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DIGITAL HEALTHCARE–PROS AND CONS

Mohammad Bajwa

Professor, Health Informatics, University of Maryland Global Campus, Adelphi, United States

ABSTRACT

The Health Information Technology (HIT) has revolutionized the delivery of healthcare in US since its inception in 2004, especially during the last decade. The digital healthcare technology, especially as Electronic Health Record (EHR), has greatly impacted the health information management in US, having transformed the paper-based (analog) medical record to electronic (digital) with the potential to keep health informationform Womb (prenatal) to Tomb (postmortem), called longitudinal health record. EHR functionality has been extended by Health Information Exchange (HIE) technology that has enabled exchange of health information among providers for care coordination and then eHealth Exchange initiative enabling sharing of health information nationally from anywhere, anytime and by anyone authorized. The digital healthcare has recently been supplemented by Telehealth for healthcare delivery to remote areas and the Internet of Health/Medical Things (IoHT / IoMT) as wearable devices to monitor physical activity, health status and manage chronic disease conditions.

KEYWORDS: *E-health Exchange, EHR, Electronic Health Record, Health Information Exchange, Health Information Technology, IoHT, IoMT, Tele Health, Medical Sensors, Wearable Devices*

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INTRODUCTION

Health Information Technology (HIT) or Digital healthcare is the use of technology in improving healthcarethat takes many forms - Electronic Health Record (EHR), Health Information Exchange (HIE), eHealth exchange (formerly Nation-Wide Health Information Network–NwHIN / NHIN), Tele health, wearable gadgets (smart watches, Fit bits), ingestible sensors, Mobile Health (M Health), AI (Artificial Intelligence), and robots. Digital healthcare transformation through these technologies helps providers maintain life-long health record and deliver healthcare in remote areas, and patients can monitor their health status and manage chronic disease conditions.

Digital healthcare is the outcome of Institute of Medicine (IOM)[1]2009 report " To Err is Human: Building a Safer Health System"according to whichup to 98,000 people die in hospitals as a result of preventable medical errors exceeding the combined deaths by motor vehicles, breast cancer and AIDS. According to more recent report from John Hopkins Medicine (2016)[2], 250,000 people die of medical errors in US annually and medical errors currently is the third cause of deaths in US after heart disease and cancer, while another study reports this number as 440,000 (Sipherd, CNBC Report Feb. 02, 2018)[3].

History of Digital Health

The IoM (1999) [1]report highlighted that medical errors occur as "inaccurate or incomplete diagnosis or treatment of disease or a disorder, injury, syndrome, behavior, infection or an ailment and that the most common cause of medical errors is the fragmentation of healthcare system that does not prevent medical errors and thus faulty systems, processes, and conditions lead to mistakes or fail to prevent them". The common medical errors by IoMare classified as "Diagnostics as missed, wrong or delayed diagnosis; failure to employ recommended tests; use of outdated tests, failure to act on the results of diagnostic tests or monitoring; Therapeutic as performance of a procedure, administration of treatment, incorrect dose or method of administration, delay in the treatment or responding to an abnormal test or any other inappropriate care; PreventiveCare as failure to provide prophylactic treatment or inadequate monitoring and failure of communication, equipment failure or system failure".

To mitigate the medical errors reported in 1999 report, the IoM (2001)[4]in their report "Crossing the Quality Chasm: A New Health System for the 21st Century"recommended computerizing the medical record to prevent the preventable medical errors. The IoM recommendations were implemented by the President Bush administration by creating an Office of the National Coordinator for Health Information Technology (ONCHIT or ONC) to oversee the Health Information Technology (HIT) implementation. However, the progress remained meagre till 2009 when President Obama signed Health Information Technology for Clinical and Economic Health(HITECH) Act (2009)[5], part of the ARRA (American Recovery and Reinvestment Act, 2009) which allocated $25.8 billion for HIT to help healthcare providers financially to adopt and effectively utilize Electronic Health Record (EHR).HITECH Act required all healthcare providers to adopt Certified EHR that will be linked regionally (city, state) to create Regional Health Information organizations (RHIOs) which in turn will be interconnected to form eHealth Exchange through Health Information Exchange (HIE) technology (infrastructure to help exchange information between health information systems).

