Chapter

Improving Healthcare Access through Digital Health: The Use of Information and Communication Technologies

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Abstract

Healthcare has been going through major digital transformations due to the extensive use of information and communication technologies (ICT) in the sector. Many patients lack access to healthcare services due to lack of knowledge of the exitance of the service, physical or mental disability, distance, siege, lockdown and other possible reasons. Access to healthcare services has been impacted by a number of innovations including electronic health record, artificial intelligence, sensors, wearable devices, Internet of (medical) things, Blockchain, big data and other applications. COVID-19 has created new realities in accessing healthcare services through telehealth and telemedicine services as many countries have imposed lock-down and physical distancing. Digital health has been used to empower people, in general and patients in particular, to enable them to access healthcare services at the point of care or remotely. Healthcare professionals have been using digital health to enhance their knowledge, skills and more important to enable them to reach to patients to provide guidance and assistance. Using digital health solutions has a number of challenges which can be legal, ethical, infrastructural, human and material resources, training, education, attitude, cultural, organizational and behavioral. A number of national, regional and international agencies have adopted resolutions and developed strategies to support digital health implementation in countries. This chapter provides few examples to demonstrate how access to healthcare services is being enabled and facilitated by information and communication technology (ICT) through proper national planning of digital health.

Keywords: Healthcare services, information and communication technologies, eHealth, digital health, artificial intelligence, big data, telehealth, telemedicine, empowerment, patients, COVID-19, national planning

1. Introduction

Access to healthcare means having "the timely use of personal health services to achieve the best health outcomes. It consists of four components:

- Coverage: facilitates entry into the healthcare system. Uninsured people are less likely to receive medical care and more likely to have poor health status.

- Services: Having a usual source of care is associated with adults receiving recommended screening and prevention services.

- Timeliness: ability to provide healthcare when the need is recognized.

- Workforce: capable, qualified, culturally competent providers [1].

In 2001 Gulliford, et al. [2] provided a description of access to health services in which they said "Facilitating access is concerned with helping people to command appropriate healthcare resources in order to preserve or improve their health. There are at least four aspects, they said:

- If services are available, in terms of an adequate supply of services, then a population may 'have access' to healthcare.

- The extent to which a population 'gains access' to healthcare also depends on financial, organizational and social or cultural barriers that limit utilization. Thus, utilization is dependent on the affordability, physical accessibility and acceptability of services and not merely the adequacy of supply.

- The services available must be relevant and effective if the population is to "gain access to satisfactory health outcomes".

- The availability of services, and barriers to utilization, have to be evaluated in the context of the differing perspectives, health needs and the material and cultural settings of diverse groups in society

The Institute of Medicine (IOM) defined access to healthcare "as having timely use of personal health services to achieve the best possible health outcome [3]. According to The Agency for Healthcare Research and Quality's (AHRQ) [4] "access requires gaining entry into the health-care system, getting access to sites of care where patients can receive needed services, and finding providers who meet the needs of patients and with whom patients can develop a relationship based on mutual communication and trust". The National Academies of Sciences, Engineering, and Medicine [5] suggested that "People use healthcare services to diagnose, cure, or ameliorate disease or injury; to improve or maintain function; or to obtain information about their health status and prognosis". Anderson and Newman [6] presented a framework (4th phase) of health-care utilization that includes predisposing factors, enabling factors, and magnitude of illness. The framework suggests that an individual's access to and use of health services is considered to be a function of three characteristics:

1. Predisposing Factors: The socio-cultural characteristics of individuals that exist prior to their illness:

   a. Social Structure: Education, occupation, ethnicity, social networks, social interactions, and culture

   b. Health Beliefs: Attitudes, values, and knowledge that people have concerning and towards the healthcare system

   c. Demographic: Age and Gender

d. Enabling Factors: The logistical aspects of obtaining care:

e. Personal/Family: The means and know how to access health services, income, health insurance, a regular source of care, travel, extent and quality of social relationships

f. Community: Available health personnel and facilities, and waiting time

g. Possible additions: Genetic factors and psychological characteristics

2. Need Factors: The most immediate cause of health service use, from functional and health problems that generate the need for healthcare services.

a. "Perceived" need will better help to understand care-seeking and adherence to a medical regimen,

b. "Evaluated" need will be more closely related to the kind and amount of treatment that will be provided after a patient has presented to a medical care provider.

People go, or more important they do not go to healthcare services for different reasons. Three overarching categories of reasons emerged based on the necessity, availability, and desirability of care-seeking [7]:

1. low perceived need to seek medical care;

2. traditional barriers to medical care, in which people may want to seek care but are limited in their ability to do so; and

3. unfavorable evaluations of seeking medical care, in which people may perceive care-seeking as necessary and an available option, but not desirable.

