



Health Information on Cellphones over Wireless Application Protocol (WAP): Issues, Obstacles, and Strategies for the Philippines

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Abstract

Medical records are the backbone of the health care service sector. Automating medical records has been one of the challenges in the IT industry and has been shown to bring numerous benefits for patients, health providers, and facilities. Globally however, stakeholders in developing countries have been slow in adopting information and communications technology into their health careflow because of the significant investment in hardware and software. The Philippines is the texting capital of the world with more than 25 million people with access to a cellphone. This study demonstrates a prototype electronic medical record that is accessible with WAP-enabled cellphones (wireless application protocol). Technical, economic and clinical considerations attendant with such portable wireless medical records are discussed as well as strategic directions for future development in the Philippines.

1. Introduction

Medical records are the backbone of any health facility. It is a document that contains all the transactions that are related to the care of an individual patient. Its uses range from patient care, to research, to teaching, and even to medicolegal cases.

In the past fifty years, as the field of computer science matured, there have been attempts at shifting the medical records system from paper-based to electronic format. Called electronic medical records (EMR), these new systems were proffered to be better than paper-based records because of the enhancements that come with automation such as speed, reliability, legibility, and efficiency. Together with this shift to EMR however, was an increase in mobility of patients and the re-orientation of many health systems to managed care. This created a demand to make their medical records portable across different health facilities. Health data portability is such a desired state

that in the United States that a special law was passed to ensure this feature.¹ Economic benefits of portability have been cited by experts in the range of billions of dollars.²

This study proposes providing portability to electronic medical records using cellphones as the access devices. The popularity of cellphones in the Philippine setting offers a unique opportunity to enhance its use beyond simply commercial messaging.

2. Objectives

Develop a prototype application for accessing an electronic medical record system using cellphones and the Internet

Determine factors which influence usability of cellphones for accessing electronic medical records over the Internet

Enumerate opportunities for future work in the area of portable medical records in the Philippine setting

3. Method

The author for this project adopted an existing electronic medical record system. The Community Health Information Tracking System (CHITS at www.chits.info) is a product of the University of the Philippines Medical Informatics Unit through its lead developer, Dr. Herman Tolentino.³ CHITS is a web-based application that can be used on any networked computers running Linux. It requires a server running Apache, MySQL, and PHP. The system has been functional in two health centers in Pasay City (Lagrosa and Malibay



Health centers in Pasay) and will be installed citywide in Marikina.

Although considered a successful project (a health technology project still used beyond one year based on Heeks criteria), CHITS has several concerns. First, it requires substantial investments in hardware. In a typical setup, CHITS will require four terminals: two at the reception area, one in the doctor's office, and another at the treatment room. These workstations should all be connected in a local area network with one designated as server. The system also necessitated a significant amount of training to be given to the end users who are mostly midwives and nurses who have not used computers at all in their whole life. Lastly, technical support and maintenance personnel must be readily available to fix problems as they occur. The value of CHITS decreased for every day that the application was down.

These concerns led the investigator to look for other devices that may be used to access CHITS. One such device is the cellphone. The cellphone is as ubiquitous to Philippine society as any other communications device. It is affordable (some selling as low as Php 1500) and is a networked device right out of the box. Technical support is readily available. And health workers without IT skills would invariably have some exposure to a cellphone than to a desktop computer and are less averse to the technology.

The key maneuver is to enable the cellphone to communicate with a web server that runs CHITS. The HTML (hypertext markup language) and WML (wireless markup language) hybrid adapted Web server (or HAWHAW at <http://www.hawhaw.de>) is a toolkit to create such universal mobile applications. Using HAWHAW's application programming interface (API), some elements of CHITS was ported into a WAP interface and delivered through a standard micro display viewed using a Siemens SL55 desktop emulator (see figure). A general packet radio services (GPRS) connection from myGlobe

(Globe telecommunications) was used in the actual prototype running on a Nokia 6230.

A typical CHITS application has the following modules:

Master patient index registration – adding a patient into the system
Consult – starting and ending a consult for a patient already registered in the system
National Tuberculosis Program (based on the Directly Observed Therapy Short Course of the Department of Health)
Maternal Care module
Expanded Programme on Immunization (EPI) module

There are other modules but for this proof of concept the NTP drug intake module was chosen.

For these data elements, the following functionalities were developed:

- Registering a patient into the master patient index
- Searching for a patient and his/her medical record number in the registry
- Starting and ending a consult
- Choosing a patient from the list of active consults
- Submitting an NTP drug intake report

For purposes of this study, only these functionalities were chosen as they represented the major components of electronic medical record systems. As simple as these components seem to be, they already brought out several issues and concerns related to the use of EMR in cellphones (see screenshot series).

4. Observations

Observations were made during development and during implementation (alpha testing). The following parameters were noted during development: ease of development and display issues. During implementation the following





parameters were recorded: ease of use, data integrity, storage, security, ethics, quality, training, portability, reliability of connectivity, and cost.

