IST-Africa 2016 Conference Proceedings
Paul Cunningham and Miriam Cunningham (Eds)
IIMC International Information Management Corporation, 2016
ISBN: 978-1-905824-55-7

Improving Healthcare Delivery with the Use of Online Patient Information Management System

Oliver Madima LULEMBO[1], Richard SILUMBE[2]
Department of Engineering, Information and Communications University, Lusaka, 10101, Zambia
[1]*Tel: +260 961 230429, Fax: + 260 11 271184, Email: omlulembo@gmail.com*
[2]*Tel: +260 979 303567, Fax: + 260 11 271184, Email: rsilumbe@zrdc.org*

Abstract: The general state of healthcare in Zambia is poor and this can be attributed to a number of reasons. One of these is the suboptimal management of patient data and information for decision-making. This research paper focuses on the comparison of the performance of the paper-based patient record management systems and the Patient e-Files Online Health Record Management System (OHRMS).
The performance evaluation of the two systems is with respect to the time spent on two basic registry operations. These basic operations are the registration of a new patient and the retrieval of existing+ patient records. The benefits of the OHRMS and the disadvantages of the current paper-based systems are discussed as well.

Keywords: Electronic Medical Record, Online Health Record Management System, Management Information System, node.

1. Introduction

According to a study by KPMG Africa in 2012, it is evident that Africa lags behind the rest of the world when all indicators of health care delivery are measured. Zambia is one of the African countries that are contributing to these alarming statistics. There are quite a number of issues that affect the Delivery of health care. One of these is the management of patient data and information. Sound and reliable information is the foundation of decision-making across all health system building blocks, and is essential for health system policy development and implementation, governance and regulation, health research, human resources development, health education and training, service delivery and financing [1].

Electronic medical record (EMR) systems, defined as "an electronic record of health-related information on an individual that can be created, gathered, managed, and consulted by authorized clinicians and staff within one health care organization," have the potential to provide substantial benefits to physicians, clinic practices, and health care organizations. These systems can facilitate workflow and improve the quality of patient care and patient safety

A health record is the principle repository (storage place) for data and information about the healthcare services provided to an individual patient. It documents the who, what, when, where, why and how of patient care. Health Record will be used interchangeably with Medical record throughout the paper, as will Electronic Health Record (EHR) and Electronic Medical Record (EMR). Previous researches that have been carried out have shown the improvement that can possibly be offered to the delivery of healthcare services to patient by better managing their health records. Most health facilities in Zambia still use

paper based record management systems, however, the fact that some health institutions do use EHR systems will not be overlooked. One thing however, that stands out in all systems is that there is no centralized information repository for all health facilities.

The health information system provides the underpinnings for decision-making and has four key functions: data generation, compilation, analysis and synthesis, and communication and use. Of the four functions, The Patient e-Files OHRMS concentrates on the data compilation, communication and use and generation. The following are some of the reasons why shifting from paper based records to electronic records is necessary. Paper based records are not structured and they consist of data that should be but is not shareable with other systems. This makes it difficult for the data to be useful in other areas that it may be required apart from the health facility that the patient is at. Other shortcomings of paper are: (1) records are expensive to copy, transport and store (2) easy to destroy (3) difficult to analyze and determine who has seen it (4) paper also has a negative impact on the environment. Electronic patient encounters represent a quantum leap forward in legibility and the ability to rapidly retrieve information. Almost every industry is now computerized and digitized for rapid data retrieval and trend analysis. An EMR system should improve patient safety through many mechanisms: (1) Improved legibility of clinical notes, (2) Improved access anytime and anywhere, (3) Reduced duplication, (4) Reminders that tests or preventive services are overdue, (5) Clinical decision support that reminds clinicians about patient allergies, correct dosage of drugs, etc., (6) Electronic problem summary lists provide diagnoses, allergies and surgeries at a glance. [5]

The patient e-Files system was compared to the paper-based system in order to determine whether users (medical personnel and registry staff) are able to save some time by spending less time on two basic registry operations. These two operations are entry of a new patient and the retrieval of a patient record. Throughout this paper "the two basic registry operations referred to, are the registration of a new patient and the retrieval of patient records. These tests were carried out at Makeni clinic in Lusaka, Zambia.

