CURRENT EVIDENCE

Introduction to Digital Health

BENEFITS AND CHALLENGES

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What is Digital Health?

Digital health is defined as the use of information and communications technologies in medicine and health to manage illnesses and to promote wellness.

Digital health is gaining more attention due to the unmet need of healthcare as a result of:

- Ageing population
- Rising costs of healthcare
- Worsening of income disparity
- Increased child morbidity & mortality
- Emerging of new epidemics & pandemics
- Racial discrimination on access to healthcare

Different authorities (or countries) have different methodologies in classifying digital health technologies, as demonstrated by:

- WHO Digital Health Intervention Classification
- United States Food and Drug Administration (FDA) Classification
- French National Authority for Health Classification
- National Institute of Health and Care Excellence (NICE) Classification

Unfortunately, none of the above taxonomy provides a clear and comprehensive classification due to emerging and multifunction nature of digital health technologies. As such, we propose a new classification of digital health technologies, which comprise of the nine domains as follows:

- Health Information Technology
- Mobile Medical Applications
- Wireless Medical Device
- Telemedicine
- Artificial Intelligence
- Software as a Medical Device
- Medical Device Data Systems
- Virtual Reality
- Augmented Reality

Below are the nine domains of digital health technologies with their respective benefits and challenges during implementation:

Health Information Technology

Defined as hardware, software, integrated technologies or intellectual property that are designed to support health care entities or patients for the creation, maintenance, access, or exchange of health information.

- Health IT includes:
  - ✓ Electronic medical record (EMR)
  - ✓ Electronic health record (EHR)
  - ✓ Health information exchange (HIE)
  - ✓ Health databases (e.g., MyHix, MyHDW)

- **Benefits of Health IT:**
  - ✓ Providing accurate, up-to-date, complete, and easy-access information about patients at the point of care.
  - ✓ Securely sharing electronic information with patients and other clinicians.
  - ✓ Enabling safer and more reliable prescribing (reduce medication error).
  - ✓ Helping providers improve productivity and efficiency.
  - ✓ Reduce costs through decreased paperwork and reduced duplication of testing.

- **Challenges during implementation:**
  - ✓ High cost of implementation: hardware, software set-up costs, implementation assistance, staff training, ongoing network fees, and maintenance.
  - ✓ Staff resistance: Medical staff may show reluctance to adapt to the technology due to lack of awareness or an inconvenient interface and functions.
  - ✓ Time-consuming (training): Prior to deploying the system, the staff needs to be given thorough training about the new workflow. Thus, physicians have to spend extra time and effort to understand the new system.
  - ✓ Data privacy: concerns of the patient community as well as the provider.
  - ✓ Data migration: It is a logistical nightmare for the staff to export or transform paper-based documents into the digital records.
  - ✓ Limitation of technical resources: This is often faced by small clinical establishments and private health practitioners who rarely own an in-house technical team and hardware to equip the health IT solution.

Mobile Medical Applications (mHealth)

Mobile medical app (or mHealth) is a term used for the practice of medicine and health using mobile devices.

mHealth applications use mobile devices in collecting community and clinical data, delivery/sharing of healthcare information for practitioners, researchers and patients, real-time monitoring of patient vital signs, as well as training and collaboration of health workers.

- **Benefits of mHealth:**
  - ✓ Improve on clinical outcomes by allowing continuous health monitoring: Most of the fitness apps (e.g., MyFitnessPal, Apple Health) come with the capability to monitor heart rate and blood pressure. These realtime health information allow doctors to track the progress of diseases and the effects of the treatment on the patient.
  - ✓ Improved patient health: Apps are available to help patients being complaint to medications as per the doctor's prescription by alerting people about taking drugs at the right time and right dosage (e.g., Medisafe Pill Minder). Some apps enable users to track sleep and reminder for daily calorie intake.
  - ✓ Healthcare cost reduction by enabling remote treatment: Consultation, dietary suggestions, and exercise regimens can be conducted and report can be produced right through the mobile apps. This saves all the trouble, time, and costs for any visit to medical facilities.
  - ✓ Effective prevention, disease surveillance and quick response to disease outbreaks: mHealth helps to trace and control the spread of communicable diseases (e.g., MySejahtera).
  - ✓ Improvement of public awareness: mHealth promote awareness among the community (e.g., organ donation, early detection of cancer, vaccination program).

- **Challenges during implementation:**
  - ✓ Data security and privacy: mHealth has not shown strong evidence of patient data confidentially which is a grievous militant against success because data capture, storage and retrieval are not securely handled.
  - ✓ Network access: Network coverage is not evenly distributed with very bad signal in some rural areas, meaning mHealth cannot be operational in such places.
  - ✓ IT Illiteracy: Lack of education (lack of understanding and confusion) for technology and its adoption which leads to low uptake.
  - ✓ Policy and regulation: There is currently no specific legislative or regulatory framework in Malaysia that defines the terms "digital health". In Malaysia, digital healthcare products or medical devices are primarily governed by the Malaysian Medical Device Act, 2012.