• Observations during development

Ease of development

The HAWHAW application programming interface is fully documented and easy to use. There are two methods for developing applications with HAWHAW: using PHP or XML (eXtensible Markup Language www.w3c.org). The author opted to use XML because it is easier for novices to understand and because the language is supported by international standards governing bodies like the W3C consortium (www.w3c.org). It should be noted that some PHP still had to be used for processing the data that has been collected. Figure below shows how HAWHAW was placed within the CHITS application framework.



A slightly difficult part in the programming is the integration of logic into the application in anticipation of human-prone errors. An example of this is when a registered patient is re-registered inadvertently by the user. Logic must exist in the application to warn the end user that a duplicate entry of the same name will be created if he or she proceeds with the registration. As in any health application, end users have the privilege to override the logic if needed.

Display

The Siemens SL55 test interface is limited to 4096 colors and 101x80 pixels (Nokia 6230 is 128x128 pixels). This is similar to most cellphones on the market although Nokia and other smartphones have larger displays. Due to this limitation in display, efficiency of information has to be considered when delivering content to the cellphone. Delivering standard web pages created for desktops will be impractical for cellphones. For one, the display will require significant amount of scrolling vertically and horizontally to view the full page. For another, the large sizes of web pages designed for desktops will consume substantial bandwidth and time if delivered in raw format to cellphones. It was for this reason that HAWHAW developer put a limit on the size of files to be displayed. The most logical option was to perform an abstraction of relevant data elements in CHITS and create the instruction set in XML that will eventually be delivered to the cellphone to display.



Observations during implementation

Internal alpha testing revealed several issues as follows:

Display

With an effective display area of 101x80 pixels, viewing the medical record becomes the most prominent issue when it comes to delivering health information to cellphones.





The small display size severely limits the amount of information that can be delivered to the end user⁴. In effect, completeness of data could not be guaranteed and the end user encounters great difficulty putting the piece-meal information into one coherent picture. To mitigate this limitation, an option is to deliver content in installments (several consecutive pages). Many other space saving techniques were employed like the use of small fonts, text wrapping, and removal of external field labels and placing them inside the fields as default values instead⁵. This last technique can save up to 33 to 50% of the display area but carries a higher risk for errors in data entry. (See figure below).

External labels (top); Labels are placed inside input boxes (bottom)



Data integrity (synchronization with the master patient index)

A fundamental component of any medical record system is the master patient index (MPI - the number that uniquely identifies every patient within the health facility). This number has to be recorded in every transaction between

facility and patient. Using a web-based database-driven system, synchronization with the MPI is inherent because there is only one central master patient index for all end users that they can access over the Internet. This synchronization is not easily achievable with stand-alone applications that do not share a central database.

Keeping the unique patient identifier in the cellphone in sync with the central master patient index then is easier with a web-based solution since in practical terms, there is only one database that is being accessed by all. Transactions made for and on behalf of the patient from any cellphone device are then recorded consistently with the same numerical identifier making later consolidation of data for any particular patient seamless and error-free. These unique identifiers are usually hidden from end users, as they are only machine-readable. End users are presented with the more familiar identifiers like name and age.

Storage

Using the web-based system, no data is actually kept in the cellphone. All data are stored in the central database and none is retained in the cellphone. The only data that may be saved is the web address of the application. No patient identifying information is saved. This is consistent with ethical use of health information.

Security

Security of the web-based application is made possible with usernames and passwords.

Ethics

Only authorized personnel with the proper usernames and passwords are able to proceed further and access the other features of the medical record. An audit trail is available



where records retrieved by end users are documented. Uses of health information outside of the application however cannot be documented and this is a weakness of portable records.

Quality

Validation of forms may be embedded within the application to ensure quality of data entry; i.e., if the data entered is of the wrong format (e.g., entering letters when the data required are numerical), the application can alert the end user of the error and the correct response can be given.

Training

Some amount of training is necessary in setting up GPRS services and in navigating web pages on cellphones. Another study is needed to determine the ease of use of the WAP interface to workers at various levels of the health system.

Portability

Access to the most current version of the record is made possible if a centralized database is made available over the Internet. The prototype application was accessed in the Philippine General Hospital, in Quezon City, in Jose Rizal Provincial Hospital in Roxas City, Capiz, and theoretically, anywhere Globe GPRS services are available.

Reliability of connection

There were instances when an error message "Network is not available" was seen on screen during testing. These errors were temporary in nature and the application would once again be available at a later time. One possible reason is cellular service network congestion if there are

too many concurrent users.

Costs

Globe GPRS charges twenty-five centavos per kilobyte (one kilobyte of message has about 1000 characters). This would translate to around five centavos per NTP drug intake report. For a total of 180 days (the six month duration of TB drug intake) this would result to nine pesos charges incurred to report the drug intake of every patient using the cellphone.

Discussion: Opportunities for Future Research

Several issues with regard delivery of medical information into cellphones were noted. These issues must be discussed as they have significant impact on the development strategy and on marketing of the end product.

Display

Viewing medical records in cellphones are not only impractical but could also be dangerous. With small screens, it is difficult to get a complete picture of the patient's data and makes browsing tedious and ineffective. Efficient navigation of medical records through small interfaces will require health workers to undergo intensive training to search and to retrieve relevant information.