The results of these tests were then used to determine whether or not the amount of time saved from the two basic registry operations is significant to make a difference in the delivery of health care. Working on the assumption that the time saved from the operations is redirected towards administering healthcare services to patients, then we could conclude that the delivery of health care be improved by the better management of health records.

2. Objectives

This paper has a single objective and that was to compare the two systems and determine whether or not the system allows medical personnel to save time by spending less time on the two activities referred to previously.

3. Methodology

The Patient e-Files system was implemented at Makeni clinic in Lusaka's Makeni area. There, the system was used at the test site for a period of three weeks, during which, the system was used to carry out the operations (registration and record retrieval) alongside the traditional paper-based system. These activities were also timed and they were carried out. At the end of the three weeks, the number of patients that were entered into to the system was 80. An average was derived from all the recorded times. It was then these averages that were compared and conclusions drawn from these comparisons.

4. Technology Description

The OHRMS is an Information systems/ Management Information System (MIS). A management information system (MIS) is a broadly used and applied term for a three-

resource system required for effective organization management. The resources are people, information and technology, from inside and outside an organization, with top priority given to people. The system is a collection of information management methods involving computer automation (software and hardware) or otherwise supporting and improving the quality and efficiency of business operations and human decision making. Management information systems strive to efficiently collect, format, and communicate information to a wide variety of people. The effectiveness of a Management Information System is largely dependent on the quality of the information. The quality of information refers to things such as the integrity, accuracy, currency, consistency, manageability, etc. Management Information Systems consist of a number of components and the following three are the most common: hardware, Software, and a network (an internet / intranet / the Internet / Extranet). There are three primary MIS categories: transaction processing systems, management support systems, and office automation systems. More specifically, the OHRMS falls in the Transactions processing MIS category. Transaction processing systems handle daily business operations; they collect and organize operational data from the activities of the company. In this case the business operations are the interactions between patients and medical personnel (patient encounters). The operational data is the data that is collected after the interaction, be it test results, prescriptions, diagnoses, etc.

The OHRMS being a MIS, it also consists of people, information and technology. The people are the clinicians/medical personnel, the technology is the OHRMS system itself and the information consists of the patient records. The OHRMS system is broken down into the following: the hardware components, the network and the software. The Hardware components are the computers or devices that will be used at the various facilities to access the system. The network will be the internet connection that connects all the computers to the server on which the database resides. The software is the User Interface (UI), the database, both of which reside on an online server and other supporting third party software that has been integrated to enable certain functionalities.

The system will be hosted on a web server where it will accessible on a web browser through HTTP. This will make the system accessible to every medical facility that has a computer and an internet connection. This means it will be necessary for medical facilities to have a computer that is reliably connected to the Internet. The web-based system includes a responsive User Interface (a user interface which will adjust its display to fit the size of the screen it is being viewed on.), a web hosted database, and the internet connection to keep all the records updated. The database which is hosted on the web server is the centralized database which is shared by all medical facilities. The responsiveness of the website will allow for it to be viewed on a variety of screens including mobile phones and tablets for mobility's sake.

The system allows patients to be assigned to doctors so that only those doctors can access their files. This comes in handy in cases where patients have specific doctors also known as private doctors. The system allows medical personnel to view all patient history and therefore there will be no case where information that is needed for vital decision making, is missing. Doctors are also able to prescribe medication for patients and specify how long the course will run. This enables other medical personnel to know what medication the patient was recently on or is still on or should be on in cases of non-compliance. This is an important advantage and can be vital because combinations of certain medications could have detrimental effects on the patient's health.

Patient information is only accessible by authorized personnel. This is implemented by the use of a username – password user authentication scheme in order to protect the confidentiality of patient records. Patient records are easily found by the use of the patient file number as the unique identifier. A patient just needs to know this number in order for their records to be retrieved easily. The system also allows medical personnel to set up

appointments with patients and remind them via SMS when there are two days or less to the patient's appointment.

The backbone of the security of the system is user authentication. Information is only accessible by users with the right authentication. People with malicious intent will have a hard time having access to user password, except through social engineering (an approach where the people with malicious intent try to get passwords from users through social interaction). This is because the passwords are encrypted using a MD5 algorithm. The MD5 algorithm is not a reversible algorithm and therefore, even in a case where this person retrieves the password through various hacking means, they will be unable to decipher it into something useful.

