Summary

An Electronic Health Record (EHR) is a technology widely accepted in developing countries. It is an outcome of collaboration between the fields of medicine and information technology. It has been found to improve adherence to guideline-based care, healthcare services, the efficiency of health professionals, and continuum of care that has helped in reducing the cost of care and chances of medical error.

The virtues of EHR make it a very lucrative option to be used in developing countries which are facing a shortage of qualified doctors and are looking for a solution to optimally utilize the health professionals currently available. This is especially true in countries like India, where a majority of the population resides in rural areas while the concentration of healthcare providers is in urban zones. Thus, an EHR system can be used as an effective tool to connect the dots and provide good quality healthcare services for human resource challenged populations.

However, challenges do exist in the adoption and implementation of EHR. While the medical fraternity is transitioning towards the use of computers and other high-end technologies in dispensing care, such adoption is a slow process, particularly in developing nations. Often, attitude and willingness of the individual healthcare practitioner in adopting these new technologies plays a critical role in the successful use of EHR in medical settings. In addition, the current technologies are not custom-designed to be used by people who are technological novices. All of these factors pose a threat to the successful implementation of EHR.

This paper has two main objectives: First, the report seeks to identify the key gaps between the user’s abilities and attitudes in using such technologies. Secondly, the paper also evaluates the technology in terms of comfort of use and suggests specific ways to make it more user-friendly for the healthcare professional. The underlying assumption is that users will not accept technology when they do not see any value in it and therefore recommendations are made to improve the EHR to aide the health professional in their day-to-day activities for better acceptance, and subsequently for improvement of healthcare services delivered.

Introduction

Hospitals, laboratories and other related partners in the healthcare delivery system in the developed world have identified the importance of using an electronic health record system within their organizations. The benefit of using a computer-based system is being recognized in developing countries like India, Cameroon, and Kenya. Many of the players in the healthcare
delivery market are keen to use such a technology in under-served, low-resource rural areas. Using these technologies would affect the continuum of care and adherence to guideline-based care thus affecting the overall health of the rural population in a positive way.

Introduction of such technology would also have an impact on the work routines of healthcare professionals and its successful implementation would largely depend on the capabilities and characteristics of these professionals. This paper reports the various parameters needed to be taken into account for successful implementation of the technology. The study has been conducted in a Rural Micro Health Centre (RMHC) located in Alakkudi in Tanjore district of Tamil Nadu, and is run by SughaVazhvu, a not-for-profit organization.

CHAPTER II contains the current literature reviewed in the field. It covers various definitions of an EHR system, the importance of EHRs, implementation of EHRs in the past in various developing countries, and methodologies to conduct a usability study for such technology.

CHAPTER III frames the problems that are addressed in this report.

CHAPTER IV contains the analysis and results obtained thereafter.

CHAPTER V concludes the work carried out in investigating the problems identified and summarizes the future application of this work.

Literature Survey

An Electronic Health Record (EHR) system is described as a digital collection of patient information or a computer-managed health information system (HIMSS, ISO definition). Data is recorded in one or more meetings with the patient. The type of information an EHR system contains may vary, but most papers emphasize systems information such as the patient's medical history, demographics, laboratory reports, diagnosis, medication, allergies, etc. (Hayrinan, et al, 2008). Additionally, an EHR system may support billing information (Schmitt & Wofford, 2002) and doctor’s appointments. They have also been cited to incorporate alerts, reminders and other features that help monitor the quality of healthcare (Kukafka & Ancker, 2007; Bostrom & Schafer, 2006). An EHR system may also include a pool of information provided by doctors regarding lifestyle modification required of the patient (e.g. diet, exercise etc.) during the process of treatment (Grimson, 2001; Thiru & Hassey, 2003).