Cellphones are not being able to display all relevant data at the same time because of the limitation of the screen size. This becomes an issue to the physician wishing to see relationship of laboratory data with, perhaps, physical examination or clinical history. Such relationships are difficult to deliver on a small screen⁶. As such, the effect of small screen size





is the inability to deliver comprehensive information enough to make a clinical decision. The cellphone may not be an effective tool for viewing complex data. However, for smaller discrete data (e.g., latest vital signs or the latest serum potassium levels, or a warning of a possible drug interaction), the cellphone may be an adequate display tool.

In this study, the investigator opted to use the cellphone as an input device rather as a display device. This limited the usability of the cellphone for comprehensive medical record purposes but defined a safer and more effective way of employing this technology for health. In the future, cellphones may be best suited for collecting health data from the field and entering them directly into a central database. Other interface paradigms, like that of the personal digital assistant, a slightly larger interface common to smartphones, may also be used and tested ⁷.

Stand-alone application versus network-based

In a multi-user and multi-protocol environment (such as a rural health unit in the Philippines), a central database system where there is consistent access to a master patient index is crucial for data integrity and optimal research. It is therefore important for portable wireless applications (such as the CHITS over cellphones) to query central databases. Stand-alone portable applications therefore have limited use in the aforementioned environments.

Although the prototype used in this study was made using wireless application protocol (network-based), a similar application with the same functionalities may be made using a programming language like Java. The output of such an activity will be a standalone program that can work on the cellphone even without a network connection. This may seem

advantageous since a reliable connection is not required and allows the end users to create and edit medical records even if they are offline. However, there are significant issues in consistency of data when several users try to edit the same record at separate times. Synchronization takes great effort and may become burdensome to the end users. Data integrity comes into question and may not be resolved unless sophisticated protocols and priority schedules are established.

On the other hand, a network-based solution where all users access a central database ensures that there is always only one consistent copy of any record on the system at any point in time regardless of the device used. Duplication is limited and efforts at consolidation are minimized. Maintenance of data and records is simplified.

Connectivity and costs

By using cellphones and the widely available wireless application protocol, this technology leverages a communication network that exists around the country. This opens up possibilities for the deployment of cellphone devices as tools for discrete data entry.

Eliminating the tedious paper trail and using a central database model, the model proposes shows a more timely, effective, and efficient way of collecting National Tuberculosis Program data directly from the field. Such a model may be employed with other similar programs of the Department of Health like malaria, HIV/AIDS, and dengue to name a few. It does not require sophisticated equipment like desktops or laptops connected to network devices (hubs and switches). All it requires is a WAP-enabled phone that may be purchased from any cellphone store around the country.

Conclusion





The ubiquity of cellphones in the Philippines makes them attractive for accessing electronic medical records. Although electronic medical records are in their early stages of development in the country, possibilities for portability, if built into these EMRs, can open up a large market among the health sector. Cellphones are well suited for discrete data entry especially in the field. The wide coverage of the telecommunications network companies makes this possible.

Devices with small displays however, are not optimally built to provide a comprehensive look into the whole electronic medical record. It is safer to limit their use for data entry and for field data encoding.





¹ Health Insurance Portability and Accountability Act (Kennedy-Kassebaum).

<http://www.hipaadvisory.com/regs/HIPAAprimer.htm>

²<http://informationweek.com/story/showArticle.jhtml?articleID=161601166>

³Linking Primary Care Information Systems and Public Health Information Networks: Lessons from the Philippines. Herman Tolentino, M.D., Alvin Marcelo, M.D., Portia Marcelo, M.D., M.P.H., Inocencio Maramba, M.D., M.Sc. [Stud Health Technol Inform](#). 2005;116:955-60. ([http://iospress.metapress.com/\(o1czznmbz15u2uqym03dfju4\)/app/home/contribution.asp?referrer=parent&backto=issue,169,182;journal,3,13;linkingpublicationresults,1:300379,1](http://iospress.metapress.com/(o1czznmbz15u2uqym03dfju4)/app/home/contribution.asp?referrer=parent&backto=issue,169,182;journal,3,13;linkingpublicationresults,1:300379,1))

⁴Improving Web interaction on small displays. Matt Jones, Gary Marsden , Norliza Mohd-Nasir , Kevin Boone , George Buchanan. *Computer Networks* 31 (1999) 1129–1137

⁵An evaluation of integrated zooming and scrolling on small screens Steve Jonesa, Matt Jonesa, Gary Marsdenb, Dynal Patel b, Andy Cockburn. *Int. J. Human-Computer Studies* 63 (2005) 271–303

⁶Effective search results summary size and device screen size: Is there a relationship? Simon Sweeney, Fabio Crestani. *Information Processing and Management* Volume 42, Issue 4 , July 2006, Pages 1056-1074

⁷Improving web search on small screen devices. Matt Jonesa, George Buchananb, Harold Thimblebyc,* . *Interacting with Computers* 15 (2003) 479–495.