Some of these reasons relate to the human nature of the people while others relate to the health facilities themselves. People go to these services to seek methods of prevention, protection, diagnosis, treatment, palliative care, education, research and a multiple of other reasons. Healthcare services may be provided in different ways and locations including hospitals in tertiary services, clinical and other professional services, dental services, home healthcare services which are at the increase as more patients move from hospital care to home care, nursing care services at the hospital or at home], pharmaceutical and medication dispensing services in addition to other over the counter medicines.

eHealth is one of the enablers of "access to healthcare services" along with a number of other factors. Social determinants of health represent a collection of factors that interplay in their influence of the health of people and therefore their ability to access health services using digital health technologies. It has become imperative to design and deploy such technologies in the communities to reduce inequity and improve ability to access health services. eHealth has been described as the "... use of information and communications technologies (ICT) in support of health and health-related fields, including healthcare services, health surveillance, health literature, and health education, knowledge and research" [8]. eHealth includes the ICT-enabled components of health informatics, healthcare informatics, medical informatics, biomedical informatics, mobile health (mHealth), and telehealth

and telemedicine, as well as the human and non-electronic components which are essential for these systems to function. Digital health has been extensively used to mean all concepts included in eHealth plus the use of digital devices to capture, monitor and report health data images, and vital signs: body temperature, pulse rate, respiration rate and blood pressure) from individuals and the relevant signs from the environment. The World Health Assembly (WHA) adopted a resolution in 2017 [9] and then a global digital health strategy in 2020. The description provided by the two documents of digital health extensively referred to eHealth as the core component in national eHealth planning, integration of eHealth in health systems, application development, monitoring and evaluation. In a review of definitions of eHealth in 2005, [10] the reviewers found that technology was viewed both as a tool to enable a process/function/service and as the embodiment of eHealth itself. They expressed pleasure to note that technology was portrayed as a means to expand, to assist, or to enhance human activities, rather than as a substitute for them.

A diversified range of areas in which eHealth can be used as many studies indicate [11–13]. Some of these are directed to service providers while others are directly linked to patients. In all cases the ultimate benefit goes to the citizen.

This range of areas may include:

1. Improving access and exchange of information and data;

2. Improve the quality of care;

3. Reduce costs of healthcare;

4. Support research by academic and other researchers;

5. Building evidence for possible policy setting;

6. Safeguard patient empowerment and safety;

7. Health worker training and supervision: Pre-service and in-service and both remote and in-person mixed media training; mobile supervision checklists and observation data collection forms;

8. Data collection and reporting: At the household, community, facility, district, and national level; longitudinal patient tracking (electronic health records), patient registries, disease surveillance, contact tracing, vital events tracking, civil registration;

9. Supply chain management: Cold chain management, commodity tracking, counterfeit detection and prevention, equipment maintenance;

10. Financial transactions: Health savings accounts, insurance payments, provider reimbursements, salaries, per diems, conditional cash transfers, performance-based incentives, electronic vouchers;

11. Health workforce management: Tracking of training, certification, deployment and retention, provider work planning and scheduling;

12. Clinical care: Point-of-care intelligent diagnostics, remote clinical care, remote monitoring of patient compliance and status, clinical decision support (guidelines, algorithms, checklists);

13. Real-time communications: Between managers and providers (e.g., treatment guideline updates, routine health reporting), providers and providers (e.g., referrals, consultations), and clients and providers (e.g., symptom notifications, post-referral follow-up);

14. Public health information and behavior change: Public health education messages, appointment and treatment reminders, health provider point-of-care job aids, health information hotlines.

In a review of definitions of digital health [14], the findings showed that digital health, as has been used in the literature, is more concerned about the provision of healthcare rather than the use of technology. The reviewers added that "Wellbeing of people, both at population and individual levels, have been more emphasized than the care of patients suffering from diseases. Also, the use of data and information for the care of patients was highlighted. A dominant concept in digital health appeared to be mobile health (mHealth), which is related to other concepts such as telehealth, eHealth, and artificial intelligence in healthcare". Improving access to healthcare services: especially in rural and deprived areas with low (or no) availability of healthcare services, eHealth tools can enable remote consultations, therapies and rehabilitation [15].

eHealth and digital health will be used in this chapter interchangeably to mean the "use of information and communication technology in health". They are considered true interdisciplinary sectors that bring knowledge and practices from the fields of computer and information sciences, telecommunications, social sciences, health sciences (medicine, public health, pharmaceutical, dentistry, health management], health services research, communication, law and engineering. Success of eHealth depends on the extent and ability to integrate and function as an interdisciplinary system. Elements and applications of digital health have become an integral part of health services and information delivery. One cannot imagine a health service without the use of one or more of a digital health device or an eHealth application. eHealth is contributing to achieving Universal Health Coverage (UHC) and the Sustainable Development Goals [16]. eHealth has shown to enable national health system that use ICT to ensure that the people are aware of the availability of and accessibility to health services, that people are happy (satisfied) with the services they receive and that a monitoring and evaluation system is in place [17–20].

WHO (2013) [21] describes the goal of UHC as to ensure that all people obtain the health services they need- prevention, promotion, treatment, rehabilitation and palliation without risk of financial ruin or impoverishment, now and in the future. eHealth empowers patients and make services and providers more transparent and providers are become more efficient when they use eHealth technologies to manage or deliver healthcare services.

WHO (2016) [22] confirmed that "It has become increasingly clear that UHC cannot be achieved without the support of eHealth." The results of the Global eHealth Survey conducted by WHO in 2015 in which a total of 125 countries participated provided some key findings based on the themes that were covered in the Survey. These included:

1. More than half of WHO Member States now have an eHealth strategy, and 90% of eHealth strategies reference the objectives of UHC or its key elements. It is becoming mainstream for countries to have policies for managing information.

