these computers to allow data storage, preservation and sharing. The test results of patients are currently written on paper from results obtained through medical devices, or printed out from them. Subsequently, they are then physically stapled to paper records and handed to the patients.^{8,9} Doctors write diagnostic results as well as therapies needed for recovery of patients in medical examination books. Moreover, many healthcare facilities offering treatment to the patient will provide a separate medical examination booklet to the patient. Thus the patient ends up carrying multiple medical examination booklets from various health care providers, often confusing them and making retrieval of medical data difficult for doctors. Manual paper-based storage methods, though simple and easy to implement, cannot be used to manage large amounts of patient information. Also it is an inefficient means to store, search and share data. Thus there is a need to develop EMR keeping systems for hospitals and healthcare centers in developing countries such as Vietnam.

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2.2. EMR systems for developing countries such as Vietnam

EMR systems have the potential to transform health care in terms of cost saving, reducing error and sharing medical information.¹⁰ Telemedicine applications in these low resource settings may serve as the only means to reliably obtain healthcare.^{11–13}

Some of the EMR systems developed in Vietnam and used locally are:

Medisoft2003 is software designed by researchers from the MoH-Vietnam and implemented in some of the hospitals in Vietnam. Medisoft2003 is used to maintain epidemiological information on the health and illness of the general population for preventive care. The hospitals report the epidemiological statistics to the MoH-Vietnam.^{1,2}

HTMedsoft is a software designed by Medsoft-Vietnam Co., Ltd and used to manage patient medical and pharmacy data, record financial and billing transactions and manage medical staff information. This software system is implemented at various clinics around Vietnam.²

Some of the EMR systems, which were developed outside Vietnam and could be applicable to hospitals in Vietnam, are: Management systems such as Picture Archiving and Communication System (PACS), Radiology Information System (RIS) or Hospital Information System (HIS). These systems could be applicable for managing patient data in hospitals in Vietnam. However, due to very high investment costs along with the requirements of network communication facilities these systems are not currently available in hospitals in Vietnam.^{13–15}

Some open source software such as VistA, Care2x and OpenMRS can be developed for deployment in hospitals in Vietnam. But the software is primarily focused on medical management for text-based patient data, most of the times the interface is in English, and is not widely implemented in hospitals in Vietnam.^{13,16,17}

3. Design Objectives

3.1. BK e-Hospital Software Model

The BK-eHospital EMR software model was designed based on the research and analysis of health facilities in Vietnam. This model shown in figure 1 is suitable for the majority of hospitals in Vietnam in need for management, storage and sharing of a large number of patient medical records. To overcome shortcomings in the management of information at hospitals in Vietnam, every patient will have a unique Patient Identification (PID). This will allow all information related to patients to be included in the server database according to their PID. Once patient information is transmitted from clinical stations to the database, the doctor will login to the system using the unique PID and view all patient information on a server database to assist in the diagnosis and treatment. In addition, the system will provide remote medical services such as online information for patients through login from the Internet or share patient information to other hospitals when patients require hospital transfer.^{7,8}

The BK-eHospital software records the patient medical data in two formats (a) Text and (b) Image. The Text data will be generated primarily at the patient registration

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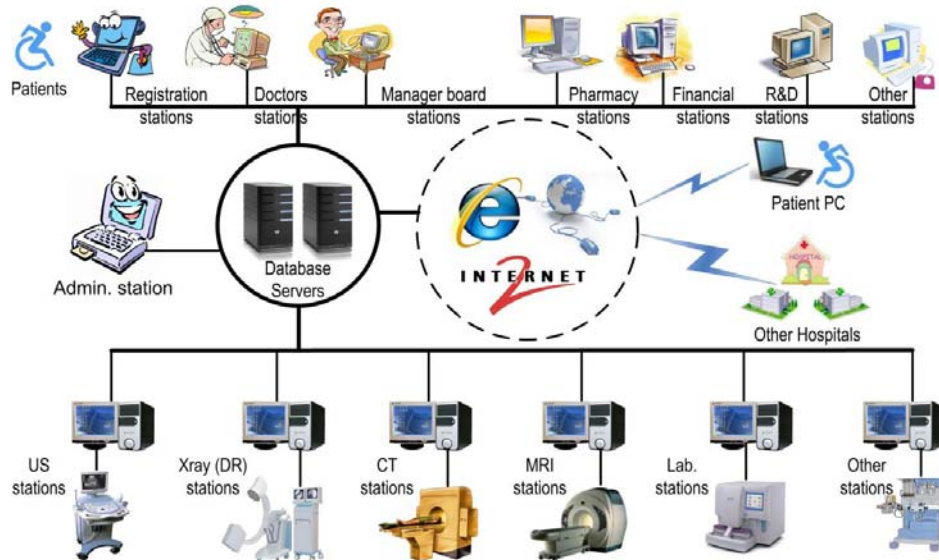


Figure 1: BK-eHospital software system model to automatically acquire store, manage and share patient medical data.

stations, clinical, financial, pharmaceutical information, and auto-acquisition results of the examination in the laboratory stations via RS232 interface and from the system (PID, password access and others). The Image data will be generated from the data acquisition primarily from the imaging stations (Ultrasound, Digital Radiography X-ray, Computed Tomography CT, Magnetic Resonance Imaging MRI and other imaging devices), through software modules communication between computers and imaging equipment. Image data will be converted to common formats of the Windows operating system and transmitted to the server database following the PID of the patient. Image data requires more space and resources, so this will be a key point to evaluate the effectiveness of our system in Vietnam compared to traditional methods and other modern systems such as PACS or RIS. Table 1 compares the main parameters of medical information management models.^{7,14} Table 1 shows that the BK-eHospital model is designed in accordance with the conditions of Vietnam today. The system is designed to ensure communication of medical image information, adequate image quality for diagnosis, the ability to store and share information, and also very low investment and operating costs.

