Digital Health Innovations: Transforming the Dynamics of Healthcare Delivery and Patient Outcomes

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Introduction

The world is evolving at a faster pace. The advent of the Industrial Revolution, which began in the 18th century, has reverberated and impacted the world dramatically. What would take several hours just a few decades ago can now be done in milliseconds. Interestingly, the healthcare industry is also one of the direct beneficiaries of the ripples.

For example, it might be interesting to know that the arterial blood pressure measurement, which has become a household test today, actually began as an invasive procedure requiring extensive cannulation in the 18th century. And just two decades ago, aneroid sphygmomanometer paired with a stethoscope was the sole machine of choice for blood pressure readings. (Tsyrlin *et al.,* 2016).

Ranging from medicine design and innovations, drug production and administration, patient diagnosis, testing, care, to health information system management, the integration of digital health innovations has stamped an indelible mark on global healthcare delivery.

The impact and extent of this integration have become so disruptive that it now raises some concerns among professionals, especially on the basis of patients' safety and effectiveness

Definitions

Digital Health:

The field of knowledge and practice associated with the development and use of digital technologies to improve health (WHO).

Digital health expands the concept of eHealth to include digital consumers, with a wider range of smart devices and connected equipment. It also encompasses other uses of digital technologies for health, such as the Internet of Things (IoT), artificial intelligence, big data and robotics (WHO).

eHealth:

The cost-effective and secure use of information and communications technologies in support of health and health-related fields, including health care services, health surveillance, health literature, and health education, knowledge and research

Concept of Digital Health Innovations and Adoption

Compared to other scientific innovations and breakthroughs, digital health evolution has enjoyed less stiffened criticism and rejection; most digital innovations have rather witnessed a generous acceptance and adoption across the continents.

At the 73rd World Health Assembly of 2020, the World Health Organization launched a Health Technology Strategy Plan for 2020 -2027. The strategy was founded on the fact that “there is a growing consensus in the global health community that the strategic and innovative use of digital and cutting-edge information and communications technologies will be an essential enabling factor towards ensuring that 1 billion more people benefit from universal health coverage, that 1 billion more people are better protected from health emergencies, and that 1 billion more people enjoy better health and well-being.”

The vision of the strategy is “to improve health for everyone, everywhere by accelerating the development and adoption of appropriate, accessible, affordable, scalable and sustainable person-centric digital health solutions to prevent, detect and respond to epidemics and pandemics, developing infrastructure and applications that enable countries to use health data to promote health and well-being.”

Major Digital Health Innovations

A. Telemedicine and Telehealth:

The use of electronic information and communications technologies to provide and support health care when distance separates the participants (Institute of Medicine).

Or the remote delivery of healthcare services—including consultations, diagnoses, and medical monitoring—using electronic communications like video calls, phones, or messaging

Advantages/uses

- Remote consultations
- Virtual clinics
- Remote patient monitoring
- Resourceful tools during pandemics such as COVID-19

B. Mobile Health Applications (mHealth)

Health-based mobile apps are downloadable software that can use data collected by smartphones for health functions (e.g., diagnosis, monitoring, treatment). Specific to mobile devices, the FDA defines mobile medical apps as mobile-based software that can be used as an accessory to an already regulated medical device or that intends to transform the mobile device into a regulated medical device.

With over 5.7billion people using smartphones across the globe, Mobile health apps have become a new playfield for myriads of innovative health meters (Keith Carlson, 2025). In their overview on smartphone apps, Charlotte Wells and Carolyn Spry observed that there are over 350,000 mobile applications available for download in app stores, used for a variety of disease areas. These areas include chronic disease, stress, mental health, fitness, sleeping problems, general medication adherence and tracking, and vital sign measurements.

They also discovered that health apps often fall into 1 of 4 categories: informational applications, diagnostic applications, disease management applications, and fitness tracking applications.

They stated that smartphones can collect data related to fitness (e.g., number of steps walked or flights of stairs climbed), weight, breathing, heart rate, and location. Some phones have built-in or pre-downloaded health apps (e.g., Apple health, Samsung health, Google fit), and as mobile technology improves, smartphones are being equipped with more built-in tracking features. For example, starting in 2021, Google Pixel phones have the capability to measure a user's heart rate and respiration using the phone's camera.

