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Primary Health-Care Service Delivery and Accessibility in the Digital Age

Thierry Edoh

Abstract

The primary care is within a health-care system, the first contact and main point for people requiring health and medical care. Patients requiring specialized health and medical care are directed to the appropriate specialists by a general physician (GP) who coordinates the needed specialist care. GPs base their decisions partially on patient-centered information and partially on the results of medical examinations. Many health-IT systems for primary health care are available today. Their first aims are to assist GPs in their daily duties and the patient in collecting his medical data and to self-manage his conditions. IT systems enabling the patient to collect accurate information on his condition to self-manage his condition provide accurate patient-centric data, which shows the potential to outperform patient-centered information, which in turn is based on the patient's personal feeling and perception. Patient-centered information are biased. Beyond providing patient-centric information, health-IT systems can facilitate access to health-care services, increase the quality, efficiency, and effectiveness of health-care services, and can contribute to reducing medical expenses. This chapter aims to paint down the global trend of health-IT systems and the supporting technology. The chapter will further present some existing health-IT systems and discuss their role in the health-care accessibility, particularly in rural regions.

Keywords: health-IT, care accessibility, primary care, patient-centered data, patient-centric data

1. Introduction

Various health information technology (HIT) initiatives emerge today and are part of the strategy defined by each nation to assist health-care professionals in their daily duties as well as to decrease the medical expenses, which keep increasing day by day. High-income countries (HIC) as well as low- and middle-income countries (LMIC) are putting efforts to provide their health-care systems with HIT. Beyond these efforts, researchers are working on innovative HIT to assist the patient in managing his health conditions [1, 2], access to health-care services [3], and to assist general physicians (GP) in their daily duties.

LMIC and rural regions in HIC are mostly medically underserved and thus facing poor access to care services. LMIC rural regions are severely facing poor care access issues. Patients are living very far from care units [4]. Rural regions in HIC

are mostly suffering from a low rate of physicians providing medical services in these regions [5].

Overall, the primary health-care sector is increasingly being provided with modern information systems that assist medical doctors in their daily duties supporting them in decision-making, diagnosing, prescribing, and remote delivering care service to patients.

eHealth, mHealth, telehealth, and telemedicine are modern HIT-enabled tools aiming to provide better, efficient, and effective care services to the patient. Telehealth and telemedicine enable care service delivery regardless of the time zone, the geographic residence place of the patient, and his medical doctor(s). Rural regions (medically underserved) are mostly taking benefit of these tools supporting remote care [6].

HIT systems collect and provide medical information to medical doctors (MD), to the patient for self-management of his health conditions (for example, glucometer and tensiometer). HIT also processes collected data to assist in decision-making. These data are stored in the so-called "electronic health records—EHR—or electronic medical records—EMR." Evidence has shown the benefits of EMR/EHR. They could reduce prescription errors [7] and enable inter- and extra-organizational information sharing [8]. Beyond decreasing the rate of prescription errors, EMR could support accurate diagnosis making and thus impact the patient's health outcomes.

The objectives of this chapter are to paint the tableau of existing HIT and systems in primary care, which improve access to health-care services, assist health-care professionals in decision-making by providing them with appropriate data at the right time, empower patients toward their conditions (diseases awareness and health literacy), medical document management, etc. This chapter further aims to discuss the state of the art and the future of the HIT.

The remainder of the chapter defines some HIT-related terms (Section Backgrounds and definitions) presents the state of the art in LMIC and HIC. It discusses the future of HIT (Section Discussion and conclusion) and concludes the work in the last section.

2. Backgrounds and definitions

Health information technology (HIT): it is the field of information and communication technology mainly focusing on process automation and medical data processing to support health-care service delivery, patient's self-management, and any other related processes. The main purposes and priorities of implementing HIT are summarized in **Table 1**. Zayas et al. discuss the HIT priorities for the research. Data quality, harmonization, interoperability, storage, integration, and aggregation are the main points that the HIT research has to focus on [9].

eHealth: — stands for electronic health. The term "eHealth" lacks uniformity of definition—*standard definition*—[10]. We define eHealth as the use of information technology and/or systems and electronic devices for health-care service delivery. Furthermore, eHealth mostly focuses on medical informatics and deals with data, while biomedical provides medical devices to support care services. An electronic medical record system is an eHealth system that records patient's medical data. A hospital information system is also an eHealth system that collects, processes, and stores any data related to a hospital as described in **Table 2**.

mHealth: it is a subset of eHealth supported by mobile technology, i.e., mobile network, and mobile devices such as mobile phones and tablets.

