Book Review

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Patient Will See You Now: The Future of Medicine is in Your Hands

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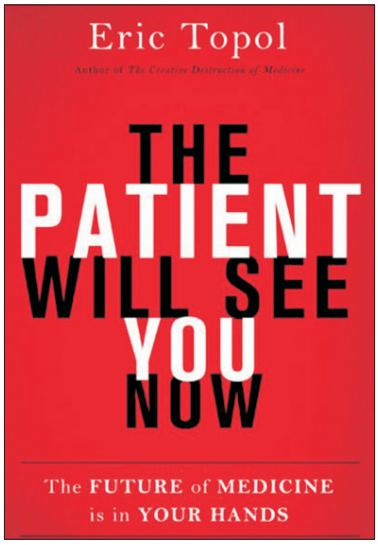

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Eric J. Topol is Professor of Genomics with the Scripps Research Institute, Director of Scripps Translational Science Institute, and a cardiologist. He is considered a pioneer in the area of cardiovascular medicine and a futurist. In 2013, he wrote the book *The Creative Destruction of Medicine: How the Digital Revolution Will Create Better Health Care*, which touched on genomics and digital technology for future medicine. In this book he continued to discuss the future of medicine, focusing on how a new innovative technology can be adopted in the medical field.

This book consists of three sections, readiness for a revolution, new data and information, and the impact. The first section emphasizes the influence of smartphones and the growth of genomics in medicine. The second section describes the importance of the personal geographic information system (GIS), called my GIS, individual big data including multiple layers of demographic, physiologic, anatomic, biologic, and environmental data. It touches on smartphone usage in lab tests and scanning as well as by doctors. The last section discusses the impact of new medicine, genomic medicine, and digital medicine, focusing on issues related to privacy and security due to the openness of medicine, the prediction and prevention of disease with medical informatics tools, and the transformation of the consumer's role into the 'doctorless' patient.

The book title *The Patient Will See You Now* seems to be a play on the expression "the doctor will see you now". In this book, Topol argues that power will shift from doctors to patients, and he emphasizes the age of patient-centered medicine, in which patients generate medical data using their own digital devices and communicating via their smartphones. The author insists that the smartphones might be one of the

most rapidly adopted and humanized technologies in human history. It seems apparent that we are now entering an age of global smartphone, in which one in four people worldwide is a smartphone user [1]. Increasing numbers of patients approach medicine through smartphones; easier electronic connectivity between people, especially wireless connection via the Internet, are the important factors forcing the development of medicine's democratization in a new direction. Topol calls connected medical devices the Internet of Medical Things (IoMT) due to their ability to share information with anyone, including physicians, nurses, family, network friends, etc. He insists that a patient would be the chief operating officer (COO) who monitors all operations of his/her own body. The patient also could be like a senior manager who is fully in charge of an information technology (IT) team for accurate data collection, rapid analysis, and reporting to the COO and the chief executive officer (CEO), the doctor. Patients and doctors will be forced to make full use of computer resources for patient care. He considers the smartphone comparable to Gutenberg's press in changing the direction of future medicine by calling it 'the Gutenberg of healthcare'. The author points out the example of the extremely rapid paradigm change from the age when only 8% of Europeans could read before the advent of the printing press to an age when literacy became the norm after printing became available. He uses a term 'individual active participant (IAP)' meaning an active participant in health care and a similar concept of 'participatory' in P4 medicine [2]. This can be exemplified by the case of Angelina Jolie (a famous actress) showing the significance of the growing genomic medicine era and the consumer's (patient's) changing role. The author insisted that 'eminence-based' medical practice should be changed to 'evidence-based' medical practice as there is a driving force for cultural change in the medical community and new technology from outside, as in the case of Gutenberg's press. The use of smartphones will be further extended to the area of recording personal health and physical examination data, performing lab tests or medical scans, and graphically displaying or using data for predictive analysis.