Some mobile apps require additional non-medical device wearables to function or provide increased capabilities. For example, fitness trackers such as Fitbits, Garmin watches, Samsung watches, and Apple watches can measure heart rate and heart rate variability, blood oxygen saturation levels, activity levels, sleep quality and quantity, electrodermal activity, and skin temperature, which then feed the data into specific apps for tracking. The difference in accuracy of certain data between wearable trackers and phone-only trackers (such as the number of steps taken) is disputed, but wearable trackers can often provide greater functionality for collecting different types of health data. However, the use of wearable technology can be cost-prohibitive for many people, and so phone-based tracking may be a viable solution for many individuals. Other apps do not automatically collect health data, but may require a person to fill in data manually into the app.

Advantages of Mobile Health Apps

- Remote Accessibility: Overcomes geographical barriers, allowing users in rural or hard-to-reach locations to connect with healthcare providers without travelling.
- Enhanced Patient Engagement: Empowers individuals to actively participate in their well-being by tracking vital signs, medications, and lifestyle habits.
- Improved Efficiency: Saves time for healthcare professionals through optimized scheduling, mobile charting, and secure messaging
- Cost & Time Reduction: Cuts down on in-person clinic visits, lowering healthcare delivery expenses and minimizing wait times.
- Data-Driven Care provides doctors with continuous, real-time health metrics to make faster, highly personalized diagnoses and treatment decisions.

C. Artificial Intelligence in Healthcare

Artificial Intelligence (AI) refers to the science and engineering of making intelligent machines through algorithms or a set of rules, which the machine follows to mimic human cognitive functions, such as learning and problem solving.

In the words of Satya Nadella, the chief executive officer of Microsoft: "AI is perhaps the most transformational technology of our time, and healthcare is perhaps AI's most pressing application."

AI systems have the potential to anticipate problems or deal with issues as they come up and, as such, operate in an intentional, intelligent and adaptive manner. AI's strength is in its ability to learn and recognise patterns and relationships from large multidimensional and multimodal datasets; for example, AI systems could translate a patient's entire medical record into a single number that represents a likely diagnosis (Bajwa *et al*., 2021).

In their article titled Artificial intelligence in healthcare: transforming the practice of medicine, Bajwal and colleagues noted that "despite more than a decade of significant focus, the use and adoption of AI in clinical practice remains limited, with many AI products for healthcare still at the design and develop stage. While there are different ways to build AI systems for healthcare, far too often there are attempts to force square pegs into round holes, i. e find healthcare problems to apply AI solutions to without due consideration to local context (such as clinical workflows, user needs, trust, safety and ethical implications)."

AI represents several subfields (such as machine learning and deep learning) that, individually or in combination, add intelligence to applications. Machine learning (ML) refers to the study of algorithms that allow computer programs to automatically improve through experience. ML itself may be categorised as 'supervised', 'unsupervised' and 'reinforcement learning' (RL), and there is ongoing research in various sub-fields including 'semi-supervised', 'self-supervised' and 'multi-instance' ML.

- Supervised learning leverages labelled data (annotated information); for example, using labelled X-ray images of known tumours to detect tumours in new images.
- ‘Unsupervised learning’ attempts to extract information from data without labels; for example, categorising groups of patients with similar symptoms to identify a common cause.
- In RL, computational agents learn by trial and error or by expert demonstration. The algorithm learns by developing a strategy to maximise rewards. Of note, major breakthroughs in AI in recent years have been based on RL.
- Deep learning (DL) is a class of algorithms that learn by using a large, many-layered collection of connected processes and exposing these processors to a vast set of examples. DL has emerged as the predominant method in AI today, driving improvements in areas such as image and speech recognition.

Advantages/uses

- **Diagnostics & Imaging:** Foundation models analyze medical images (like X-rays, MRIs, and CT scans) with high precision, often spotting early signs of cancer or cardiovascular conditions that the human eye might miss.
- **Personalized Medicine:** AI sifts through vast sets of patient data to tailor specific treatment plans and predict high-risk medical events.
- **Administrative Automation:** Generative AI is heavily used for documentation—such as creating visit notes, care plans, and discharge instructions—which heavily reduces the administrative burden on clinical staff
- **Robotics & Surgery:** AI-driven robotics assist with complex surgeries and support rehabilitation
- Predictive analytics
- Drug discovery
- Clinical decision support systems

D. Wearable Health Technologies

Wearable health technology refers to electronic devices that are close to or worn on a body part or embedded in clothing or accessories, which detect and collect data through retrieval methods. It uses the miniaturization of sensors and the integration of network connectivity and predictive analytics to automatically capture, transmit, and analyze biometric information.

