GSM Based Referral System for Primary Health Care Centres in Nigeria

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Abstract: In an attempt to reduce paper work, forestall the problem of case notes getting lost in transit, shield the contents of case notes away from patients which could also lead to a psychological breakdown by the patient and as a result of all these reduce mortality rate in the primary health care centres in Nigeria, an electronic referral system is designed to alleviate all these aforementioned problems. Medical personnel's (such as nurses, local health officers and doctors) were interviewed in an attempt to acquire a detailed knowledge of their manual process of referring patient. The results showed that patients' case notes (which encompass patients' symptom, diagnosis, medication with the clinical number) were transmitted using mobile phone on a Global System for Mobile Communication carrier from the referral package within few seconds. In conclusion, the work has the potential to increase medical personnel productivity, reduce prenatal and neonatal mortality rates, improve medical care and minimize the cost of referral since GSM facilities are already on ground and some mobile operators offers free text services.

Key words: GSM, referral, medical personnel, patient

INTRODUCTION

In health care, huge amount of information is processed. This information has traditionally been mostly paper-based and stored in health care institutions, e.g., hospitals and health centres. In many domains especially in industry, which are as information oriented as health care, applying computers to manage and transfer data is self-evident (Ragupathi, 1997).

In health sector, the confidential nature of the data and heterogeneous health care organizations has been the major obstacles in adopting computerized systems into clinical use. Since a patient is often treated by several clinicians working in different places, introducing an advanced electronic patient record system in one place does not have a dramatic impact on the health care process from a patient's point of view (McDonald, 2005; EHTO, 2005). It is still as difficult as some decades ago to explain to another clinician what another clinician has explained or examined. This together with patients' awareness of different treatment options and quality demands has caused pressure for cost-effective patient-specific hospital information systems (Hallman et al., 1994).

Rapid progress in telecommunications and increasing storage costs of paper based patient records (Karinen et al., 16997) have recently remarkably stimulated the activity to develop electronic patient records but it would not be possible to transfer or share electronic patient case history among hospitals without networking those hospitals together. This work arose from the need to have electronic patient case note and to nullify the disadvantage of multiple paper patient records, often with conflicting information and other disadvantages associated with paper records.

However, the use of telecommunications will give health care opportunities, which nobody was able to imagine a decade ago. In line with this, Global System for Mobile telecommunication (GSM) will be used in this study, as the transmission media to convey patient's medical history because of the lack of internet facilities in these villages to be linked and also making it easy for the patient to have a practically unlimited movement. It also has a wider coverage area when compared to its cabled or wired network counterpart, which will make possible for some primary health care clinics within the state to enjoy this innovation together with her citizenry.

Transfer or sharing of patient's medical history among primary health care centres will so much contribute and enhance medical care. In this study, we present Mobile Phone based Electronic Referral System for Primary Health Care Centres in Nigeria (MERS). This system will allow transfer of patients' case note from Primary Health Care centres (PHC) to tertiary hospital via the GSM network.

REFERRAL SYSTEM

Referral system is one of the strategies put in place for ensuring the best use of hospital resources and health

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care services. Referral has been defined as a process in which the treating physician at a lower level of the health service, who has inadequate skills by virtue of his qualification and/or fewer facilities to manage a clinical condition, seeks the assistance of a better equipped and/or a specially trained person, with better resources, to guide him in managing a particular episode of a clinical condition in a beneficiary (Al-Mazrou *et al.*, 1990).

In health practice, a referral is requested in 2 main situations: emergency and routine. Emergency referral is made in emergency cases, which could not be totally managed at a health centre. Emergencies are defined and classified according to Principles and practice of primary health care, which is used as a manual at the health centres (Al-Mazrou, 1997). Most of the time routine referral was usually made to seek expert opinion regarding a patient, seek admission and management of a patient and seek facilities for investigation (Tawfik *et al.*, 1997). None of the primary health care centres in Nigeria have the electronic referral system put in place. This poses a lot of problems because a patient case file is not meant to be handed over to the patient as that is one of the ethics in medical practice and that serves as impetus for the development of this system.

RELATED WORKS

Over the years, a lot of work and researches have been done in the area of designing and developing an electronic referral system and few of them are discussed below.