Future medical data will be obtained from digital resources, such as smartphone and wireless medical devices and big genomics data. Human GIS data covering an individual's whole life from prewomb to tomb (my GIS) [3] will be recorded and processed by digital devices. This would include information from analysis of genome, transcriptome, proteome, metabolome, microbiome, epigenome, exposome, anatome, physiome and phenome (phenotypic traits) data. The amount of information has expanded rapidly as the cost of genome sequencing has dropped extremely low from $28.8 million in 2004 to less than $1,500 in 2015, which makes even individual genome sequencing possible. Physiome data can be collected by wearable and noninvasive sensors in addition to anatome (the study of one's anatomy) imaging information, which can be viewed on a tablet or smartphone. The data could be used not only for traditional medical record information but also for individual, personalized medicine, if the individual GIS is connected to social network and the data collected and updated continuously. Social networks will also play an import role in health care by sharing larger quantities of data, which will be beneficial for the social graphs of individuals. The book suggests that a more intelligent GIS approach could contribute to the effective treatment of diseases. Individual GIS in the future may include the profiling of drug interactions together with emphasis on individual GIS, ten-by-ten: ten omic tools and ten stops along the way of one's life span. This would comprise massive, multiscale, panoramic information per individual, which could be one of the main topics in the field of medical informatics. Lab test and image scans will be performed or stored in smartphones or other small digital devices, possibility shown in Theranos lab test via a nanotainer of blood, lab-on-a-chip, lab-in-the-body with embedding a chip into the bloodstream for assaying a wide range of substrates, etc. There have been miniaturized imaging modalities, as a smartphone-sized devices. This means that lab and image data could be also generated by patients themselves and stored in their smartphones as technologies develop. Each individual may own his/her own Electronic Medical Record (EMR) together with GIS in the future to store the medical data through a smartphone using an attached camera, otoscope, microphone, lab tests, and physical examination devices, scanning images, etc. The book introduces some products of smartphone apps and devices, including Mango Health, CyberDoctor, AiCure, Nightingale, MediMinder, MediSafe, and Care4Today. The Kaiser Permanente health system with a mobile app is considered an example of future EMR. Others include a tagged microchip in a small pill, medication adherence digital hardware tools, the medSnap app id of pills, etc. Dr. Topol mentions that Korea is a country where medical costs are low. He argues that medical costs in the United States are not transparent, and a lot of unnecessary medical services lead to higher medical costs. These costs could be lowered by using the abundant GIS data and information processing that will be available in the future. One revolutionary change mentioned in this book is that the smartphone, robot or cyber doctors (avatar, algorithm, or Dr. Siri) could take over the role of the doctor, especially in diagnostic medicine. Some aspects of this revolutionary

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change are available already, as demonstrated by the virtual visits (e-visits, 'Anywhere Care') provided by NowClinic, LiveHealthOnline, Kaiser Permanente Northern California, etc. Telemedicine has been also growing rapidly as nearly 1 in 6 doctor visits in the United States was expected to be provided via telemedicine by the end of 2014. Teleconsults with genetic counselors will be a special area in the future. Dr. Topol mentions that Korean doctors argued against the telemedicine laws in late 2013 due to the fear of losing jobs. He suggests that telemedicine, using best available technology, contribute to solving the problem of the shortage of medical professionals in the United States, although there are many opposing opinions.

He also describes a future digitalized hospital and introduces mobile apps, such as 'Smart Patient' and 'Smart Hospital' developed by Asan Medical Center, South Korea. Open medicine supported by digital information will be expected to further broaden transparency in future medicine. Massive open online medicine (MOOM) can play a role in not only continuing education for physicians but also extending medical knowledge to the public. The IBM Watson computer could provide important information from the analysis of big data, including multiple MOOMs data similar to GIS data, covering a range of types from sequencing to clinical data. The US government has released the Medicare database and other medicinal data resources, and the US FDA allows public access to information regarding drugs. There have been concerns regarding patient privacy and security due to vulnerable aspects of medical openness because cyberazzi and hackers can access and invade patient data. For instance, the external website of Boston Children's Hospital was attacked, and a community health system was hacked by a Chinese cyberattack. Since an individual's genomic data has been the identifier of an individual, genomic privacy specialists in biomedical informatics have attempted to solve the problem by developing security methods such as encrypted genome copy, and so on. The observation made by Tim Harford of the Financial Times that "big data has arrived, but big insights have not" reflects that a lot of work is needed, such as algorithm development with machine learning and artificial intelligence [4]. Technology has been developed, such as IBM Watson, a winner of Jeopardy show, has now enabled speech decoding and image recognition by developed algorithms. It can be used to provide medical information and knowledge as well as to predict diseases by analyzing big data, such as GIS data, in the future. In addition to algorithm development, small devices and technologies, such as smartphone ophthalmology kits (Stanford-developed), smartphone-based microscopes, and cheap point-of-care sequencing tools will be major contributors to digital medicine in the future. Digital medicine will be available to all people as the cost of smartphones decreases and will play an important role in the development of open and democratized medicine. The active participation of patients has been increasing, and doctorless patients, like driverless cars, will be possible with innovative mobile technologies. The author insists that the movement of any one of the stars (patients, companies, employers, doctors, government, data scientists) in the iMedicine galaxy will affect all of the others, as in an actual galaxy. This implies that data scientists in addition to physicians will have very important roles to play in future medicine by providing important medical information using big data.

Dr. Topol has consistently predicted that new innovative technologies will change the medical community in the future. The technologies will play an important role in digital medicine and genomics medicine generating big data. They will also contribute to the changing role of patients, who are becoming active participants in their own medical care; thus, the profession of data scientists will become an increasingly integral part of future medicine. Dr. Topol believes that open and democratized medicine without paternalism will be realized in the future, although there will be many difficulties and challenges to achieve it.

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