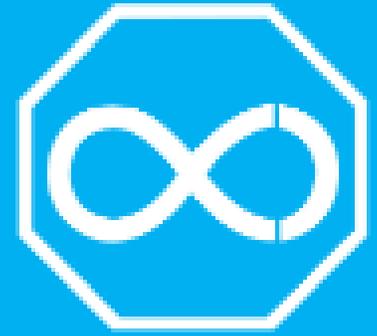




OCTAVUSSM CONSULTING
Intelligence Redefined

DIGITAL HEALTH





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INTRODUCTION

Our global population is 7.7B and is expected to reach \$10B in upcoming 20 years with advanced demands. In today's era Digital Health is on peaks in terms of global health innovation and technology. Digital Health is advancing with its increasing cost and demands which proves to be a challenge across the world. The major challenges are among the vast disruptive ways in form of changing population needs, consumer benefits with improved life expectancy, easier accessibility, and advancement in healthcare services. The advancement in digital health helps HCPs to access data and information of the patients easily and hence bring improvement in the quality of data. The necessity is to deliver proper care to people in great needs, in right time and in right intervention. However, this advancement in digital health technology is necessary with increasing demands. The future expected for digital health is to get personalized solutions and treatment for the diseases individually as "healthcare made for me". The future world will be a leader in technologies with personalized care and comfort along with the usage of AI, IoT and Cloud Computing in Digital Health.

The first FDA approved ingestible medicine tracking system, **Abilify MyCite** (Aripiprazole drug) approved in Nov'17, for schizophrenia, acute treatment of manic and mixed episodes associated with bipolar I disorder and as an add treatment to depression. The technology works by sending message from pill to wearable patch and further transmit to mobile app, allowing HCPs, physicians to access information. The device also includes a box warning for elderly patients with dementia-related psychosis, treated with antipsychotic drugs are also at a high risk of death.¹

How Abilify MyCite Works





Earlier in 2018, Novo Nordisk launched a chatbot named "Ask Sophia" specifically for people with diabetes. It is available on Cornerstones4Care as "Ask Sophia" tab, directly answers questions, addresses concerns/forwards/redirects when it doesn't know the answer. It is built on grounds of AI and natural language processing technology.

Digital Health could have major outbreaking outcomes in the world of increasing population. Public is turning digital from ordering food to medicines online and many more to come. The solutions will be personalized treatments for patients. The major advancement with digital health will be less paperwork, more accuracy in results and less manpower required by hospitals and clinics. Earlier in 2018, Novo Nordisk launched a chatbot named "Ask Sophia" specifically for people with diabetes. It is available on Cornerstones4Care as "Ask Sophia" tab, directly answers questions, addresses concerns/forwards/redirects when it doesn't know the answer. It is built on grounds of AI and natural language processing technology.

Digital devices and software have been developed to diagnose and treat illness and disease, facilitate the self-management of chronic diseases and help people monitor their bodily functions and activities. Digital technologies are increasingly used in medical training and education and for patients and other healthcare consumers to access, share and create health information. The digital data generated from devices and software provide opportunities to enhance knowledge and understanding about health, illness and disease, and improve medical diagnosis and care.²

BACKGROUND FOR DIGITAL HEALTH

In early 90s, the world was serving as a backward life in terms of technology and digital health with no wireless, mobile app, mhealth in world. In 1920, healthcare professionals started using medical records to document details, complications, and outcomes of patient care. After a long period of four years the industry evolved with the use of computers, a standard way of sharing medical records.



Earlier, Weed created first problem-oriented medical record (POMR) to arrange information in medical records. In 1965, Medicare and Medicaid were introduced for the development of information systems. Till late 70s the industry made many advancements like Eclipsys, a computerized physician ordering system, development of a system support HELP (Health Evaluation through Logical Processing. Earlier in 1980s, MPI Master Patient Index was created to keep a track of patients with their medical data. In 1987, MediSense launched ExaTech a glucose meter to measure glucose levels at home.³

It was estimated that almost 44,000 and 98,000 hospitalized Americans die each year due to error in medical records. In 2009, Barack Obama the President of America planned to sign Health Information Technology for Economic and Clinical Health (HITECH) Act, used to promote adoption and meaningful use of health information technology in healthcare.