These computer-based records have been found to facilitate the monitoring of patients’ health and to reduce the cost of illness, increase efficiency as well as decrease the chance of medical errors (Electronic Patients record, Sixth Report of Session 2006-2007, House of Commons Health Committee). Moreover, by storing historical data related to medical events, overall continuum of care is also ensured. Studies report that EHR systems have improved the quality of care because of increased adherence to guideline-based care, enhanced monitoring and surveillance of the patients’ conditions (Wager, et al., 2009). An EHR system may also enhance the quality of care by improving and analyzing aggregate clinical information that is accessible to the clinician, thus helping him or her to take better-informed decisions (Carter, 2008). Alerts and reminders can prompt health professionals to conduct needed medical interventions each time a patient walks in. Thus it plays an important role in promoting preventive care (Wager et. al, 2009).

EHR systems have traditionally been used in institutions such as hospitals and laboratories in developed countries. More recently, this technology has been adopted by similar institutions in the developing world. However, several studies have pointed out the importance of studying EHR systems specifically within the public health context in developing countries. For example, (Kamadjeu et. al 2005) refer to the implementation of EHR systems in primary healthcare practices in Cameroon and how this brought about improvements in medical practices and the continuum of care. (Peters et. al 2006) studied the impact of EHRs on patient care in primary healthcare in India and concluded that an EHR system has the potential to improve quality of healthcare and increase the percentage of population under care. However, both the studies have also raised concerns about the willingness of health professionals in accepting such computer based systems.

The value addition that an EHR system offers healthcare services depends upon the technology being appropriate for use within each developing nation and the corresponding public health system. The public health system today in a developing country such as India is below international standards. Primary healthcare centres lack decent facilities and even the equipment
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for performing simple laboratory tests (Bulletin on Rural Health Statistics in India, 2005). The country lacks trained doctors and other healthcare professions to adequately serve the entire population. Healthcare services are inferior in rural areas, where the majority of the population resides, because of reluctance of doctors to travel to, practice in and live in these remote areas (Kumar, 2007). These populations rely mostly on untrained or unqualified providers (Peters et al, 2006). For such populations, an EHR system may serve many critical uses, one of which is the ability for health professionals to better pre-screen and diagnose incoming patients. The initial screening of the patients on the basis of the symptoms may be handled by nursing staff with the aid of an EHR system. An EHR system would assist the nursing staff in maintaining, in a protected and confidential manner, the medical history of all patients, in suggesting tests to perform, and to evaluate possible causes based on the symptoms displayed or the description given by the patient (Peters et al, 2006).

The introduction of an EHR system in a public health system may also lead to a change in work routines and requirements from the health professionals in ensuring its implementation (Fleuren et al, 2004; Francke et al, 2008). Health professionals must be comfortable working with computers. Studies have pointed towards the unwillingness of health professionals to accept computerization of their work (Dahm & Wadensten, 2008; Smith & Smith, 2005; Timmons, 2003). Thus, it becomes critical that new technologies such as an EHR system put health professionals in an advantageous position by improving their output and decreasing the workload. Otherwise the acceptability of such technologies becomes unlikely (Anke & Anneke, 2010). Improved usability would lead to better data entry, less medical errors and increased productivity. Importance has been given to usability assessments for computer-based interfaces and therefore institutions should monitor the usability of an EHR system carefully.

The aim of this paper is to explore the determinants of motivation of nursing staff towards using an EHR system and to test the usability of an EHR system in a rural primary healthcare clinic in a developing country. The paper also discusses the problems faced in the implementation of an EHR system in a setup where health professionals have had little prior experience with computer usage. Understanding these determinants and the opinions of nursing staff on EHR systems is important for the further implementation of an EHR system in rural primary care clinics.

The Challenges

This paper reports the usability evaluation and improvement process utilized during the implementation of an EHR system in a Rural Micro Health Clinic (RMHC) in rural Tamil Nadu, a southern state in India. The clinic is built and managed by Sughavazhvu Health Care Limited (SGV), a non-profit organization, and provides primary care to residents of Alakuddi, a village in the Thanjavur district of Tamil Nadu. The healthcare delivery model is designed by IKP Trust, Center for Technologies in Public Health (ICTPH), a not-for-profit research organization, working to improve the health of poor populations by focusing on designing, developing and delivering innovative solutions in healthcare concerning India and the developing world.