Table 1 : Comparing the important parameters of the Paper-based, BK-eHospital and PACS, RIS model

Parameter	Paper-based	BK-eHospital	PACS, RIS
Investment costs	–	Very low	Very high
Operating costs	Very high	Very low	High
Time patient waiting	Very long	Short	Very short
Speed transmission	–	Fast	Very fast
Image quality	–	Medium	High
Storage capacity	Limited	Very high	High
Ability to share	Limited	High	Very high

4. System Description

4.1. Design Scheme of Algorithm and Database for the BK-eHospital System

Figure 2 shows the flowchart of the algorithm of the BK-eHospital system. First, patients will be registered at the registration station, if it is a new patient, the system will create a new PID, a blank record database, new Username and Password that corresponds with this PID. Next, the patient will go to the general doctor station with the PID that has been provided. Based on the PID, the doctor will login to the database to review the basic information on the patient to diagnose the patient's health. In case of the need for additional tests for the diagnosis, the doctor will put a request for testing into the database of the patient. The patient will then be scheduled for tests corresponding to the request made by the doctor. At the test station, the medical staff

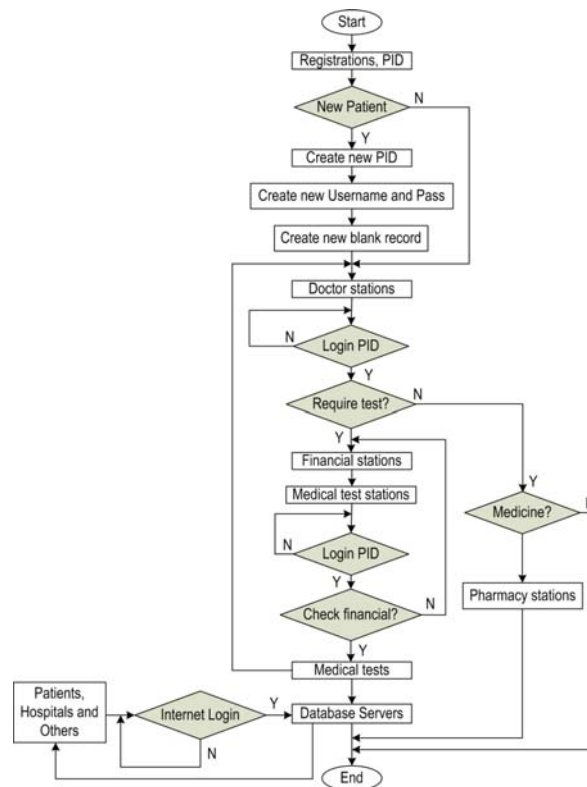


Figure 2: Algorithm of the BK-eHospital system for medical record management.

will sign into the database to check the necessary information. If the request is valid they will perform tests and submit the results to the database. Then the patient will return to the general doctor station to get the medical examination results and their treatment therapy. If necessary, patients will go to the pharmacy station to buy drugs before leaving the hospital. At home, at other hospitals or other places where the Internet is accessible, patients can login to the system by Username and Password that

was provided in the hospital, and review their medical records, doctor's diagnosis and the treatment results.

Figure 3 shows the structure and the overall relations between the information tables in the entire database for the BK-eHospital system. Because the hospitals and clinics are quite different in size and functions, so the modules as shown in the database should depend on the facilities of each hospital, and they need to be adjusted accordingly. However, the database structure model shown in figure 3 will be the main premise for development of the BK-eHospital system.^{1,8} The information tables designed include: the table for the Diagnostic Ultrasound stations (US), the Digital Radiography stations (DR), the CT-Scanner stations (CT), the MRI-Scanner stations (MRI), the Laboratory stations (LAB) and other diagnostic stations (Other). The patient information table (Patient) is created at the registration station, the examination and treatment information table (Exam) is created at the doctor station, the hospitalized information table (therapy, bed) is created at the staff station, the information doctor table (Doctor), administrator (Admin), medical staff (Staff) are created at personnel management stations, the pharmacy information table (Medicine), equipment (Equip), the provider (Manufac), contract (Invoice), procedures of payment (Payment) are created at the financial, pharmacy and equipment stations respectively.