Health Information Technology (HIT) Components

The three envisioned components of the HIT were: EHR (Electronic Health Record), RHIO (Regional Health Information Organizations), and eHealth exchange through HIE (Health Information Exchange). So far, only the EHR has mostly been implemented effectively. As of 2017, 86 % of office-based physicians had adopted EHR of which 80% had adopted a Certified EHR, while this figure for the hospitals was 95 % in 2016 (Health IT, n. di & ii)[6]. There is hardly any information available for the HIE implementation despite initiatives by 50 states and yet no news of eHealth Exchange implementation. The barriers to HIEs included funding, staffing, governance, technical, privacy, and administrative issues (AHRQ, n.d.)[7].

EHR is "electronic record of health-related information of an individual that conforms to nationally recognized interoperability standards and that can be created, managed, and consulted by authorized clinicians and staff across more than one health care organization."(US Department of Health and Human Services, n. d) [8.] Thus, EHR is a longitudinal electronic record of patient's health information form Womb to Tomb. The EHR is a core system that integrates several health-related applications, such as patient management, clinical/medical information system, Lab information systems, radiological information systems, e Prescription and billing as well as contains information on patient's demographics, histories (medical, social, family), lab results, radiological images, vital signs and personal statistics like age and weight, and financial information.

EHR Adoption

As of 2017, 99 % of large hospitals, 93% small rural hospitals, 97 % of medium, 95 % of small urban, and 93 % of critical access hospitals have implemented EHR in US (Health IT, n. d. iii)[6]. The Certified adopted EHRs included Epic (27.7 %), All Scripts (9.44), E Clinical Works (7.48), Next Gen Healthcare (7.48 %), and GE Healthcare (5.16 %). The Office-Based Physicians' adoption of Certified EHR reached 86% (Health IT, n.d. IV) [6]. Three major barriers to EHR adoption outlined by the ONC (2018)[9] included Technical barriers that limit interoperability due to lack of standards, data quality, and patient and healthcare provider data matching; Financial barriers, such as cost of developing, implementing, and optimizing Health IT with changing healthcare environments and Trust barriers since most healthcare providers conceive their patient data as their asset and are reluctant to share to maintain their competitive edge. Additionally, from providers' perspective major barriers to EHR adoption included cost of adopting, maintaining and updating EHR systems, EHR usability and training, loss of work efficiency during training, inadequate time for entering health information, no Retune-over-Investment (RoI)incentive, change in workflow, privacy concerns, legal issues, and behavioral change (Hoyt and Hersh, 2019)[10]

EHR / HIT Pros

According to Health IT (n.d. v)[6], implementation of EHR has yielded several benefits, most salient being"accurate, complete and quick access to health information of patients, reduce preventable medical errors for safer healthcare, Provide Patient- provider interaction and communication, use of E prescription for sending prescriptions directly to Pharmacies avoiding errors resulting from illegible handwritten prescriptions, information on life threatening allergies for emergency staff, complete documentation for coding and billing, and cost reduction through reduced duplication of diagnostic testing". Beside these primary benefits, the secondary benefits of EHR implementation accrue through improved medical chart quality; integration of medical, family and social histories; avoidance of drug related adverse reactions, patient reminders for follow-ups, permit multiple providers access to patient's health information simultaneously, easy locating, filing and copying health information, reduce duplicate writings as in paper medical records. In addition, benefits of EHR comprise aid in practice management for scheduling patients, accurate medical billing with reduced claim denials, elimination of costly storage space, reduction in paper chart materials, reduced transcription, chart pull and storage costs. EHR also provides links to public health systems (registries and communicable disease databases), automatically send information to the government mandated agencies and the accrediting organizations and provides patient education resources and guidance for chronic disease management. Most EHRs also contain real-time Analytical and Clinical Decision Support Systems (CDSS) to help make evidence-based decisions as well as provide access to clinical guidelines and online medical resources for accurate diagnosis and treatment options.

EHR / HIT Cons

Like any other technologies, EHR is a double-edged sword. The common disadvantages of the EHR according to Physician's feedback (Heier, n. d)[11]are too much time spent on entering data not directly related to patient care (82 %), disrupting practice workflow (65%), and disallowing eye contact with the patient during exams (60 %), beside some minor unclassified factors (16 %). Other EHR adversaries comprise financial implications of EHR implementation, maintenance and updating; temporary loss of productivity during implementation and training (20 % in the first month, 10 % in second and 5 % in the third) beside changes in workflow and unintended consequences, such as over dependency on technology and down times and increased medical errors due to incorrect selection of radio buttons and check boxes common to all EHR systems. Still other disadvantages include too many clicks for viewing and entering documentation and too many

alerts (alert fatigue).