As per the model, all the residents of the village have been enrolled as a member and each household has been given an identity card with a unique ID. Health information of each member has been saved in the EHR system. Each member’s health information can be accessed by searching the EHR by member’s ID or by name. The clinic is managed by two nurses, who are primarily the users of the EHR, under supervision of a doctor. For every walk-in visit to the RMHC, the nurses enter the details of the encounter in the EHR system. The clinic employs six nurses and a pair of them manages the clinic on a fixed working schedule every week. The clinic receives traffic of an average 40 patients a day from the nearby villages.

This particular EHR is being developed with the help of a partner organization, Swasth India. It is a web-based EHR designed in consultation with various doctors. The EHR system is constantly evolving on the basis of users’ feedback, including patient information as well as the suggestions made by healthcare professionals, researchers and operations staff actively using the system. It should be noted that the reporting in this paper includes the development of this EHR system up to August 2010, when this project was concluded. More recent developments of this EHR system are actively underway and can be accessed by contacting the organization directly.

One of the ways an EHR ensures that quality healthcare service is being provided by the nursing staff is that it enforces the SOAP method of consultation to the nurses. SOAP Consultation is a process that allows care providers to enter clinical consultations for patients based on a standard structure using Subjective, Objective, Assessment, and Planning (SOAP) information. Pre-defined categories of consultation help care providers in gathering complete information from the patient. Diagnosis assessments can be entered during a SOAP consultation, which can also trigger a list of relevant outcomes for easy selection (Bickley & Szilagyi, 2009).
During the first few months of EHR implementation, it was found that the consultation data for very few patients visiting the clinic had been entered. The quality of data needed improvement. Many of the fields in the EHR had been left blank or incorrect data had been erroneously entered. The implementation team decided to conduct a usability study of the EHR in order to understand the underlying problem and identify appropriate solutions.

The aim of the usability study was to explore the nursing staff’s capabilities, motivation and barriers towards using the EHR systems and to test the EHR largely on ease of use. The expected outcomes of the study were two-fold:

1. Identify usability problems and suggest ways to improve user-friendliness of the system.
2. Suggest ways to address usability problems through training.

Methodology

The purpose of the study was to identify usability problems, and so heuristic evaluation and formative evaluation methodology were considered. Heuristic evaluation is an inspection method. It is performed by a usability expert, someone who knows and understands the heuristics and has used and encountered a variety of interfaces (Nielsen & Mack, 1994). Unfortunately, it was not feasible to get an expert to conduct the usability study and so this method was discarded.

However, in a formative evaluation, the nursing staff or any other available staff may serve as the user and this method was thus adopted for ease of use and accessibility of nursing staff. In a formative evaluation, the user’s primary role is to perform a task using the EHR system. The user is asked to think aloud in verbalizing what she is thinking as she uses the EHR. Thinking aloud gives the evaluator a window into the user’s thought processes, so that the evaluator can clearly understand what the user is trying to do and the challenges she is encountering (Gomoll et. al. 1990). The results of formative evaluation are largely qualitative observations, usually a list of usability problems. This kind of user test is usually done in an environment that is under the evaluator’s control and therefore may lead to results that are not accurately representative of real world contexts. In an attempt to avoid this problem, the formative evaluation was done on the field.

Participants

The study was conducted on the EHR system with participation and contribution of each of the six SughaVazhvu nurses. Before starting the test, the nurses were briefed on the purpose of the application and the purpose of the test. It was made clear to the staff that the test was being conducted for the purpose of trouble-shooting the computer system and not for the purpose of testing them individually. The nurses were further informed that they would play a crucial role in helping the evaluators identify the EHR usability problems. In order to increase the users’ comfort level during the test, they were also assured that the results will be completely confidential and only generally reported upon for the purpose of improving the EHR system.