By the time of 2015, electronic health record adoption was accepted by 96% of hospitals and 87% of physicians. The adoption has led to greater insights of:

- How applications interact with users
- How systems communicate with each other
- How information is processed and managed
- How consumer devices integrate

PRESENT SCENARIO OF DIGITAL HEALTH

The scenario for digital health in our daily routine is changing from one level to another with advancement in technologies involving less manpower. The new and rapidly changing landscape for healthcare globally has made multiple changes in society. The diverse changes in technologies and addition to our real-life has help patients to improve their Quality of Life. These technologies have helped patients to live their day to day life according to the schedule without any disturbance in life. The scenario has just begun and will keep changing in upcoming years. While the people are not use to these technologies but with easy techniques and user-ability, people are getting attracted to these techniques. Wearables and smart devices help to keep track on everything from calories burned to heart rate to sleep cycles to stairs climbed, providing users a dashboard of data and insights about their health and well-being.

Earlier in 2019, WHO has released 10 guidelines on Digital Health Interventions recommending, how to utilize digital health technology via mobile phones, for improving



health and essential services worldwide. The guidelines also include recommendations about telemedicine addressing the patient's accessibility for health services in remote areas via phones and web portals. Additionally, WHO has developed eHealth Strategy Toolkit, MAPS toolkit & Digital Health Atlas where implementers can register their digital health activities. In 2019, a Department focusing on Digital Health is also developed to enhance WHO's role in assessing digital technologies.

MAJOR ADVANCEMENT IN DIGITAL HEALTH

Verily Study Watch an ECG measuring watch with enabled sensors to measure cardiovascular, movement disorders and having a battery life of one week, launched by Verily in 2017. The device received FDA 510(K) clearance for the watch as a Class II medical device for its on-demand ECG feature.



There are major advancements in digital health has helped to doctors to keep a better record of patient health. The era has accepted advancements in multiple devices in fields of digital health.

1. Advancement in wearables and mHealth

The society has made innovation in Digital Health with the introduction of new Apple Watch Series 4 with enabled ECG or EKG functionality and an irregular rhythm notification in Europe and Hong Kong. The watch has also received FDA's clearance. Earlier in January 2019 FitBit and NIH jointly launched a Digital Health Project, Fitbit Bring-Your-Own-Device (BYOD) gathering real world data for improving the ability of preventing and treating diseases based on lifestyle, environment and genetics. Additionally, in

January 2019, Google has also received FDA clearance for its ECG enabled watch, Verily for transferring information to HCPs. Multiple Chatbots⁴ are available like Florence⁵ or "personal nurse" reminds people when to take their medications, helps users manage their health and wellness care. It also tells the doctor or a pharmacy available to your location or prescribed one. An another one, Safedrugbot is a messenger app offering support to HCPs and physicians who are need of drugs used for breast feeding and Izzy is an app which is used by women to take information regarding out menstrual health and sexual issues.



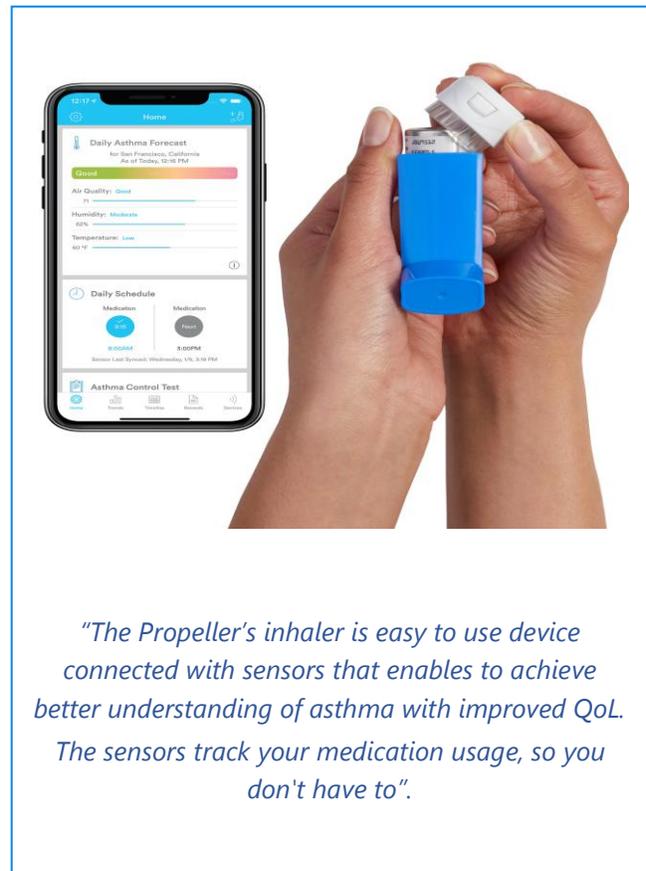
2. Patient Access Solutions

The problems handled by HCPs in billing and monitor patient health is being solved by Patient Access Solutions. The technique helps patients and their families to take control and monitor their own health. They can also provide review about doctors, staff administration, health centers with the help of review sites like Healthgrades and ZocDoc. PASHealth's⁶ EMR (electronic medical record) solution, a healthcare solution firm helps to manage patient's information reviewing patient history, medications, allergies, visits etc. With this technology the updates will be transparent to patients and HCPs as well.