One of the greatest fears of the electronic health information both form the patients and providers perspective is the Privacy and Security of Health Information as 27 % global data breaches in 2018 occurred in healthcare against the 14 % in financial sector (Keller, n. d.)[12]. The 5ways to ensure health information security suggested by Keller include control of data accessibility, train employees to recognize potential attacks, take notes of the devices the data passes through, secure wireless network and messaging systems, and any paper record that may contain user login credentials or provide any clue to location of sensitive data. According to Newman (2018)[13] healthcare data security breaches are becoming more common and challenging as stolen healthcare data can fetch 10-times more than the credit cards. The health data breaches reported to the Department of Health and Human Services (HHS) comprised 77 major breaches in 2018 affecting more than a million patients' records and 477 in 2017 affecting 5.6 million patient records. Of these, 30% accounted for the improper access of the healthcare workers, and the others to unencrypted health information and lack of password protection. 58 % of the data breaches involved insiders.The security measures to mitigate these threatsshould comprise training employees to recognize potential threats, monitor devices the data passes through (laptops, tablets, smart phones IoT devices) and secure wireless and messaging systems (Verizon Data Breach Report, 2019)[14].

The potential and shortcomings of EHR have been summed up by Baker's Health IT and CIO Report (2013)[15]as the Good, the Bad and the Ugly. The Good included improved data accessibility anytime from anywhere and by anyone authorized, all information in one place, communication between providers and patients, and preventive health and health management; The Bad comprised lack of interoperability between EHR systems, costly implementation and maintenance, loss of productivity, and increased workload; and the Ugly encompassed HIPAA violations as EHR can provide easier access to sensitive health information with increased risk of privacy and security, empty data fields, and copy and paste functionality.

Health Information Exchange (HIE)

Functionally, the HIE is a technology that facilitates flow of health information between providers' health information systems. It allows clinicians and other healthcare providers to appropriately access and securely share a patient's medical information electronically improving speed, quality, safety and cost of patient care (Health IT, n.d. vi)[6]. According to Health Information and Management Systems Society (HIMSS), HIE provides the capability to electronically move clinical information among disparate healthcare information systems and maintain the meaning of the information being exchanged (HIMSS, 2014)[16]. Types of HIEs vary according to their scope and management: State-wise HIEs are run by the government; the Private or Proprietary focus a single community or network; Hybrid HIEs collaborate between organizations; and Regional HIEs are mostly inter-organizational. Their primary architecture employed in US are Centralized with centrally stored patient care data, Federated comprising inter-connected databases of patents, and Hybrid, an amalgamation of these two (HIMSS, 2014)[16]. Irrespective of the scope and the architectural models of the HIEs, their principal function is data exchange for patient care coordination. HIEs have given rise to Health Information Exchange Organizations (HIOs) that oversee HIEs in accordance with the nationally recognized standards within their jurisdiction. The nation-wide HIEs and RHIOs finally merge into eHealth Exchange, a group of federal and non-federal agencies with the mission of "improving patient care, streamlining disability benefits claims, and improving public health reporting through secure, trusted and interoperable health information exchange" (HIMSS, 2014)[16]. The eHealth Exchange created by the Office of National Coordinator for Health Information Technology (ONCHIT or ONC) in 2004 remained dormant and only received impetus in 2009 under the Health Information Technology for Economical and Clinical Health

(HITECH) Act (2009), a component of American Recovery and Reinvestment Act (ARRA) that provided financial incentives to providers to implement EHRs and allocated funds for the HIEs (Health, IT, n. d. vi)[6] and E Health Exchange.

However, the implementation of the HIEs and the E Health Exchange has been slower than anticipated because of several technical (lack of technical and data quality standards), financial (costs of developing, implementing, and optimizing HIT), and trust (legal and business incentives to keep data from moving as Health information networks and their participants treat individuals health information an asset to gain and maintain competitive advantage) challenges as enumerated by ONC (2018)[17]along with administrative, reporting requirements and usability. To catalyze the adoption of the health information technology (HIT), the government instituted Regional Extension Centers (RECs) to serve communities nationally (Health IT, n. d. viii)[6] on the pattern of Agricultural Extension Centers (AECs) that provided technical help to farmers to grow crops. Consequently, little information is available on the current HIE adoption and progress.