Wireless Medical Device

Wireless medical devices, or wearable technology are smart electronic devices that are worn close to and/or on the surface of the skin.

They detect, analyze, and transmit information concerning body signals (e.g., vital signs) and/or ambient data and which allow immediate biofeedback.

They come in many forms, including smartwatches, head mounted displays, smart jewelry, smart clothing, epidermal electronics.

- **Benefits of wireless medical device:**
  - ✓ Closer monitoring to patients' condition: Wearable technologies are used to gather health data from patients remotely. Hence, doctors no longer need to have their patients come into the clinic to collect the necessary data. This data lead to better treatment plans and patient monitoring.
  - ✓ Easy to use: Wearable technology is handy, smart, comfortable to wear, easy to setup, and user friendly.
  - ✓ Valuable for elderly: Smartwatches have medical alert systems with built in fall and heart attack detection that automatically contacts the emergency services. They also come with features to provide reminders for important times such as when to take medication.
  - ✓ Encourages fitness: Using wearables to track fitness goals can encourage the community to exercise more and promote healthy living.

- **Challenges during implementation:**
  - ✓ Skills and knowledge required: Although wearables can perform ECG, the result may be unsatisfactory if the device is not applied carefully. Even if patient capture ECG successfully, the results would still need to be interpreted by a physician.
  - ✓ Data security concerns: Wearables collect personal and confidential data which may be misused by the app developers.
  - ✓ Capabilities are limited: Although the functionalities of wearables have been expanded, it is worth noting that many functions of the wearables are still dependent on smartphones to be able to work.
  - ✓ Expensive: Current available wearables can be relatively expensive and some apps need to be purchased. As a result, the communities from lower socioeconomic status are unable to enjoy all the benefits.

Telemedicine

Telemedicine is the practice of medicine using technology to deliver care at a distance.

- **<u>Benefits of telemedicine:</u>**
  - ✓ Improved access to healthcare: Telemedicine provides healthcare services for patients with a lack of transport, lack of mobility, lack of funding, quarantined due to disease outbreaks, or from rural area.
  - ✓ Higher patient engagement rates: Online consultation, appointment booking, and reminders help patients to be more engaged in their care. This also reduces the risk of exposure and anxiety during office visits.
  - ✓ Better patient outcomes: Closer monitoring for diabetes, high blood pressure, heart disease, musculoskeletal problem and behavioral health produces better health outcomes.
  - ✓ Reduce hospital burden: Telemedicine may help solve increasing shortages of healthcare professionals and to reduce hospital visits.
  - ✓ Cost-cutting for patient and healthcare facilities: Telemedicine enable more efficient care at lower cost (reduce the time and distance required for treatment).

- **<u>Challenges during implementation:</u>**
  - ✓ Lack of acceptance among healthcare providers: lack of desire or unwillingness among some physicians to adapt clinical paradigms for telemedicine applications.
  - ✓ Reimbursement: Medicaid and Medicare did not reimburse the use of telemedicine at the same level as traditional on-site visits.
  - ✓ Security measures: Early in the pandemic, it became clear that Zoom, for example, was not robust enough to abide by HIPAA security standards.
  - ✓ Lack of awareness: If patients are unaware of the telemedicine option, they may never request it.
  - ✓ Lack of IT literacy: Patients may not have the technology required to make effective use of telemedicine. The ageing community may have trouble using technology.

Artificial Intelligence (AI)

Artificial intelligence (AI) is the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions.

It exhibits traits associated with a human mind such as learning and problem-solving.

- There are 6 major branches of AI:
  - ✓ Machine learning (ML) - supervised ML, unsupervised ML, semi-supervise ML, reinforcement ML
  - ✓ Neural network (Deep Learning)

- ✓ Natural Language Processing (NLP)
- ✓ Fuzzy logic
- ✓ Expert systems
- ✓ Robotics

- **Benefits of AI:**
  - ✓ Better data-driven decisions.
  - ✓ Increased disease diagnosis efficiency.
  - ✓ Reduced time required for treatment.
  - ✓ Create time-saving administrative duties of healthcare professionals.
  - ✓ Integration of information.
  - ✓ Reduced unnecessary hospital or clinic visits.
  - ✓ Better patient care at reduced costs.

