

Electronic Medical Records: A Review Comparing the Challenges in Developed and Developing Countries

Sanjay P. Sood

C-DAC School of Advance Computing, Quatre Bornes, Mauritius, sood@spsood.com

Stacie N. Nwabueze

Southern University, Baton Rouge Louisiana, stacienwabs@aol.com

Victor W.A. Mbarika

Southern University Baton Rouge, Louisiana, victor@mbarika.com

Nupur Prakash

GGs Indraprastha University, Delhi, India, nupurprakash@rediffmail.com

Samir Chatterjee

Claremont Graduate University, California samir.chatterjee@cgu.edu

Pradeep Ray

University of New South Wales, Sydney Australia p.ray@unsw.edu.au

Saroj Mishra

SGPG Institute of Medical Sciences, Lucknow, India, skmishra_1956@yahoo.com

Abstract¹

Studies on the adaptation of Electronic Medical and Personal Health Records in developing countries are scarce. There are sharp differences between barriers to adaptation and implementation in developing countries to that of developed countries. This paper examines the challenges faced by developing countries toward the development, progression and sustainability of Electronic Medical Records. The paper also provides a review of implementation of varying types of electronic medical data management systems in developing countries.

1. Introduction

Information technology and its application to healthcare is a major global issue that has triggered a marked amount of research.

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Implications of information technology for healthcare reform command much speculation [47].

Though health information technology promises benefits to healthcare, many problems exist. Despite years of research in the area of information technology, the progression in adaptation remains low.

This paper will examine varying degrees of adoption of one particular unit of information technology in healthcare, the Electronic Medical Record. The paper will first look at development and the progression of the Electronic Medical Record in Developed countries, identifying elements that allow for interest and continuous development, focusing on the emergence of the Personal Health Record and its potential benefits for healthcare. We will then look at the challenges faced in developing countries that hinders the development and progression of the Electronic Medical Record, and conclude with a look at systems in developing countries attempting to facilitate electronic management of patient information.

This paper aims to highlight the benefits of EMR and issues that may arise, and suggest various ways by which developing countries can benefit from adopting EMR systems. Further, a

global comparison of EMR issues between the developing economies and that of the United States (a developed economy), is made. The paper concludes with a summary of findings and future thoughts.

2. Current Developments

In past years we have witness rapid technological developments in services such as internet and cellular technologies, which have led to the emergence of new ways of managing information [29]. Specifically for healthcare, the need for portability and instant communication has transformed the use of the Electronic Medical Record. The EMR has been augmented by a component that utilizes current technological developments such as internet technology to create a more complete source of healthcare data management. The Personal Health Record or PHR is such a unit. Together, these technologies have the potential to transform aspects of information management in health care, from the way health information is documented to the way it is retained and stored. Such technologies are exposing individuals to improvements in healthcare and generating positive attitudes toward managing their own medical information [18]. The PHR allows people to add, maintain, and access their own medical information. In the United States in particular, the idea of PHR is not a new concept, but recently this concept has been gaining momentum. Among other factors contributing to its growth are the mandatory implementation of EMR by the healthcare industry by 2014, the great loss of patient information as a result of hurricane Katrina, and the growth in research of EMR showing benefits of individual accessibility to information. Such factors have allowed government to see the potential benefits to consumers of healthcare, to have control of their own health [20,11].

Recently, a number of web-based services have begun to provide patients with secure access to manage their medical information. Though there is no standard framework for PHR, there is rapid development of this concept. Characteristics for any PHR system should include a lifelong comprehensive patient record, immediate accessibility of the patient information as needed, health management and information tools, privacy and security of the patients' information and the

ability for the owner to control access to these records [48]. One emerging concept is the categorization of PHR. In an article published in *Family Practice Management* in 2006, PHR were categorized as:

1. A provider owned and maintained database which provides patients with read only information such as lab results and disease management information.
2. Patient-owned software that allows the patient to enter and organize their own information.
3. A portable inter-operable digital file where clinical information can be inputted and transferred. These files can be stored on USBs, cellular phones, or smart cards, allowing for portability and exchangeability of health information by consumer discretion [12, 48].

