

A Systematic Review and Comparative Study of Electronic Medical Record (EMR) Systems to Support Healthcare

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Abstract: The need for an Electronic Medical Record(EMR) system has grown exponentially with the vast increase in population, where it is strenuous to deal with patients' medical records physically. EMR grants the electronic entry, upkeep and perpetuation of medical information of patients over long periods which in turn provides quality care and safety in healthcare organizations. Nevertheless, EMRs have been a huge leap in the medical field, where hospital records are computerized for the betterment of patient care. In fact, EMRs are ought to reduce the manual work done and upgrade the efficiency in healthcare systems. This paper focuses on the significance of EMRs in healthcare organizations with the help of a review on the researches done on EMR systems and a comparison done between the EMR systems which have been implemented so far. Also through this, it is aimed to identify the insights along with the features and functionalities to be included when implementing a quality and an innovative EMR by bridging the gap in the knowledge for improving EMRs in the healthcare sector.

Keywords: Electronic medical record(EMR); healthcare; hospital records; computerized; patient care

Introduction

An electronic version of patients' medical records is termed as Electronic Medical Records through which we can gather, create and store medical records of patients

electronically and with these, doctors can provide complete and accurate details about their therapeutic assessment. The development of EMR systems has resulted in many novel possibilities for patient awareness and confidentiality. For an improved deployment of the EMR system, keeping the privacy and security of information and using national and international standards are dominant prerequisites. Enhancing patient care and enlarging the efficiency of primary care practice are principal considerations of an EMR system. Actually, it is meritless to utter regarding the current healthcare systems which are managed physically with very composite and external rules. Those kinds of systems are enormous obstacles to dispatch a quality service to the users. In order to avoid such kinds of drawbacks, the EMR is very significant and to gain the benefits of EMR systems it is needed to have a system and team based attentiveness and attestation-based drugs. Also it is a durable record of patient medical data generated by so many encounters. EMRs provide considerable benefits to physicians, clinical operations and healthcare institutes(Agency for Healthcare Research and Quality). Indeed, as the use of EMR inflates, along with the depth and breadth of details they contain, the ethical use of EMR data needs building and maintaining patient confidence and acceptance in the stewardship of their particulars(Aviran, 2020). Benefits from the upheaval in medical information systems

would not be precise until and unless there is the worldwide adoption of a truly interoperable EMR in a global extent(B. Devkota and A. Devkota, 2013)

According to the third global survey on eHealth based on the reported data 2016, below are key discoveries on EMRs. A steady increment has been observed in the adoption of EMR systems and also there is a 46% global increase in EMR systems. EMR systems have been adopted over 50% by the Upper-middle and High-income countries as depicted below. Adoption rates of EMR in countries with lower-middle income are 35% whereas low-income countries adoption rate is near 15%.

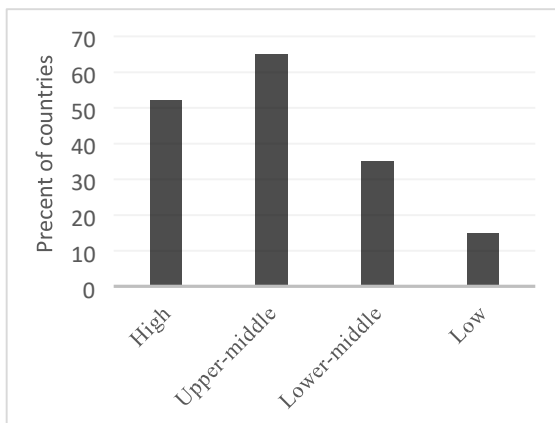


Figure 1. Percentages of countries with a national electronic health record system classified by the World Bank Income group(Global Health Observatory (GHO) data, World Health Organization)

Taking the above facts into consideration it is much obvious that the utilization of an EMR provides much more benefits to the healthcare sector and the main objectives of this paper are to identify the significance of the utilization EMR systems and to recognize novel and innovative features and functionalities that should be included in the implementation of an EMR through a comparison study done between the EMR systems and a literature review done on EMR systems in addition to the analysis on the evolution of EMR.

Background

The basis for the development of the EMR systems was set out in the 1960s and 1970s. The usage of EMRs, has not only made it simple for seeking medical information of patients from anywhere the system is accessible, but also has an impact on healthcare by transforming the format of medical records which were used as paper records earlier as a tradition.