The system also has a section for obstetrics and gynecology where mothers and expectant mothers' information can be tracked and stored. It is under this section that there is a sub-section for antenatal visits and the birth of children. Birth information for the child is also stored in the system and a birth certificate is generated but cannot be printed because there is a separate body that is responsible for the publishing of birth certificates and not the medical facilities. Deaths can also be recorded in the system. However, the death certificates like the birth certificates, even though they are generated by the system, cannot be published.

As brought out earlier, the Patient e-Files system consists of three major Hardware components which are: The nodes (The computers or mobile devices which will be accessing the web system), The web server and the network. The hardware lays the platform for the software which does the work, which will be discussed in this section.

The software component can be broken down into a few parts. The database where the patient information is stored is one of the main components of the software. A MySQL relational database was used because the patient information is relational. The relational data model is based on tables. The relational model gives us a single way to represent data: as a two-dimensional table called a relation. The columns of a relation are named by attributes. The name of a relation and the set of attributes for a relation is called the schema for that relation [8]. The database resides on the online server it being available for use by all the nodes makes it the central database.

Relational databases use unique identifiers for the identification of every row. This is essential because every patient needs a unique identification number by which their records will be distinct. This unique identifier is generated automatically by the system. The id (which is known as a primary key in databases) is divided into three parts. The first part is the facility code (for Makeni clinic the code is "MHC"), the second part is a number that is incremented on every new entry. The last part is the last two digits of the current year. These three parts are separated by a forward slash.

The User Interface (UI) was designed with the use of a mobile phone as a node in mind. It is a responsive web site which means the user interface morphs according to the resolution of the screen on which it is being viewed. If a user was to access the website from a tablet or a phone, it would not be distorted but the elements would rearrange themselves neatly and fit the display. Below is an example of how the system operates.

The operator accesses the system via its URL. The node will connect to the server and via HTTP and retrieve the User UI. This is another major component of the system because it gives the operator user friendly access to the database allowing them to carry out CRUD (Create Retrieve Update Delete) operations on it. The UI which is designed in HTML and JavaScript will be retrieved by the operator and they will have an easy way of interacting with the system.

The example which will be examined is the retrieval of a patient record. The first thing that must be taken note of is that for one to retrieve a patient record they must be logged in as either an administrator, a doctor or a nurse. They log in by clicking on a link which

redirects them to a page with two text fields for the username and password (the log in page). After a successful log in with the correct credentials, the operator (the person currently using the system) can now open the 'find_patient.php' page (Via a link on the menu) where there is a search dialog where they can enter the patient's file number or name. The search box brings a list of suggestions as the operator is typing, which contain the patient's name and file number. These suggestions can be clicked to open the patient's electronic file. The patient's electronic file contains all the patient's medical history ever since they opened an electronic file at any medical facility, their prescriptions (past or current medication they are on), and past test results. This information is sorted by date. Every visit the patient pays to a health facility is dated and therefore, the operator can view records from any date.

5. Developments

Most facilities in Zambia today are still using a paper-based record management system, including the largest Hospital in the country, The University Teaching Hospital (UTH). This is quite alarming considering the volume of the patients that go to UTH every day. After conducting casual interviews, the approximate figure came to 1,000+. It is a mammoth task to sort all the patient records for such a large number. There are a number of disadvantages of paper records such as: vulnerability of the records – records easily get destroyed or lost, difficulty in finding records – records need to be searched for physically, the bulkiness of the paper records, the mobility or lack thereof, of paper records, etc.

In a few private health facilities around the country, there are some that make use of EMR systems. However, these systems are all independent of each other and therefore leads to a situation where there is information asymmetry. If a patient moved from one facility where they had a file (Electronic or paper) they would leave it there and they would need to have a new file opened at the facility they go to next.

Since 2005, SmartCare has been deployed in more than 550 clinics and hospitals, in all nine provinces and 72 districts in Zambia. Sites include public, private and military health facilities. As the electricity infrastructure develops in more remote areas of the country, SmartCare implementation will follow to strengthen health systems [10].

This is the one EMR system that has been the best effort put in place by the Zambian government to eradicate the problem of information asymmetry by allowing patients to keep a card which contains their Medical information. With this system, a patient can have access to their medical information whenever they go to a facility which has the SmartCare system. There is also an aggregation of information among facilities that have the system. This however is done after a specific period of time and is quite costly because the information is physically transported with the use of a flash drive.