Existing PHR services provide the following features: Access (password-protected); Medical conditions (diagnosis and treatment); Medications (dose, frequency); Laboratory and Diagnostic tests (results); [25]. Besides these, some PHR also provide insurance information, tele-medical events, data and even genetic code map [1]. The Palo Alto Medical Foundation (PAMF), an online PHR system implemented in 2002, allows patients to view key aspects of their record such as laboratory results, as well as allow continuous patient access to information and resources. This system allows for transparency in healthcare. 92 percent of users of this system were reported as being satisfied with the service [48].

Other functions of PHR include summary of personal medical information for presentation to healthcare providers; portal to patient-specific consumer-level healthcare information; provision of interpretive information about laboratory test and diagnostic study results and serves as a database if information is for patient-specific self-monitoring and disease management [25]. By empowering patients to actively become involved in their healthcare and its outcome, PHR should be able to provide many of the benefits to the individual, as EMR provide to the system. These benefits will include costs savings, improving safety through better tracking of medications, improve the relationship between doctor and patient and generally improve the quality of care provided.

2. Factors Affecting Global Progression of EMR

The progression of EMR in developing countries is not a simple task. Many factors contribute to the progression and diffusion of such technologies [8, 37]. In this section we will identify some of these factors that will affect diffusion among many developing countries.

Healthcare Infrastructures

Countries such as the United States, United Kingdom and Australia have growing and robust healthcare infrastructures that receive substantial funding and support from its governments. [30,47] Though significant failures still exist in these systems, there is strong support and motivation to accomplish goals associated with comprehensive development of successful information technology systems [4]. These countries are able to make significant investments in research to develop information systems that would meet the need of their particular healthcare system. This is in sharp contrast to the healthcare infrastructure of many developing countries. For many of these countries the delivery and management of healthcare services alone comes with many challenges [8]. In many of these countries, implementers of healthcare information technology based solutions are faced with complex challenges such as inadequate funding, lack of resources and weak healthcare infrastructure. In addition, some economies may have just a rudimentary application level of healthcare technology. In a study by Sood [39] which examined challenges faced by the healthcare workforce toward the implementation of EMR, many of the clinical workforce developing countries were considered computer illiterate. Hence for the developing country many initiatives die out, or fade away after good pilot runs and in many cases very few initiatives are sustained.

Healthcare Workforce

According to the 2006 US Employment and Wage Report published by the United States Department of Labor, In developed countries like the United States the healthcare industry remains one of the fastest growing industries with salaries higher than most other industries. With statistics

like these many of the healthcare workforce from developing countries migrate to countries like the United States, creating imbalances in global health. This causes a shortage of qualified workforce and lack of medical expertise in developing countries competent medical and paramedical personnel leave their country in search of greener pastures. It has been estimated that over 18,000 Zimbabwean nurses work abroad and in Zambia & Malawi, migration of nurses represents almost 40 percent of the annual output from training [53].

Counterfactual analysis about the possible state of affairs in Africa (Figure 1) is a disheartening study.

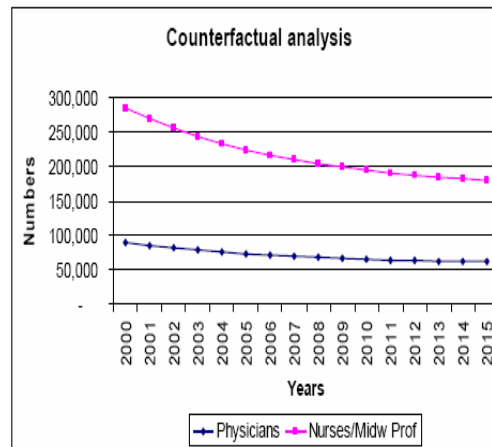


Figure 1. Projection of workforce in Africa – based on current trends (source : WHO, 2004)

The exodus of medical workforce from developing countries reinforces healthcare delivery systems and services in developed countries. According to The United Nations Commission for Trade and Development, each professional leaving Africa costs the continent USD 184,000 or USD 4 billion a year – one third of official development funds to Africa [16]. Hence, shortage of medical workforce in many developed countries, to some extent, is fulfilled through this foreign workforce; unfortunately this happens at the expense of developing countries. One study by Misra and others [33] suggests the underutilization of IT in developing countries may be augmented by the lack of trained healthcare personnel.