2. A large number of countries reported at least one mHealth initiative (83%). Despite the rapid growth, however, very few Member States reported

evaluations of government-sponsored mHealth programmes, thereby limiting knowledge of what works well and what mistakes to avoid.

3. By offering care at a distance, telehealth services enable greater equity in health coverage. The use of telehealth continues to grow, and teleradiology is the most widespread (77%). Other services, such as telepathology, remote patient monitoring, and tele-dermatology, are also in use in nearly half of countries.

4. eLearning, which encompasses a variety of interventions in terms of tools, content, learning objectives, pedagogical approaches, and setting of delivery, is used for medical students' and doctors' education in over 84% of countries. Implementation of eLearning is associated with a number of challenges. For example, there is a lack of robust and comprehensive health science eLearning evaluation standards, leading to haphazard evaluation and accreditation of eLearning programmes.

5. National electronic health record (HER) systems are now reported in 47% of countries.

6. In total, 78% of countries reported legislation protecting the privacy of personal information, and 54% reported legislation to protect the privacy of electronically held patient data.

7. Nearly 80% of countries reported that healthcare organizations use social media for the promotion of health messages.

8. 17% of countries already report having a national policy or strategy regulating "big data" use in the health sector.

As healthcare itself is data and information intensive sector it simply means that for this sector to achieve its objectives, it has to collect, exchange and utilize high quality data. Health data has a number of characteristics including:

1. Critical patient data and information remains scattered across different departments and systems;

2. Data is not accessible and handily available in times of need. Too much data, little information;

3. Multiple service providers (public, private, army, charities, etc.) in the system do not have a system in place for smooth process management;

4. Very little or no exchange (sharing) of information on patients, diagnosis, treatments, etc.;

5. Privacy, confidentiality and ownership of personal health data are compromised;

The above has led to potential misuse, no use or underuse of health data. Digital health strategies have become integral parts of the overall public health and health-care delivery system in many parts of the world as health and digital technology

seamlessly integrate. Planning, monitoring and evaluation of digital health have become essential to the health systems strengthening process. These have become part of the health system's resilience and learning. A country cannot afford to have a resilient health system that is responsive to current and future demands without using digital health technology to predict, protect, diagnose, educate and treat. Adopting digital health strategies carries the promise to improve the quality of health services, reduce costs, improve equity of access, and empower citizens in a person-centered healthcare system [23]. Evidence, to prove that all these are attainable at the same time, is still being built. Digital health technologies vary in form and utilization, but have a number of commonalties:

1. They are all made to help/assist healthcare professionals to better collect data, diagnose, educate and treat individuals;

2. They represent serious attempts to replace healthcare professionals in performing tasks that look tedious or dangerous, especially when a disease is difficult to diagnose or treat using traditional means;

3. They may work together to perform a task for the sake of both the healthcare provider and the patient. This simply means more than one technology functions with others to perform the same task of data collection, diagnosis or treatment.

Digital health has adopted a number of other "new" technologies that were not originally designed for the health sector. This has shown that this sector is in a real need for such technologies to enable safe, secure, affordable, timely and equitable access to health services.

2. Range of digital health solutions used to improve access to healthcare

The range of technological solutions that are used to enable access to healthcare services is endless. The attempt here is to provide details of the eHealth/digital health types of applications that are more used rather than the list of technologies themselves. These include:

2.1 Electronic health record

Electronic health record (EHR) is a repository of information regarding the health status of an individual in computer processable form which is collected primarily to support the provision of integrated holistic healthcare to that individual but may also be used, subject to legislation and consent, for secondary purposes that benefit the health of the wider community [24].

The EHR has been one of the most persistent and yet changing technology in healthcare. It's the cornerstone of any electronic health system which influences the rate of success of the digital health services in an institution or even a country. EHR systems come in different forms and sizes aiming at collecting, storing, sharing and utilization of health data by healthcare providers, the patient and other third-party players as the legal and ethical frameworks permit. The complexity of the record's structure, compliance with both semantic and syntactic standards, the interface, open vs. commercial suppliers, language version and many other issues pose challenges to implementation of EHR systems to enable access to health services.

Healthcare institutions may avoid implementing of such systems due to a number of issues they face, which automatically limit access to healthcare services by people (patients and non-patients):

1. Inaccurate patient identification in a record makes it extremely difficult and impractical to offer health services. Absence of a unique number for each patient may cause not only delay in provision of health services but could cause medical errors;

2. Lack of standard terminology and standard data exchange format hamper the efficiency of data exchange due to lack of semantic interoperability. This will cause both delay in service provision, inability to report, cost and more important medical errors;

3. Healthcare professionals, patients and the community have expressed concerns about privacy, confidentiality and the quality and accuracy of electronically generated information. The better secure technology, blockchain for example, legal and ethical awareness may reduce anxiety;

4. Patients may not trust the EHR due to both hardware and software reasons. Interrupted electrical (power) supply, wrong algorithms, lack of training on the system, etc. are all reasons limiting access to healthcare services.