Tele Health

Tele health, Telemedicine and E Health are very broad terms but have the sole purpose of delivering healthcare to remote patients through technologies that permit two-way, real-time interactive communication between the patients and providers. Tele health is considered alternative to the traditional face-to-face provision of healthcare. Tele health is defined as "the use of electronic information and telecommunications technologies to support and promote long-distance clinical health care, patient and professional health-related education, public health and health administration"(Health, IT, n. d. ix)[6]. The common Telehealth applications include Live (synchronous) and Store and Forward (asynchronous) videoconferencing, Remote Patient Monitoring (RPM) and Mobile Health (mHealth). WHO (2009)18 has adopted the broader description of Tele health as "The delivery of healthcare services, where distance is a critical factor, by all health care 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 health care providers, all in the interests of advancing the health of individuals and their communities". Tele health differs from the Telemedicine in that it provides more than just the clinical care services and takes several forms, like teleconsultation, primary care, teleradiology, teleneurology, telepharmacy, telepsychiatry, teledermatological, and virtually every discipline of healthcare including telerobotic surgery. Major advantages of Telehealth for patients are no transportation need and cost, saving in travel and wait times, quick access to healthcare services, and elimination of rural barriers; for the providers, these comprise less practice cost and reduction in practice overheads; and payers benefit in terms of quick access to healthcare with cost saving in the long run as escalation in illness. Despite these benefits, barriers to telehealth include limited reimbursement, limited research showing benefits of Tele health and RoI (Return over Investment), limited availability of high speed telecommunication in remote areas, lack of ability for high resolution medical images, lack of standards and certifying organizations, fear of malpractice, ethical and legal challenges, sustainability and state licensure issues (Hoyt and Hersh, 2019)[10].

Tele health has greatly benefitted from mobile technology, especially the smart phone technology and other mobile devices and is termed as Mobile Health or mHealth. The Global Observatory for eHealth of the World Health Organization defines mHealth as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices" (Hoyt and Hersh, 2019) [10]. The M Health being still in infancy faces several challenges, including interference with medical devices, privacy and security of the stored and wirelessly transmitted health information, lack of standards and quality control, and lack of evidence of usefulness.

Wearable Devices

Another digital healthcare technology is the mushroom growth of wearable devices also called as medical sensors grouped as Wearable Health Technology (WHT) that allows continuous physiological monitoring or biosensing with minimal manual or bodily intervention. The sensors can be integrated into other wearables like garments, glasses, wrist bands, socks, shoes, wrist watches, headphones, and smart phones. Some sensors are even gadgets that can be used as stand-alone. Some devices are multiple digital health sensors integrated with other sensor networks as WBAN (Wireless Body Area Network), a wireless network of interconnected bodily wearable devices to monitor and detect abnormalities as well as perform therapeutic functions. They can also be referred as IoHT/ IoMT (Internet of Health/Medical Things) identical to IoT (Internet of Things) devices. Most of these devices are used for remote monitoring of home healthcare; sports, fitness, and activity tracking; monitoring heart rate, pulse, blood pressure, glucose level, sleep, fetal heart rate and the nervous system; and therapeutic purposes to manage pain, pump insulin or provide respiratory therapy.The salient benefits of the wearable devices accrue from monitoring health status and collecting health data used for patients' health management, although some now provide timely therapeutic functions (e.g., insulin pumps) also. According to Augusta University Medical Center report wearable device registered 89 % reduction in patient deterioration in preventable cardiac and respiratory arrest (Phaneuf, 2020)[19]**.** The global market of wearable devices is expected to grow to $ 57.49 billion by 2025 (Industry Arc, n. d) [20]. Their only few disadvantages surfaced so far are short battery life, inaccurate measurement, and privacy of the health data as being small to tiny, they lack the ability of encryption and use WI-FI or Bluetooth connection for inter-device communication – baits for cybercriminals.

The future of IoHT / IoMT would include AI (Artificial Intelligence); ingestible sensors (E Pills) that are pill-sized devices to monitor internal physiology and act as diagnostic devices sending medical information and images to outside connected devices; nano-devices that beside monitoring human physiology would deliver drugs to targeted areas like cancer cells; connected lenses that would determine tear glucose and eyes diseases; blood clot monitoring sensors to avert heart attacks; nursing and medical assisting robots; smart hospitals, virtual clinics and microsurgery. As more low-cost, low-power consuming wearable and electronic devices become available, the IoHT technology will continue to scale up supporting the use and integration of millions or even billions of devices collecting and sending health data.