In 2000, an electronic referral system known as Digital Referral System (DRS) was developed. This system allows the use of digital cameras to photograph and e-mail images of suspect patient conditions directly to dermatology consultants, together with an e-mailed referral letter. The images from the cameras are good enough to permit diagnosis but they need to be combined with extensive background information in the referral letter. With the system, skin cancer can be diagnosed quicker and could reduce outpatient demand and thus bring costs savings (Olympus, 2005).

In 2004, Medical Access and Referral System (MARS) was developed to communicate with West Virginia University (WVU) physicians about your patients and receive patient discharge summaries. With the system, referring physicians are provided with timely patient information including notification of scheduled (and rescheduled) patient admissions or procedures, personal phone calls by WVU physicians, personal visits by the Physician Services Specialist and documentation including discharge summaries and notification of patient expirations (WVU, 2005).

In Nigeria, Hospital Referral System (HORS) was developed in 2004. HORS was developed for referral of patients from one hospital to another. Patient's case file, referral note and results of medical examinations such as X-rays, pathological data and endoscopic images are transmitted electronically. The system was developed so as to minimize cost of running state hospitals (Idowu *et al.*, 2004). The system is based on landline (NITEL facilities) which is almost dead now.

The deficiency of this system is the high bill charged by NITEL at the end of the month for making subscription to their line apart from the fact that NITEL is almost dead. Another problem is the difficulty in relocating since it is a cabled network. So, there is a need to develop a system based on Mobile Phone which have more than 4 providers in Nigeria now and not only available in cities but almost all locations where primary health care centres are in Nigeria. Also, in HORS, the state hospitals within the state were networked together but in this system (MERS), the most deprived health sector which is primary health care will be well catered for in terms of efficient and effective referral services.

METHODS

In software engineering, there are models used in developing software, spiral model was used because it allows going back to earlier stages a number of times as the project progresses. We interviewed some medical personnel and visit some Primary Health care Centres (PHC) and it was discovered that some of the PHC have no Internet or Landline facilities but they all almost have GSM network which mobile phone uses. We also gathered data that are related to referral of patients from PHC to tertiary hospitals and formulate a diagrammatic representation of the system (which is shown in Fig. 1) in order to have a good database. The database relationship
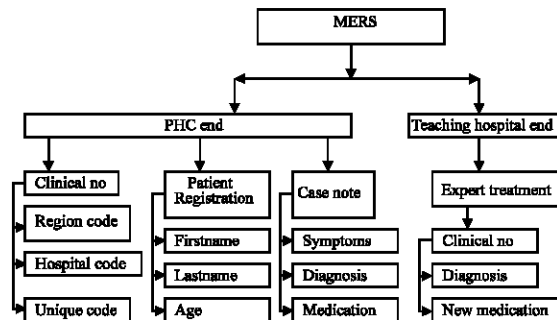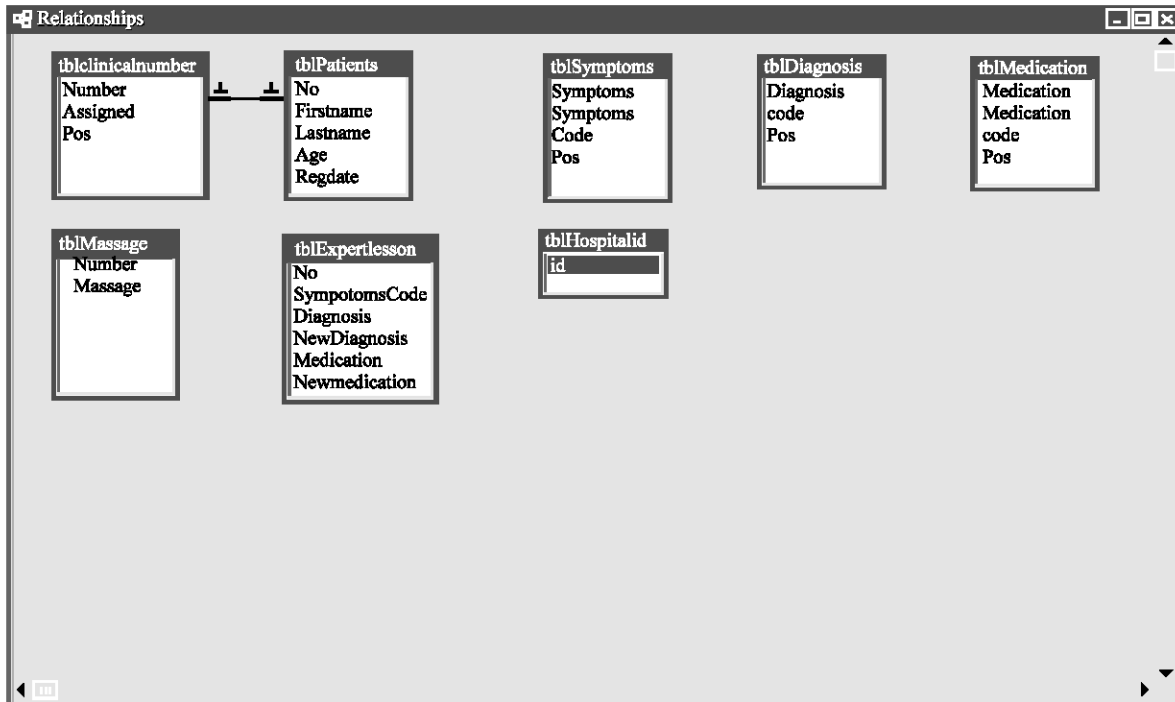