Despite all these challenges, benefits of an EHR system to collectively enable fast and reliable access to healthcare services have been documented. These can be:

1. Health information and data. Immediate access to key information. This would improve caregivers' ability to make sound clinical decisions in a timely manner;

2. Result management. Ability of all providers participating in the care of the patient across multiple settings to quickly access new and past test results. This would increase patient safety and effectiveness of care;

3. Order management. Ability to enter and store orders for prescriptions, tests, and other services in a computer-based system. This should enhance legibility, reduce duplication, and improve the speed with which orders are executed;

4. Decision support. Using reminders, prompts, and alerts to improve compliance with best clinical practices, ensure regular screenings and other preventive practices, identify possible drug interactions, and facilitate diagnoses and treatments;

5. Electronic communication and connectivity. Efficient, secure, and readily accessible communication among providers and patients. This would improve continuity of care, increase timeliness of diagnoses and treatments, and reduce the frequency of adverse events.

6. Patient support. Tools that give patients access to their health records. This would provide interactive patient education and help them carry out home monitoring and self-testing, which can improve control of chronic conditions.

7. Administrative process. Computerized administrative tools such as scheduling systems. This would improve hospital and clinic efficiency and provide more timely service to patients;

8. Reporting. Electronic data storage that employs uniform data standards. This will enable healthcare organizations to respond more quickly to personal, federal, state, and private reporting requirements.

2.2 Telemedicine

Telemedicine is not a new concept but the technology has been extensively used in the last two years due to the corona virus (COVID-19) pandemic. This is not the place to enlist the history of telemedicine as a technology and as a method to enable access to healthcare services remotely. The World Health Organization [2009] defines telemedicine as "the delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities" [25]. Telemedicine and telehealth are two concepts that are exchangeable despite the fact they differ as telemedicine focuses on provision of health services to an individual while telehealth focusses on provision and assessment of healthcare services to a population. In their systematic review, Monaghesh and Hajizadeh (2020) they indicated that "telehealth can become a basic need for the general population, healthcare providers, and patients with COVID-19, especially when people are in quarantine, enabling patients in real time through contact with healthcare provider for advice on their health problems" [26]. The promise and potential of telemedicine have been to provide timely, safe, and less expensive care, where the patient/individual does not need to be in the same place/room with the healthcare provider. This simply means that access to healthcare services does not have to move from where the patient is to get into the point of care. During COVID-19 social/physical distancing, has resulted in radical increase in the use of telemedicine services in all countries. This mode of service was provided to avoid contact between patients and healthcare providers who might have been diagnosed as positive COVID-19 and to ensure continuity of primary or secondary healthcare services and in some case tertiary care. Telemedicine services have been provided to ensure timely access to high quality information and care, including prevention and protection services, provision of public health support, provides a form of patient engagement with other patients, family members and healthcare providers, the more advanced form of support includes screening for diagnosis and disease discovery and supports eLearning for both care providers and recipients [27–29].

2.3 Health on the Internet

A number of concepts are being used to mean information accessed and delivered through the use of the Internet. Among these is the web, which has been defined as "a techno-social system that allows individuals to interact on technological networks, thus improving individual's cognition, communication and cooperation" [30]. Other applications on the Internet include email services and social media platforms. Consumers of health information have found these applications in multilingual forms, easy to access and many of them have been found to be

useful and relevant to their needs. The move from Web 1.0 to Web 4.0 has resulted in providing the end user with more power to control what is being posted and searched on the web using natural language processing. Consumer health, where web developers or owners directly reach out to people poses a challenge of quality of health information, timelessness and possible abuse by predators on the internet [31]. Eysenbach, and Diepgen, [32] provided a number of important issues emerging as a result of failure to control the quality of health information on the internet. They concluded:

1. The quality of information on the internet is extremely variable, limiting its use as a serious information source;

2. A possible solution may be self labelling of medical information by web authors in combination with a systematized critical appraisal of health-related information by users and third parties using a validated standard core vocabulary;

3. Labelling and filtering technologies such as PICS (platform for internet content selection) could supply professionals and consumers with labels to help them separate valuable health information from dubious information;

4. Doctors, medical societies, and associations could critically appraise internet information and act as decentralized "label services" to rate the value and trustworthiness of information by putting electronic evaluative and descriptive "tags" on it;

5. Indirect "cybermetric" indicators of quality determined by computer programs could complement human peer review.

The perceived value of information, the quality, usefulness, the level of trust and the language of the site are factors that influence the level of attraction to use a website to search for health information. The emerging quality management sites such as "Heath On the Net- HON" [33], that provides 8 principles (in 38 languages) to make a judgment of the web site is a good example of how health infuriation consumers may get guidance on quality of health information on the Internet. Meeting these principles will result in a certificate provided by HON to the website. It's important, however, to make sure that searching the web for health information, especially for self-diagnosis is no alternative to consulting ad as specialized healthcare professional as "the immediate and widespread sharing of medical and other scientific information outside of expert circles before it has been thoroughly vetted (eg, preprints) can be dangerous, especially in a pandemic [34].

As early as 1997 [35], the use of health information on the internet has been a major issue for consideration as a way to get information that may lead to further use of healthcare facilities and qualified health workforce personnel, while for others, it has been used as the sole source of information resulting to what has been described by WHO (2020) [36] as the "infodemic" being too much information including false or misleading information in digital and physical environments during a disease outbreak. It causes confusion and risk-taking behaviors that can harm health. It also leads to mistrust in health authorities and undermines the public health response. An infodemic can intensify or lengthen outbreaks when people are unsure about what they need to do to protect their health and the health of people around them. With growing digitization – an expansion of social media and internet use – information can spread more

rapidly. This can help to more quickly fill information voids but can also amplify harmful messages." The use of social media has aggravated the situation due to availability and finding unvetted information.