3. IoT Enhancement

The IoT has opened a way full of possibilities in fields of health. IoT has made numerous applications in healthcare, from remote monitoring to sensor monitoring and device integration with the belief of safety and accuracy. IoT will also help to improve the techniques use for monitoring health and concerns in patients. IoT has made its way—with connected Inhalers, Ingestible pills, smart contact lens which help in better insights of patients.⁷

Connected Inhalers includes sensors which are usually connected to smart phone apps to help keep patients on track and to make sure they are adhering to their medical regimens properly getting reminders on the phone with check in progress, stats and information. The ingestible pills which helps to tackle problems of patients, consists of a sensor patch connected with smartphone. The pill is usually made of a coated digestible metals copper and magnesium when swallowed activates the sensor and

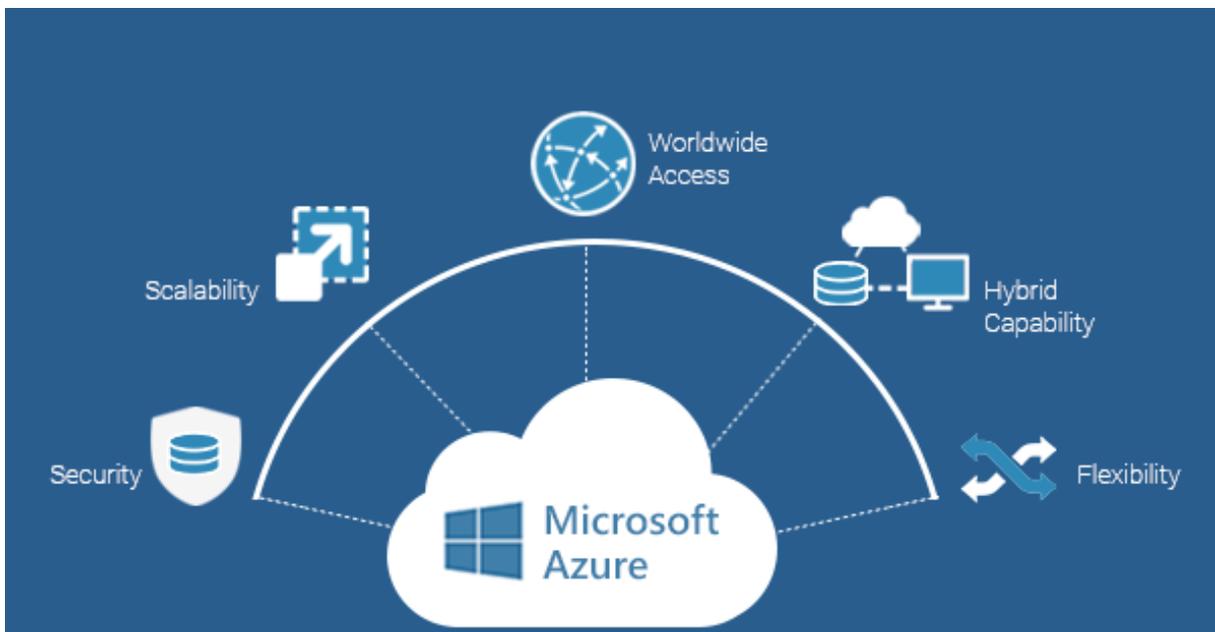




transmit signals to patch worn. Novartis is currently under construction for the technology.⁸

4. Cloud Computing

Cloud computing has helped to ensure that every HCP can access a data storage solution that will adequately protect patient's sensitive information. Cloud computing is a network that enables HCPs to share, store and review the data of a patients which is under protection at lower cost. According to BCC Research report the global health care cloud computing is expected to reach \$35B in 2022 with annualized growth rate of 11.6%. The cloud computing has helped professionals to efficiently store data with enabled sharing and provide effective care to patients immediately. The cloud computing techniques is offered by three major public sectors Amazon, Google and Microsoft. Amazon's Simple Storage Service (S3) and Amazon Elastic compute Cloud has been helping in for data storage in meeting needs of business in addition to Google Health APIs and Microsoft Azure. In 2019, as applications become more mobile and web-based, we will continue to see a cloud adoption across pharmaceutical and life science organizations on a global scale.⁹





5. Big Data

Big data is used across many industries with some techniques and principles to achieve a specific outcome, while in case of healthcare and digital health it is used to analyze huge data sets to positively impact patients' outcomes. The health industries produce large data in terms of clinical, financial, administrative and genomic data that needs to be handled beneficially.

