IMPLEMENTING AN ELECTRONIC HEALTH RECORD AS AN OBJECTIVE MEASURE OF CARE PROVIDER ACCOUNTABILITY FOR A RESOURCE-POOR RURAL AREA IN THE DOMINICAN REPUBLIC

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Abstract

Open source medical record software provides a low-cost way of implementing electronic health record (EHR) systems in resource-poor areas. This facilitates provision of longitudinal care of a patient population and offers an objective means for evaluating a short term medical trip’s impact. The goal for this project was to assess the feasibility of implementing the Open Medical Record System (OpenMRS)—an open source EHR developed by Partners in Health (PIH) and the Regenstrief Institute—by medical students at various resource-poor rural sites on the outskirts of Jarabacoa, Dominican Republic. An EHR based on an OpenMRS platform was developed for use in the primary care setting of a short term international medical trip (STIMT). Medical and nursing students were trained to use the system in a site-specific simulated environment with Spanish-speaking standardized patients at the Clinical Skills and Simulation Center of UCF College of Medicine. The EHR system, utilizing a laptop, battery pack, router, and school-issued iPads, was transported and deployed in rural communities near Jarabacoa in the Dominican Republic. The data of 125 patients was recorded using the EHR system. Patient demographics, medical history, physical exam, and the physician’s assessment and plan were entered into the EHR. Patient data is stored presently on a Dell Latitude E6410. The patient records are accessible via this host laptop and may be exported to other clients via a Microsoft Excel file. Preclinical medical students and nursing students successfully deployed a highly-portable EHR system for three different resource-poor communities across the Greater Jarabacoa area. Future uses of the proven mobile EHR system include: an objective means for evaluating interventions, assessing healthcare needs, and providing continuity of patient care. Data obtained from this trip will be used to generate new patient scenarios for pre-trip simulation training and determine the appropriate medications and supplies for the subsequent trip.

1 Introduction

Significant strides have been made in improving health care to resource-poor and rural areas using electronic health record technology. An electronic health record (EHR) can not only substantially improve care and clinical outcomes for a resource-poor region [1-7], but it can also provide a medical school’s faculty and administration an objective means of assessing the impact of their school’s short term medical activities through sustained patient tracking. There is significant debate in the literature regarding the cost-benefit and efficiency of EHR implementation in various practice settings across the United States [8-13]. Traditionally, medical record keeping in the setting of STIMTs has been sparse. In 2005, Operation Smile International was the first international organization to implement EHR to evaluate outcomes for quality assurance purposes and patient tracking [14]. The utilization of EHR technology is steadily growing in the US and according to a recent survey its use in clinical practices has surpassed 50% [15].

E-Health is defined as: “the application of Internet and other related technologies in the healthcare industry to improve the access, efficiency, effectiveness, and quality of clinical and business processes utilized by healthcare organizations, practitioners, patients, and consumers in an effort to improve the health status of patients” [16]. According to a 2010 eHealth WHO Report based on self-reporting by a selected group of eHealth expert informants from the Dominican Republic, the Dominican Republic’s government has promulgated legislation related to the legal and ethical frameworks for eHealth, such as sharing health-related data using EHR. However, the report also indicates that there is still no adoption of a national eHealth policy. Furthermore, when asked about the barriers that exist to implementing mobile health initiatives (mHealth)—using mobile phones and PDAs for health services and information [17]—the survey respondents answered that they were due to competing priorities, lack of knowledge of applications, lack of demand, and perceived costs being too high [18]. In the past, startup costs for such systems were relatively expensive whereas the recent advent of free and open source software (FOSS) EHRs has greatly reduced spending by removing software-related expenses. Certainly, potential tradeoffs for using FOSS versus a private vendor include a prepackaged functioning system and dedicated software support.

One customizable program in particular, OpenMRS—a FOSS EHR based on Wiki technology that was developed in 2004 by the Regenstrief Institute of Indiana University in collaboration with Partners in Health—has garnered international attention for its deployment in many resource-poor areas across the world [19, 20]. OpenMRS is a
customizable medical record system and offers multiple features as described on the website [21].

OpenMRS modules are programs that allow the implementer to modify or add-on to the original system to meet specific project needs [22]. For example, using the XForms module allows clients to design an entry form unique to the specific clinic setting. Patient data can be exported into a spreadsheet format for analysis or be compiled into a report using report-building modules. Data import is controlled by the HL7 engine. HL7 is a not-for-profit organization formed in 1987 dedicated to the development of international standards for healthcare informatics interoperability [23]. Patient workflows allow implementers to longitudinally track patients after their placement in certain programs (studies, treatment programs, etc.). Cohort manager permits users to group patients for export, reporting, etc. Localization/Internationalization refers to the capability of using OpenMRS in multiple languages that are supported by UTF-8; this will be advantageous when the system is using OpenMRS in multiple languages that are supported by UTF-8. Recent studies have shown that this approach can improve the quality of care provided to patients [24-26].