Approximately 73 hospital and clinical details were in progress by 1965. The Problem Oriented Medical Record(POMR) is one of the most outstanding attempts to upgrade the maintenance of medical records of patients which was invented by Dr.Lawrence Weed in 1968. The main objective of this was to dispense the EMR notion to provoke an electronic record that allows a third party to recognize the diagnosis on its own, and it predominantly concentrated on clinical data handling. These systems are also termed as hospital information systems. POMR is still being practiced by some medical providers where the system has mainly five facets that operate to provide the precise view of a patient's well-being and therapy requirements. The five facetes include database, complete problem list, initial planning, daily progress notes and discharge summary. However, the POMR framework is fairly harsh, and was refused by many healthcare professionals saying that the POMR is very troublesome, and an long-winded process.

And in 1972, the very first version of EMR was introduced. The Regenstrief Medical Record System(RMRS) was developed and launched by Dr.Clement McDonald. McDonald recognized the issue of the outline of the database and the diverse problems that emerge when aiming to interconnect healthcare institutes, regulations and healthcare authorities through a central medical record system. Through clinical tests, McDonald spotlighted the ways of

enhancing patient care with the use of EMRs. However, due to the high cost of the system, it prevented the usage of the system among physicians, instead of being used by healthcare institutions.

In order to keep track of patient therapeutics, various academic and research centres have implemented their own electronic medical record systems. Novel features and functionalities have become available additionally for healthcare providers and outlined to further enhance patient care, electronic systems, past medical history, housed drug dosages, side effects, allergies and drug interactions there by improving the healthcare sector. Also, it has facilitated the providers to take care of their patients with the incorporation of electronic diagnostics and treatment methods.

In the late 1970s EMRs were implemented and gradually became the Veterans Information Systems and Technology Architecture(VISTA) in the early 1990s. Implementation of EMR (by the Veterans Administration(VA)) that occurred at the same period as the Regenstrief system emerged. That system permitted the medical ordering, procedures, lab tests, diets and x-rays.

Also, some EMRs were developed with hierarchical databases with the integration of hospital billing and scheduling systems and this can be cited as a major approach in the medical field. Some clinical systems like COSTAR, PROMIS, TMR and HELP were implemented between 1971 and 1992 to enhance the developing medical care for the utilization in medical exploration.

In fact many publications that had a huge influence on the improvement and success of EMR systems were published, the book named "The Computer Based Record :An Essential Technology for Health Care" which was published in 1991 is one of them. The main idea behind this was computer based

patient records. Institute of Medicine of the US stated that by 2000, physicians' offices must have technology to enhance patient care and also gave policy recommendations of the way to reach that goal in 1991. In 1996, the Health Insurance Portability and Accountability Act(HIPAA) was established as a reaction to the vast developing electronic medical information.

In the 2000s, the EMRs were built with the inclusion of security needs that are still taken in to consideration while an EMR is implemented. EMR products include the safety precautions such as data backups, log-offs, data encryption and access control. Only 20% of office based physicians had taken on an electronic record system by 2004. Also the advent of web based technology made it possible for more providers to bring in the benefits without the need to spend much on hardware. Extending the services provided by the EMRs was done by cloud based systems to address providers' needs beyond documentations.

Research(Boricky and Kushniruk, 2012) depicts that North American healthcare organizations are in the preliminary phases of EMR adoption. In addition, it describes how EMRs create medical information more approachable to physicians and support healthcare providers with their organizational and decision making in related to healthcare. HIPAA restrictions were tightened and subjected to enforcement in 2009 with the effect of Health Information Technology for Economics and Health(HITECH) act. As a result, EMRs make security conformability easy, without allowing time and resources , the encryption and access controls with individual authentication able to make it simpler.

In chapter 18 of the book named "Handbook of Medical and Healthcare Technologies"(Kastikas,2013) discusses the impact on EMR with the rapid change in proliferation of Information and

Communication Technology(CT), threats against the security and privacy of EMR other than the legal and ethical requirements to adhere to when addressing the scope with regard to the security of EMRs.

Furthermore, Artificial Intelligence(AI) has proven the enhancement of EMR quality care and has a great potential to make the EMR systems efficient, flexible and intelligent since complicated navigations have been a critical issue faced by many physicians with the existing systems.

Literature Review

This section deals with the vast amount of researches that relate to the EMR systems which depict the development and evolution of EMRs and their impact on healthcare.