Availability of Training Facilities for Healthcare Workforce

Training is considered central to any healthcare delivery system. It is known beyond a doubt that the use of computers and IT by health science or medical students will result in more effective medical training. But little information is available on the level of training and utilization of IT among healthcare professionals in developing countries [6]. Today, in developed countries cutting edge technologies like 3D simulations, virtual reality and robotics are being used for training clinicians. Conversely, for many developing countries these technological advances are way beyond the scope of their exposure or healthcare need. In the developed country there are strong expressions and promotion of the advantages of these techniques to improving healthcare. Hence, absence of innovative IT based training techniques and lack of exposure to advanced concepts through medical training programs tend to widen the gap between the clinicians on the two sides of the divide. One consequence of this gap may be the efficiency and success of PHR and EMR implementations in developing countries.

Dynamics with Healthcare Systems and Organizations:

Healthcare organizational characteristics are unique to the make up of the organization and the goals that are in place for output by that organization [45]. Impact of a new IT based system has ramifications not only for the micro-level of the social subsystem of the organization, where there is person to person interaction, but also for the macro level of the subsystem, affecting facets such as the organizational culture and the organization's capacity to learn and adapt [5]. For many developing countries factors such as skewed organizational structures and policies, and politics influence organizational dynamics. Hence, implementing EMR systems in a developing country may be difficult compared to that in developed countries.

Barriers to language

Culture is a critical determinant of the successful implementation of EMR systems in developing countries. One particular issue is that of language. Since most EMR systems are designed in English,

it becomes difficult to facilitate interaction between divergent cultural subsystems, preventing transfer of knowledge from one culture to another [24] for instance, the Sub Saharan Africa region is notable for its incredible language diversity. For example, Cameroon, with a population of about 14 million has 279 distinct languages, Nigeria has 515, Ghana has 79, and Senegal has 36 [43]. Furthermore, despite the role of English as the Lingua Franca of the Internet, information presented in the users' native language, seems to be the most decisive factor for attracting website visitors [26] thus, language becomes a significant factor in assessing usage of EMR systems in non-English speaking regions.

3. Potential Benefits of EMR and PHR in Developing Countries

Compared to the problems faced by developed countries in the implementation of information technology, developing countries present far more significant challenges and limitations. Notwithstanding such challenges, many EMR systems have been successfully implemented in these countries [14,38,3,13]. EMR and PHR implementation in developing countries presents many benefits that can improve healthcare management and open these countries up to information and advancement of their healthcare industry.

As noted before to enable the use of IT based applications, a country requires the appropriate IT infrastructure [30] with the increasing spread of wireless telecommunications, mobile and ad hoc networks are advancing in developing countries [34]. Developing countries are taking huge strides in terms of adoption of information technologies. Worth mentioning, researchers expect African mobile subscribers to grow at 22% from 113.55 million in 2005 to 378.62 million by 2011 [35]. The rate of growth for the entire continent has been more than 82 percent a year, much faster than the growth rate in the Americas. In many countries, such as Cameroon, Kenya, Senegal and Tanzania, annual cellular growth rates have been running in excess of 300 percent [23].

EMR systems are currently amongst the prime transformers of IT based technologies in healthcare [48]. Healthcare users and consumers of EMR in countries like Kenya, India, and Haiti have been reaping the benefits for quite some time

now. These systems, if compared with legacy or traditional manual systems provide basic benefits which can also be seen as potential benefits of EMR systems in other developing countries [51]. Such systems have been shown to provide greater accuracy, efficiency and cost benefits.

Though these benefits are significant there are still more inherent advantages to EMR. Studies on the impact of EMR list such benefits as efficient clinical management, improved diagnosis, reminders, and simple warning tools that help clinicians and patients reduce possible errors like drug incompatibility and interactions resulting in significant improvements in quality of care [9]. Networked EMR systems can enable laboratory data to be entered from remote locations. Specific benefits of PHR and EMR systems include [13].