The usability study was done in three parts with the first two parts done as preparation for the formative evaluation and the third and final part being the actual formative evaluation:

1. An observation of the users meant to facilitate the understanding of:
   • The current situation and workflow
   • Users’ capabilities
2. Individual interaction with nurses to understand:
   • User’s motivation
3. Formative Evaluation of the EHR system.

Current Situation and Workflow

Notes were made on the current situation and workflow by observing the RMHC in action on a typical day, examining current records, and talking to and interviewing the doctors and nurses maintaining the clinic. Specific points recorded were:
1. What is the average number of patients visiting the RMHC every day?

2. Is there a specific time when the RMHC traffic is at its peak? If so, what is the peak visit rate (patients/hour or average patient time)?

3. What is the current patient process?
   - Who meets the patient?
   - When does registration take place?
   - When is data entered into the IT system?

4. How long does it take to service the patient – specifically patient registration, EHR entry (if applicable), doctor/nurse consultation, dispensing of medications and billing? What is the ordering of each of these steps, and who does each of the actions above?

5. Are there case sheets being maintained per patient? What information is captured in the case sheet?

6. How is the drug inventory managed, on paper or on computers? What information is recorded there?

**User’s Capability**

Usability often gets hampered because the proposed users are not adequately trained or skilled. Since this was an early stage of implementation, it was imperative that nurses learn to successfully use and give feedback on the EHR system.

These were the skills that were assessed in order to understand user’s capability:

1. Do users understand the diagnostic tests and medical terminology meant to be recorded in the EHR?

2. Are users comfortable with computers?
   - Can they shut down and restart the machines?
   - Can they connect to the internet and actively use it?
   - How comfortable are they with typing? How fast can they type?
   - Are they comfortable with a tablet PC? Can they use a tablet as a notebook and write on it?

3. Are users comfortable with the English language? How is their spelling?

4. Are users comfortable with the EHR visit workflow? Have they been trained in the SOAP method of consultation?

This set of observations may highlight the need for adequate training program for the doctors and nurses.

**Individual Interaction with Nurses to Understand User’s Motivation**

The following questions were asked to nursing staff, prompting for honest answers:

1. Do they know why they are being asked to enter the data in EHR?

2. Do they see a value in using the EHR? What value do they see?

3. Is too much data being captured? Do they think all is required to be captured?

4. What part of the process they do is especially difficult manually right now (maybe creating clinic visit, cash collection or drug sales reports) that they think can be done in EHR?
5. What are the 3 biggest barriers/cumbersome parts of the manual process right now?

6. Is there any accountability on them in entering the data in EHR?

After the following exercise, the users were prepared for the formative evaluation of the EHR. Nursing staff were trained on the various concepts, features and workflow options in the EHR. The nursing staff were given a demo on the EHR specifically mentioning the features that work and the ones which do not. After the training, the nurses were paired up and asked to use the EHR on their own, to apply the information given in the training, during real consultation at the RMHC.

The nurses were asked to do the following exercise:

- Each nurse was given 3 different cases to enter the details of encounter in EHR:
  1. Patient with membership and with ID card
  2. Patient with membership and without ID card
  3. Patient not in IT system

For each visit, the user was asked to talk aloud while she was using the system. She was instructed to speak out aloud what she was trying to do for every activity (e.g. are they looking for a specific button, or fill in this text field). If they discontinued doing so in some part of the exercise, questions were asked to prompt them into speaking using the following cue questions:

1. What are they conceptually trying to do in the IT system? Do they know that they have to look up the member and then add a visit?

2. What micro steps (e.g. search for the member by ID, identify the family member, add visit) do they have to do in EHR for the given cases?

All of the information collected through this exercise, like actions that take a long time to do, text which is hard to enter, common errors in data entry, and spelling mistakes that were being made, was revisited to understand if there is a need to redesign the RMHC processes, conduct specific trainings for the RMHC staff or change the EHR to be of more use at the RMHC.