There are different uses of health information on the web such as:

- Education and awareness for both healthcare providers and citizens;
- Self-diagnosis with all the disadvantages related to this;
- Access to diagnostic result reporting for clinical staff;
- Searching for healthcare sites location, profiles, personnel, services, etc.;
- Searching for health and medical products and services;
- Electronic ordering of laboratory services (pathology, radiology services);
- Patient event history via special forms or email services;
- Discharge letter production;
- Attending an appointment on the internet;
- Searching for health and medical information in books, journals and other information sources.

2.4 Mobile health (mHealth)

mHealth is a medical and public health practice supported by mobile devices, such as mobile phones, smart phones, the Internet, patient monitoring devices connected to mobile phones, personal digital assistants (PDAs), and other wireless devices. mHealth support includes patients, care-takers, pharmacists, or other healthcare providers making use of any digital technology in addition to the devices mentioned above specialized applications called APPs [37]. The top six areas of using mobile phones for health, according to the WHO global survey, include: toll-free emergency, health call centers, appointment reminders, community mobilization, information delivery, mobile telehealth and emergency management systems and mHealth applications [38]. Mobile APPs are software programs that run on smart phones and other mobile communication devices. They can also be accessories that are attached to a smartphone or other mobile communication devices, or a combination of accessories and software [39].

These APPs:

1. Help patients/users self-manage their disease or condition without providing specific treatment suggestions;
2. Provide patients with simple tools to organize and track their health information;
3. Provide easy access to information related to health conditions or treatments;
4. Help patients document, show or communicate potential medical conditions to healthcare providers;

5. Automate simple tasks for healthcare providers; or

6. Enable patients or providers to interact with Personal Health Records (PHR) or Electronic Health Record (EHR) systems.

A very wide range of mobile health APPs is available right now, which helps patients (and non-patients) to access healthcare services and information on their own convenience. There are infrastructural, cultural, legal and ethical challenges. In general, these APPs have been used in areas such as: sports and fitness activity tracking, diet and nutrition, weight loss coaching, pharmacy; sleep cycle analysis, stress reduction and relaxation, meditation, symptom checkers, access to personal health records, digital imaging, electronic chart review, laboratory results review, life scan for patients with diabetes, remote heart monitoring, ECG viewer, oxygen level remote check, telehealth services, prescription management, appointment reminders, International Classification of Diseases (ICD) reference guide, evaluation and management coding, specialized medical reference material, pregnancy and baby development, exercise and fitness, remote dictation, surgery scheduling and interoffice communication.

2.5 Big data

"Big data in health refers to large routinely or automatically collected datasets, which are electronically captured and stored. It is reusable in the sense of multipurpose data and comprises the fusion and connection of existing databases for the purpose of improving health and health system performance. It does not refer to data collected for a specific study" [40]. Leveraging big data to find patterns and predict diseases which helps both medical researchers and health leaders to better understand the disease distribution in a country or a community, which if properly used can contribute to building sustainable healthcare systems, collaborate to improve care and outcomes and eventually increase access to healthcare. It is to be noticed that the major bulk of medical data unstructured and is clinically relevant, that data resides in multiple places like individual electronic medical records (EMR), laboratory and imaging systems, physician notes, medical correspondence, claims, etc. [41]. Accompanied with big data concept is data analytics which is evolving into a promising field for providing insight from very large data sets and improving outcomes while reducing costs. The potential of big data to transform healthcare has been identified [42]. The study of data science and the emerging importance of data as a resource in health have influenced the way that healthcare is being studied and its cost-effectiveness, efficiency, disease prevalence and accessibility are predicted.

2.6 Geographic Information Systems (GIS) for health

Among the major challenges to accessing healthcare services is lack of knowledge of their existence, lack of knowledge of the distance between the place of residence and the healthcare centre and unaffordability to transport to the centre. Brown [43] enumerated five potential benefits of integrating GIS in healthcare IT: identifying health trends, tracking the spread of infectious disease, utilizing personal technologies, incorporating social media and improving (health) services. Brown concluded that "GIS is a powerful tool that has been successfully implemented to help address a number of significant health issues ranging from disease management to improved services". Geolocation technologies for health have made it easier to locate the nearest healthcare centre, provision of the full

profile of the centre and the best method to reach it. Integration of geographic data elements (locations) and the thematic data in a database utilizes the best of the two worlds as it has become possible to locate the place where a specific type healthcare services exists. "GIS plays a critical role in determining where and when to intervene, improving the quality of care, increasing accessibility of service, finding more cost-effective delivery modes, and preserving patient confidentiality while satisfying the needs of the research community for data accessibility [44].

2.7 Blockchain in healthcare

Blockchain in healthcare which has been described as "a distributed system which records and stores transaction records. "... a shared, immutable record of peer-to-peer transactions built from linked transaction blocks and stored in a digital ledger" [45]. It allows to securely transfer the ownership of units of value using public key encryption and proof of work methods [46]. Security and data privacy have been among the major reasons for not trusting a system by the patients. Not trusting a system is one limiting factor to access to healthcare system. Increasing security and trust would encourage more people to come forward to use healthcare systems. For patients, in particular, block chain allows payments through cryptocurrencies, which is becoming a trend in the money market. Patient safety is being monitored through drug traceability, especially tracing of counterfeit medicine. Patient data management as personal health data is growing at a very high rate and from multiple sources, many patients became more conscious that data about them needs to be more secure and less accessible by unauthorized parties.

