The Future of Healthcare

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Introduction

The Patient Will See You Now, by cardiologist Dr. Eric Topol, envisions a healthcare revolution due to a new era of innovative technologies. The new digitally enhanced healthcare system has the potential to transform medical practice in the same ways as Gutenberg's printing press changed the world. Dr. Topol highlights several of the most immediate causes of healthcare transformation, such as the smartphone revolution, the ability to examine multiple layers of a patient's medical information, the democratization of healthcare data, and the ability to build complex electronic medical record systems. In this article, we will examine each of the overarching technologies that will affect the future of modern medicine and look at the potential effects of these changes. The exhilarating thing about the next few decades is that we will be able to witness a rapid transformation of the healthcare industry. Also, it is important to note that the new advances proposed by Dr. Topol will hopefully give solutions to certain problems that physicians are facing right now.

The Smartphone

One of the most immediate changes in healthcare that Topol notes is the introduction of the smartphone. He relates the "smartphone revolution" to the momentous change that Gutenberg's printing press brought about to the world. He compares the attributes that are shared between the two technologies such as the explosion of knowledge, spur of innovation, basis of social networks, reduction in cost of information, easier communication, and the relief of boredom. The big question to ask in relation to healthcare is how the increased use of smartphones will change the way medical practice is conducted? One way that smartphones have already entered healthcare is with the introduction of "health apps" and devices such as the Fitbit or the Apple Watch (Segarra 2017). These devices monitor the wearer's physical data such as rate or quality of sleep. While the accuracy of these measurements is still being debated, it is still a step in the direction of incorporating electronic devices in the healthcare field. In the future, it is very possible that we may see telecommunication with a healthcare professional over the phone via telecommunication software with the addition of sensor to measure a patient's vital signs. The use of this concept could reduce time spent in the waiting room of a doctor's office because of the ability to examine patients over the phone and direct them to a proper facility without having to physically come visit a primary care practitioner (Duffy 2015). In the even further future, it would not be unlikely to have a supercomputer examine patients and administer the appropriate advice or treatment.

Another way that smartphones are changing the healthcare world is through the ability to access information anywhere, which results in better-informed patients. The internet gives patients a newfound ability to understand their results and allow them to make more informed medical decisions. Now, we begin to question how medical information is shared with patient. Historically, the flow of medical information has only been to the doctor. Dr. Topol emphasizes that he hopes to see a democratization of medical data in the future, meaning that all data are made available to all people. As the world changes with the incorporation of new electronic devices and sensors that allow the recording and interpretation of medical data, we will see a change in the doctor-patient relationship that demands more information to be shared between them. We will begin to see more of a cooperative partnership between the family doctor and the patient with the availability of new types of medical information.

Human Health-Based Graphic Information System

How do graphic information systems (GIS) relate to healthcare? A classic example of a GIS is Google Maps. When you search the address to a location, Google uses a system of intertwined datasets such as traffic, satellite systems, and street views that are superimposed on map. Dr. Topol highlights the ways in which we could use a GIS system in healthcare. In healthcare today, we examine the phenotype, anatomy, and physiology of a patient. Most of the data we collect and use in diagnoses come from just these datasets. However, Dr. Topol wants to emphasize that as science advances the access to more layers of data will become available for doctors to use. The genotypic data of patients have the highest potential to be added to common examination practices in the near future, as we already incorporate these data in some areas of medicine. It will not be long before we are able to identify certain RNA, protein, and metabolic changes in a patient. The human GIS will incorporate multiple layers of demographic, physiologic, anatomic, biologic, and environmental datasets. This is a highly complex combination of datasets that will be used to defines a person's medical essence. When it is fully compiled and integrated into the healthcare world we will have a better way to dispense medical care.

Defining the Human GIS

It is essential to understand the human GIS that we examine in depth the components that comprise each layer. The layers encompassing the demographic, physiologic, anatomic, biologic, and environmental factors of humans which is illustrated in the image below.

The Demographic Layer:

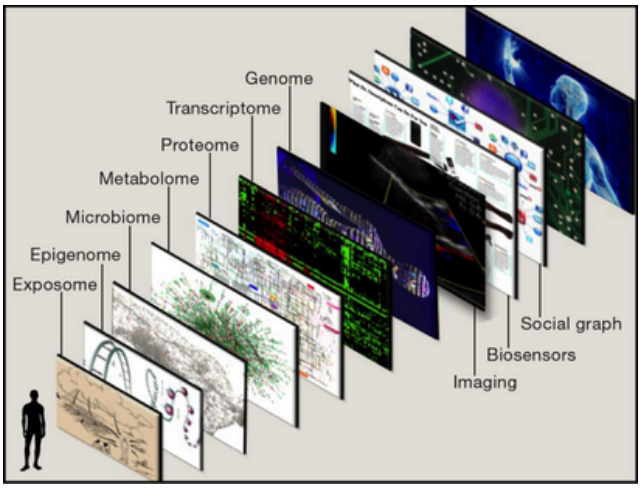
The demographic layer consists of a person's demographic, location, family, friends, job, hobbies, education, and many other social interactions with the world. Dr. Topol and many other researches have noted that this layer of information could be easily collected through social networking websites such as Facebook, Twitter, Instagram, LinkedIn, etc. The social interactions a person has with the world has a profound impact on their health. Social groups influence rates of smoking, obesity, drinking, exercise, and many other parts of their lives. Social networks will have an increasing role in a person's medical background in the future that extends the normal records taken today. Historically, a person's medical record consists of their "age, gender, occupation, family history, medical conditions, operations, and procedures" (Topol 2015). However, physicians can add to this using data gathered from social networks to gain more accurate insight into their patients' medical profiles.