- 1) Facilitates speed and accessibility in obtaining consultations from distant specialists.
- 2) Makes clinical notes and documentation legible, reducing clinical errors associated with illegible handwriting.
- 3) Provides reminders to routine screenings, prescriptions, administration of vaccines and other health maintenance benefits.
- 4) Generates warnings for abnormal laboratory results.
- 5) Supports the handling of data for clinical research.
- 6) Management of chronic diseases such as hypertension, diabetes etc
- 7) Provides information on drugs for prescribing.
- 8) Supports program monitoring, including reporting outcomes, budgets and supplies
- 9) Backs-up data
- 10) Provides ease to information transfer and sharing.

Hence, EMR systems promisingly provide a myriad of benefits to enhance the efficiency of healthcare delivery systems in developing countries. These systems are presently being provided through user friendly and very intuitive interfaces like MS Windows applications built around MS Access, Web interface, PDAs, Voice interface systems (for POTS and Mobile phones), scanner reports through OCRs and e-mail.

4. Global EMR Perspective on Implementation

An added advantage of EMR, owing to its effectiveness, is the ability for information technologies to link direct patient care processes

within the micro information systems in healthcare delivery, based on EMR with the macro-information systems (government initiatives and international programs) [17]. Such IT based linkages may have more profound impact on healthcare scenario in developing countries [11]. Although this factor in itself is enough to justify the implementation and adoption of PHR in developing countries, it may not be quite like it was in the case of developed countries. Diffusion of Innovations model [37] informs us that spread of ideas is highly influenced by social systems. In present case there are numerous users of PHR and each of them comes from a diverse intellectual and social background.

In a study by Kim and others [25] there were 10,000 active users of PHR in 2002 in United States alone in 2006, more than 42 percent of Americans said they used PHR [12]. So far there have been no documented figures for the number PHR users in developing countries. At the stage where the developing country develops the use of PHR there will be substantial development in the country's healthcare infrastructure. Although developed countries (like USA) have been slow in adopting EMR, they are still working on strategies to stimulate adoption and implementation of these systems [32].

- Expanding Health Information Technology (HIT) Agenda.
- Announcing financial incentives to stimulate EMR/HER market place.
- Specifying HIT standard setting; enabling policies.
- Supporting educational, marketing and supportive activities.

Though there is no published evidence on the use of PHR in developing countries we can postulate the number of patients who have computerized medical records in one or the other form. The easiest way get an estimate about this is by analyzing the use of EMR systems in developing countries.

The Following are some of the estimates of the populations covered by EMR implementations in developing countries:

- a) Mosoroit Medical Record System (MMRS), Kenya [18,19]– This system has been implemented at a primary care rural health center. The system provides patient registration and patient visit records management. This system

- maintains information of over 60,000 patients.
- b) Computerized System for the Control of Drug Logistics (SICLOM), Brazil– This system is managing antiretroviral treatments to over 100,000 patients.
 - c) Lilongwe EMR – is a patient management information system for a wide range of clinical problems in a pediatric department of The central hospital in Malawi. This system contains information of over 160,000 patients.
 - d) Highly Active Antiretroviral Therapy (HAART) out patient clinic in Botswana used optical character recognition technology for seven months to manage 3000 patients in HAART. The pilot run concluded with encouraging remarks for such an information system [7].

Other EMR projects in the developing countries include:

Partners in Health (PIH)-EMR, Peru; HIV-EMR system, Haiti; Careware, Uganda; PEPFAR project, Tanzania; National EMR, project Zambia. Few like Sir Ganga Ram Hospital's EMR system, India are underway [44].

Implementing EMR in Developing Countries

Lafky and others [27] have identified person centric dimensions to consider in implementing such technology. We will thus highlight PHR and EMR implementations in developing countries in terms of Lafky's dimensions:

Security, Confidentiality and Reliability:

A well trained local data manager is fundamental in maintaining data quality. Like developed countries, issues of security of the information and confidentiality are significant but for many developing countries support for these concepts varies. Since most of the present EMR implementations in developing countries are centered on HIV/AIDS treatments. The issue of social stigma is something that needs to be considered while implementing EMR/PHR systems. Combinations of technical and human protocols have been advocated for use with these systems in developing countries [13].