A research(Williams and Borren, 2008) reveals that an EMR elevates efficiency of the workflow of healthcare providers. EMR systems aid in precise medication records, clear notes and prescriptions, instantly accessible charts, decreased medical issues and development in quality care and regulations in patient well-being. This research has also exposed the fact that despite the significance of EMR systems in improving clinical care and policy in developed countries, some issues or provocations that must be overcome still exist. Those include hardware and software compatibility, practise, lack of quality assurance and outdated configuration. Another issue faced by the world associate with sustainable energy, availability and authenticated permit to electricity is crucial in healthcare evolution.

The study(Waithera et.al, 2017) has exposed the fact that the EMR systems have led the way to an elevation in the productivity of healthcare conveyance and better decision making related to healthcare. The vital barriers spotted were scarcity of funding for the adaption and manipulation of the EMR systems, computer ignorance of employees

and reduction of Information Technology(IT) personnel in the provision. The furtherance in IT has had influence in all sectors including healthcare that have assisted in alleviating barriers faced by healthcare currently. These barriers include decreasing avoidable blunders, developing communication between healthcare providers and managing the expense for the medical care. A customary drawback upheaved was system and network failure. Also some tasks were not attainable. The utilization of IT in healthcare is rapidly obtaining world demand with many personnel adopting electronic medical record management systems.

Another research was to find the effects of EMRs on citizen health. Health Information Technology is becoming more comprehensively employed, however, the industry has still not been able to reach its overall approachability. The aim is to identify whether the use of electronic medical information can improve the healthcare in the society, as well as to recognize main constraints for its adoption and the key use. As worldwide adoption of a completely interoperable EMR advances, variety of obstacles identified in this review such as standards, and resistance to alter could be alleviated. As more data becomes attainable through the EMR, relationships to consequences should emerge. Appropriate training on EMRs usage, may help with the level of intricacy among healthcare providers and their employees. Also, EMR can enhance healthcare productivity and coherence to well deliver citizen health. A plenty of healthcare information can be administered through databases by using EMRs, and this makes data simply shared between providers and organizations(Kruse et.al, 2018).

In a research(Poelgeest, 2020) qualitative study was conducted using twelve experienced medical experts of twelve

distinct Dutch hospitals with different specialisms, whose expertise within the hospitals ranges between 5 to 27 years where semi structured interviews of 90 minutes were held. Through this study, it was concluded that the interviewees consider digitalized records as a great leap forward when compared with the paper records due to its real time access.

In many countries, healthcare systems have been modified with the utilization of some form of IT, principally with reference to EMR. IT which is utilized productively, can restore old disputes in supplying healthcare services (Drak et.al, 2013). This article also discusses on the implementation of EMR in healthcare systems worldwide through SWOT analysis (Strengths, Weaknesses, Opportunities and Threats) and cluster a lesson that can be learnt with the continuation of the systems. However, some technical and non-technical challenges also must be sorted out before strong EMR systems can be converted in to realities in healthcare sector. These include problems of patient privacy and confidentiality, medical practitioner acceptance of closer inspection by management, regulatory standards for electronic medical records and cost effective justification for funding in EMR systems.

A study (Alsharo et.al, 2020) explored the attitude of healthcare experts towards adopting a Health Information System (HIS) nationally where the context of the study was done in Jordan. The discoveries of this research suggest that perceived usefulness of HIS is a significant cause of user perception towards utilizing the system. Also it was observed that at the early stages though the system might be somewhat difficult to use owing to the reason that it is newly practised, but after adapting their practices to using the system and realizing the value of the HIS, this attitude changed to positive.

The research (Hamade et.al, 2019) aimed at identifying interventions for improving EMR

practicing in primary healthcare settings using ten online databases which were searched to investigate studies conducted in primary healthcare background aimed at implementing interventions to identify the use of EMRs and promptly quantify the utilization of EMR tasks and results.

Another research (El-Yafour et.al, 2020) investigates the vast usage of EMR systems throughout the United States and the factors influencing the adoption of these systems such as intention drivers, subjective norms factors, perception drivers and perceived behavioral control drivers contributing to the research group by revealing the specific drivers of the behavior of healthcare providers. However, the limitation of this research is that it only concerns physicians but not on the other crucial actors of the healthcare organization namely, nurses, pharmacists, patients, medical administrators etc.