Fig. 1: Diagrammatic design of MERS

Fig. 2: Diagram of database design relationship

model in Fig. 2 is used to develop the databases using Microsoft Access and Visual Basic.Net programming language is used to develop the system.

THE MERS

MERS consists of three main menus namely: Control panel, Hospital Records Management and Expertise. The Control Panel contains 2 sub menus which are the Configure and the Exit sub menus. This package is then initialized by clicking on configure under the Control Panel. The forms designed for this system depict three different phases which are the input phase, processing phase and the output phase. The forms designed for these three phases are as explained as follows:

Input menu: The input menu is designed to collect data about the patient. It is the duty of the local health officer at the primary health care to enter this data so as to shield the data away from the patient. The various input forms designed in this package, are explained and shown thus.

Initialize referral system form: This form is shown in Fig. 3. This is the form that makes it possible for Primary Health Care Centres (PHC) to enter their region code, their unique hospital code which is different from other PHC's code in that region. This form is used only when one is setting up the package for the first time (initializing) in the PHC. The unique patient's number that identifies each patient is automatically assigned or generated by the system. This form has three buttons; Close button (to returns system back to the three main menu screen), Reset button (to re-enter the data) and Generate button (to generates the region and hospital code which is going to be a constant assigned and attached to every patients' number).