The big data can be used in six categories:

- Web and social media- information regarding Facebook, Twitter, blogs and LinkedIn
- Machine to Machine data- information from sensors, and other devices.
- Biometric data- fingerprints, handwriting, X-rays, retinal scans and images.
- Human generated data- emails, documents and Electronic Medical Records (EMRs)
- Pharmaceutical R&D data- related to MoAs, target behavior in body.
- Transaction Data- usually required in billing, healthcare claims etc.¹⁰

Earlier in 2017, EU funded a five years project, Bigdata@heart an Innovative Medicine Initiative (IMI) project. The project is aiming to apply genomics and bigdata to the treatment of heart failure and other cardiovascular diseases like atrial fibrillation (AF), heart failure (HF) and acute coronary syndrome (ACS). The project brings Europe's leading experts in CVD treatment and management.¹¹

6. Super Computers 12

Super computers have a specific capacity to perform multiple functions in a second. Supercomputers and servers are playing a significant role in managing the new waves of digital health technologies. Super computers are used as models and simulate complex, dynamic systems leading to proper orientation of data resulting in better insights of data.¹²

Exascale Supercomputers are better example of next generation super computers allowing scientists and HCPs to better simulate the complex processes involved in stockpile stewardship, medicine, biotechnology, advanced manufacturing and energy. These are 10 to 20 times faster than other computers. These are capable to perform billion-billion calculations/sec and 500 to 100 times more powerful. The three



supercomputer clusters are located at the Edinburgh Parallel Computing Centre (EPCC) at the University of Edinburgh, the University of Bristol and the University of Leicester, and will run more than 12,000 Arm-based cores, hosted by HPE Apollo 70 HPC (High-Performance Computing) systems. Examples of some super computers are Sunway TaihuLight, Tianhe-2, Titan, Sequoia, etc. China is on the top in fields of fastest supercomputers.¹³



Titan or OLCF-3 is built by Cray at [Oak Ridge National Laboratory](#) and is exceeding a performance of 27,000 trillion calculations per second (27 petaflops) containing 16-core AMD Opteron CPU and NVIDIA Kepler graphics processing units (GPUs) .

Features and Specifications:

