

Future of Healthcare: A Primer

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Abstract: Technologies are evolving at a rapid pace. They are regarded to be the driving force behind improvements in healthcare. Advancements in technology have changed the way consumers manage their own healthcare and interact with medical providers. The future of healthcare will likely be driven by digital transformation, enabled by artificial intelligence, and the integration of newly emerging technologies. Prevention and early diagnoses will be central to the future of healthcare. This paper is a primer on the future of technology in healthcare.

Keywords: Healthcare, Future Of Healthcare

I. INTRODUCTION

Technology is a tool that usually helps improve efficiency and effectiveness. Every area of our lives has been transformed through various digital technologies. Technologies designed for the treatment and care of patients have been profound and have caused the healthcare industry to be constantly evolving. They have enabled better quality research, treatment, and access to healthcare. The root of physicians' transforming role is technology. Technology-focused companies such as Google, Amazon, and Apple⁹ are beginning to make significant impact on the existing market [1].

Nothing is more important than our health and healthcare system. Health is crucial to human, social, and economic development. We all interact with the healthcare system one way or another. The cost of healthcare affects individuals, families, and employers as well as local, state, and federal budgets. The present healthcare system consists of disconnected components - health plans, hospital systems, pharmaceutical companies, medical device manufacturers. The system is essentially a sickcare system, not designed to deal with the current huge growth of chronic disease. The system continues to evolve in an everchanging landscape. Changing the system is an uphill task. In order for the health systems to remain successful and flexible, healthcare systems need a clear goal about adopting new technologies and a strategic plan that will help them get there. Health systems have more opportunity to leverage data and technology to deliver the best care to all patients. Healthcare industry has been a fertile ground for technology applications and research over the years. Decision making technologies have developed and applied in healthcare delivery [2].

II. EMERGING HEALTHCARE TECHNOLOGIES

It is well known that healthcare is a bit behind other industries when it comes to adopting technology. Becoming familiar with emerging healthcare technologies puts healthcare leaders in a winning position when they are planning for the future. Emerging technologies expand the options for where patients are seen. Doctors will be less tethered to the hospital and able to perform more procedures in the office, making care more convenient and accessible. Some of the trends in healthcare can be summarized as follows [3].

- The Affordable Care Act

- Automated procedures and services
- Telehealth and remote patient monitoring
- Digital transformation and interoperability
- Cloud growth is inevitable
- RFID implants for recreational purposes
- Artificial intelligence is controlling the world
- Nearly all procedures will be done by AI and robots
- Virtual reality (VR) is changing the lives of patients and physicians alike
- Price transparency initiatives are changing care delivery models
- Prescription drug prices is skyrocketing
- Improving patient experience, engagement, and satisfaction
- Consumerization of healthcare payments
- Physicians becoming data-driven
- Healthcare organizations are struggling to attract the needed talent
- Pharmacy costs and pricing continue to generate debate
- Patients will take a more active role in managing their healthcare
- The hospital of the future puts people first
- Care will happen anywhere and everywhere
- Need for a healthcare reform
- Stem cells, nanobots, and other scientific breakthroughs
- Digitization of the consumer experience
- The use of telecare and E-healthcare will mean shorter waiting times for patients
- 3D printing will be used to produce medicine, eliminating the need for pharmacies
- The future of pharma will be 3D-printed drugs.
- Telemedicine will be used as an appropriate alternative for the first post-operation visit in adolescents.

III. FUTURE OF TECHNOLOGY IN HEALTHCARE

The healthcare sector is seeking for ways to treat patients virtually, predict and prevent diseases, increase hospitals' efficiency, as well as to address privacy and security issues. From telemedicine to 3D printing, healthcare is starting to look a lot like the tech industry. The future of healthcare is shaping up with advances in healthcare technologies, such as telehealth, artificial intelligence, robotics, cloud computing, 3D-printing, and nanotechnology. Future technologies in healthcare include the following [4, 5].

- **Telehealth:** This is the provision of health-related services using telecom technologies. It is the ability to engage in healthcare quickly and seamlessly through technology like smartphones, laptops, and streaming services. It allows remote advice, care, education, monitoring, and treatment assessment. Reliance on telehealth and the technology to maintain it will grow. Telehealth services benefit both the patient and the

medical physicians. They allow patients to make virtual appointments from the comfort of their homes. Patients also take advantage of the availability of telehealth services to manage and monitor chronic illnesses. Telehealth allows doctors to see more patients efficiently and giving office staff more time to process paperwork. More healthcare systems, doctors, and medical practitioners are providing telehealth services.