The World Health Organization defines mHealth as:

> *mHealth is a component of eHealth. To date, no standardized definition*
> *of mHealth has been established. For the purposes of the survey, the Global*
> *Observatory for eHealth (GOe) defined mHealth or mobile health as medical and*
> *public health practice supported by mobile devices, such as mobile phones, patient*
> *monitoring devices, personal digital assistants (PDAs), and other wireless devices.*
> *mHealth involves the use and capitalization on a mobile phone's core utility of*
> *voice and short messaging service (SMS) as well as more complex functionalities*
> *and applications including general packet radio service (GPRS), third and fourth*
> *generation mobile telecommunications (3G and 4G systems), global positioning*
> *system (GPS), and Bluetooth technology [11].*

Digital health care: while eHealth is dealing with supporting the health and medical care delivery using health-IT, digital health focuses more on the patient and personalized medicine by using digital channels to collect patient's medical data, helping the patient to self-manage his health conditions using digital platforms or tools.

Pos.	Priority	Description
1	Medical data quality	The improvement of the quality of medical data at the point of the collection is very important. Biased or wrong data could negatively impact patient's health outcomes. Today, with the advancement of technology, efforts are put to collect accurate and right data using technology such as RFID, sensors, and camera. The Internet of Things is the widespread paradigm today to autonomously and automatically capture, process, and store medical data.
2	Data harmonization and interoperability	For analytics purposes, data harmonization is needed. However, data harmonization is still challenging. HL7 is a standard that is used to overcome harmonization issues. In health-care systems, many devices using different data formats are being used. In many cases, an intercommunication and data exchange between these devices is mandatory. Therefore, HIT application need to be support any data format (Data interoperability).
3	Data processing and storage	In the digital age, the amount of data produced every day is fast growing. Processing and storing such data are challenging. Big data computing and data sciences provide the framework and technology to face issues related to the fast-growing data.
4	Data sources integration and aggregation	Many data sources are emerged due to the digital age and technology advancement. The advancement of the Internet provides social media data, wearable technology produces many health data, etc. All these data need to be integrated and aggregated.

Table 1.
Priorities of health-IT [9].

Hospital information systems (HIS)	• Electronic medical record systems (EMRs, EHRs, and PHRs)
	• Clinical decision support systems
	• Computerized disease surveillance and monitoring systems
	• Patient's bed management system
	• Health-care professional management system (HR)
	• Drug management systems
	• Health insurance management systems, etc.

Table 2.
Sub-systems of HIS.

3. Existing eHealth and digital health applications categories (state of the art)

This section presents some existing categories of health-IT applications and some concrete developed and deployed health-IT applications. These applications cover the key areas listed above. They are using Internet technology and services and assist in decision-making, etc.

3.1 Categories of health-IT applications

eHealth applications mostly cover the following areas:

1. *Electronic medical records* (EMR): it is a sub-set of *electronic health records* (EHR) also called federated EMR [12] that includes patient's medical records, digital imaging and archiving systems, e-prescribing, e-booking, and clinical administration systems. Despite that, the use of EMR/EHR could positively impact patient's health outcomes and make the patient care safer [7].

   The adoption of (mobile) patient's medical records is worldwide moderate [11]. Health-care professionals and care units (hospitals, clinics, etc.) possess temporary and non-maintained patient's records. The patient's medical data are dispersed everywhere and thus incomplete at each point. Connected EMR aims at overcoming these issues in bundling the data to a central point.

2. *Telemedicine and telecare services*: telemedicine is a discipline of health informatics that uses HIT to provide health and medical care service a remote. It covers all fields of common health care such as surgery (telesurgery), cardiology (telecardiology), tele-education, and telediagnostics.

   Telemedicine uses technologies like video streaming, voice IP, etc. Its main purpose is to increase health-care accessibility in regions facing poor access to health care by delivering care services to remote patients. Teleconsultation is the most used telemedicine artifact followed by tele-education and teleassistance. Care specialists can use it to assist less experienced health-care professionals.

3. *Health information networks* (HIN): HIN are standards, policies, and services. The objectives of HIN are to secure health information exchange over the Internet. HIN are, therefore, important than medical data, which are sensitive data that need to be protected for reasons such as data integrity prevention.

4. *Decision support tools*: machine learning/deep learning all sub-sets of artificial intelligence (AI) are being involved in eHealth applications to support decision-making. Decision support tools mostly use patient's data as sources and base the analysis on such data. They ease the data analytics and can assist in event medical prediction.

5. *Internet-based technologies and services*: the Internet is the data highway that enables data and information exchange as well as communication between the different actors within a health system.

The Internet of Things is an Internet-based technology that enables us to collect data and transfer them over the Internet to a remote server, where the data will be processed.

3.2 Existing applications

The existing applications are shown in **Table 3**.