The Physiologic Layer:

The physiologic layer consists of physiological data such as blood pressure, heart rhythm, oxygen concentration in the blood, respiratory rate, body temperature, blood glucose level, and numerous other measurements. These measurements are usually taken at a doctor's visit by trained professionals, but as technology advances we are beginning to see a surge in the number of biosensors that can be used by the average person to record many physiological metrics. As these technologies advance, we will begin to see the incorporation of nanotechnology into the blood stream that can provide constant monitoring of blood pressure, heart rate, tumor DNA, oxygen levels, immune activation, and many more metrics. These data could then be constantly reported to your physician so that he or she may better provide care in the future.

The Anatomic Layer:

The anatomic layer consists of a person's bodily structures. We have come a long way in the past century in our ability to examine the anatomy of a person without preforming surgery. Technological advances in imaging systems such as CT scan, MRI, ultrasound, and other scans have given physicians very detailed pictures of what our body structure look like. However, these types of imaging systems are extremely expensive and rather large. It is likely we will see many scans being performed in the future with smaller hand-held devices. Dr. Topol notes the emerging use of pocket-sized ultrasound and x-ray equipment able to produce high resolution images. We may see the swap of the iconic stethoscope with small devises able to perform the job more effectively.



The Biological Layer:

The biological layer refers to the genome, proteome, transcriptome, and the microbiome. The current understanding of the biological layer is expanding exponentially with new advances in many areas of science. For example, the understanding of human genes has exploded in the recent years. We can now examine patients' genomes to look for genes that cause certain diseases such as the *Brac1* gene that has been associated with breast cancer (Breast Cancer Risk Factors). Since sequencing technologies have improved, human genomes can be sequenced with marginal costs. There are databases filled with genomic information on the internet that people can access. Many organisms have had their genome sequenced and placed into a database that scientists can use to better understand genomics. The future understanding of how genes, RNAs, and proteins interact will provide physicians with the opportunity to better understand how humans function normally at a biological level, and thus better understand many diseases.

The Environmental layer:

The environment layer encompasses everything we are exposed to during our lives such as radiation, air pollution, pesticides, lead, and much more. There are many new monitors and sensors being created to measure exposure to environmental factors, Hopefully, one day we will be able to monitor and quantify patients' exposure to these harmful

environmental factors with portable devices that people can carry around with them to provide real-time data of potential dangers. Data collection could also provide more conclusive evidence that certain environmental factors are associated with disease.

Conclusion

The future of healthcare is going to be focused on the incorporation of the many different layers of information that make up the health-based GIS system. These layers of data can provide a highly personalized and detailed look at an individual's health. The health-based GIS system will also implement real-time data collection systems to constantly monitor the health of an individual. The constant monitoring will give physicians more information to better treat and even prevent disease. It is likely that we will see this type of real-time monitoring soon, with alteration of devices mentioned earlier such as the Fitbit and the Apple Watch that will be connected to smartphones with applications that transmit data to physicians.

The entire health-based GIS system will ultimately collect vast quantities of personalized data that can be stored. The collection of the stored data has the potential to drastically change healthcare by allowing physicians to compare individuals with the same disease at all the layers incorporated in the health-based GIS that will lead to a better understanding to the roots of what causes a disease. Further into the future, we will probably see kiosks that provide diagnoses for individuals using the data that are collected and stored via the GIS system. For example, if a 20-year-old male, feeling ill, steps into the kiosk which then measures his phenotypic, anatomic, genomic, and proteomic data, and then compares these data to all other 20-year-old that have been diagnosed with a disease. After comparing the data, a diagnosis will be produced based on the similarities to other people with a particular disease such as a sinus infection.

However, to fully reach this level of the democratization of healthcare data, many laws and regulations will need to be put in place to ensure people's privacy. Privacy will need to be protected mainly because of the potential of insurance companies to take advantage of these data to only insure low-risk patients. There are many genes that are known to cause disease, and more are being discovered rapidly; this information could be used against people with these genes to either increase the rate for insurance coverage or to not be insured at all. Upon passing laws that protect the privacy of individuals and allow for the sharing of information, we will begin to see a greater shift into the prevention of disease and not just the treatment.

The reality of the health-based GIS system is that it is still a long way off, but it is inevitably going to happen because of the potential benefits it brings to healthcare. The GIS system can fix many of the problems facing the medical world right now such as doctor shortages, costs, misdiagnosis, and much more. The complete understanding of how our bodies interact with themselves and the environment on multiple levels is the next step in healthcare.

REFERENCES

Breast Cancer Risk Factors: Genetics. (n.d.). Retrieved from http://www.breastcancer.org/risk/factors/genetics

Duffy, J. (2015, February 11). 10 Apps That Are Changing Healthcare. Retrieved from https://www.pcmag.com/article2/0,2817,2476623,00.asp

Fitbit Group Health. (n.d.). Retrieved from https://www.fitbit.com/group-health

Genetics Home Reference. (n.d.). breast cancer. Retrieved from https://ghr.nlm.nih.gov/condition/breast-cancer

Segarra, L. (2017, September 12). Apple Watch's Heart Rate Monitor Just Got an Upgrade. Retrieved from http://time.com/4938045/apple-watch-watchos4-heart-monitor/

Topol, E. J., Summerer, E. M., & Tantor Media. (2015). *The patient will see you now*.