Analysis and Results

The behavior of users, including interactions between users, patients and system, was noted. Feedback from users was recorded on a permanent basis by the observer. To assess users’ perception, formal interviews were conducted using a standard interview protocol. Areas of investigation included workflow in the clinic, user’s capability and motivation.

Workflow

The RMHC operates from 9:30 AM to 5:30 PM everyday and remains closed on Sundays. The patients include members, i.e. the residents of the same village as well as non-members, and patients from nearby villages. The RMHC witnesses peak traffic in the first hour of each day. One of the reasons for large patient inflow in the early hours may be the work routine of villagers. The villagers normally left for work early in the morning and stopped by at the clinic for their health problems. The average number of patients visiting the clinic is around 40 a day. The distribution is uneven throughout the week. On Mondays, the RMHC encounters around 60 patients and the number gradually decreases to around 30 on Saturdays.

The nursing staff were to use the outpatient piece on the EHR, which enforced the SOAP method of consultation and recorded the visit details of each patient. It was observed that visit details were not directly entered into the EHR. Instead, nursing staff entered the details into a notebook, may be because they were more comfortable writing in a notebook, and later on copied the data on to the EHR. Other possible reasons which inhibited nurses from entering data directly into the EHR were (a) a patchy internet connection: it took long for some web pages to open or get submitted thus increasing patient’s
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waiting time; and (b) there were a few bugs in the EHR that led to error messages during the entry process. So the nurses used notebooks to write down patient visit details. The notebook had following table:

It took around 3-4 minutes for the consultation process which included patient details being entered into the notebook, conducting physical examination and dispensing the medication. It was noticed that in the whole process, the EHR was not being used as an assisting tool rather just a data repository. Nurses took on an average 5-6 minutes to copy each patient’s visit details into the EHR.

Other than the notebook, nurses used a Microsoft Excel workbook to maintain the drug inventory and updated it at the end of the day every day.

User’s Capability

The usability of the EHR was also getting hampered because nursing staff were not adequately skilled. The EHR was web based and was used on a computer. It was observed that the nurses were equipped to switch on or restart the computer; however they did not know the way to connect to the internet or troubleshoot any technical problems in the system. Since the nurses had no prior experience of working on computers, their typing speed was very slow and that resulted in more time in data entry. Tablet PCs were also used as an experiment to observe their comfort level. It was found that using a tablet PC made their task easier and them much more efficient.

While nurses were using the EHR to enter details of patient visits, it was observed that they were not following the SOAP method of consultation and were entering wrong or no data under different tabs. Nurses also used different non-standard acronyms in order to save time in data entry. They were also not confident about the meaning of different medical terms used in the EHR.

The user’s capability study suggested that the nursing staff need training on computer skills and the SOAP method of consultation. They also need to be trained on various medical terms used in EHR.

User’s Motivation

The user’s motivation analysis was done by interviewing the nurses, with questions that would evaluate the perceived usefulness of the EHR. Most of the nurses perceived EHR as a repository of data and found it to be useful in referring to a patient’s illness history. However none of the nurses related it to improving the quality of healthcare or as a tool to aid them in diagnosis.

Some of the nurses rather found EHR to be troublesome and as a barrier in their daily workflow. They also opined that working on a computer while talking to the patient would give a negative impression to patients that they were not attentive enough to them. However they did feel that it is important to maintain a record on an EHR and that is why they were entering the data after they complete each patient’s consultation.

Formative Evaluation

The nurses were prepared prior to the formative evaluation. They were trained to improve their skills in using computers. They were given detailed demonstrations on different functionalities of the EHR. There was a talk arranged to counsel them on the importance of the EHR with demonstrations by case studies on how would it improve their diagnosis. The
training was done via a power point presentation followed by a demo on the working of the EHR and concluded by a case study.

After the training, nurses were made to use EHR in the clinic while performing real-time consultation. Nurses were instructed to think aloud so as to give the observer a window into their thought process in order to understand which page they were on and where they wished to navigate to and the difficulties faced by them.