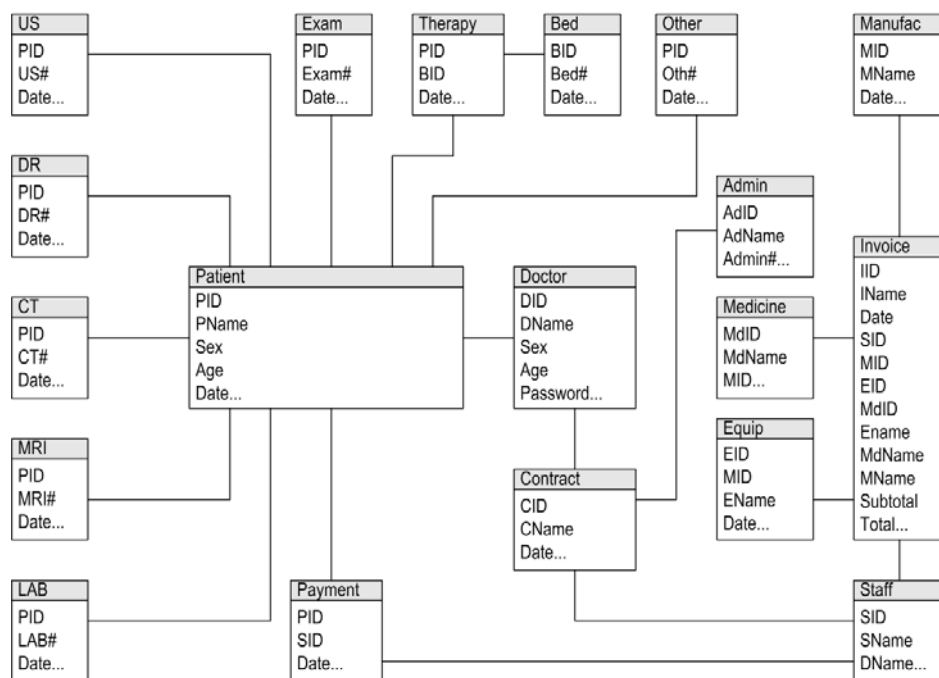


Figure 3: Database structure of this system.

4.2. Acquisition Image Information from the imaging devices

To perform image data acquisition from imaging devices on computers we need to solve two problems: (1) design of the hardware circuit for the computer to communicate with peripheral devices having separate standards; (2) design of software

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for data stream acquisition to be sent from the peripheral to the computer. Our research showed that most current medical imaging equipment has image signal output, which is a Composite-video or S-video.² Moreover, current computer's communication ports often can acquire image data via USB, PCI, LPT, LAN or WiFi standards. Therefore we designed a circuit that can communicate to both receive image data from imaging devices and send data to the computer using industry standards. In this model we designed circuits according to the PCI standard to communicate with a standard video input and output. We found this method to be convenient, easy to use, stable and low cost.^{2,8} It responds to the requirement for high speed transfer of real time image data.

4.3. Acquisition Test Results from the Laboratory Equipment

Unlike the image data acquisition discussed above, the data received from the test results from the laboratory equipment will be easier to process as it is in text format. So the rate of data communication is slower and the information is often received as a message. Our research showed that most laboratory devices send output data using RS232 at the COM ports. Since the communications are available on the computer for data acquisition, we connect the laboratory equipment and computer via RS232 interface. The software is designed to read the data sent to the computer.⁹ However, in order to design the software to read the message and then determine the exact parameters of the tests, we need to know format of the data frame the equipment manufacturer used. Often this information is available in the technical support documentation of the manufacturer (the service manual). If the information is not available, we analyze the data stream format beforehand, by reading the message from the device by software (such as Terminal, Collect, Virtual Serial Port Kit and others), and then compare with the result displayed on the equipment to determine the data frame structure.¹⁸

5. Status Report

The system was built by using the ASP.Net, VB.Net and C++ languages and manages information using the SQL Server2000. Currently the system is implemented and tested in the Khanh Luong Hospital, Hanoi, Vietnam. The experimental results showed that the system is robust in its performance, the duration for data acquisition and transfer rate is quick given the computer network capabilities of the hospital and, the information storage, printing and reporting statistic modules of the software work appropriately. The BK-eHospital system meets the current needs of the hospitals in Vietnam and has the capability of catering to the needs in near future. The modules of the BK-eHospital system which are currently functional include: registration and automatically create PID stations, acquisition and processing ultrasound images, DR, CT and MRI stations, hematology analyzer stations, biochemical, immunology, microbiological, cellular, endocrine and urine tests stations, reviewing and processing patient information for clinical doctor stations, financial stations, pharmaceutical stations; administrator station; sign in and review online information for the patient.^{8,9} Figures 4 and 5 show the design, testing and implementation of the BK-eHospital system for patient medical record storage, management and sharing.