When the improving functionalities of the EMRs are considered, a study depicts that "Six of the twelve completing the study favored the use of the Speech Recognition (SR) for creating electronic progress notes of traditional method of entry. There was no clear perceived benefit from SR in terms of data entry time savings, quality of care, quality of documentation, or impact on clinical and administrative workflow" (Holmes, 2016).

The comparative study (Abiy et.al, 2018) focuses to fill the evidence gap by evaluating the absoluteness and trustworthiness of paper and electronic medical records and investigate the provocations of guaranteeing data standard at the Anti-Retroviral Therapy (ART) clinic at the University of Gondar Referral Hospital in Northwest Ethiopia. ART care is a long-lasting treatment, which requires precise and authentic data gathered over an extensive period of time. Poor standards of medical records have left a provocation and are

immediately connected to the quality care of healthcare sector. In order to enhance this, there is an improving tendency to implement EMRs in healthcare institutes. Nevertheless, there is miniature proof on the influence of EMR on the standard of medical information in less resource containing hospitals like in Ethiopia. The overall ART data standard was still moderately better in paper records than the EMR systems. The major reason influencing the EMR data quality was the contemporary dual documentation utilization both physically and electronically for the same patient in the healthcare institutes. It is the responsibility of hospital authorities to decide to use either the paper or the electronic system there by saving time with single documentation practice. Trainings and uninterrupted sustain for healthcare staff have been proposed to build the capability of healthcare employees on data management practices.

Another systematic review exposes that physicians may come across a series of challenges as they proceed towards EMR implementation. And also it concludes that the quality of change management plays a major part in the advancement of EMR implementation(Boonstra and Broekhuis,2019).

Also, apart from EMR systems which are implemented with the intention of maintaining patient medical information in diagnosing and prescribing medications, some systems were also researched and implemented for some fundamental procedures which are practised within healthcare organizations.

A study(Ali et.al, 2015) focused on a Blood Donation Management System(BDMS), a web application with the sole intention of the blood donation procedure, supporting a mobile application that supports patients and blood donors which is much beneficial easing the access to available blood donors.

Another study(Ruwisch et.al, 2016) aimed to conduct a content analysis of EMR adjustment for serving tobacco treatment and to arrange those modifications in a document with the use of 5A's framework(Ask, Advise, Assess, Assist, Arrange).

Discussion

Storage and maintenance of patient records digitally for an extended period of time support in diagnosing the diseases accurately and reliably and there by preventing patients from unneeded checkups and therapeutics. And at the same time it is able to determine how patient measures up to certain essentials like blood pressure readings, vaccinations etc. Therefore, it can be stated that organizations get advantages of providing coherent and precise care for the customers through EMRs.

Initially, the physicians began with paper records, and still nowadays also it is been used. But healthcare information sharing among providers is difficult and inconsistency of health records collected from various physicians leads to errors, delays and lowered the level of health care.

Table 1. Comparison between EMR Systems which have been used since decades

Software	Security				Client type		Features																		
	Secure authentication and access control	Secure storage	Secure exchange	Logging mechanism	Web based	Native	Mobile	Client of Documentation	Record Management	Patient Administration	Report Generation	Scheduling	Billing	Medication Management	Accounting	Statistical Analysis	Staff Management	Order Entry	Prescribing	Laboratory Management	Medical Consulting	Community Health Management	Mobile Access	Disease Management	Electronic Data Interchange
FreeMED	✓	✗	✗	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
GNUmed	✗	✗	✗	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
GNU Health	✓	✗	✗	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hospital OS	✗	✗	✗	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
OpenEMR	✓	✗	✗	✓	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
OSCAR	✓	✗	✗	✓	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
WorldVista	✓	✗	✗	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ZEPHS	✗	✗	✗	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ClearHealth	✓	✗	✗	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MediFax	✗	✗	✗	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

systems in order to provide a better service to the patients. Furthermore, it has been a huge need to have an EMR system with easy navigation because as the functionalities of the system expands the complexity of navigations within the system also increases. However, the developers of the EMR system and the IT system may decide the survival of the EMR system which pave the path to the vast number of EMRs with diverse functionalities and features which make those systems distinct from each other. Furthermore, it can be stated that family history, past medical history, social history, allergies, detailed symptoms, assessment, referrals, followups, lab reports and many more aspects can be used as key tools in addition to the features which have been utilized in the already implemented EMRs discussed in the paper when diagnosing a disease accurately and reliably for a better healthcare service.

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