REFERENCES

1. *Institute of medicine (IoM). (1999). To Err Is Human: Building a Safer Health System. https://genialebooks.com/ebooks/to-err-is-human-building-a-safer-health-system/.*
2. *John Hopkins Medicine. (2016). http://www.hopkinsmedicine.org/news/media/release/study_suggests_medicine_errors_now_third_leading_cause_of_death_in_the_us.*
3. *Shippard, R. (2018). CNBC Report Feb. 02, 2018: The third leading cause of death in US most Doctors Don't want you to know about: https://www.cnbc.com/2018/02/22/medical-errors-third-leading-cause-of-death-in-america.html.*
4. *Institute of medicine (IoM) (2001). "Crossing the Quality Chasm: A New Health System for the 21st Century" http://cwa.chm.msu.edu/resources/documents/CrossingtheQualityChasm.pdf.*
5. *Health Information technology for Clinical and Economical Heath (HITECH) Act. https://www.hhs.gov/sites/default/files/ocr/privacy/hipaa/understanding/coveredentities/hitechact.pdf.*

6. *Health IT (n.d.). Office-Based Physician Electronic Health Record Adoption https://dashboard.healthit.gov/quickstats/pages/physician-ehr-adoption-trends.php.*
7. *Health IT (n.d.). Hospitals Progress to Meaningful Use by Size, Practice Setting, and Area Type. https://dashboard.healthit.gov/quickstats/quickstats.php.*
8. *Health IT (n.d.). Percent of Hospitals, By Type, that Possess Certified Health IT.https://dashboard.healthit.gov/quickstats/pages/certified-electronic-health-record-technology-in-hospitals.php.*
9. *Health IT (n.d.) Quick Stat.https://dashboard.healthit.gov/quickstats/quickstats.php.*
10. *Health IT (n.d.). What are the advantages of electronic health record? https://www.healthit.gov/faq/what-are-advantages-electronic-health-records.*
11. *Health IT (n.d.). What is HIE. https://www.healthit.gov/topic/health-it-and-health-information-exchange-basics/what-hie.*
12. *Health IT (n. d.). State Health Information Exchange. https://www.healthit.gov/topic/onc-hitech-programs/state-health-information-exchange.*
13. *Health IT (n. d.). Regional Extension Centers. https://www.healthit.gov/topic/regional-extension-centers-recs.*
14. *Health IT (n. d.). Telemedicine and telehealth. https://www.healthit.gov/topic/health-it-initiatives/telemedicine-and-tele health.*
15. *Agency for the Healthcare Research and Quality (AHRQ) (n.d.). Health Information Exchange.https://digital.ahrq.gov/ahrq-funded-projects/emerging-lessons/health-information-exchange.*
16. *US Department of Health and Human Services (DHH) (n.d.). National Library of Medicine (NIH). https://www.nlm.nih.gov/services/queries/ehr.html.*
17. *ONC (2018). Barriers to EHR Adoption. (ONC Annual Update 2018).*
18. *(https://www.healthit.gov/sites/default/files/page/2018-12/2018-HITECH-report-to-congress.pdf).*
19. *Hoyt, R. E. and Hersh, W. R. (2018). Health Informatics: Practical Guide, 7th Ed. American Medical Information Association (AMIA).*
20. *Heier, E. (n.d.). Key Benefits of Electronic Health Records. https://www.selecthub.com/medical-software/benefits-of-ehr-systems/*
21. *Keller, J. (n.d.). 5 Ways to Maintain Better Healthcare Information Security. https://www.selecthub.com/medical-software/5-ways-maintain-healthcare-information-security / Newman, D. (2018). what is Not Working Well in Healthcare IT? Disadvantages of EHRs. Verizon (2019). 2019 Data Breach Investigation Report. https://enterprise.verizon.com/resources/reports/2019-data-breach-investigations-report.pdf.*
22. *Becker's Hospital Review (2013). https://www.beckershospitalreview.com/healthcare-information-technology/electronic-health-records-the-good-the-bad-and-the-ugly.html.*
23. *Health Information and Management Systems Society (HIMSS). 2014. What is Health Information Exchange? https://www.himss.org/resources-faq-health-information-exchange-hie.*

24. *Office of National Coordinator for Health Information technology (ONC). 2018. 2018 Report to Congress. https://www.healthit.gov/sites/default/files/page/2018-12/2018-HITECH-report-to-congress.pdf.*

25. *World Health organization (WHO). (2009). Telemedicine: opportunities and developments in Member States: report on the second global survey on eHealth. https://www.who.int/goe/publications/goe_telemedicine_2010.pdf.*

26. *Phaneuf, A. (2020). Latest trends in medical monitoring devices and wearable health technology. https://www.businessinsider.com/wearable-technology-healthcare-medical-devices 17.*

27. *Industry ARC. (n.d.). Wearable Technology Market - Industry Analysis, Market Size, Share, Trends, Application Analysis, Growth and Forecast 2020–2025. https://www.industryarc.com/Research/Wearable-Technology-Market-Research-504119.*