2.8 The Internet of Things (ToT)

The IoT is described as a network of physical devices that uses connectivity to enable the exchange of data [47–49]. The Internet of Medical Things (IoMT) has allowed patients to stay at home or anywhere and yet provide health data about themselves to specialized centers for monitoring purposes. This amalgamation of medical devices and applications that can connect to healthcare information technology systems using networking technologies meant that patients can still access healthcare services enabled by technology without them leaving their places. Wearable devices for health monitoring are technologies that can be worn on the human body. This type of devices has become a more common part of the tech world as companies have started to evolve more types of devices that are small enough to wear and that include powerful sensor technologies that can collect and deliver information about their surroundings. A wearable device is often used for tracking a wearer's vital signs or health and fitness related data, location, etc. These may include continuous glucose monitoring devices, smart bandages, smart pills and remote patient monitoring, monitoring of patient's movement, dietary system, etc. Adherence to medication helps patients to take medications on time and even inform medical professionals if the patient fails to adhere to medications. In addition to the many advantages to patients, wearables aid healthcare providers in many ways, by simply improving access to healthcare services while having real time health data collection and time saving. Home care and monitoring are provided to many of the aging patients, patients with chronic diseases and those that are for economic or logistic reasons they are advised to stay at home while access to health services is enabled by digital health tools. Hospital to Home Healthcare (H2H) has become the solution of choice and is an integral part of health service delivery system. These technologies have been used to:

a. Reduce unnecessary hospital visits and the burden on healthcare systems by connecting patients to their physicians;

b. Allowing the transfer of medical data over a secure network;

c. Empowering individuals to better control their healthy lifestyle, well-being and fitness;

Landers, et al. [50] suggested four pillars as the key characteristics of the home health agency of the future: patient and person centered, seamlessly connected and coordinated, high quality of care and technology enabled that allows patients to more easily connect with healthcare professionals and receive more intensive services in new settings.

The mobile device (smart phone or an internet connection) connected to a medical device at home and linked to health centre provides the opportunity to send signals related to vital signs of the patient. The functionality of these devices depends on the type/reason for which this device is provided. These may include measuring body temperature, blood pressure, glucose level in the blood, heart beat rate, respiration and air flow in real-time mode, for patients that need kidney dialysis machines.

Medical wearables with artificial intelligence and big data are providing an added value to healthcare with a focus on diagnosis, treatment, patient monitoring and prevention. Access to healthcare is enabled by wearables as these provide a number of advantages. Wearable devices applied to healthcare offer multiple advantages to healthcare professionals as well as the patients [51]:

1. Premature diagnosis. Wearable devices allow the early detection of symptoms thanks to more precise medical parameters;

2. Personalization. The doctor, with the help of a software can quickly create a program based on the needs of the patient;

3. Early diagnosis. Precise medical parameters in the wearable devices allow early detection of symptoms;

4. Remote patient monitoring. Healthcare professionals can monitor patients remotely and in real-time through the use of wearable devices;

5. Control and monitoring of the patient: the medical professionals can monitor the patient's evolution in real time and, if necessary, make changes in the treatment remotely. In addition, patients can also control their health status by connecting the device whenever and wherever they want.

6. Adherence to medication. Wearable devices help patient to take medications on time and even inform medical professionals if the patient fails to adhere to medications;

7. Information registry. The data are stored in real-time, allowing a more exhaustive analysis of the information. This results in a more complete and precise report on the patient's medical history, which can be shared with other medical specialists;

8. Optimum decision by the doctor. The doctor is able to compare and analyze data to make a sharper clinical decision to enhance the patient's quality of life;

9. Saving healthcare cost. Remote healthcare via wearable devices mean saving time and mobility, as it removes the need for the patient to be continuously transferred to the medical center.

It is recognized that some patients require multiple technologies which resulted in the emerging of the technology that tends to streamline data collection, delivery and use. The Internet of Medical Things (IoMT) is an amalgamation of medical devices and applications that can connect to healthcare information technology systems using networking technologies.

2.9 Artificial Intelligence and Machine Learning in Health

According to a World Health Organization's survey (2017) [52], there are still 400 million people who do not even get essential healthcare support and services. Although artificial intelligence (AI) can reduce this number, the only hurdle is its implementation is the need for huge financial support. Among the reasons for this state of affairs is that patients cannot access healthcare services due to a number of social determinants of health. AI provides an opportunity for many of those who cannot access health services to be reached out "virtually" through image recognition and interpretation, diagnostic assistance, generating reminders and alerts and therapy planning. AI brings a number of benefits to the healthcare system, including to patients. It provides fast and accurate diagnostics, it reduces human errors, it contributes to cost reduction as the patient can get doctor's assistance without visiting hospitals/clinics which results in cost cutting. AI assistants provide online care and assist patients to add their data more frequently via online medical records, etc. and it supports the Virtual Presence of patients through telemedicine services which allow specialists to assist their patients who live in remote locations. Using a remote presence robot, doctors can engage with their staff and patients in hospitals or clinics and assist or clear their queries. More recently, WHO released its guidance on "Ethics and Governance of Artificial Intelligence in Health" [53]. The guidance provided the areas of application of AI in healthcare delivery as it has been used in:

1. Diagnosis and prediction-based diagnosis. AI is being considered to support diagnosis in several ways, including in radiology and medical imaging. Such applications, while more widely used than other AI applications, are still relatively novel, and AI is not yet used routinely in clinical decision-making.