6. Results

This test was done basically to test the speed of the two systems (manual and Patient e-Files) as the users went about the two activities. The results for the tests are summed up in table 1 below.

Table 1: Comparison of Duration of Patient Record Management Activities between Manual & e-File Systems, Makeni Clinic, Lusaka, 2016.

Activity	Manual System (Paper-based)		Patient e-Files (OHRMS)	
	Range (sec)	**Average** (sec)	**Range** (sec)	**Average** (sec)
Registration	46.00-123.00	88.10	19.00-112.00	52.50
Retrieval	22.00-213.00	73.25	3.00-12.00	3.99

The results of the test at the clinic showed that the Patient e-Files system was clearly faster that the manual paper based system by quite a notable gap. The difference is remarkable when we look at the time difference between the average for the retrieval of results using the manual system and the web-based system. Figure 1 below gives a graphic view of the differences in the times taken in carrying out the activities between the two systems.

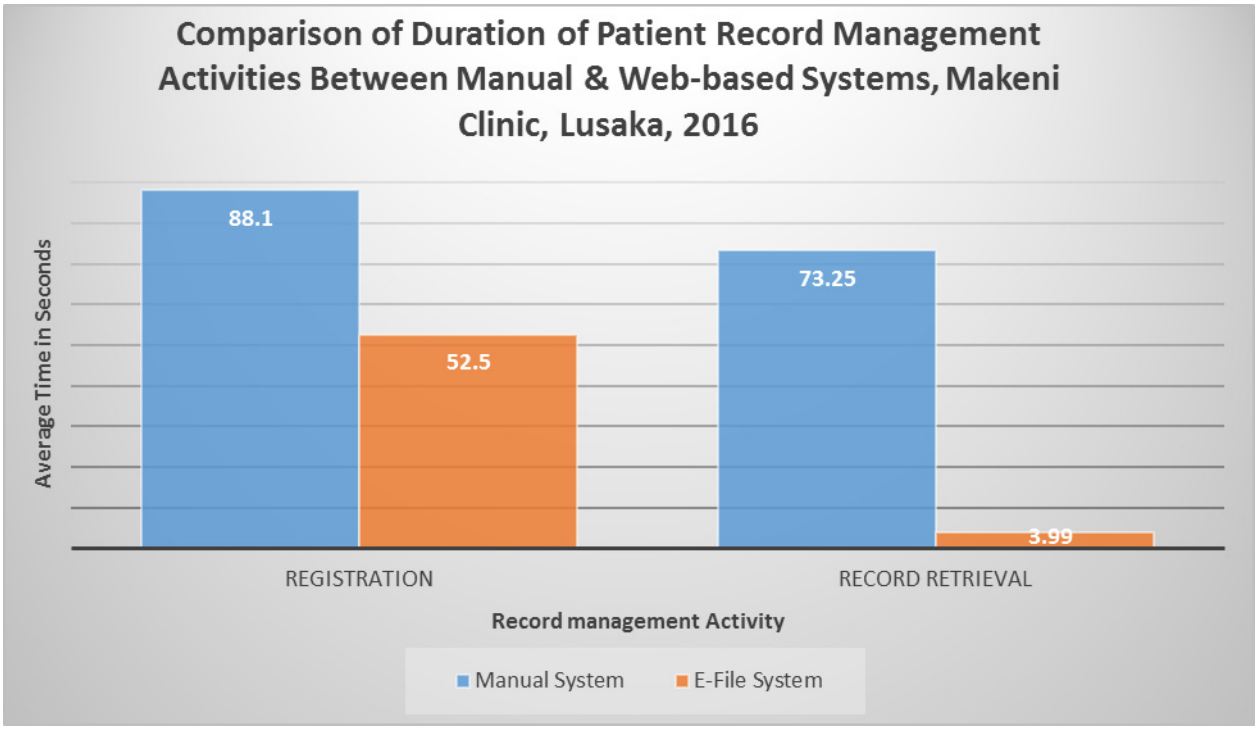

Figure 1: Chart Showing the Comparison of Duration of Patient Record Management Activities between Manual & Web-based Systems

It must be noted however, that the registration time should only apply when a patient is going to any medical facility in the country for the first time. With the current manual system, the patients have to register whenever they go to a different facility. This leaves the records at their old facility dormant and the new records become redundant. With the Patient e-Files system, patients don't have to register again as long they have been to a medical facility in Zambia before in their lives. These results therefore are working on the assumption that the patients entered in the system have never been to any medical facility. In actual fact, if patients have been to other facilities before registration time with Patient e-Files would be 0 because there would be no re-registration.

