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# Making Digital Health Equitable

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**Abstract.** Most agree that the current healthcare system is broken. Fortunately, technology is increasing at an exponential rate and provides a solution for the future. Digital Health is an integrator concept that has the potential to take advantage of technological advantages. Digital Health converges health, healthcare, research, and everyday life. It includes technologies, platforms, and systems that engage consumers in all aspects of life. It makes health and healthcare be people-centered and personalized. Digital health requires total interoperability – standards, common data elements, and the integration of data from all sources. It demands data sharing. Digital Health brings together a wide range of stakeholders for similar goals using the same resources. Digital Health uses mobile devices and wearable sensors and uses Artificial Intelligence and Machine Learning to handle the vast amount of data Digital Health engages. Finally, Digital Health has the potential to open the gap between the different social and economic classes that must be addressed.

**Keywords.** Digital health, equity, health literacy

## 1. Introduction

The integration of technology into the healthcare system has been interesting and constantly changing. In the beginning, the first healthcare use was in Hospital Information Systems operational on large, expensive mainframe computers. Outpatient settings were largely ignored because of the cost of the computers. In the mid-1960s, the minicomputer came along. At Duke, we began the development of an ambulatory medical record system known as The Medical Record (TMR). In those early years, the computer was the weak link in the partnership between the computer and the healthcare system. The advent of personal computers in the 1990s further advanced the number of uses and users in the healthcare industry. Computer technology increased further around 2010 with laptops, iPads, and tablets. Technology advanced once again with nano-computers, compatible devices, and wearable computers. Today technology is advancing even further with robotics, driverless cars, and, the use of artificial intelligence and machine learning.

Over these decades, technology has far outpaced the ability of humans to fully use what is available. Computers have followed Moore's law – faster, bigger, cheaper computers with global real-time communications that instantly connect the world. Small mobile devices are becoming ubiquitous. We have access to more knowledge than we humans can use. Importantly for health, we have the ability to

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aggregate all data about a person from all sources and build aggregated disease-oriented databases for analytics. The result is a rich mixture of media to enhance our understanding of disease and its treatment.

Telehealth and telemedicine slowly began as a very specialized field, separated largely from traditional health and healthcare. From a technology perspective, we can now deliver personalized health and healthcare to every individual. We now have provided a label for this approach to health and healthcare – digital health. Digital health is much broader than many people realize. It is more than telemedicine and telehealth; it encompasses all parts of health and healthcare. What is required is a new approach beyond looking at how technology can help the current system to look towards what technology can enable in the future.

With the current healthcare system, clinicians have difficulty getting the data they want out of the EHR. All the data they want is not in the EHR. There are gaps and a lack of communication between patient care, research, and administration. Reimbursement dominates healthcare. Humans resist change. Developers and designers are controlled by assumptions that can and must be changed.

## 2. Digital Health

Digital Health is the convergence of digital technologies with health, healthcare, research, and living in a society. It includes technologies, platforms, and systems that engage consumers for lifestyle, wellness, and health-related purposes. It makes care and treatments more personalized and precise. It means capturing high-quality relevant data with consistency. It enables the delivery of the right data at the right place to the right person about the right person at the right time for the right purpose. It permits the use of data that is appropriately localized and personalized. Digital Health can and should act as a force multiplier of innovations to combat challenges for individuals and for population health. Digital Health can ensure that equitable care is available for all. (modified from Wikipedia)

Digital Health uses mobile telecommunication for the delivery of health and healthcare information in support of wellness. It includes personal wearable and internal devices as well as sensors in people, homes, cars, workplaces, and communities. Digital health enables us to identify health risks and assist with the diagnosis, treatment, and monitoring of health and disease conditions. It complements the episodic data from people that are captured by current healthcare approaches.

### *2.1. Key Elements for Enabling Digital Health*

- Interoperability – Data must be able to flow freely without loss of meaning and understandability among all components of the health care system.
- Data standards – a universal set of data elements; data transport standards such as Health Level Seven ® Fast Healthcare Interoperable Resources ®; standards for Application Program Interfaces – SMART on FHIR; others
- Integration of all sources of data into a common network – wearables, sensors
- Real-time capture of data outside of the traditional healthcare environment
- Integration of Artificial Intelligence (AI) into the interpretation of real-time data and performing the correct actions.

### *2.2. Integration of Stakeholders and Functionalities*

- Patients, practitioners, researchers, communities, application developers, medical device manufacturers, distributors, standards developers, drug manufacturers, federal agencies, policymakers
- Create new relationships between providers and patients; establish a respectful, valued, and trustful relationship
- Support integration of genomic, social, economic, environmental, behavioral, clinical, and geographical data (location)
- Extend the appropriate use of decision support algorithms that have been properly vetted
- Integrate and link Application Support Interfaces and Algorithms to make a larger whole
- Integrate the use of AI into diagnosis, treatment, evaluation, and outcomes
- Use of the dashboard, data visualization, and virtual and augmented reality for providing new opportunities for displaying data in a more understandable way and in teaching both patients and providers

## 3. A Vision of Future State

Policy and federal regulations are moving in a direction that will require a greater and expanded use of technology. Federal grants require a plan for data sharing. Big data has become a desirable asset. Organizations unable to share patient data will find it very difficult to improve quality and avoid penalties under value-based care. Unique and universal patient identity will become mandatory for the error-free exchange of data. National and global data registries will become a required asset, meaning we will need to move toward a national and then global common data model. Block chaining will become a method to track patient data located in many different places. All patient data in a given system will be stored together, likely in a data lake. Interaction with the data storage will be through REpresentational State Transfer (REST). The functionality will move outside the data storage and will function through APIs [1].

