ELECTRONIC REFERRAL SYSTEM FOR HOSPITALS IN NIGERIA

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Abstract

The advent of Information Technology gave birth to Telemedicine, which has led to electronic-based consultations such as electronic referral system in hospitals. In Nigeria, all the state hospitals are having problems in referring patients from one hospital to another. Most of the time before a patient could be referred from one hospital to another (specialist), the patient would have given up the ghost. This led to the design of a system that will handle referral of patients from one hospital to another electronically in Osun State, Nigeria. This paper focuses on referral of patients from one hospital to another over a computer network among the hospitals in Osun State, Nigeria. Patients were referred from one zone to another; the patient's case file and examination data were transmitted over the network among the zones successfully. In conclusion, the HOspital Referral System (HORS) has the ability to guarantee the security of patients' case note, examination data and effective referral of patients, which in turns makes patients treatment timely, efficient and cost effective.

Keywords: Information Technology, telemedicine, computer network, referral system, general practitioner

1. Introduction

The concept of the Referral System can be dated back to 1960s and evidence of wide variations in the rates at which general practitioners refer patients to specialists began to emerge in the 1970s (Office of Population Census and Surveys, 1979). The rate at which patients patronize hospitals in a particular country depends on the population of that country. Nigeria with over 120 million population (Kea, 2001), the rate at which people patronize the hospitals will be higher in Nigeria and the referral rate will also be higher than any other country in Africa. On average, general practitioners make about five outpatients referral per 100 consultations per year (Wilkin, 1992) (Office of Population Census and Surveys, 1997). The reasons for referring patients, could be for investigation, advice on treatment, second opinion, reassurance for the patients, request by patients or relatives, fear of litigation, diagnosis among others.

Referral of patients is a key feature of any nation's health system. General Practitioners use their professional skills in referring patients to the most appropriate specialist at the most appropriate time. In Nigeria, while contributing to the relatively low cost of health care, patients have less access to specialists compared with other countries of the world where patients have direct access to specialists.

Referral system is one of the strategies put in place for ensuring the best use of hospital resources and health care services (Idowu, 2003). Referral system was defined as a process in which the treating physician at a lower level of the health service, who has inadequate ski by virtue of his qualification and/or fewer facilities to manage a clinical condition, seeks the assistance of a better equipped and or specially trained person to take over the management of a particular episode of a clinical condition (Al-Mazrou *et al.*, 1990).

In the state hospitals in Nigeria, especially Osun State, patients' records and referral of patients from one zonal hospital to another are done manually. Most of the time, due to this manual way of transferring patient's case files, the files often get missing in transit. In some cases, when a patient is referred to a particular hospital where the medical expert is, the case file may not be available and since the medical expert does not have access to case file, he may place the patient on the drug which the patient has used before and it may lead to loss of life of such patient. But if the case file were transferred electronically to the medical expert before the arrival of such patient, the doctor would have received the case file and proffered necessary treatment even before the arrival of the patient.

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This referral system problem is what this research work addressed; the researchers developed an electronic referral system for hospitals in Nigeria with Osun State Hospital Management Board as a case study.

2. Prototypical Design of HORS

The hospital electronic referral system prototype was developed at the Department of Computer Science and Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria. The prototype was designed to be peer-to-peer configuration. Each Computer in the network consist of a monitor, PIII 450 MHz motherboard with at least 128MB of RAM, a 20GB hard drive, multimedia card, and a network adapter card with Windows XP as the operating system.

Four computers were located in College of Health Sciences Building, Faculty of Science Building, First and third floors of the Computer Building respectively (each of the buildings is about 400 m apart on average). The four systems were interconnected and linked together over an existing Obafemi Awolowo University NETwork (OAUNET) campus-wide network. Patients' case file, referral note and examination data (such as x-ray images, pathological data, among others were sent from one computer to another and vice versa. Ultrasound video was digitized, compressed at one location, transmitted, decompressed and displayed at the other location in real time using MPEG-1 at 30 frames/second. The physicians' response with regard to the reliability and responsiveness of the system was positive

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3. System Requirements for HORS

Electronic referral system for hospitals will require different combinations of the hardware and or software components, which are described under each of the following categories.