2. Clinical care. Clinicians might use AI to integrate patient records during consultations, identify patients at risk and vulnerable groups, as an aid in difficult treatment decisions and to catch clinical errors.

3. Emerging trends in the use of AI in clinical care. The reports indicated that several important changes imposed by the use of AI in clinical care extend beyond the provider–patient relationship. Four trends described in the report are:

   a. the evolving role of the patient in clinical care;

   b. the shift from hospital to home-based care;

   c. the use of AI to provide "clinical" care outside the formal health system; and

   d. use of AI for resource allocation and prioritization.

The guidance also provided other areas in which AI has been contributing including health research and drug development, supporting health systems management and planning and in public health and public health surveillance that includes Health promotion, disease prevention and outbreak response.

2.10 Monitoring, evaluation and quality management of healthcare services

Monitoring is the periodic and ongoing operation to ensure that the healthcare services are on track while evaluation is designed to measure the relevance, efficiency and effectiveness of healthcare services and their impact on the health of people. In both cases quality data is essential and require setting the baseline by which progress or lack of it can be measured. A data system, usually computer-based health information system, that routinely collects and reports information about the delivery and cost of health services and patient demographics and health status. The major purpose of monitoring and evaluation (M&E) is to measure progress aiming at learning and improving the services. Reeve, Humphreys and Wakerman [54, 55] in the Australian context indicated that Integral to improving rural and remote health outcomes is the provision of appropriate, accessible and effective healthcare services relevant to the needs of communities, which requires a mechanism to monitor and evaluate the impact of health services on improving health outcomes for communities.

M&E requires data collection, its storage and analysis which transforms it into information, knowledge and evidence that can be used for making evidence-based policies, decisions and actions. M&E is based on a set of indicators and measurable targets, which makes it necessary to use ICT tools to fulfill these requirements of data collection, its storage, trends analysis, comparison of achievements with targets, evidence creation and application.

Quality of health services is generally understood to mean that, at all levels of a health system, there is an inherent and explicit recognition of the value of efforts to improve the quality of health services provided – and such efforts are systematically promoted within an enabling environment that encourages engagement, dialog, openness and accountability [55].

Fundamental success factors for provision of quality health services [56] were widely considered to be prerequisites for quality health services include: essential infrastructure, health workers and health management information systems and data systems (e.g. availability of quality measures and data collection templates to generate data, computer hardware/software to analyze data and synthesize the findings into actionable information for further improvement).

3. Challenges to digital health implementation

A number of country studies have listed challenges and opportunities of using digital health solutions from legal, ethical, infrastructural, human and material resources, training, education, attitude, organizational, cultural and behavioral points of view [57–66]. These challenges may include:

1. Infrastructure. Stable electric power supply, place to put computers, air conditioning, local area networks, and other logistics to host computers and their programmes;

2. Availability of ICT info-structure including computers, programmes, applications and internet that were designed with users in mind;

3. Connectivity (Internet, telephone lines, or else) represents a major constraint not only at the national level but could be at the local and even community and household level. The Internet penetration rate at global level is 59.5%. Major parts of Africa, for example, the major part of the continent needs access to the internet which creates a considerable obstacle in developing digital infrastructures. The very limited bandwidth in many communities makes it very difficult to download or even to properly access the Internet (web, email, social medial platforms, etc.);

4. Lack of financial incentives and priorities in countries where priority setting in the health field focusses on building hospitals, delivering drugs, caring of people during the pandemic and focusing of health workforce rather than investing in eHealth to serve the sector in a more cost-effective manner. It is believed in many countries that ICT in health is costly and investing in this area might not be the priority and a cost saving measures. The organizational financial, logistic and legislative support coupled with changes in the workflow of patient care may have a real impact of acceptance of technology as more investment in time and resources is being provided;

5. Difficulty in using the ICT for health to provide the necessary support of patients. System operators and patients alike have a sense that technology has potential to improve and is not really doing what it is supposed to do. If that technology is a little bit more user-friendly it could have a better chance of penetration and utilization in the healthcare setting;

6. Lack of well-trained workforce to manage eHealth programmes and projects. Human resources include not only the technicians who should be trained to operate ICT services but also policy-makers, managers and the public at large. Literacy rate that limit acceptance of digital tools to help in managing health resources hampers the progress in this area;

7. ICT professionals are, to a great degree, are disconnected from healthcare professionals. They both work in silos which limits the understanding and disagreement in the common objectives of helping people to get access to and having better healthcare services. Cultural barriers that exists between the ICT professionals, ICT investors, developers, and practicing physicians do exist and limit the potential to make full use of ICT resources for health. The lack of time from the healthcare staff point of view limits the ability to give feedback and utilize the technology;