- **Challenges during implementation:**
  - ✓ Reluctance among medical professionals to adopt AI.
  - ✓ Integration of data is complex, which can result in missing and disparate data.
  - ✓ Challenges such as trust issues among patients.
  - ✓ Talent shortage (specific skills and knowledge needed to succeed with AI).
  - ✓ Fear of job replacement and increased unemployment (i.e., concern that computers will replace physicians and staff).
  - ✓ Less human interaction and affectionate care.
  - ✓ Concern regarding data privacy (data usage could be interpreted as an
  - ✓ infringement of a patient's right to privacy).
  - ✓ Difficulty in learning a new technology in the workplace.
  - ✓ High initial capital requirement (high development costs).
  - ✓ Lack of curated healthcare data (lack of database for "learning").

Software as a Medical Device (SaMD)

Software as a Medical Device (SaMD) is a standalone, independent software intended to be used for medical purposes that function without being part of a hardware medical device.

Nonetheless, it may require non-medical devices like tablets, smartphones, smartwatches, or computers in order to run correctly.

- **Benefits of SaMD:**
  - ✓ Improved health outcomes: SaMD amplifies the effectiveness of existing treatment by enabling easy and fast collection of high-quality data, which leads to better health outcomes.
  - ✓ Cost-effective: SaMD enhances and builds on existing medical device functionality through software solutions that are faster, and often cheaper to updatethan hardware.

- **Challenges during implementation:**
  - ✓ Difficult to integrate and adapt: Difficult to integrate and adapt: SaMD is hard to adapt to ever evolving technology.
  - ✓ Security of the software: Cyber attacker to remotely take control of the device, change its functionality and affect the safety or effectiveness of the device, or leak confidential information.

Medical Device Data Systems (MDDS)

Medical Device Data Systems (MDDS) are hardware or software intended to transfer, store, convert formats, and display medical device data. It does not modify the data or modify the display of the data, and it does not by itself control the functions of other medical device.

It generally run-on computers or server platforms for the purpose of making their stored data more widely available.

- **Benefits of MDDS:**
  - ✓ Versatility (supports a long list of medical devices).
  - ✓ Reduce data entry errors (send data directly to EMR).
  - ✓ Improve productivity and save time (healthcare providers can spend time providing care, instead of performing manual data entry).

- **Challenges during implementation:**
  - ✓ High cost (the cost of developing and maintaining a MDDS is a major concern. In addition, the need of an extensive expertise make MDDS development a great expense).
  - ✓ Data privacy (connected devices are vulnerable to deliberate attacks as well as undirected malware).
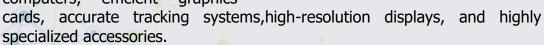
Virtual Reality (VR)

Virtual reality (VR) uses head-mounted display, smart glasses, and/or haptic gloves to generate realistic images, sounds and other sensations that simulate a user's physical presence in a virtual environment, enabling a person to interact with virtual environment.
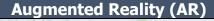
- **Benefits of VR:**
  - ✓ Can be used remotely (training for medical staff can be done off-site).
  - ✓ Easy to use.
  - ✓ Can be used to collect data (e.g., measuring movements of rehabilitating patients or the accuracy of motor skills of surgeons in training).
  - ✓ Can be used for training (optimally train medical staff on surgical skills so that fewer mistakes to be made on real patients).

- **<u>Challenges during implementation:</u>**
  - ✓ Reduced face-to-face communications: The use of VR to perform rehabilitation exercises at home without direct supervision of the healthcare provider could have undesirable outcomes.
  - ✓ Cost: Establishing and developing VR programs requires high-quality hardware, high-speed computers, efficient graphics cards, accurate tracking systems, high-resolution displays, and highly specialized accessories.
  - ✓ Reluctance: People who are unfamiliar with IT may also resist the use of new technologies.
  - ✓ Side effects: Cybersickness, perceptuomotor aftereffects, headaches, eye strain, and addiction have been reported as the potential side effects after prolonged exposure to VR.

Augmented Reality (AR)

Augmented reality (AR) is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information.

AR alters one's ongoing perception of a real-world environment, whereas VR completely replaces the user's real-world environment with a simulated one.

- **<u>Benefits of AR:</u>**
  - ✓ Enhance the learning experience in medical training.
  - ✓ Increase accuracy and efficiency for surgery and medical procedures (e.g., venepuncture and ultrasound guided needle placement).

- **<u>Challenges during implementation:</u>**
  - ✓ Same as VR.

If you are interested to be part of our digital health research initiative, we welcome you to join our upcoming events as follows:

Dates	Topics	Speakers
4th August 2022	Applications of AI and ML in healthcare and their challenges (a tea session with discussion)	Faculty of Computer Science and Information Technology, Universiti Putra Malaysia
October 2022	Applications of telemedicine and its challenges	To be confirmed
December 2022	Applications of mHealth and EMR and their challenges	To be confirmed
February 2023	Applications of wearable technology in healthcare and its challenges	To be confirmed
April 2023	How to deal with big data in healthcare (with hands-on)	To be confirmed
June 2023	Data mining in healthcare databases (with hands-on)	To be confirmed
August 2023	Mobile apps development (with hands-on)	To be confirmed