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(a)

XÉT NGHIỆM - BK-eHospital.LAB.HH - [XÉT NGHIỆM HUYẾT HỌC]

1. Điều khiển 2. In ấn 3. Tìm kiếm 4. Thống kê 5. Danh sách chờ 6. Hệ thống 7. Trợ giúp 8. Thoát

Xét nghiệm **XÉT NGHIỆM HUYẾT HỌC** **BK-eHospital.LAB.HH** 03:02:17 18/05/2009

Thông tin bệnh nhân

ID Bệnh nhân: 000000000

Họ và tên:
 Giới tính: Nữ
 Tuổi: 59
 Quốc gia: Việt Nam, Vĩnh Phúc
 Đối tượng: BHYT

Chẩn đoán

Thông tin bệnh viện

Ngày: 30/05/2009
 Bệnh viện Bạch Khoa Hà Nội
 Khoa Xét nghiệm
 Phòng xét nghiệm HH-01
 Bác sĩ: Hà Văn Nam

BK-eHospital.LAB.HH

THÔNG SỐ XÉT NGHIỆM

WBC	15	(3.5 - 10)	$10^9/l$	MCV	52	(80 - 97)	fL	% LYM	20	(17 - 40)	%
RBC	4.2	(3.8 - 5.0)	$10^{12}/l$	MCH	36.5	(26.5 - 32.5)	pg	% MON	6	(4.0 - 10.0)	%
HGB	210	(170 - 160)	g/l	MCHC	200	(115 - 350)	g/l	% GRA	50	(40 - 70)	%
HCT	0.4	(0.35 - 0.50)	l/l	RDW	11	(10 - 15)	%	# LYM	4	(1.2 - 3.2)	$10^9/l$
PLT	280	(150 - 350)	$10^9/l$	MPV	9	(6.5 - 11)	fL	# MON	0.6	(0.3 - 0.8)	$10^9/l$
PCT	0.4	(0.1 - 0.5)	$10^{-3}/l$	PDW	12	(10 - 16)	%	# GRA	3.5	(1.2 - 6.8)	$10^9/l$

Các giá trị WBC, HGB, MCH, MCHC, %LYM, nằm ngoài dải bình thường!

Nhận xét: Ghi chú:

Cổng COM đang mở

Phím tắt: Ctrl+N: BN mới | Ctrl+F: Tìm kiếm | Ctrl+K: Thống kê | Ctrl+D: Danh sách chờ | Ctrl+P: In ấn | Ctrl+F10: Cài đặt

(b)

Phong siêu âm

Phòng: SATIM **Ánh sáng Bitmap** 2/19/2009 2:01:50 PM

BK-eHospital.US

Thông tin bệnh nhân

Ngày: 30/05/2009
 Bệnh viện Bạch Khoa Hà Nội
 Khoa Chẩn đoán hình ảnh
 Phòng siêu âm: 02
 Bác sĩ: Nguyễn Việt Đông

Thông tin bệnh nhân

ID bệnh nhân: 000000000

Họ và tên:
 Giới tính: Nữ
 Tuổi: 59
 Quốc gia: Việt Nam, Vĩnh Phúc
 Đối tượng: BHYT

SA tổng quát **SA tim** **SA tuyến giáp** **SA thai lớn** **SA thai nhỏ** **SA thai 4D** **SA vú** **SA phụ khoa** **SA tử cung**

SIÊU ÂM TIM

Kết quả

Thất phổi: Bình thường

Chẩn đoán trước van 2/3: Bình thường

Tâm trương

LVSD: 12.5 LVSD: 30.2
 LVDd: 12.5 LVDd: 12.9
 LWd: Bình thường LWs: Bình thường

Điểm phải

Gốc Aorta: 10 Thận: 2
 Phổi: 6 Trĩ: 7

Phản xuất tổng máu EF: Bình thường % (teichub)
 Rút ngắn FS: Bình thường

Điểm gốc van

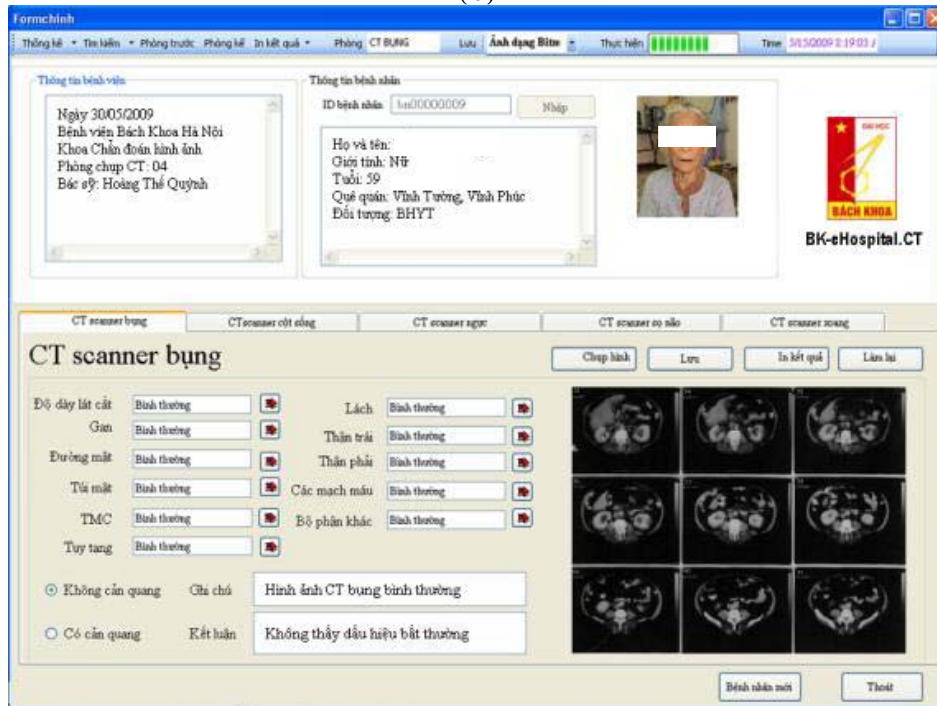
DMC AO: Bình thường AVO: Bình thường
 Van 2/3 Aorta: Bình thường Van 3/4: Bình thường