Localization/Internationalization refers to the capability of using OpenMRS in multiple languages that are supported by UTF-8; this will be advantageous when the system is eventually transferred to a local team as Spanish is the national language of the Dominican Republic. Medical images, sound files, and other complex data can be stored using OpenMRS which offers opportunities for telemedicine.

Despite OpenMRS generally being deployed as a vertical program—specifically targeting one disease such TB, malaria, and HIV—it also has potential application as a horizontal program (primary care) [24-26]. The article, “The OpenMRS Implementers Network,” recounts the history of the OpenMRS project and highlights its implementation in three sub-Saharan African countries (Rwanda, Kenya, South Africa) for treating HIV/AIDS and tuberculosis [27]. OpenMRS has also been successfully deployed in Kenya, Tanzania, and Uganda for HIV/AIDS treatment monitoring [28]. Recently, Zanmi Lasante, PIH’s sister organization, opened its first HIV program in Elias Piñas, a site in the Dominican Republic located along the Haitian border [29, 30].

Documentation of patient demographics, nutritional status, and medical conditions provides a resource for development of future trips. Such information could be used to gauge a trip’s impact on the targeted patient population. Since current research standards require documentation to be recorded into a secure database for utility and patient confidentiality, it is intuitive to minimize workload by directly recording patient encounters electronically. The restricted portability of paper-documentation provides barriers to long-term patient tracking and hinders the possibility for integrating data across multiple trips and creating longitudinal studies.

First and second year medical students comprise a significant portion of the students attending the mission trips. The use of an electronic medical record system on a STIMT is often a student’s first exposure to patient evaluation and electronic documentation. The educational value as well as students’ positive experiences are an important factor supporting a school’s decision of continued involvement. A system for patient documentation in a readily reviewable and transferable format can be utilized to determine the trip’s immediate and longitudinal impact, for the communities served and for the medical students.

Accumulation of patient data can create opportunities for longitudinal studies and foster future curricular development based on the cases students observe. Continual patient tracking may improve efficiency by eliminating repetitive history taking and allow for more personal care. Students can reference previous trip data to prepare for the most common patient presentations and pack medications and supplies more pertinent to the needs of the rural Jarabacoa population. The main objective of this project is the deployment of the OpenMRS in a resource-poor site in the Dominican Republic. This system would be accessible by multiple physician and student teams servicing the area at different times of the year for continuity of patient care, establishing a database to assess future healthcare needs, and evaluating interventions. In the present study, we introduce the first execution of an EHR in a collaborative STIMT between University of Central Florida and University of South Florida College of Medicine.

2 Methods

This project was separated into three phases: the first was program development and testing through simulation at the University of Central Florida College of Medicine (UCF COM); the second was implementation of the site-specific system during a UCF-University of South Florida (USF) COM STIMT to the Dominican Republic in December 2011; and the third was data extraction in order to analyze patient information and provide the results to the USF team.

2.1 Institutional Approval

The project was put forth to UCF’s Human Research Protection Program, which concluded that the project does not meet the federal definition of human subjects research; the requirement for institutional approval of the research activities conducted abroad was waived.

2.2 EHR Customization

At UCF one of the principal goals was investigation of the OpenMRS application and its associated modules so that it could be adapted to meet the primary care needs of the Greater Jarabacoa area. A paper intake form from a 2010 UCF-USF collaborative STIMT to the Dominican Republic was used as the template for the electronic health record form. Data collection for OpenMRS using the Apple iPad was also explored [31, 32]. All current UCF COM students are provided these devices.

The OpenMRS 1.82 Enterprise WAR package and its required supplementary applications were downloaded from the OpenMRS download page and installed on the UCF COM-issued Dell Latitude E6410 [33]. Next, an initial intake form, including patient demographics and vital measurements, was created using the ‘Patient Xform Design’ function. A complete medical intake form based on the previous year’s paper-based patient intake form, which included a full history and physical exam as well as assessment and plan was created.
2.3 Mobile EHR System Production

A mobile data intranet was constructed using the following components: a Dell Latitude E6410—the laptop issued to all UCF class of 2014 medical students—as a central server for the OpenMRS program; a Netgear N600 WNDR3400 wireless dual band router to provide secure wireless access to the central server; first and second generation UCF COM-issued iPads to interface with the central server for data entry at the Dominican Republic site location; and a Duracell Powerpack 600 to power the system when electricity was not available. The server and battery pack were purchased using FIRE project funding.

2.4 Development and User Training

Prior to the STIMT, 13 trip participants composed of nursing and medical students tested the use of the UCF COM-issued Dell Latitude laptop for data entry Clinical Skills and Simulation Center (CSSC) of UCF COM. Since the system was not yet functional a trial template similar to the one that would be employed in OpenMRS was generated using Microsoft Infopath. Participants were given 30 minutes to obtain, and simultaneously, record a patient history with Spanish-speaking standardized patients whose pay was funded using FIRE budget allocations (Figure 1). A generalized patient scenario was generated from the previous year’s patient records. A track consisting of sounds pertaining to the site location (e.g., passing motor vehicles, livestock, popular local music, and idle chat in Spanish) was played to further simulate the work environment. Faculty and students with native-level Spanish proficiency monitored the session in order to provide the participant with feedback (Figure 1). A feedback session was held after the event to gain insight into improving functionality of the electronic form for the user. Users from USF COM were trained on site.