Hospital record management menu: It is shown in Fig. 4. It has 2 sub menus namely: Patients and Diagnostic tools menu. Patient's menu also has sub menus which are new patients and Review patient's information menu. The New patients menu when clicked allows one to enter the patient's firstname, lastname and the age. Register button on this form is clicked to register the patient. Review patient information sub menu makes it possible for one to correct, amend or edit patients' record entered into the system by first clicking the down arrow on the combo box to select the patient number of the patient you want to edit his or her record.
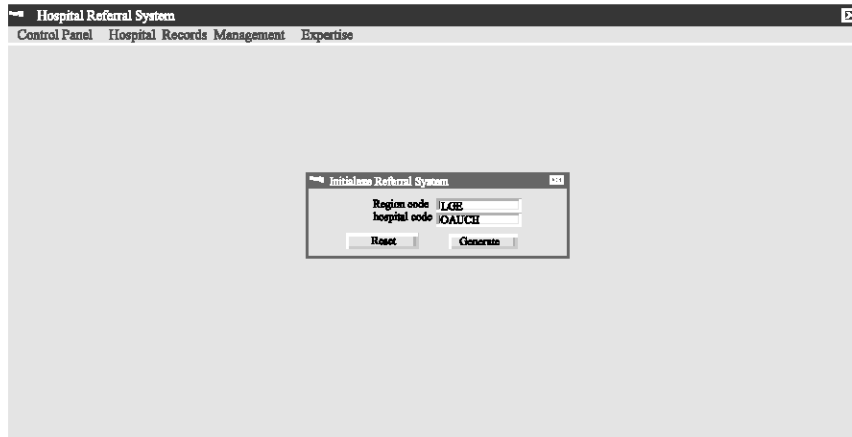
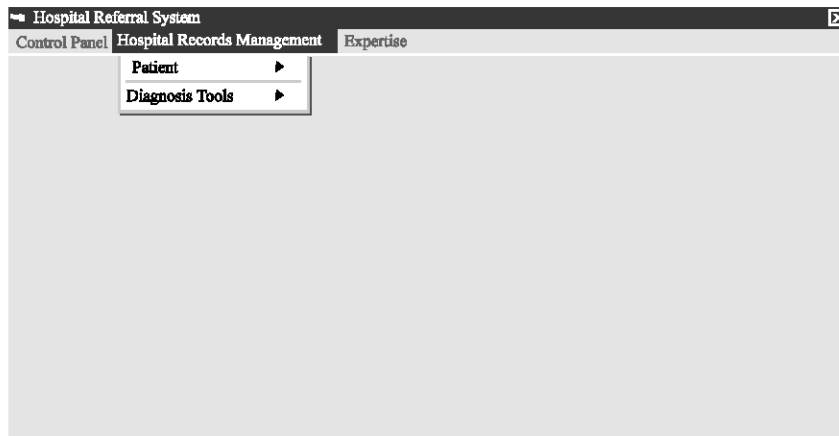Fig. 3: Form that depicts the initialize referral patient menu

Fig. 4: Menu that depicts hospital records management and its' sub menus

Find patient by clinical number button is used to retrieve the record of the patient to be edited. Update button updates or add the new correction made into the system. Add to treatment list has 3 sub menus which are Add symptoms, Add diagnosis and Add medication. Add new button is clicked upon after each entry to add the symptom into the system.

The second sub menu under Hospital Record Management menu is the Review treatment list. This form makes it possible to change or edit the symptoms, diagnosis and medication that have been entered into the system. A category to be edited is picked or selected. The makes it possible to change or edit the symptoms, diagnosis and medication that have been entered into the system. A category to be edited is picked or selected. The cursor is moved to the items under that category to activate it. Each item is assigned its corresponding Code. One can now edit and after, click

on Change to e ffect the change and one can afterwards click on Close to exit this screen.