It was found that the nurses had difficulty searching for a patient’s name in the database. This may be due to the fact that the village had many members with similar names and also the spellings of the names were not standardized. Nurses also had problems in adding a new member to the database and the user interface to add a new member needed to be improved.

One of the major barriers to the comfortable use of an EHR was that the nurses did not understand all the medical terms used in the EHR system. That delayed the consultation process and also confused them as to what to do next. Nurses need to be trained on the terminologies used in the EHR by a doctor in a way that they could associate it with the local terminologies thus improving their knowledge and use of EHR.

Nurses were very comfortable clicking on radio buttons meant for selection of various symptoms and physical examination results but they had difficulty entering free text. This may be because they were not comfortable typing and also used various acronyms which were not standard. Slow typing speed reduced their efficiency thereby increasing the waiting time for the patients making them restless. Hence, the nurses preferred to ignore the free text part in the EHR, leading to scarce data.

It was also found that the EHR demanded them to enter a lot of data, which many times they found unnecessary. This inhibited nurses from using the EHR and used the conventional pen and paper instead. This problem could be resolved by designing an EHR as a decision support system where the data entered by the nurses at the initial stage of consultation would help them narrow down on the options in later stages and would finally shortlist the differential diagnosis. A lot of time would thus be saved in finding, entering and analyzing unnecessary data.

Overall, it was found that working on an EHR was uncomfortable for them and it distracted them from giving due attention to their patients.

However, the study for the evaluation of the usability and implementation of an EHR was conducted with a very small sample space of nurses. The results are based on the characteristics of six nurses working for SughaVazhvu Health Ltd. which is too small a number to judge the parameters of a nurse’s characteristics in effective implementation of EHR in a rural setting. Also, the nurses’ capabilities and characteristics were observed for less than a week because of time constraints and this may not be conclusive enough either to suggest strong recommendations.

Conclusions and Scope for Future Work

Conclusions

The successful implementation of an EHR in a rural setting will require a comprehensive modeling of the local medical practice, the choice of an appropriate terminology and a coordinated approach involving all stakeholders. The EHR needs to be designed to suit the nurses’ capabilities and so the use of appropriate terminology and adaptation of local medical practices into the design becomes necessary. The nurses in rural areas are not well acquainted with using computers and so it is necessary to provide them with basic computer training. It is also important to convey the value of an EHR in order to make them realize its importance. The nurses would also see value in an EHR when it helps them in their daily chores, reduces time taken and increases their efficiency and knowledge. Strengthening the EHR could contribute to its position as a valuable source for healthcare delivery in an RMHC. It is extremely important to develop EHR as a medical aide as well as information tool for nurses. The EHR should aid them in making better diagnosis and also help them learn about various other conditions and diseases.

Thus, the successful implementation of EHR in a rural health center would require nurses to put in effort to improve their skills and be motivated enough to use new technology for care delivery. At the same time, the implementers would need to design the EHR taking into account the shortcomings in the users’ capabilities and incentivizing them by adding features that would help the nurses to improve their knowledge.
Scope for future work

The study recommends the following as future work:

- Developing EHR as a tool to aid nurses to make better diagnosis: Clinical Decision Support System (CDSS). It is essential to overcome the difficulty of entering a lot of data and later analyzing them. This would also ensure that the nurses are asking the right questions and delivering a standardized care.

- EHR to provide knowledge to the nurses, to improve acceptance of the new technology. The nurses need to be able to see value in using an EHR and that would be possible if it provides them information about various medical terminologies and practices. For e.g., an EHR can be a source of information containing details of conducting a physical examination. The EHR can act as a tutorial giving information about methods and correct patient postures via texts, photos, audios and videos for conducting the examination and also analysis of the findings thus obtained.

- Developing EHR as a medical reference system is also necessary as the nurses can refer to various papers or past cases in the history related to particular conditions, symptoms and diseases and thus can take a better decision.

The above mentioned work would help the implementer in addressing motivation issues and result in effective implementation of the EHR.

References