- **Artificial Intelligence:** AI focuses on how computers learn from data and mimic human thought processes. It has affected healthcare in a big way. It has the potential to redesign healthcare completely. The AI algorithm has outperformed all human radiologists on pre-selected data sets to identify breast cancer. It revolutionizes drug development. AI algorithms are able to mine medical records. AI can improve radiologists' ability to make diagnoses for all types of medical imaging. In the coming years, the adoption of robotics, machine learning, and artificial intelligence in healthcare will become a part of the "new norm." AI-powered systems will be widely used in personalized medicine. Autonomous AI will begin to replace human doctors. As patient trust increase, AI will become more reliable and widely adopted. The computing power of AI will drastically reduce the time scientists spend analyzing data.
- **Robotics:** This is one of the most exciting and fastest growing fields of healthcare, with developments ranging from robot companions through surgical robots. In healthcare, robots can help alleviate loneliness, treat mental health issues or even help children with chronic illness. Robots can allow paralyzed patients to move around. Robotic surgery operations will continue across the healthcare system, especially in spine, cardiology, and oncology. Robot health assistants can be used to help keep an eye on the health of people in a household. Figure 1 shows a robot as doctor [6].

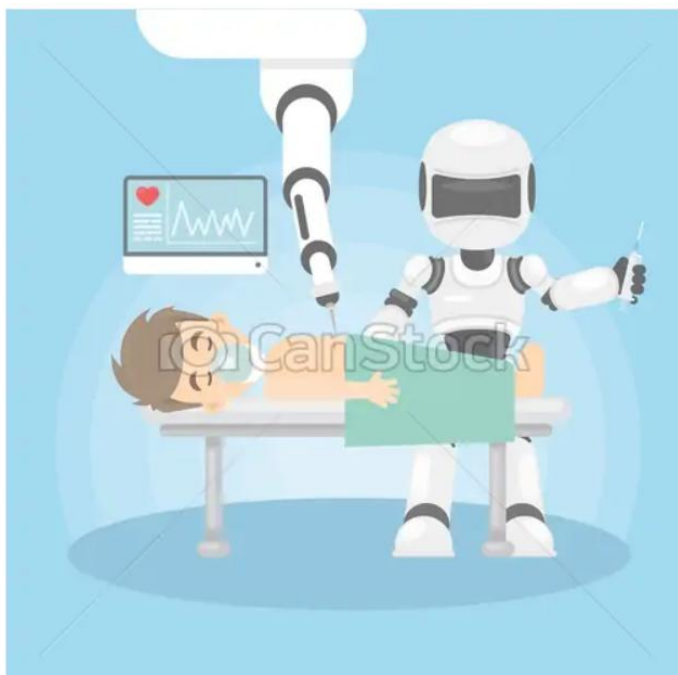


Figure 1: Robot as a doctor [6].

- **Internet of Things:** The Internet is becoming the media for healthcare delivery. IoT is disrupting the notion of who and what can be monitored and managed—and from where, and for how long. The future of eldercare and at-home healthcare, in particular, will leverage the gathering wave of IoT. The convergence of IoT and telemedicine has brought about a variety of wearable devices. Figure 2 shows how IoT is used in healthcare for varying purposes [7]. The Internet of Medical Things (IoMT) covers a variety of smart devices: ECG, EKG monitors, smart beds, connected inhaler, etc.



Figure 2 IoT is used in healthcare for varying purposes [7].

- **3D-printing:** This has emerged as a disruptive technology in healthcare. It is being leveraged to create personalized medical devices and provide training to future medical professionals. 3D printers are beginning to infiltrate homes and enter the mainstream. It has created a new generation of at-home and do-it-yourself manufacturers and children are starting to adopt it. The technology has enormous potential for the healthcare industry and will significantly change its future. It can bring wonders in all aspects of healthcare. The pharmaceutical industry is also benefiting from this technology.
- **Nanotechnology:** This is perhaps the most advanced and promising solution for healthcare. It is a relatively new interdisciplinary field that studies materials at the nanoscale (about 1 to 100 nanometers). We are living at the dawn of the age of nanomedicine. For example, nanotechnology can be used to treat as well as diagnose. It also has the potential to transform current chemotherapy treatments. As nanotechnology evolves, we will see more practical examples of in medicine. Nanodevices are expected to improve the drug delivery system.
- **Cloud Computing:** Cloud computing is a promising technology that has the potential to transform the healthcare. It has many benefits like flexibility, cost and energy savings, resource sharing, and fast deployment [8]. The cloud provides unprecedented scaling, data integration, and access advantages. Easy access to and sharing of data is an essential foundation for building a healthcare system. Cloud computing will allow physicians to have access to complete information on a patient's electronic health record, prescriptions, test results, imaging, etc. Concerns about interoperability, security, legal compliance, and potential downtime when dealing with the most

sensitive personal data can all be addressed. Global collaboration depends on cloud computing.