Bất thường:
 Kết luận:

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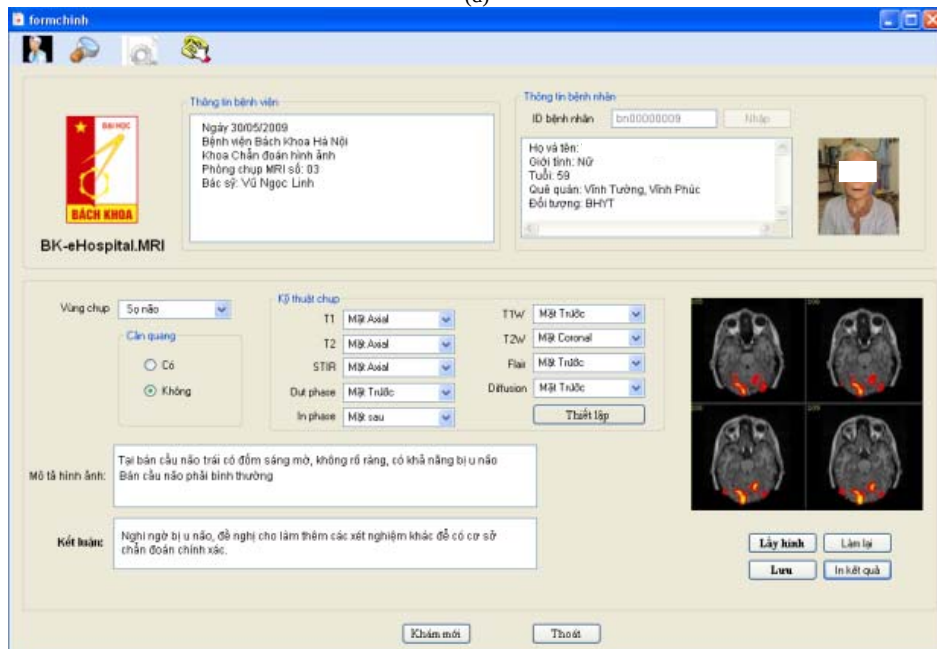
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(c)



The screenshot shows the 'Form chính' (Main Form) for the CT scanner interface. It includes a top menu bar with options like 'Thống kê', 'Tia laser', 'Phòng trước', 'Phòng kế', 'In kết quả', 'Phòng CT BỤNG', 'Lưu', 'Ánh xạ Bức', 'Thực hiện', and 'Time'. The main area is divided into several sections: 'Thông tin bệnh nhân' (Patient Information) with fields for ID, name, gender, age, and insurance; 'Thông tin bệnh viện' (Hospital Information) with fields for date, hospital name, department, and doctor; 'CT scanner bụng' (Abdominal CT Scanner) with various settings like 'Độ dày lát cắt', 'Gan', 'Đường mật', 'Tia mật', 'TMC', 'Tủy tạng', 'Lách', 'Thận trái', 'Thận phải', 'Các mạch máu', and 'Bộ phận khác'; and a grid of CT scan images. Buttons for 'Chụp ảnh', 'Lưu', 'In kết quả', and 'Lần lại' are present. At the bottom, there are buttons for 'Bệnh nhân mới' and 'Thoát'.

(d)



The screenshot shows the 'Form chính' (Main Form) for the MRI station interface. It includes a top menu bar with options like 'Thống kê', 'Tia laser', 'Phòng trước', 'Phòng kế', 'In kết quả', 'Phòng CT BỤNG', 'Lưu', 'Ánh xạ Bức', 'Thực hiện', and 'Time'. The main area is divided into several sections: 'Thông tin bệnh nhân' (Patient Information) with fields for ID, name, gender, age, and insurance; 'Thông tin bệnh viện' (Hospital Information) with fields for date, hospital name, department, and doctor; 'Kỹ thuật chụp' (Imaging Technique) with settings for 'Vùng chụp', 'T1', 'T2', 'STIR', 'Diffusion', 'T1w', 'T2w', 'Flair', and 'Diffusion'; and a grid of MRI scan images. Buttons for 'Chụp ảnh', 'Lưu', 'In kết quả', and 'Lần lại' are present. At the bottom, there are buttons for 'Khám mới' and 'Thoát'.

Figure 4: Acquisition and management of medical records (a) Laboratory stations, (b) Ultrasound imaging stations and (c) CT-scanning stations and (d) MRI stations.

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BK-eHospital system provides a login interface common for all doctors and medical staff at the hospital. After login, the system will identify the kind of user who has logged into the system, for example, whether the user is physician, nurse or medical staff, financial staff, pharmacy staff and other staff members. Based on this information the system will provide appropriate access to the database servers. The online login interface via the internet is provided for the patients. After the patient's information is updated via the Registration station interface, the system will automatically allocate PID, user and password to the patient for access to the system. A camera will automatically capture images of patients for inclusion in the database.