7. Business Benefits

In the current system, paper-based files are opened for each patient and stored in a room or on a shelf in the reception. As earlier stated, the objective of this paper was to analyse the performance of the OHRMS. The research hypothesis is that the OHRMS will improve the overall delivery of health care services by improving the management of health records. The idea is to redirect the time that is saved from better managing the records, towards the actual administration of health care to patients. The OHRMS also adds a new dimension to the systems that are currently in use in a few medical facilities in Zambia, the centralized database. This eradicates the problem of data inconsistencies. There is usually a lapse in information when EHR systems are completely separated from each other but that is done away with when the centralized database is adopted. This also allows for real time

information flow. All in all, the projected positive effects of this information being shared across all medical facilities are numerous.

The time between when the patient is attended to by the receptionist and when he/she is attended to by the doctor is the time that we will pay attention to. That is where the difference comes in. It is those minutes that can make a difference when directed towards attending to the patient.

8. Conclusions

Healthcare delivery is something that is held in high regard in any country. Based on the results from the test, much higher speeds are noticed with the retrieval or records. Another major improvement with respect to time, is the complete avoidance of the recreation of files that are already existing.

The Patient e-Files system will be a beneficial addition to the medical field in Zambia. It will be beneficial not only to the medical personnel and the patients but also the medical facilities (both public and private) and the country at large. The functionalities being implemented will take the current solutions a step further and better the delivery of healthcare.

Future works will see the website being developed into a mobile application which will be able to run on mobile devices without the dependence of the Internet. The information stored locally on the app would later be pushed to the server as it is done with the local desktop nodes. The same will be implemented on the computer nodes where a local duplicated database will be stored for use in times of poor Internet connectivity and will be synchronized with the server.

One benefit that is not directly related to the tests carried out is that, the information from the centralized database can be used by the country to examine certain medical statistics such as prevalence of certain diseases, maternal mortality rates, child mortality rates, etc. Information that may prove vital to the country at large can be made available while still maintaining the confidentiality of patient information through anonymity of the samples used in the information. This information will be made easily accessible with future works which will make the generation of certain statistics easier.

Some of the challenges met during implementation were: (1) A steep learning curve from the traditional paper-based system to the Patient e-Files system, (2) The shortage of maintenance personnel in the case of any system failures, (3) The lack of a standard across facilities and therefore adjustment to the new format of the system is a challenge at facilities where their current system is considerably different from the OHRMS. At Makeni clinic the current system structure was not very different from the OHRMS and therefore, there was not much of a problem. However, the staff admitted not to be computer literate.

After the revelation of these challenges, some of the requirements for having the system launched were discovered. One of these is the training of personnel in the use of the system. This would also have to include computer literacy trainings. Apart from this, Documentation could be produced for future use, in order to allow users to refer to it. Some of the other requirements for the deployment of the system are the following: (1) Personal Computers to be procured for all medical facilities (at least two per facility) (2) a monthly charge for maintaining Internet connectivity.

References

[1] KPMG Africa limited (2012), The state of healthcare in Africa. KPMG Africa Limited, Cayman Islands.

[2] N. B. Sayles (2013), Health Information Management Technology: An Applied Approach, AHIMA Press, Chicago, USA.

[3] http://www.practicefusion.com/health-informatics-practical-guide/, December 28, 2015.

[4] https://www.techopedia.com/definition/8240/management-information-system-mis, 6th January 2016.

[5] https://healthit.ahrq.gov/key-topics/electronic-medical-record-systems, 11th January 2016.
[6] http://www.aafp.org/practice-management/health-it/product/features-functions.html, 11th January 2016.
[7] http://www.expatarrivals.com/zambia/healthcare-in-zambia, 13th january 2016.
[8] H.Gracia-Molina et al (2009), Database systems The Complete Book 2nd Edition, Prentice Hall, New Jersey, USA.
[9] http://www.saylor.org/site/textbooks/Business%20Information%20Systems.pdf, 14th January 2016.
[10] http://www.jhpiego.org/content/zambia-leads-way-smartcare-electronic-health-records-system-benefit-both-providers-and-patie, 1st January 2016.