8. The culture of monitoring, evaluation, creation and use of evidence are missing. The absence of these put a lot doubt in the minds of policy-makers, funders and even the community to accept ICT in health applications. In fact, a number of studies were developed which some of them call for development of M&E frameworks while others call for building and using evidence for eHealth;

9. Seamless integration of technology is health systems at the higher level and the implementation level where, for example the electronic health record or the mobile health application is not an integral part of health services provision. The absence of integration creates silos and a sense this technology is being for the "elite", for "testing" purposes, to comply with a donor wish or even "to enable data collection about patients for use in research and other purposes;

10. Sustainability of eHealth solutions where people get used to a service and then it is stopped as a result of shortage of funding, lack of enthusiasm by managers and lack of leadership and shortage of human resources to manage the investment. Lack of interest by people due to distrust and not meeting their expectations;

11. Data integration supported by interoperability standards is constraints that has been recognized not only by operators but also by patients. The question is why do operators have to fill in the same data more than once in the same healthcare facility? Why do patients have to provide even demographic information in multiple settings? More vicious than this the inability to share data about the same symptom with different codes being assigned to the same disease?

12. Ethical and legal constraints that hamper access to health information including privacy, confidentiality, data ownership and digital divide. The context in which eHealth is being implemented by individuals, communities and countries provides a better understanding of these constraints. Ethics and legal frameworks differ from one culture to the other making the accepted practices in one society not accepted in another which makes it more difficult to generalize among cultures. In their scoping study, James et al. [67] found that "Of greatest challenge to eHealth systems are ethico-legal factors, particularly privacy and research ethics concerns, such as informed and broad consent, secondary uses of data and return of results". The WHO guidance on ethics and governance of AI [68] addressed three parties: Healthcare providers (Ministry of Health and others, the manufactures of AI solutions and the Universal Declaration of Human Rights [69] provides an excellent framework for countries to use as ethical principles are laid down, which strongly promote the concept of "All human beings are born free and equal in dignity and rights." Privacy, confidentiality and personal information are all protected. Digital divide is persisting not only at global level as countries do have access to ICT resources, while others do not enjoy the same privileges. The same divide exists at the community level and at the gender level. All these issues have a serious impact of access to healthcare. One would not expect an individual or a community to have access to health resources if this person or community is deprived from basic human rights and suffers from a digital divide.

4. National planning of digital health

Over 85 countries have developed their national eHealth plans, strategies or policies [70]. It is noted that some of the these are for ICT in general and health is part of that. The toolkit provides a road map for eHealth applications development and services to enable secure, relevant and cost-effective utilization of ICT in health. The national eHealth strategies aim to help the healthcare sector to improve the health outcomes using the ICT resources at the national level while considering fundamental elements in terms of regulatory, governance, standards, human capacity, financing and policy contexts and more important it aims at ensuring coordinated effort by the two sectors: Health and ICT in the country to produce seamless integration of ICT in health sector. This integration results from defining the common threads and links between national health strategies and national ICT strategies, where coordination, compatibility and interoperability of national, sub-national and local plans are considered and the provision of a platform for integration and joint work to develop shared solutions and systems. The national eHealth strategy seeks high level of

transparency, accountability and return on investment to allow for meager resources in a country to be fully used as it supports the rationale and basis for investment in eHealth by the different stakeholders. In most cases the Ministries of Health have a lead role in the development with ministries of ICT and other stakeholders taking part. Other stakeholders may include:

1. The community (patients and no-patients)

2. Healthcare providers in the private sector, non-government organizations and other healthcare providers;

3. Ministry of Information and Communication;

4. Departments of civil registration and national statistics;

5. Legislative bodies and legal authorities;

6. Ministry of Planning/Finance;

7. Academic institutions and research centers;

8. The relevant civil society organizations.

While countries should focus on a range of structured activities that lead to the progressive development of a national eHealth strategy, WHO and the International Telecommunication Union developed the National eHealth strategy toolkit [71] as a tool to be used y countries that already have strategies in place or those that have embarked on development of new strategies. The way forward as provided by the Toolkit suggests:

1. identifying the key health and non-health sector stakeholders who will need to be involved in the development of a national eHealth vision and plan and its subsequent implementation, and engaging with them;

2. establishing governance mechanisms to provide improved visibility, coordination and

3. control of eHealth activities;

4. establishing the strategic context for eHealth. This provides the foundation for the eHealth vision and plan, and enables the government to assess and make informed decisions on whether to pursue opportunities that present themselves from the ICT industry and other stakeholders;

5. assessing the current eHealth environment in terms of the eHealth components that already exist as well as existing programmes or projects that will deliver eHealth capabilities.

5. Conclusion

eHealth and digital health have been in use for many years. COVID-19 pandemic has accelerated the use of information and communication technology. Enabling

access to healthcare during the pandemic has provided an opportunity not only to test the capabilities of health information systems and their delivery mechanisms but also to test their cost-effectiveness, efficiency, acceptance by healthcare providers and patients, compliance with international standards, interoperability and the ethical and legal principles that they use.

New innovations will continue to emerge and the healthcare sector will continue to make full use of these and has its own innovative approaches. All these innovations aim to support the health system to be more resilient and more capable of meeting the demands of people for more cost-effective and secure solutions. The dependence on data for policy development, decision-making and actions in the health sector will be strengthened as more data is being translated into information and knowledge for action.

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