(a) Media storage

Some of the patients' case files and examination results require temporary or permanent local storage. This storage can be provided through either magnetic and/or magneto-optical (MO) drives. If the HORS system is incorporated within a PACS, new incoming and old images can be stored permanently in the PACS archive and accessed by the HORS system as needed. For reasons of simplicity and cost efficiency, the HORS prototype uses standard hard disk storage.

(b) Media acquisition

Patients' case notes and document can be images, which may be obtained from a number of sources. Still digital cameras can be used for acquiring high-resolution images for teledermatology or telepathology. X-ray films are digitized with laser scanners while images from digital imaging modalities such as MR, CT and CR are available directly in digital, DICOM-compliant formats. HORS prototype supports any video devices, including standard videocassette cameras while audio may be obtained through a mono/stereo microphone. The video acquisition hardware support image capture in 4:2:0 format. This format is required by MPEG-1 and H.261, the video-conferencing compression standard.

(c) Image and Video Processing

Image processing requirements for HORS applications can be derived from duplicating the available functionality to corresponding tasks performed in the clinical environment without HORS.

Basic image manipulation functions such as 90 degree rotations, horizontal and vertical flip are essential to correct the errors in image acquisition and assure that images can be presented to the clinicians in a way that they are accustomed to viewing them. This is particularly important in teleradiology. Zooming and panning are necessitated by the limited spatial resolution of CRTs when compared to X-ray films. Real-time window/level (brightness and contrast adjustment) is required by the need to interactively examine medical images with more than 8 bits/pixel by adjusting the range (window) and the center position (level) in the wide input dynamic range (Lee and Kim, 1996). In the case of diagnostic video, manipulation functions such as play, record, pause and rewind are important for simulating the VCR environment often used in ultrasound consultation.

(d) Compression/decompression

Compression of medical images has been historically reversible or "lossless," limiting compression ratios to between 2:1 and 4:1. Lossy compression schemes have not been widely used for both clinical and legal reasons. However, standard and newer compression algorithms such as JPEG and wavelet-based compression can yield "visually lossless" images with compression ratio between 10:1 and 20:1 (Lee *et al.*, 1995). They produce statistically identical diagnostic results compared with using the original images without any lossy compression. If this kind of compression is properly used and as it does not require much additional time for compression and decompression, it can significantly reduce the communications bandwidth, storage requirements and overall delay in the HORS system.

(e) Network interfaces

Required network interfaces for HORS can range from low to high bandwidth, depending on the application. Low bandwidth interfaces should support multiple links as low bandwidth connections are often combined together to provide the bandwidth necessary for telemedicine. These interfaces include V.34 POTS connections, 56 kbps dedicated or frame-relay connections, Integrated Services Digital Network (ISDN) connections at 64 kbps to 1.92 Mbps, and fractional T1 and full T1 interfaces which provide up to 1.54 Mbps/connection. Higher bandwidth interfaces include TAXI (100 Mbps) and SONET (155 Mbps and higher). Furthermore, interfaces between the wide area network and local area networks (e.g., Ethernet, FDDI) was required to allow the zonal hospitals consultant to access medical imaging devices, PACS and other medical information systems regardless of where the zonal hospital is located in the state. In the HORS system, there are facilities in the system where case file and referral note can be written and images produced can be in jpeg and gif format.

4. Overview of HORS

(a) Referral of patients on HORS

HORS was developed for referral of patients from one hospital to another. Patient's case file, referral note and result of medical examinations are transferred manually from one hospital to the other, most of the time through the patient or hospital staff. The problem with such a method is insecurity and waste of time, which may result in loss of life, in emergency.