### *3.1. Mobile Devices*

The ubiquity of smartphones has changed communications between and among groups. A virtual visit is becoming competitive with an office visit. Smartphone apps can be used for data collection by text, check boxes, and photographs with sufficient resolution to make clinical diagnoses in many areas such as in dermatology. Smartphones can be used for education, behavior modification, and medication-taking monitoring.

### *3.2. Wearable Devices*

Collecting data with high quality and consistency is one of the biggest challenges with the current system. The solution is to automate the process. An important step in that direction is wearable sensors. Most of the data in the current EHR is a result of an encounter with the health care system, but the first indications of change will happen in

and on someone's body. The future state will be using wearable devices, analyzing the data, and taking appropriate actions. Those immediate actions will be life-saving.

## 4. Future State - Artificial Intelligence and Machine Learning

The volume of data, including the many different types of data, and the rapid changing of knowledge in diagnosing, treatment, and evaluation, overwhelm the ability of humans to use all available data and knowledge to make decisions. Clinician burnout is a consequence of this overload, and humans need relief. Effective use of AI and ML will provide a solution in the future. AI provides the ability to bring together many types of data including new imaging modalities, digitization of health data with provenance, next-generation sequencing, wearables, the Internet of Things, social determinants of health (SDoH), and other data sources. AI can pull all these data together and make decisions based on the collective impact of the data mix. AI will enable computation at scale, incorporating data from other large databases and knowledge bases. Computers will share gained knowledge from other computers such as drug-drug interactions.

But there are less glamorous activities for AI in healthcare. AI can reduce and simplify repetitive work. For example, computers can recognize and flag inappropriate access by employees and target spot privacy violations. It can nudge the anesthesiologist during a procedure when it's time for another dose of insulin. It can predict when a neonate is likely to be ready for discharge from the neonatal intensive care unit so her parents can take her home. It can address the opioid crisis, the COVID-19 crisis, and the m-pox crisis. AI can bring the focus of healthcare back to the patient. AI can reduce missed appointments and unnecessary readmissions.

## 5. A Future State - Equity

Digital Health has the potential to widen the gap between economic and social classes of data. Equality demands that technology not isolate a component of our society. The first requirement is to make sure every person has Internet access, and that means no dead zones. While challenging, this condition is possible. The Governor of the State of North Carolina has stated this condition as a goal. Technology must support a facile data ingress and egress to and from the patient record storage via a health portal. Every person must have access to an interface device. This device may be a smartphone, an iPad, a computer, or a tablet. If a person cannot afford such a device, the healthcare system must provide it at no cost. Health literacy must be taught to everyone at all levels from early childhood for the rest of their lives. Health literacy must include why digital health is important, what the value is to an individual, and why attention to the digital health system is important. Health literacy may be taught by digital health counselors perhaps using virtual reality.

Statistics have shown that there are racial differences in both disease and outcomes. Many of the differences are a result of different levels of treatment, different access to care, and the impact of SDoH factors. The consciousness of factors of inequality is critical to solving the problems. Ai has the potential to help this recognition.

## 6. The Future State

The future health system focuses on the patient as an individual and a partner in health and healthcare. The system has removed barriers to access and understanding. Technology has integrated the use of multiple types and sources of data. Community involvement in health is in providing access to healthy food sources, transportation, exercise areas, public parks, and other health-enabling resources. Virtual health becomes a more convenient and affordable resource. Digital biomarkers and digital phenotypes provide AI-driven decision-making resources for health and treatment. We design for the future, not the present. Our health and healthcare leadership are bold.

For the ideal future state, we must address interoperability to enable data liquidity. We must have the ability to track data across all space and time; require data integrated and aggregated for the patient. We want health and healthcare personalized and monitored in real-time in a real-world setting. We will have extended use of wearables, and, through APIs, integrated into the healthcare system. We will have embedded clinical decision support driven by AI and ML. We will have equity and engagement at all levels and for all groups

"Soon it will be hard to imagine a doctor's visit or a hospital stay that doesn't incorporate AI in numerous ways. With healthy clinical evidence, we'll see AI become more mainstream in various clinical settings, creating a positive feedback loop of more evidence-based research and use in the field. In addition, AI and ambient sensing technology will help re-humanize medicine by allowing doctors to focus less on paperwork and administrative functions, and more on patient care [2]."

## References

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