These intelligent devices not only play a role in disease diagnosis and treatment but also promote health improvement. They actively record physiological parameters and monitor metabolic status, providing valuable information for personal health management and clinical care [6]. Wearable devices play a crucial role in tracking health conditions, remote health monitoring, and ongoing treatments [7]. By providing real-time data, these devices enable early detection of health issues, promote independent living, and encourage healthy behaviours (Sun *et al*., 2025)

Advantages/Uses

• Continuous Monitoring: Captures real-time health data over days or weeks, allowing doctors to spot trends and abnormalities that a brief in-office visit might miss.

• Proactive Disease Management: Empowers patients with conditions like hypertension or diabetes to easily track their health at home.

• Remote Care & Telehealth: Allows healthcare providers to monitor high-risk patients and seniors remotely, expanding care access and reducing hospital readmissions

E. Electronic Health Records (EHRs)

Electronic Health Record (EHR) is defined as an electronic system that enables the storage, retrieval, and modification of patient data across various healthcare settings, facilitating the electronic exchange of information such as medical history, medications, and laboratory results. EHRs are promoted as tools to improve care efficiency and standardization while addressing issues related to patient privacy and data security (Science Direct).

In their published article of 2012, Seymour and friends posited that electronic health records will improve clinical documentation, quality, healthcare utilization tracking, billing and coding, and make health records portable. The core components of an electronic health record include administrative functions, computerized physician order entry, lab systems, radiology systems, pharmacy systems, and clinical documentation.

The benefits of an electronic health record include a gain in healthcare efficiencies, large gains in quality and safety, and lower healthcare costs for consumers.

Electronic health record challenges include costly software packages, system security, patient confidentiality, and unknown future government regulations. Future technologies for electronic health records include bar coding, radio-frequency identification, and speech recognition (Seymour *et al.,* 2012).

Advantages/uses

- Digital patient data management
- Improved communication among healthcare professionals
- Reduction in medical errors

Other health technology innovations include

F. Internet of Medical Things (IoMT), which refers to a network of interconnected medical devices and systems that collect, analyse, and transmit health data. This technology revolutionises healthcare by enabling remote patient monitoring, diagnosis, and treatment, offering continuous monitoring, timely interventions, and personalised treatment plans. This has been noted for its numerous advantages, including simulating a smart hospital and real-time patient monitoring.

G. Robotics and Automation: This involves technologies that design, build, and program machines to perform tasks with minimal human intervention. They boost productivity, enhance safety, and combat labour shortages. While automation controls processes on autopilot (like software and conveyor belts), robotics provides the physical machines that execute these jobs. Examples of this include robotic surgery, automated laboratory systems, automated dispensing systems, rehabilitation robotics, and blockchain technology in healthcare. The advantages include data security, patient privacy, and secure sharing of medical records.

Conclusion:

With litany and abounding technological innovations within our reach, we may be living in the most advantageous generation ever, and the best we can do as professionals is to adapt, adopt and utilize this revolution to transform the healthcare delivery system forever.

Bearing in mind that every innovation comes with a seed of its challenges, we must not be averse to tackling these surmountable challenges in all their ramifications, including advocating for modifications and institutionalization where necessary, as we pursue and relish the future of veritable tools which has unprecedented potential to enhance seamless data capture, storage and sharing of relevant information across the health ecosystem, creating a continuum of care, advance health outcomes by improving drug discovery, medical diagnosis, data-based treatment decisions, digital therapeutics, clinical trials, self-management of care and person-centred care as well as creating more evidence-based knowledge, skills and competence for professionals to support health care.

Recently, the Federal Government of Nigeria approved the establishment of the National Health Technology and Data Analytics Office (NHTDAO) and appointed Dr Peter Obi Adigwe, a seasoned researcher, pharmacist and incumbent Director-General of the National Institute for Pharmaceutical Research and Development (NIPRD), as the pioneer National Coordinator.

This undoubtedly speaks to the resilient efforts of Dr Obi Adigwe and other concerned healthcare professionals over the years on the need to harmonize and coordinate the country’s digital agenda. A snippet into the role of the baby NHTDAO promises to satisfy this desire while mirroring the global agenda; we can only be hopeful that this will work as intended.

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