HORS is advantageous, since patient's case file, referral note and results of medical examinations such as X-rays, pathological data and endoscopic images can be transmitted. In addition, because of the need for state governments to minimize cost of running hospitals, few medical experts are often employed to serve the hospitals in the state. Telephone system (NITEL) was used as the transmission medium for the network because it is readily available in almost all the six zones in Osun State and radio link was used in few areas where no Telephone facility exists.

(b) HORS design principle

To allow for high performance of the HORS, the following features are incorporated into the design. These are simplicity, flexibility and expandability.

1. *Simplicity*: The choices in telecommunications and computer-based technology, coupled with the variety of medical applications possible, create an overwhelming array of options when developing any telemedicine systems. So, a simple but rugged design was used for the network.

2. *Flexibility*: The rapidly changing nature of computer based consultation technology puts a premium on creating flexible systems that can adapt to new equipment. HORS was developed in such a way that it can readily adapt to any improvements in technology as well as reductions in cost.

3. *Expandability*: The design was made in such a way that if new zonal hospital(s) is/are introduced to the existing one, the network would accommodate such zonal hospital(s) without any problem. So, HORS allows expansion within the network.

(c) HORS implementation requirement

For the implementation of this system, the following minimum hardware and software configurations are required:

Hardware: Pentium II 500 MMX, 64 MB RAM, 3.5 Floppy Drive, CDROM Drive (Read and Write version), 120 watts amplified speaker, 14" SVGA monitor, Keyboard, Mouse and Pad, 20 Gigabyte Hard Disk and a Scanner. Also, 3-Com Network Interface Card (for all communicating servers), 3.6 Kbps MODEM (for servers in each of the zonal hospitals), Coaxial cables (for local area network connection in each zone), Telecommunication facilities (local telephone line for dial up of each zonal hospital) ar Uninterrupted power supply.

Software: Windows 98, Linux (for entire network) and HORS

5. Evaluation

Computers were connected between the third floor and first floor in the Department of Computer Science & Engineering (Computer Building), Faculty of Science and Faculty of Health Sciences, Obafemi Awolowo University, Ile-Ife, Nigeria, (which is about 400 m apart). Pathological data were exchanged, manipulated and discussed interactively among the locations. Ultrasound video was digitized, compressed at one location, transmitted, decompressed and displayed at the other location in real time using MPEG-1 at 30 frames/second. The general response from the physicians was positive, particularly with regard to pathological data and responsiveness of the system.

The HORS workstation prototyped is a medical imaging and pathological data computer system with added multimedia capabilities. Medical images can be displayed at a spatial resolution of 1280 X 640.