Figure 5a shows the Clinical station module where the clinical doctors can access the entire database of patients through the PID for the synthesis, analysis, diagnosis and offer treatment guidelines for patients. For example the MRI data of patients are shown for analysis at the clinical station. Figure 5b shows the online review module for patients to access part of their EMR through Internet, for example the patient can review the laboratory test results and see if the test results are normal. Figure 5c shows the Pharmacy station module to manage all activities regarding use of medicines by the patient in the hospital. Using the PID the pharmacists can determine the financial procedures and drugs allocated to the patients. Figure 5d shows the financial station module to manage of all financial activities of the patient with the hospital. Based on PID, the financial personnel can determine the hospital fee for each examination and treatment of the patient; and verify the procedures for completing financial obligations to the patient.

(a)



The screenshot displays the BK-eHospital web interface within a Mozilla Firefox browser. The page header includes the hospital name "BỆNH VIỆN ĐIỆN TỬ BẠCH KHOA" and "BK-eHOSPITAL". The main content area is divided into several sections:

- Trang chủ (Home):** A sidebar menu with links to "Nhân sự", "Giới thiệu chung", "Cần Làm Sáng", "Khám - Điều trị", "Xem hồ sơ điện tử", "Thông tin y học", "Tin tức", "Liên lạc", and "Tham vấn sức khỏe".
- Thông tin bệnh nhân (Patient Information):**
 - Họ và tên: [Redacted]
 - Giới tính: Nữ
 - Tuổi: 59
 - Quê quán: Vĩnh Tường, Vĩnh Phúc
 - Đối tượng BHYT: [Redacted]
- Kết quả chụp MRI (MRI Results):**
 - Ngày: 30/05/2009
 - Kỹ thuật chụp: T1, T2, STIR (Mặt Axial); Out Phase, T1W, Flair, Diffusion (Mặt Trước); In Phase (Mặt Sau); T2W (Mặt Coronal)
 - Loại hình chụp: Chụp sọ não, không cản quang
 - Mô tả: Tái bán cầu não trái có đám sáng mờ, không rõ ràng, có khả năng bị u não. Bán cầu não phải bình thường.
 - Kết luận: Nghi ngờ bị u não, đề nghị cho làm thêm các xét nghiệm khác để có cơ sở chẩn đoán chính xác.
- Chẩn đoán hình ảnh (Imaging Diagnosis):** Four axial MRI brain scan images showing a lesion in the left hemisphere.
- Buttons:** "Xem kết luận" (View Conclusion) and "Trở lại" (Back).
- Contact Information:** Bác sỹ: Vũ Ngọc Linh, Điện thoại: 0987223925.

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(b)

Dangnhap - Mozilla Firefox

File Edit View History Bookmarks Yahoo! Tools Help

http://localhost:3137/xembenhtructuyen/dangnhap.aspx

Dangnhap

TRƯỜNG ĐẠI HỌC BÁCH KHOA HÀ NỘI
BỆNH VIỆN ĐIỆN TỬ BÁCH KHOA
BK-eHOSPITAL

Trang chủ
Nhân sự
Giới thiệu chung
Cán Lâm Sàng
Khám - điều trị
Xem hồ sơ điện tử
Thông tin y học
Tin tức
Liên lạc
Tham vấn sức khỏe

Họ và tên: Giới tính: Nữ
Tuổi: 59
Quê quán: Vĩnh Tường, Vĩnh Phúc
Đối tượng: BHYT

Kết quả xét nghiệm huyết học

RBC	4.2	LYM %	20
WBC	16 (Cao)	LYM#	4 (Cao)
PLT	280	MON %	6
HCT	0.4	MON#	0.6
PCT	0.4	EOS %	-
MCV	92	EOS#	-
MCH	36.5 (Cao)	BAS %	-
MCHC	200 (Thấp)	BAS#	-
RDW	11	NEU %	-
MPV	9	NEU#	-
GRA %	50	PDW	12
GRA#	3.5	HGB	210 (Cao)

Xem kết luận

Trở lại

Ngày: 30/05/2009
Bác sĩ khám: Hà Văn Nam
Điện thoại: 0987223925

Thẻ bệnh nhân

Bệnh án điện tử Online

(c)

Nhap thuốc - Mozilla Firefox

File Edit View History Bookmarks Yahoo! Tools Help

http://localhost:3137/Phongduoc/nhapthuoc.aspx

Nhap thuốc

TRƯỜNG ĐẠI HỌC BÁCH KHOA HÀ NỘI
BỆNH VIỆN ĐIỆN TỬ BÁCH KHOA
BK-eHOSPITAL

Phòng quản lý dược bệnh viện-nhập hóa đơn thuốc

Mã hóa đơn: HCN098003
Tên hóa đơn: Hóa đơn số 3
Ngày tháng: 30/05/2009
Người nhập: Đinh Thị Nhung

Mã nhà cung cấp: HCN001
Tên nhà cung cấp:
Điện thoại:
Địa chỉ:
Người giao hàng:

Thông tin đã được xác nhận

Mã thuốc	Tên thuốc	Loại và hàm lượng	Đơn vị	Số lượng	Đơn giá	Hạn sử dụng
02	VRhoto	Hàm lượng trung bình	Hộp	50	50000	5/21/2009

Danh sách các thuốc đã nhập:

#	STT	Mã thuốc	Tên thuốc	Loại và hàm lượng	Đơn vị tính	Đơn giá	Hạn sử dụng	Thành tiền
1	02	VRhoto	Hàm lượng cao	Hộp	50000	5/26/2011 12:00:00 AM	2500000	

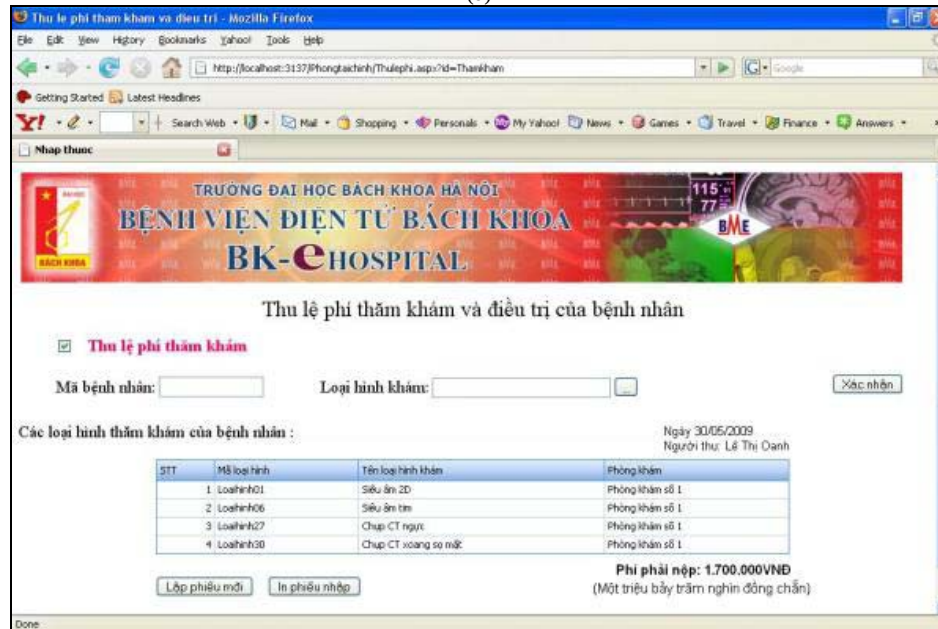
Lập phiếu mới In phiếu nhập

Tổng tiền: 2.500.000VND
(Hai triệu năm trăm nghìn đồng chẵn)

Submitted: February 19, 2010

Accepted: March 16, 2011

(d)



TRƯỜNG ĐẠI HỌC BÁCH KHOA HÀ NỘI
BỆNH VIỆN ĐIỆN TỬ BÁCH KHOA
BK-eHOSPITAL

Thu lệ phí thăm khám và điều trị của bệnh nhân

☒ Thu lệ phí thăm khám

Mã bệnh nhân: Loại hình khám:

Các loại hình thăm khám của bệnh nhân :

STT	Mô tả hình	Tên loại hình khám	Phòng khám
1	Loaheinh01	Siêu âm ổ bụng	Phòng khám số 1
2	Loaheinh06	Siêu âm tim	Phòng khám số 1
3	Loaheinh27	Chụp CT ngực	Phòng khám số 1
4	Loaheinh30	Chụp CT xoang sọ não	Phòng khám số 1

Ngày 30/05/2009
Người thu: Lê Thị Danh

Phi phải nộp: 1.700.000VND
(Một triệu bảy trăm nghìn đồng chẵn)

Figure 5: Interface to (a) manage clinical information of the patient by the doctors, (b) view medical records online by the patients, (c) manage pharmacy information and (d) manage billing and other financial information.

6. Discussion

6.1. Security of BK-eHospital System

The security of the patient medical records is of prime importance and is addressed in the BK-eHospital system. We use the administrative databases in SQL Server 2000 or 2005 that have an information table for users. The highest-level administrator of the system who is called the “Super Admin” can login as “sa”, this is the default name of Microsoft SQL Server 2000. The password of “sa” will be set and may be changed by Super Admin. Super Admin will have the right to create or delete as well as distribute access to databases for the users in the system. This includes the account to login to the system for doctors, technicians, nurses, medical staff and others. Specific access rights given to the users in the database system are determined by the administrator of the particular hospital. Only the Super Admin can directly intervene in the database system, but all the operations of the Super Admin will be monitored by the system. The other users are only allowed to add and view the patient’s record but not edit previous information. The system will monitor any activity with the patient’s record. Therefore, each user after login to the system will be responsible for his or her operations on the database. Most employees are issued their Username and Password to access the database and the computers will be kept at secure locations to prevent unauthorized usage. To ensure the security of medical record information in the database of the BK-

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eHospital system, hospitals need to invest in two database servers located in 2 different locations. The patient medical records will be continuously backed up in both of these servers.