Processing menu: The menu shows all the data (clinical code, names, symptoms, diagnosis and medication that have been entered into the system and how they are compiled and sent. (C) The third main menu -Expertise lies under this category. This menu has only one sub menu which is the Diagnostic desk. Clicking diagnostic desk brings out the form in Fig. 5. This form is the Diagnosed patients form. Patient's clinical number is used to retrieve all the information (in totality) that have been entered into the system by clicking Find Patient by Clinical Number. Information about the patient gets displayed with the symptoms, diagnosis and medication tabs showing the items under each when. Items under each category of tab are compiled for processing and transfer by clicking the >> button. The system was programmed to
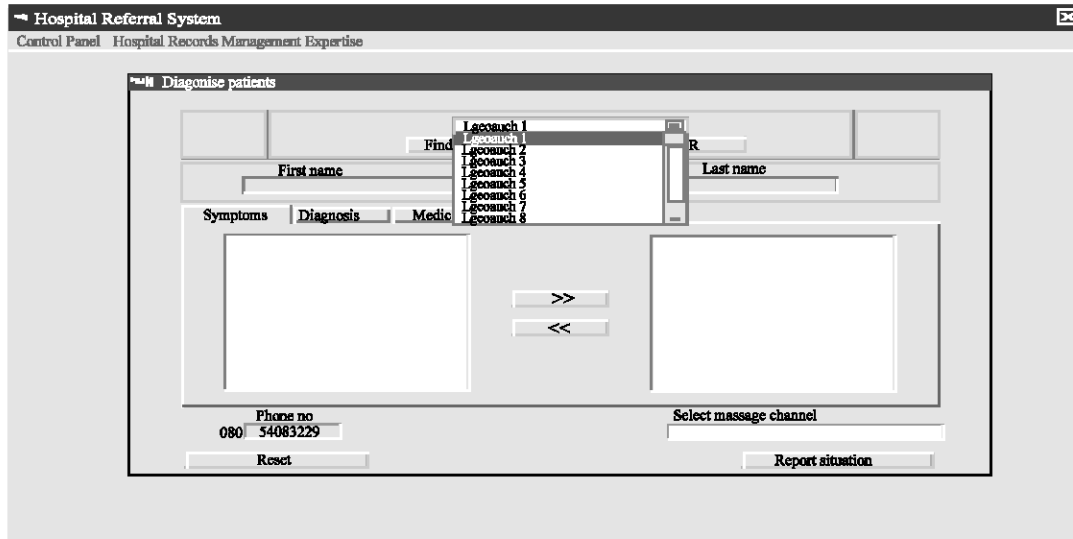
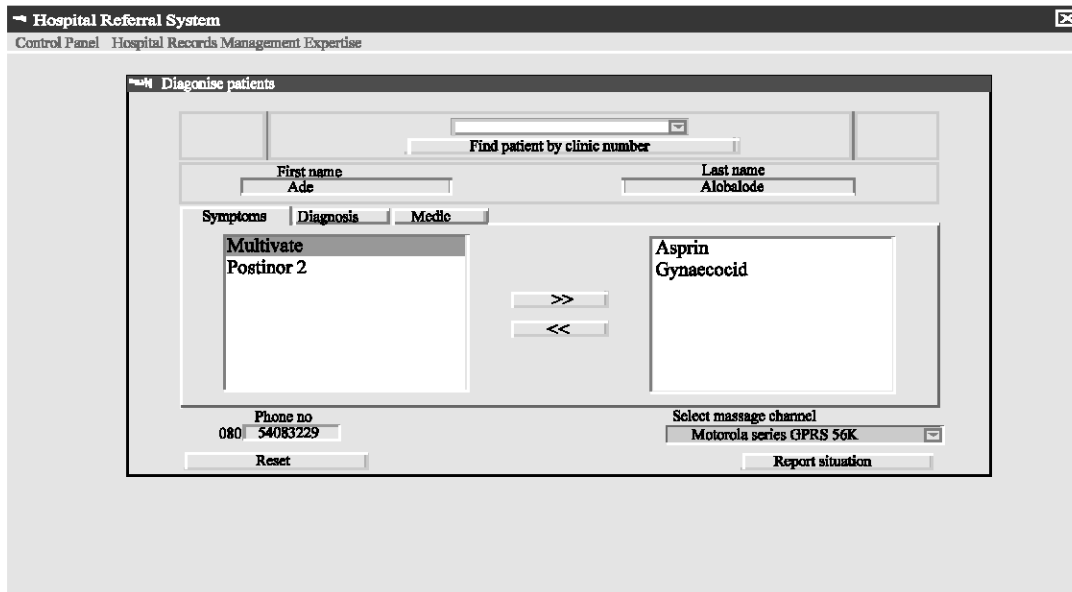Fig. 5: Menu that depicts how a patient's clinical code is selected to view patient's record

Fig. 6: Menu that displays message sent

only send the codes assigned to each item. The phone number of the phone to receive messages (codes) is inside a textbox at the bottom of this form. The drivers of the phone sending the message are shown under the Select Message Channel combo box and the driver of the one sending is selected as shown in Fig. 6. The Report Situation button is clicked upon to send the message as shown in Fig. 6.