Figure 1: Patient registration form

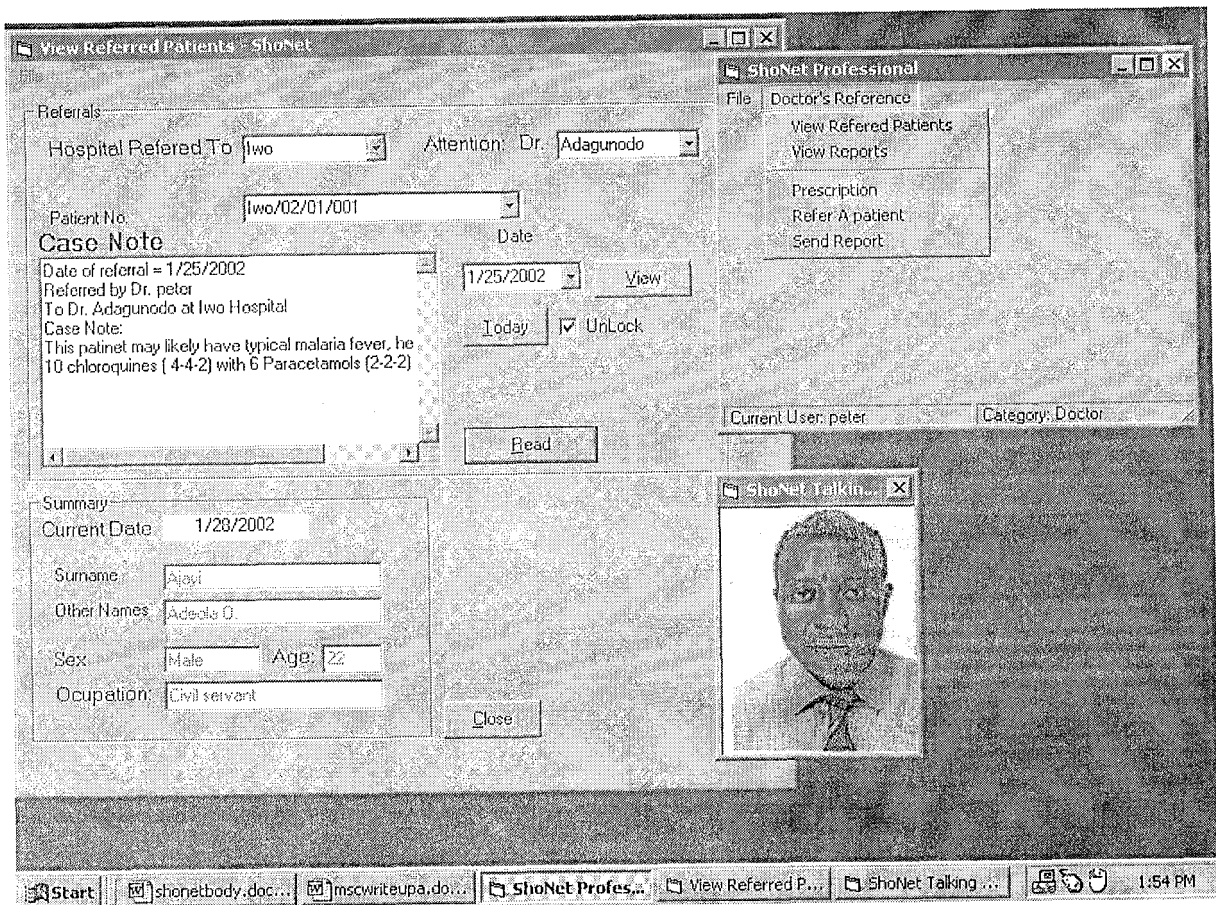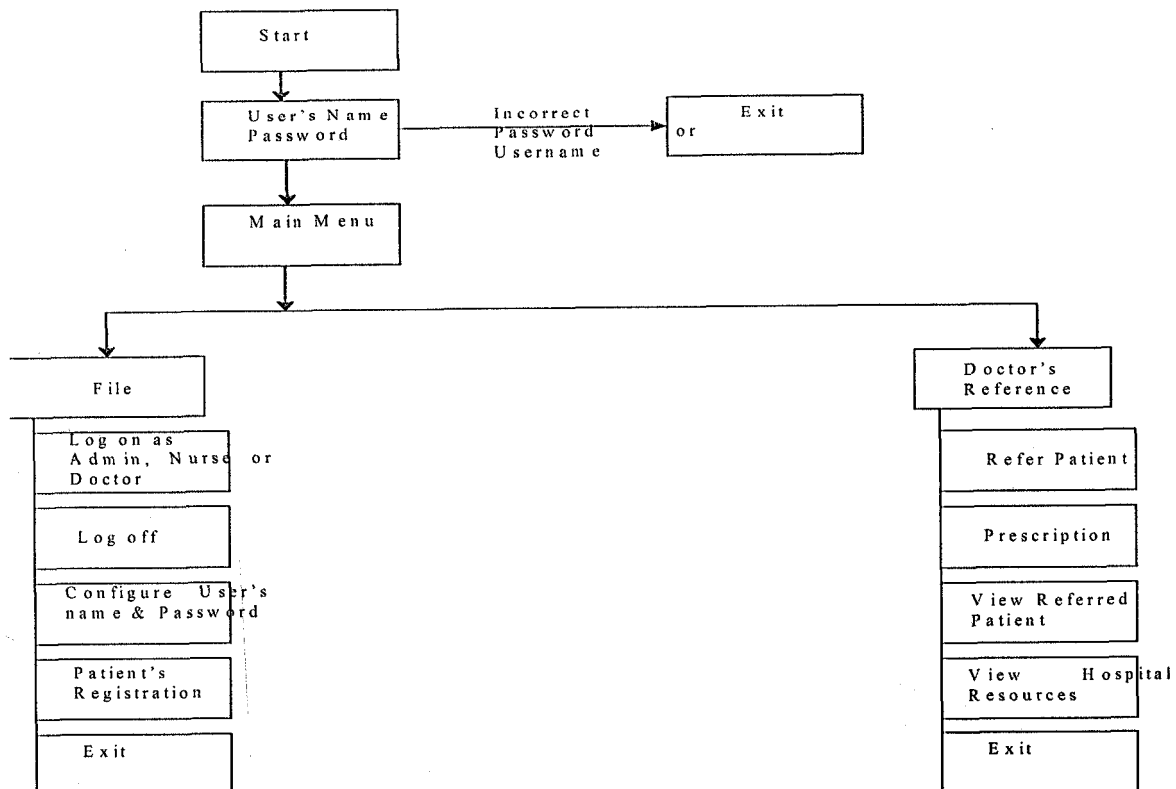Figure 2: Referral of patient from one hospital to another