System designation/country	Description
EpharmacyNet/Benin	EpharmacyNet is developed for African countries to assist patients and health-care professionals in prescribing and purchasing medicine. LMICs are lacking pharmaceutical products. This situation leads to a phenomenon where the patient needs to go to many pharmacies before purchasing the needed medicine.
Mobile HybriCare[1] Mobile electronic data capture (EDC) system/Germany	Allow fast, simple, and cost-effective recording of patient's data in real time.
eReader/Canada + Kenya	A self-measurement blood pressure device to assist the patient with the daily self-management of his blood pressure and cardiologic condition
Health and hospital information systems/Spain	This system provides a platform to manage patient's information
Maternal and child health mobile services/India	This system addresses maternal neonatal and infant mortality issues in India
Teleophthalmology/India	A system that aids primary eye care
Dry blood spot screening/Spain and Brazil	This system supports early diagnosis prevention of diseases

Source: Ref. [13]. [1]https://www.uni-kassel.de/fb07/?id=38057.

Table 3.
eHealth systems in primary health care (a digest).

4. Trends and technology supporting eHealth systems

This section will present trends and perspectives in eHealth.

4.1 Supporting technologies

A lot of modern information and communication technologies are emerging and the health-care sector is taking benefit of these technologies. Blockchain (BC), artificial intelligence (AI), and Internet of Things (IoT) are the most emerging technologies that find application in health-care service delivery. Big data computing supports computing the huge amount of medical data which ICT systems are producing day by day.

Through the emerging information technologies like AI and big data analytics, the term "personalized medicine" is becoming more important. We are surrounded by huge medical devices, which pervasively collect gapless medical data. So, collected data are accurate and complete since these devices are becoming precise, sophisticate, and powerful. Nevertheless, eHealth is confronting a critical issue called data interoperability. Purposely, HL7—Health Level 7—, a group of international standards, is provided to overcome any interoperability that could occur during data exchange. HL7-FHIR is the standard on top of HL7 to secure patient's medical data. Blockchain is using today to achieve a similar goal, data protection.

4.2 Medical and health care data records (EMR/EHR)

Despite the moderate implementation and use of electronic medical records to manage patient's medical data, each medical unit has a relatively complete patient's medical data record, which is used to collect and process part of the patient's medical data and. These data are used to deliver adequate care. Unfortunately, these data record systems are not interconnected with other systems beyond the given health center. The patient's data are thus dispersed in many small medical records (partially electronic and partially paper-based). Health records, as the superset of all patient's medical records, do not exist.

4.3 Hospital 4.0 and Health 4.0

The model of Industry 4.0 aims to automatically and autonomously collect patient's medical data within a hospital and process them for efficient and effective medical treatment. It relies on machine-to-machine and human-to-machine interactions.

> *Industry 4.0 aims to emphasize the importance of production technology, supporting information, and the communication technology sector [14].*

Hospital 4.0 is supported by modern technologies like the Internet of Things (machine-to-machine—M2M) technology and paradigm, cloud, and fog computing [15], artificial intelligence (AI), mobile network, etc. It comprehends the AI, precision medicine, and telemedicine [16].

Hospital 4.0 initiatives are emerging in developed countries, while developing countries are still facing a digital divide due to their low technical development level.

Health 4.0 like Hospital 4.0 is inspired by Industry 4.0 [17]. According to Mukherjee (2020),

> *The concept aims for virtualization of services, decentralization of records, and personalization for patients, professionals, and other stakeholders leading to the overall improvement of services, through technology. Driven by networked Electronic Health Record (EHR) systems, Artificial Intelligence (AI), real-time data from wearable devices and body sensor networks, and improved data analytics, Health 4.0 is set to completely metamorphose the health-care industry [17].*

Blockchain technology is also used to support Health 4.0/Hospital 4.0 particularly to secure patient's data and information during a data exchange process. The patient's data can be thus protected again by any manipulation.

4.4 Patient's self-management

Self-management of chronic diseases is a sub-set of Healthcare 4.0. The patient can today self-manage his condition through the data provided by surrounded devices like Google-watch, etc. Many self-management applications and systems exist today.

Patients suffering from chronic diabetes and cardiovascular diseases have various medical devices to track their condition daily. Various electronic data capture (EDC) systems exist today. They assist the patient in tracking and collecting data on their condiction. Those data are used by medical doctors to provide data-driven treatment.

5. Discussion and conclusion

Developing countries are putting effort to implement a huge ehealth system to improve access to health-care services in rural. Their effort to launch ehealth aims to improve the quality of health-care services provided. The role of ehealth in patient's health outcomes and its impacts on the care quality are well documented. However, less-developed countries face structural, infrastructural, and financial as well as manpower issues to implement ehealth systems. Many start-ups are raising today and offer low-cost solutions. In Refs. [11, 13], WHO has shown the trends eHealth/mHealth in low-resource settings. Mobile eHealth is emerging in these parts of the world.

This chapter has summarized the trend in eHealth and has pointed out the technologies that support eHealth today.

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