6.2. Security of Medical Records when accessed by patients

The BK-eHospital system creates and provides the Username and Password for patients automatically based on the patient's name and a random code. The medical staff prints out cards with login and the password information during initial registration. The patient can change the password after their first login into the system. Patients are advised not to share the login and password in order to maintain security of their medical records. Patients can only view part of their medical records, which consists of important test results, therapies suggested by the physicians, pharmacy information and other such information under the discretion of the hospital. Sharing of the medical records by other hospitals depends on the co-operation between the two hospitals.

Currently the BK-eHospital system requires a PID and digital photo of the patient to help the doctor identify the patient being treated to avoid possible errors. We are investigating the use of barcode technology to create the PID. The patient's card will have a barcode and the medical staff will use a barcode reader to determine the PID instead of entering the PID manually. This will make the system more efficient and reduce potential errors during logins. In addition, when patients would login to the system to see their medical record, along with Username and Password, the system will ask the patients to enter in the barcode number on their card.

6.3. Cost and Implementation Issues

6.3.1. Cost for designing the system

BK-eHospital was designed using a total of around \$20,000 in funding from Ministry of Education and Training (MoET) of Vietnam. Research and development was performed over the course of two years by 5 faculty members and 10 students from HUST's Biomedical Informatics laboratory.

6.3.2. Cost and technology needed of implementation of the system

Currently, the BK-eHospital is being implemented at Khanh Luong hospital, Hanoi, Vietnam with a capacity of 300 beds. The system includes: 2 Registration stations, 1 Ultrasound station, 1 CT station, 2 Laboratory stations, 1 MRI station, 2 Hemodialysis stations, 5 Doctor stations, 1 Admin station, 2 Manager board stations, 1 Pharmacy station, 1 Financial station and 4 Medical staff stations. Khanh Luong hospital has invested in 23 Personal Computers (PCs), LAN system and 2 small servers to implement the BK-eHospital and manage the medical records for around 30,000 visits by patients per year.

The Infrastructure needed in the hospital to implement the BK-eHospital would consist of PCs, LAN system and at least two servers. Depending on the size of each hospital specific requirements for the PC, LAN, and server will need to be determined. If the hospital has 500 beds or less, the equipment requirements will include approximately: 50 PCs, LAN and 2 small or medium servers. If the hospital scales from 500 to 1000 beds, the equipment requirements will include approximately 100 PCs, LAN and 2 large and robust servers.

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BK-eHospital is developed around an open-source model, so software could be easily made available and implemented in other developing countries. Since the system functions in a module fashion each module will need to be installed at the respective stations as in figure 1. The number of stations may change, depending on the size and requirements of each hospital. Currently, the BK-eHospital is implemented in Vietnamese and English languages. However, if a hospital requires other languages, the BK-eHospital could be easily translated.

In addition, BK-eHospital can be customized to fit the needs of each individual hospital. We expect all the necessary tasks for implementation of the system could be performed by 1 or 2 faculty members. These faculty members will visit the hospital to setup the system as well as provide instructions for the users. The implementation at a given hospital could take at least one month by the faculty members involved in the design of this system.

6.4. Limitations

The BK-eHospital system is designed to meet the requirements of the EMR system and provide online remote medical services for patients based on the IT infrastructure of the developing countries. However, some problems have not been resolved as yet for example: (a) if the US, CT and MRI machines do not automatically calculate diagnostic parameters or if they do not have a DICOM output, the parameters need to be calculated and entered manually into the system.¹⁴ (b) with multi slice imaging as with CT, MRI image scanners, we cannot capture the images into the software with time synchronization. The appropriate images are manually entered after being reviewed by the physicians.

6.5. Future Studies

According to statistics reported in,^{3,4} the number of cell phone subscribers in Vietnam has been increasing very rapidly. The BK-eHospital system will be further developed to allow patients to access their medical records using cell phones. Patients can login to the system by cell phone to review their disease status as well as consult with the medical staff for advice. We plan to add more features, which include automatic acquisition of other medical data types such as video data from endoscopy, 3D and 4D image data, waveforms of electrocardiograms, electromyograms, electroencephalograms, and other signals and store them in the system database.

7. Conclusion

There is a need for a web-based EMR system in Vietnam to make the medical records accessible to hospital medical staff and patients to make the healthcare system more efficient. The Biomedical Informatics laboratory at the Hanoi University of Science and Technology in Vietnam has developed the BK-eHospital system through the MoET, Vietnam to assist in providing better healthcare to the people in Vietnam. The system would minimize errors due to manual entry of patient medical data by automated data acquisition of medical information from medical equipment such as laboratory devices, ultrasound, DR, CT, MRI machines and others and is currently implemented at Khanh Luong hospital, Hanoi, Vietnam. The system also allows patients to access their

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medical information via the Internet and would provide information about their medical tests in a timely manner and the treatment recommended by doctors for quick recovery. The current system is more suitable for medium and small hospitals with 1,000 beds or less and, could be implemented in a number of such hospitals in Vietnam. Currently there are no standards in place for sharing and managing of patient health records between different hospitals in Vietnam. Through the MoET and MoH in Vietnam we are establishing standards to manage, store and share medical records between different healthcare providers in the country.

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