The current industrial revolution and smart technology in surgical practice

Mukund Raj Joshi

Department of Surgery, Kathmandu Medical College, Sinamangal, Kathmandu, Nepal

Correspondence: Dr. Mukund Raj Joshi, Professor, Department of Surgery, Kathmandu Medical College, Sinamangal, Kathmandu, Nepal, Sinamangal, Kathmandu, Nepal

Email: mukundrajjoshi@gmail.com

An American mechanical engineer, workshop supervisor and one of the first management consultants Mr. Frederick Winslow Taylor (1856-1915 AD) had realized 100 years ago that "in the past man has been first. In the future, the system will be first". We are yet to realize this fact in the work culture of our country. The present-day concept is "health care is an industry" but we are yet to realize to incorporate and implement it. In the process of industrialization, there are characterization of the division of labor, standardization of roles and tasks, the rise of a managerial superstructure and the degradation or de-skilling of work. The health care industry had been relatively spared from these changes in the past. The typical work of a general practitioner treating broad-spectrum disease in the 20th century is gradually being splintered to narrower disciplines. Some specialty like intensivists, emergency medicine physician and hospitalists focus the work during a particular shift of duty only. The protocol-driven telephone triage system and the use of non-physician clinicians for urgent appointments in primary care practices are some examples of standardization and degradation of work. The process offers the advantages for physicians due to the predictable and defined work hours but at the same time, there are concerns of physicians regarding the loss of autonomy, disruption of the continuity of care, and the potential erosion of professional values.[1] Along with this, the specialist care is becoming more expensive, but not definitely of better quality.[2]

What is Industry 4.0?

The German government declared in 2011 to enter the new era of industrial development, the concept is known as Industry 4.0. Like other countries, this is adopted differently in Japan as Society 5.0 which is "a human-centered society to achieve both economic growth and better society with a highly integrated cyber-physical system".[3]

Industry 4.0 refers to a further developmental stage in the organization and management of the entire value chain process involved in the manufacturing industry. It is the current trend of automation and data exchange in manufacturing technologies which includes cyber-physical system, internet of things (IOT), cloud computing and cognitive computing and Artificial intelligence (AI).[4] This new revolution ensures the growth and productivity to be exponentially grown in future instead of expected linear growth. The technological transformation has grown exponentially in this era of technological and this follows Moor's law (Gordon Moor) i.e." the number of transistors and resistors on a chip, doubles every 24 months". [5]

The industry 4.0 is mainly characterized by four features which are vertical networking of smart production system, horizontal integration via a new generation of "global value chain" network, engineering across the entire value chain and the acceleration through exponential technologies. Interconnected devices process real-time data and the system will figure out the best solution. As a result of which the products will be custom made with shorter lead time and reduced cost. The components of industry 4.0 are the internet of things (IOT), big data, system integration, augmented reality, additive manufacturing, cybersecurity, cloud computing, autonomous system and simulation. IOT, "Internet of things" is a system where various items are connected into the internet network where systems exchange information and affect mutually through device connection, data sensing, communication and data synthesis. This system needs big data. According to Doug Laney, Gartner, 2012 "Big data is high volume, high velocity, and/or high variety information assets that require new forms of processing to enable enhanced decision making, insight discovery and process optimization".[6]

The industry 4.0 has created the disruption in society with digitization, demonetization and democratization. Digitization simply means replacing the physical objects with information and digital products. This is creating the

disruption of present values because the marginal cost of the products is going to be zero with the explosion of domains. In general, once we really understand the value of the things around us, the utility of these things rises exponentially. Solar power is one of the examples. Demonetization means "technologies which were expensive are going to be substantially cheaper or potentially free". The best example is the smartphone fulfilling the demand of phone, camera, video camera, watch, alarm, play station, library, encyclopedia, music system and GPS at a very cheaper rate in a handheld device. The technology is so democratized that at present day the access to information by smartphone is huge. Although the technology is moving very fast, the society is not yet ready to accept the change, as society tends to be local and linear whereas the technology is global and exponential.

Smart technology in the health sector and surgical practice.

The artificial intelligence (AI) and machine Learning (ML) is affecting our daily life. AI is any technique that enables the computer to mimic human intelligence and the ML is the subset of AI which uses the statistical technique, learns to solve a task from examples and is then able to complete the task on its own. The importance of AI and its value was started to be understood when Deep Blue computer of IBM defeated World Champion Garry Kasparov in Chess in 1997. The present-day use of smart technology in health is telemedicine, medical apps, health care IOT, AI, Blockchain and cloud solution and medial robots. Kardia and BlueStar Diabetes are some of the most popular examples of apps. Stabilizing spoon "liftware" by google and electric seasoning fork by "No salt restaurant committee" are the new innovations. Along with this, robotic surgery is increasingly being used in the most of the difficult surgeries and in the area where access is very limited. The question comes how smart is the smart technology? The researcher challenge competition (Chamelyon 16) has proved that the detection of lymph node metastasis in women with breast cancer is more accurate by AI in comparison to a panel of experts. [7]

The factors driving smart technology in the health sector are the following:

- World population increases and hard to keep everyone healthy.

- The number of individuals who are above 60 years will be doubled, 2.1 billion in 2050. [8]

- Number of dementia patients will reach over 75 million in 2030.[9]

- The medical expenses will increase by 5.4% annually.[10]

- There will be a serious shortage of health care workers by 15 million.[11]

- Over 8000 startups are trying an innovation in the health sector in the world.

Besides Robotics, the AI will prevail in the surgical field in the form of IOT inside the operating room. Japanese neurosurgeon has proposed the SCOT (Smart Cyber-Operation Theater) where all machines and tools are connected to the network and there is real-time analysis of machine operations and staff movement. In this process big data and sensors, navigate and optimize the solution to give feedbacks support to doctors to help the quick decision making.

Surgical data science is an emerging scientific field with the objective of improving the quality of interventional health care and its value through capturing, organizing, analyzing, and modeling the data. The development of surgical data science pertains to patients, effectors (physicians, anesthesia team, nurses and devices including robots), sensors (images, vital signs, medical device data and motion data) and domain knowledge(including factual knowledge such as hospital specific standards related to the clinical workflow, previous findings from studies or clinical guidelines as well as practical knowledge from previous procedures). This encompasses all clinical disciplines in which patient care requires intervention to manipulate anatomical structures with a diagnostic, prognostic or therapeutic goal such as surgery, interventional radiology, radiotherapy and interventional gastroenterology. [12]

Smart technology is not without risks. There are technical risks, ethical risks legal risks, human resource risk and singularity. Singularity means AI becomes more intelligent than human and becomes uncontrollable. Another issue of AI is the replacement of some of the category of manpower as well as jobs. It is predicted that in coming years the jobs like radiologist, hematologist, research analysts etc. are going to be taken over by AI.

The question remains; will AI really replace the doctors?

In conclusion, there is no doubt that the smart services and AI will definitely change the world. It is unpredictable that whether the doctors will be replaced by AI or not. But it is predictable that the doctors who do not embrace technology will be replaced by those who do.

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