Figure 3: View of patient referred from one hospital to another

BLOCK DIAGRAM OF THE SYSTEM

HORS was written with Microsoft Visual Basic (version 6), an object based, rapid application development environment. The software has an integrated text-to-speech capacity, which gives doctor option of listening to the reports instead of reading. The database made multi-user considerations by implementing page locking mechanisms and job queuing architectures to maintain transparent availability to all users and monitor data integrity of the system.

Double-clicking HORS Icon in the Program Menu loads HORS. The log on screen will come up, the user will type his username and password, if either the username or password is wrong, the user will be denied access. If the username and password are correct, the system will display main menu. The HORS Professional Main Menu consists of two-sub menus, which are: File and Doctor's Reference.

(a) The File Sub-Module:

This module deals with access to the network. It gives access to the administrator or the doctor. It is divided into five-sub menu. These are:

- *Log on*: This module allows the user to log on as Administrator, Nurse or Doctor.

- *Log off*: This is where the user logs off from the network

- *Configure*: This is the module where administrator changes the user's password or user's name. It also allows administrator to add, modify and delete patients' record.

- *Registration*: This module allows Nurses to add new patient, edit and delete existing patient's record from the database and to register new patients.

- *Exit*: This module is used to quit the program.

(b) The Doctor's Reference Sub-Module

This module allows the user to refer a patient from one hospital to another and to view-referred patient from another zonal hospital. It allows the doctors to prescribe to the patients' after the patient registration. Doctors can also view the previous prescriptions of the patient so as to know what and what to do next for the patient. This module allows the Doctor to view the existing hospital resources in the entire zone so as to know where to refer a patient. Standards for the referral procedure include results of clinical examination, social history, current treatment (if any) and reasons(s) for referral. These standards are part of a quality assurance manual[7], which is followed by all health centre staff. However, there were no

set clinical criteria for referral for each clinical condition.

The figure 1 shows the place where the patient record will be keyed into computer and assigned registration number when the patient is coming for the first time to the hospital.

Figure 2 shows where patient are referred from one hospital to another and figure 3 shows how a patient is being referred from one hospital to another using HORS.

6. Conclusion

HORS is designed such that there is one server in each zonal hospital. Radio link was used. Ethernet Network Interface Card (NIC) was used as the interface card for all server computers and nodes serving as a switching center on the network.

HORS has the potential to increase medical personnel productivity, reduce prenatal and neonatal mortality rates, improve the efficiency of medical care and minimize the cost of running hospitals in Osun State, Nigeria among other benefits.

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