Architecture: Cray XK7

Cabinets: 200

Cores/node: 16

Memory/node: 32+ 6GB

Interconnect: Gemini

Processor: 16-Core AMD

Nodes: 18,688 AMD Opterons

Total cores: 299,008 Opteron Cores

Memory/core: 2GB

GPUs: 18,688 K20X Keplers



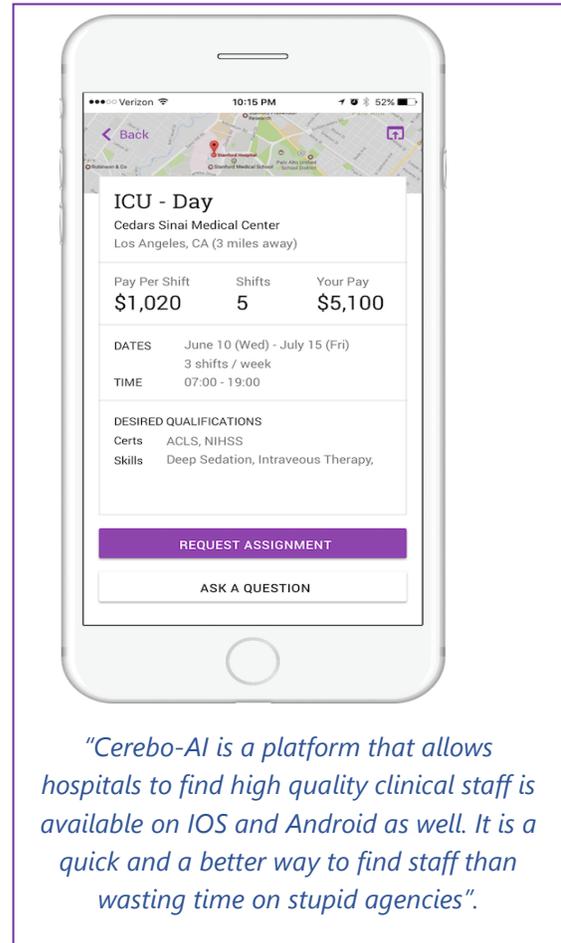
FUTURE OF DIGITAL HEALTH

With the advancement in digital health and technologies the world is becoming technology oriented. To meet their needs discoveries are done in digital health to provide less manpower and more usage of technologies in day to day life. Discovery of telemedicine wearables and other technologies have helped the world to grow a lot. Telemedicine is biggest and rapid change in healthcare system performing transformation to world.¹⁴ Telemedicine have made easier for HCPs and physicians to transfer the data and electronic records easily. Telemedicine are an addition to wearables with inbuilt sensor technology, smart fabrics, cloud computing, flexible membranes track day to day activities while keeping connected. Wearables have proven to be best friends to athletes worldwide to track day to day running activity, heartbeat rates, track of your phone notifications while connected to phone.¹⁵

The addition of chatbots which usually help people to ask their queries and have conversations with HCPs and physicians regarding their health issues. Usually a character is created which appears with a dialog box on the screen, through which you can easily conduct a conversation. The purpose is not to diagnose a disease but is created to guiding people and assisting to reveal that they are ill. They are available usually 24X7 and assist in reminding users for their daily intake of medicine.

Cerebro-AI is a platform that allows hospitals to find high quality clinical staff is available on IOS and Android as well. It is a quick and a better way to find staff than wasting time on stupid agencies.¹⁶

Izzy Care is an unlimited access offering services anchored on artificial intelligence app, allowing patients to access their medical records at any time. The platform is matched with a physician, psychotherapist, nutrition and wellness coach. It charges \$99 per month





for adults and includes free consultations for children under 12. People signing up can also add children between the ages of 13 and 17 for \$69 a month.¹⁷

FUTURE PROJECTS FOR DIGITAL HEALTH

Some projects have received \$9M funds for the enhancement of digital health, which is established by UK Research and Innovation, which is a four-year research collaboration. OpusVL a Rugby based company has developed eObs an open source electronic patient observing system, allowing physicians for observing patients digitally through hand-held devices.¹⁸

The company has also received \$8.84B fund from Innovate UK . The system calculates scores based on National Early Warning Score (NEWS) guidelines used to identify and respond risk of patients. The system can help doctors to reduce transfers within hospitals and reduce ICU referrals. The device has key features, capturing of vital signs and clinical risk indicators, automated alerts, observations stored in real time, traffic light system to indicate risk levels.¹⁹

Additionally, Red Star Consulting will apply machine learning in analyzing clinical notes recorded in the electronic health record of diabetes patients. The model will be used for predicting risk of different endpoints like heart attack and death.

Mind over Matter MedTech is working with Wessex Academic Health Science for the evaluation of novel imaging technologies. The technology will help in identifying patients with dementia, in a non-invasive manner reducing the chance of irreversible neuronal death.

The development by Snoozeal and the University of Loughborough of a device to treat obstructive sleep snoring, sleep apnea. It is connected to an intelligent platform to collect biosensor data of tongue tone, which will be classified by machine learning and AI based to deliver personalized treatment.²⁰



TOP LEADERS OF DIGITAL HEALTH





CONCLUSION

Worldwide, healthcare is at the intersection of ever-rising costs and the introduction of disruptive digital innovations, digital health innovations will expectantly play a significant role in:

- Curbing long-term healthcare costs
- Enabling better healthcare outcomes
- Empowering both the patient and the healthcare provider with real-time data and connections with each other
- Enabling the introduction of new contributors to the healthcare ecosystem

Digital revolution undoubtedly modifies the way we develop, practice, and provide medicine. This paradigm shift will directly influence the evolution of health-care systems. Technology allows a more and more precise and personalized medicine. However, overcontrol of health could lead to a new scary biopolitical power. Patients should stand at the heart of the Healthcare System. Technologies that long-term benefit to the patient will be accepted. Human relationship and empathy remain essential. The efficiency of the system should be an equilibrium between value-added medical service, global cost of the solution and maintaining the social bond.

Everyday technologies like cell phones, smartphone sensors, cloud storage, and data analytics are playing a critical role in digital health today. The use of digital health will help in early disease prediction that will lead to behavioral changes that prevent and eliminate system costs.

More accurate and timelier identification of diseases will enhance treatment and reduce waste.

Telemedicine and remote monitoring coupled with new and lower-cost care settings such as home care will improve patients' health and ensure use of the most efficient level of care. Additional and more accurate information regarding the clinical and economic performance of products and services will improve innovation.^{[21](#)}



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