

Short Communication

The world of medicine in the year 2045

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The Jewish scholars said that prophets are fools, yet forecasting the future is an essential part of our lives, planning for future. This was emphasized in the Economist Newspaper 17 years ago.

Ray Kurzweil, a well-known futurist and Google's Director of Engineering, set the date of 2045 for the singularity. This is when we will multiply our effective intelligence by merging with the intelligence we have created. Therefore, I choose 2045 to describe my vision of medicine within a generation.

Looking back – Technology is the engine of history. However, until a generation ago, the change was slow. In the new world there were 3 industrial revolutions which were linear, while now we are in the midst of the Fourth Industrial Revolution, where the rate of development is exponential. This is to say we are in a world where the rate of changes will be drastic and despite the conservative nature of men who are afraid of changes we will have to adapt to changes at an extremely rapid pace.

The Fourth Industrial Revolution is a combination of technologies that blurs over the lines between the physical and the biological and digital worlds.

In a world of:

Changing genes

Stem cells

Synthetic Biology

Science of materials

Biotechnology

Continuous development of drugs towards personalization of medications.

3 D Printing

Big Data & Artificial Intelligence

There will be tremendous rapid changes.

Please recall that for 36 years (1980-2016) we added 10 years to longevity. Based on the exponential impact of all technological changes, the average longevity in the western world will reach in 2045 at least the age of 95, and we shall see an abundance of people above 100. I believe that we shall also see people of age 130-140. Who knows which diseases we shall find reaching this age.

Excessive levels of chronic diseases, a trend which exists even today, will increase since more patients with diseases like malignancies will become chronic patients.

With the improved monitoring of high blood pressure and nanotechnology, the rate of strokes will drop and our ability to

rehabilitate these patients, especially with an extensive knowledge of the brain, will increase.

Until now technology changed our surroundings, now technology will enable us to change ourselves. We shall have computer implants that go into the eyes and ears. They allow direct interference with computers and internet-based applications. The implants are also capable of recording what the users see or hear.

Computer implants designed for direct connection to the brain will also be available. They are capable of augmenting natural senses and of enhancing higher brain functions like memory, learning speed and overall intelligence.

I would like to devote my speech to 6 aspects:

1. Tele-medicine.
2. Patient's empowerment.
3. Robots.
4. Artificial intelligence.
5. A major change in the definition of illness & health.
6. Who will be the physician in 2045?

The Technological Revolutionary in the field of sensors and the continuous development in the tele-medicine is gradually changing the paradigm that physicians must see their patients face to face.

Within the next 30 years the direct physical encounter with patients will disappear and will eliminate most of the ambulatory clinics which exist today. Practically most of the patients, at least in the western world, will communicate with the medical teams from their smart home. The hospital without beds that exists in St. Louis is showing where we are going.

The continuous decrease of inpatients will continue. In spite of the anticipated growth of the population in Israel, I believe that the number of acute beds in Israel will be below 1.5 per thousand.

Currently we are all speaking about patient empowerment, yet we are not sure how to do it. Yet again in a gradual process patients will understand that their health depends on their behavior and knowledge. Therefore the idea of Eric Topol, "The patient you will see", will be a reality. Thus the concept of preventative medicine will prevail and the treatment of chronic patients will be easier and prospective, and not retroactive.

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We all know about the assistance of robots in surgery. Gradually these robots will replace surgeons, changing completely the nature of surgery. Yet the impact of robots in the world of hospitals will be much more expensive. Most of the clerks and drivers and many maintenance workers will be replaced by robots.

Furthermore, robots will also change the basic medical work. In each I.C.U. robots will transmit data to remote physicians.

In each department robots will perform a detailed questionnaire of the patients and with guidance of technicians will perform physical examinations. Therefore, the treating physician in the department will have to read the anamnesis and results of the physical examination.

Robots will take blood from patients and will also have the ability to perform other duties such as doing an L.P. or inserting a central line or delivering medications to patients.

Yet the major revolution will be in the field of artificial intelligence. Here massive ability of calculation, sophisticated algorithms and Big Data will have a major impact on all our life.

The EHR will include genetic, social and behavioral patient information. EHR coupled with AI will promote efficiency, and improve decision making thus boosting quality.

Within 30 years our ability to analyze data will be tremendous changing completely the definition of illness and health. The definition of healthy people of the WHO 70 years ago was that those are people without an organic or mental disease.

Today we know that 20 percent of children at the age of 20, and 50 percent of people 50 years old have a chronic disease. Thus, the functional impact is the determining factor which defines who is healthy.

With the rapid advancement of genetic development, the definition of illness and health is changing. I believe that within a generation we shall be in the pre-pathology phase, changing completely the definition of healthy people.

The concept of singularity in knowledge reflects the theoretical time where artificial intelligence will augment above human intelligence and thus bring about a drastic change in society.

There is no argument that this will happen, while there are many estimated dates, among which the Median is in approximately 2045.

Current cognitive computing which is mastered in Watson of IBM can show us in which direction artificial intelligence will develop.

Professions like radiology and pathology will disappear (one has to recall that nanotechnology will replace interventional radiology). A new profession will emerge from these changes. Also the work of surgeons will be changed drastically, since almost all surgical procedures will be performed by robots.

Who has to be the physicians in a world where intelligence machines can make the diagnosis based on laboratorial data and imaging results that the machine will order?

I believe that the main role of the physician in 30 years will be the interface between the patient and the intelligent machine. Human beings still need a personal touch, although we know today that machines can communicate nicely with psychiatric patients.

The different nature of the physician's role will have a strong impact on the personality of those who will become medical students and about their training. The curriculum will be completely different.

In many aspects there will be a blurring of the role of physicians and nurse practitioners. Furthermore, there will be an abundance of medical technicians, mainly in hospitals.

A more difficult question relates to the economic aspect. On one hand, the emphasis on preventive medicine might reduce the cost of health services.

Yet the rapid aging of the population and the strong transfer of acute chronic diseases to long term chronic diseases might put strong pressure on the expenditure of health care.

I believe that the total effect on expenditure will be to increase the health care expenditure. The 6-7 western countries who operate today around 11-12 percent of the GNP will each spend 15 percent.

I don't believe that US who anticipates 20 percent of the GNP in 2025 could continue the linear increase in expenditure. Yet it is very hard to predict the future direction based on the polarization of the American society.

It is nice to dream, yet unfortunately I shall not be with you in 2045 to see where I am wrong.