- **Cybersecurity:** As a result of the increasing use of personal data, cybersecurity has emerged to be more important than ever before for healthcare providers and healthcare systems that are entrusted with that personal information. Cybersecurity is also a new priority as ransomware attackers hit hospitals and health systems. Cybercriminals will continue to discover and exploit new attacks and manage to stay one step ahead of cybersecurity. The game changer for cybersecurity could be next-generation technologies.

Applications of these technologies are poised to grow rapidly in the near future. Other emerging technologies in healthcare include precision medicine, personalized medicine, genome sequencing, virtual/augmented reality, health wearables, business intelligence, and blockchain. These are the key enablers of technology advances in healthcare.

IV. CHALLENGES

While the technologies mentioned earlier promise a new world of healthcare, there are some significant challenges to their implementation. The challenges faced by the global healthcare system in recent years have been increased in population and urbanization, behavioral changes, rise in chronic diseases, traumatic injuries, infectious diseases, regulation, patient choice, specific regional conflicts and healthcare delivery security.

The healthcare systems around the world have faced multiple challenges [9]. Some of them are listed below:

- **Consumer Demand or Patient-centricity:** Patient/consumer choice is at the forefront of the debate on the future direction of healthcare. Patient wellness is the heart of healthcare. Today, patients are well informed about their health and therefore play a more active role in their own healthcare, fueling the drive towards personalized medicine. People around the world are now living longer than in previous generations. Currently, consumers bear more cost for their care. There is a need to increase the quality of patient care at a lower cost to address our country's health disparities and inequities. Consumers are becoming ever more tech-savvy and demanding. Consumers have been used to transformations that have occurred in other sectors, such as e-commerce and mobility. These consumers will demand that healthcare follow suit. The consumer will determine when, where, and with whom he or she engages for care or to sustain well-being. Consumers have grown used to wearable devices that track their health and fitness. The center of gravity in this new system will be consumers, not the acute-care hospital. This is central to market liberalism and democracy because its focus is on property rights, individual freedom, competition, and the emphasis on self-interest as the driver of human behavior [10]. Figure 3 illustrates the shift toward patient-centric care [11].



Figure 3: The shift toward patient-centric care [11].



Figure 4: Future healthcare professionals [12].

- **Healthcare Regulation:** Changes in the healthcare industry usually occur at the legislative level, but once enacted these changes have a direct impact on facility operations. The healthcare system itself is managed and regulated by dozens of federal and state agencies, including the Department of Health and Human Services, the Centers for Disease Control, the Center for Medicare and Medicaid Services, the Veterans Administration, the Food and Drug Administration, and the Agency for Healthcare Research and Quality. These regulators will set the standards for how business is transacted. The regulators of the future will influence policy while promoting consumer and public safety.
- **Workforce:** Human factors will remain one of the major limitations of technological breakthroughs. The entire healthcare workforce will evolve, mainly because technology will expand the capabilities of healthcare professionals. Figure 4 depicts the future healthcare professionals [12]. The cooperation between people and technology may result in amazing

achievements. The healthcare industry lacks expertise, regulatory expertise, a targeted consumer base, and existing partnerships with other incumbents. There is also an increase in demand for primary care and the shortage of primary-care physicians. It is projected that in just over a decade we will face a shortage of more than 100,000 physicians. There will also be a need for engineers and designers working with 3D printers to print artificial artificial bones, limbs, braces, etc. [13].

- **Complexity:** There can be no doubt that the healthcare industry is a massive and complex business. The healthcare industry is the US's largest employer and takes more than 18% of the GDP [14]. With the rapid growth of online social networking for health, healthcare systems are increasing in complexity. Partly due to this complexity, clinical trials are expensive and time-consuming. Regulatory approval is crucial, but challenging to obtain. Concerns about the contribution of healthcare materials to toxic waste and other environmental impacts of health care have been growing for about two decades.

Other challenges include costs, aging population, healthcare consumerism, health inequities, and cultural change. These challenges shape the future of healthcare.

CONCLUSION

Technological innovations are changing the face of the healthcare industry with each year passing. New technologies and innovations are being introduced within the industry, creating excitement among medical practitioners, researchers, and patients. Over the coming decades, health will be described holistically as an overall state of well-being encompassing mental, social, emotional, physical, and spiritual health. Care will be organized around the consumer, rather than around the institutions currently driving the existing healthcare system. The future of healthcare will be focused on well-being, prevention, and early intervention rather than treatment. From time to time, we need familiarize ourselves with the latest developments in emerging healthcare technologies in order to be able to control technologies and not the technologies controlling us. The future promises a continued utilization of technology and a greater focus on patient outcomes.

Although the future is hard to predict, we know for sure that the future of healthcare is bright. Technology will continue to transform and revolutionize the healthcare industry.

and its adoption is somewhat unstoppable. There is still plenty of room for improvement in the applications of the current and emerging technologies. More information about the future of technology in healthcare can be found in the books in [15-17] and related journals: *Future Healthcare Journal* and *Journal of Medical Systems*,

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