Output: A dialog box is displayed showing message sent and the codes for the patient's history. These codes are retrieved by clicking on the retrieve case file button in Fig. 7, interpreted to its corresponding name by an algorithm embedded in this package and the expert doctor can after giving his treatment sent his diagnosis and the medication he gave back to the local health officer all using the reply button in Fig. 7.
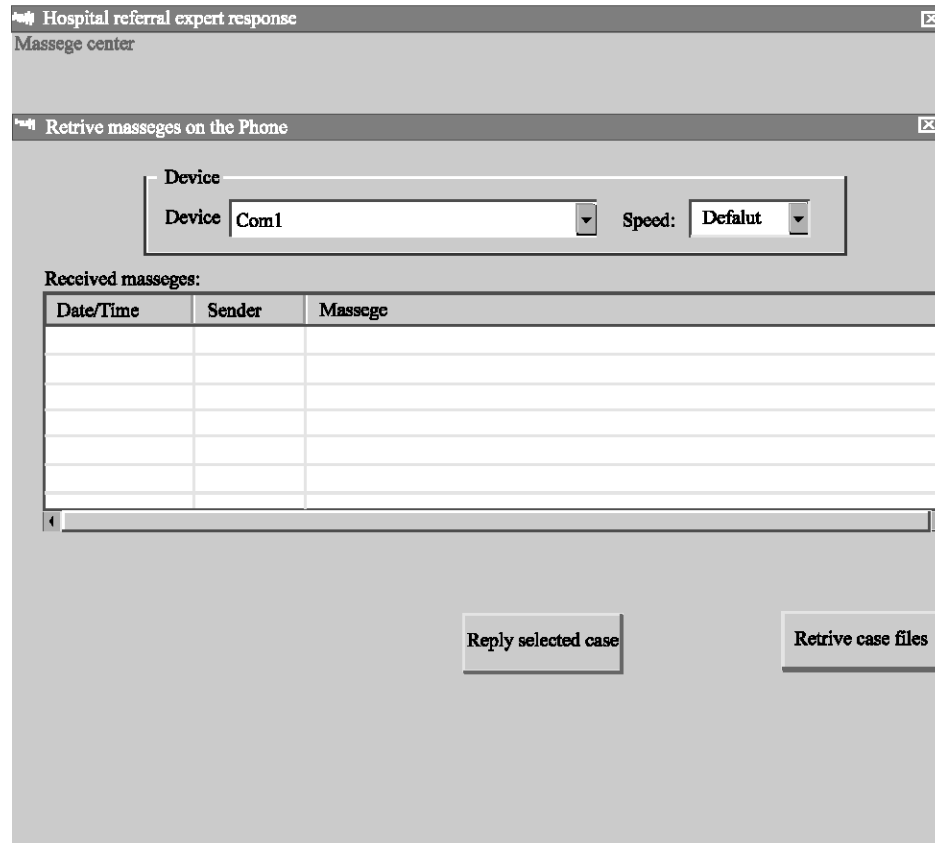
Fig. 7: Codes retrieved and interpreted using reply at the receiving end

SYSTEM REQUIREMENTS

Both hardware and software components were used to achieve this stage. Though a higher specification was used in developing this system but the minimum system requirement to achieve this operational system are:

Hardware requirements: A minimum of 2 computers will be required to achieve a referral system, one at the primary health care office and the other at the teaching hospital. The number of computers that will be used will depend on the number of PHC involved. The minimum specification are: Pentium with1.4GHZ, 512MB RAM, Floppy Drive, CDROM Drive 52X, monitor, Keyboard, Mouse and Pad, 120 Gigabyte Hard Disk, Network Interface Card, COM ports, Uninterrupted Power Supply (UPS), Voltage stabilizer to forestall power fluctuation and probably printer to print reports if need be.

Mobile phone: A minimum of 2 mobile phones (like that of PC) are also needed with their corresponding Subscriber Identification Module (SIM) inside. The mobile phone must have an inbuilt modem and there must also be a data cable for this selected phone.

Software requirements : Operating System: a minimum of Windows 98 operating system.

Standard application package: Visual Basic. Net. VB.Net was used because:

- It has a good database management facility.
- It is an object oriented language.
- It is event-driven.
- It can support mobile applications unlike VB 6.0.
- Microsoft Access database used because of the simplicity in setting up, accessing, querying and updating.
- Customized application package which is MERS.
- SMS Activex component embedded in the referral system package to interface the phone to the computer.

CONCLUSION

The MERS is designed such that there is one computer in each primary health care to access the computer at the teaching hospital. The system was developed with ability to transmit or send patients' case

note which include the symptoms, diagnosis, medication with the appended patient' clinical number using mobile phone on a GSM carrier.

The system has the potential to increase medical personnel productivity, reduce prenatal and neonatal mortality rates, improve medical care and minimize the cost of referral since GSM facilities are already on ground. Nigerian government is encouraged to fully implement the system in all the PHC so as to reduce the cost of running hospitals and also delivery effective and efficient health care system.

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