Technology, Access and Interoperability: EMR system implementations are being carried out in phases [44]. These systems are fragmented and

isolated – thus forming islands of users disconnected from each other. Furthermore, most of these use proprietary standards which make them highly specific; hence interoperability is at minimal level. One initiative in place to overcome this issue is Open MRS (OpenMRS). The available technological infrastructure is another limiting factor. These systems need computers and servers with 24x7 power supply, high physical security and clean dust-free, temperature regulated area. Off-site data back-up in a different location is indeed an important feature of EMR implementations but since this is a resource hungry feature –spells luxury from many developing countries' perspectives. Internet access is the only modality that can promise an uninterrupted access. So the accessibility of EMR systems in developing countries is higher if they are based on pure web-based systems. Although for many, 24x7 connectivity is a matter of luxury resource limited settings but a dial-up access is now a challenge of the past especially as far as bigger cities in developing countries are concerned. But these dial-up may not be meaningful if the web pages are not designed carefully [13]. Furthermore if an internet-based system is deployed then to some extent the issue of discontinuous access (owing to inaccessibility of the INTERNET access) could be addressed by maintaining a back of data locally.

Cost, language and culture: Since there are very low or slow returns on EMR systems in developing countries, these systems do not yet show up on the thrust areas of entrepreneurs in developing countries. Language is another notable factor that influences the adoption of EMR systems in developing countries primarily because of the language diversity that may exists in many developing countries. There has been notable research examining the cultural dimensions of technology and their impact on adoption of information technology in general. The beliefs and values ingrained in people by their cultural context significantly affect their ways of thinking and their perspective and therefore, their approach to technology [46]. The Culture construct has two sub-constructs: (a) Culture-specific Beliefs and Values – which represent specific beliefs or values that a person might hold because of the influence of their cultural background, and; (b) Technology Culturation - which represents a person's exposure to a relatively technology-intense culture [46]. In the context of studies of ICT diffusion in

developing countries, this could indicate the degree to which a citizen of a developing country has been exposed to more technologically advanced cultures [9].

Eventually, after studying the published evidence of implementations of EMR major pitfalls reported in implementing EMR/PHR systems can be identified as:

- Lack of user training.
- Poor initial design limiting capabilities and expansion potential.
- Systems difficult to use or complex
- Dependence on one individual 'champion'.
- Lack of involvement of local staff in design and testing.
- Lack of perceived benefit for users who collect data.

Major technical challenges listed by implementers of EMR systems in developing countries are:

- Lack of back-up systems in the event of computer loss.
- Poor system security leading to viruses and spyware.
- Unstable power supplies and lack of battery back-up.
- Inadequate data back-ups.
- Lack of technical support [13].

5. Lessons Learnt

The implementation such noteworthy number of EMR systems in developing countries is encouraging. Still some concerns like interoperability, access, security, and resistance remain. Key lessons learnt from EMR implementations in the developing countries include [17].

- The cost of IT systems that support EMR functions is less than costs of the care programs such as medications.
- Imposed solutions will not work as local staff drives the need for design changes to adapt the system to local and national needs [19].
- Resource use in health can be measured as a by-product of the direct patient care processes, through the use of effective

system design where data are captured only once, yet is usable many times over for no significant additional costs [14,50].

- Information required to manage care is more timely reliable and accurate [14,50].
- With involvement of the local population in the whole process and providing these people with 'ownership', the EMR and other information systems facilitate economic wealth through increased employment and funding. Initial funding may be through research and philanthropic sources but over time there will be an increase in local self-sufficiency to manage the projects.
- Documented success of EMR implementation in developing countries verify the processes involved in the adoption of new technologies as described by Rogers[37].
- Through the use of World Wide Web these systems can be more readily available to developing countries and it also promotes standardization of data capture and care regimens (OpenMRS).
- The fundamental principle to the success of EMR projects is local population acceptance and much more, it is the empowered, responsible, accountable control of the technology and its outputs. The affected population must become committed owners of these projects.

6. Conclusions

For developing countries many challenges exist that are unique to the population and environment. Medical record systems so far have been shown to do the job but significant problems are encountered in the management of many systems. Web-based systems for information management will be the first step in making systems workable. Such systems will eliminate the problems caused by frequent power outages that may affect data storage causing loss and damage to data storage and backup. This will set the stage for more comprehensive development of EMR and then PHR.

Developing countries may need to build on current structures of healthcare data bases technologies such as HIV system which have already be shown to work , then add only relevant modules to the system such as childhood

immunization management system then over time adding more disease specific modules that are unique to that country's needs.

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