![Figure 1: Left: A native Spanish-speaking medical student observes the site-Specific simulation training exercise of another student. Right: A medical student participates in the site-specific simulation training exercise with a Spanish-speaking standardized patient.](image)

2.5 Mobile EHR Deployment

A total of 34 medical volunteers participated in the UCF/USF COM short term medical trip from December 18-22, 2011. The group was equally divided in two teams: one utilized the electronic health record and the other utilized paper-based records. This STIMT was 3 days and covered a total of 5 site locations among the electronic health record and paper-based record teams. On day 1 both teams were based at a monastery where the group was lodging. For the final 2 days the electronic health record team relocated to Los Higos and La Chinola, whereas the paper-based documentation team was sent to Los Dajaos and San José. The OpenMRS system was used to record the demographics, history, physical exam, assessment, and plan of 125 patients (first day: 24, second day: 45, and third day: 56).

2.6 Data Extraction and Preliminary Analysis

Data was shared with the USF COM team through a Microsoft Excel file using the Data Export Management function of OpenMRS. Microsoft Excel was then utilized for basic data analysis to show potential applications for future STIMTs to the Dominican Republic (Figure 2).

3 Results

The assembly of the mobile EHR system required approximately 30 minutes at each site. Notably, students without previous experience were able to operate the EHR system with less than one hour of training. After competency was achieved with program use, it required an estimated 10 extra minutes to input patient data as compared to a paper record system. Students worked in teams of two and were paired based upon level of medical training and Spanish proficiency. Once patients were evaluated, he or she was sent to the pharmacy station where medications were dispensed utilizing the prescription information previously recorded electronically which ensured accurate dispensing of patient medications. Patient records are currently maintained on a Dell Latitude E6410. Patient data is accessible via the host laptop and may be exported via a Microsoft Excel file. The patient information is primarily text-based and not in a coded format. The categories of data obtained include the following: internal database ID, given name, family name, gender, age, birth date, date and time of encounter, address, history of chief complaint, past medical history, past surgical history, menstrual history, obstetrics history, medications, allergies, review of systems, height, weight, pulse, respiratory rate, systolic and diastolic blood pressure, physical exam, assessment and plan, attending physician, medical student, pharmacy checkpoint, and educational station checkpoint.
Figure 2: The graphs above display basic applications for the data collected from the DR collaborative STIMT using OpenMRS. The frequencies of general patient population descriptors, such as adult blood pressure and gender were extracted.

4 Discussion

An interdisciplinary healthcare team consisting of medical and nursing students recorded the demographics, history, physical exam, assessment, and plan of 125 Dominican patients into a central OpenMRS database using Apple iPads. The accomplishment of this project demonstrates the feasibility of implementing an electronic health record system to record patient data during STIMTs, even in groups of providers and students with limited training. Despite the success of the OpenMRS EHR implementation, many factors can be altered to improve future projects.

Data migration is one aspect to be addressed to improve the impact of subsequent STIMTs. Ideally, a permanent data server should be established at a secure location with reliable electricity and connectivity. In addition, the permanent server should allow for remote access via an internet connection for downloading and uploading patient data to portable data systems similar to the one used for this project (Figure 3). The proposed information system would offer the advantages of a central location where patients could travel for more advanced care while still maintaining the ability to send medical teams to resource poor rural locations for health screening.

Figure 3: A data migration model that displays the interconnectivity between a central server and mobile EHR systems, which consist of multiple tablet computers with keyboards, laptop, router, and battery pack. a,b,c

Another area for improvement involves better coordination with local government, non-governmental organizations, and academic entities. One focus of this partnership is collaborating to determine the relevant diseases that can be adequately treated by the Dominican healthcare system and/or intermittent short term medical trip teams; a public health team could also be consulted for this matter. The collaboration model displayed by Partner’s In Health and other successful international healthcare organizations has shown that it is important to build rapport with local governmental and academic groups. Having access to a group familiar with and willing to share information regarding the local culture (i.e. customs, medical practices, folk remedies, etc.), demographics, and politics is essential for a productive project outcome [34-42].

The OpenMRS system offers many opportunities for medical education. Data obtained from this trip will be used to generate new patient scenarios for pre-trip simulation training and determine the appropriate medications and supplies for the subsequent trip. The simulation component provides an environment to practice patient documentation with an EHR as well as clinical skills in a non-English language and distinct cultural context.

The data collected from this project will also allow the efficiency of the medical record system to be enhanced by creating input coded for the more frequently encountered illnesses. Another option for optimizing workflow includes purchasing keyboard cases for the iPads instead of students using the touch-screen feature. Furthermore, a comparative study of the paper-based medical record and the mobile EHR system should be created to provide an objective assessment of the advantages and disadvantages of each. Given the results of this project, it is believed that continued diffusion of EHR use for STIMTs in resource-poor rural settings will provide an objective metric to significantly impact the healthcare disparities in such areas.

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References


