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Technology Driven Healthcare

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Abstract

Sound health is central to human happiness and well-being. Healthy citizens contribute to the economic growth of any country, in a progressive manner. It is an undisputed fact that Medical Sciences and Health care in India still needs a significant make-over. However, with the innovations and advancements in medical technology, several opportunities are waiting to be tapped.

Demand for more and better healthcare services keeps increasing from consumers all over the world. Some key drivers playing a critical role in this sector are income levels, breakthrough innovations in medical domain, treatment methods, shift in diseases pattern, private healthcare spending etc. Hospitals and healthcare centres, today, are using advanced medical technologies and also update them from time to time. This article attempts to frame a snapshot of the top ten emerging trends in healthcare during the past few years globally. The top trends are Digitization, Synthetic biology, Biomaterials, Genome sequencing and Pharmacogenomics, 3D bioprinting, implanted sensor based drug delivery, Robotics and Artificial intelligence, Sensors and wearable devices, big data and DIY (Do-It-Yourself) diagnostics. The potential areas, which need to be focused by the Indian medical sector, also have been highlighted.

Keywords: Emerging trends; Healthcare; Medical technologies

Introduction

Healthy citizens contribute to the development of any nation. Being a country of one billion plus population, medical sciences and healthcare sector in India cannot be ignored and presently, calls for a major overhaul. Ensuring the health and efficiency of the population is critical for transforming India into a leading player, globally.

India is faced with the triple burden of diseases- communicable diseases (CDs), new and re-emerging infectious diseases and increasing incidence of non-communicable diseases (NCDs) or lifestyle-related diseases. More than half of all deaths are now attributed to NCDs like cardiovascular diseases, type 2 diabetes, cancer and chronic respiratory diseases. On the other hand, tuberculosis, HIV/AIDS, viral hepatitis, vector borne diseases, water-borne diseases, and zoonotic diseases are still major public health concerns.

The most prevalent factors, which have a significant effect on this sector, are income levels, breakthrough innovations in medical domain, treatment methods, shift in diseases pattern, healthcare spending etc. When compared to olden days, the health facilities in the present generation has improved a lot and the life span of people increased tremendously. In order to increase accessibility and penetration of health care services, private sector has evolved with a multi-pronged approach. It has tackled the issue of lifestyle related diseases with the development of high-end tertiary care facilities. Novel delivery models in the form of day-care centers, single specialty hospitals, end-of-life care centers, etc. are also on the horizon to service larger sections of the population and address their specific needs.

It is hoped that the situation will be tackled more effectively in future through deployment of advanced technologies and smart management practices. Areas like genomics including (molecular diagnostics, pharmacogenomics, and targeted therapies), regenerative medicine, information technology and the development of medical devices and equipment are emerging technologies have all made considerable contributions in improving the health of people all around the world.

Technology Trends in Healthcare

Hospitals and healthcare centres, today in India, are using advanced medical technologies and also update them periodically. Nowadays, there is increasing awareness among people, regarding health measures, more especially among the ones using smart phones with android and IOS apps which enable them in learning effective and efficient methods to prevent diseases [1,2]. The technological developments in medical and health care delivery systems are quite astonishing. However, the following ten technological trends (as shown in figure 1) in healthcare sound promising to achieve sustainable development goals set by the Government of India [2].

The afore-said technologies pertaining to healthcare sector were shortlisted from a basket of Key Technologies (which will have significant impact by 2035 in India), identified through a nation-wide survey conducted by TIFAC recently. A technology is identified to be "key" if it helps to improve quality of life of citizens, contributes to wealth creation, is relevant in terms of making India a global leader or has a potential to impact other technologies. The respondents were asked to rate the criticality of the technology specified (based on criteria spelt-out earlier) and also indicate the level of the familiarity of the respondent with the technology (on a scale of 0-3). The online questionnaire was sent to more than 1500 experts and around 700 responses were received and collated subsequently.

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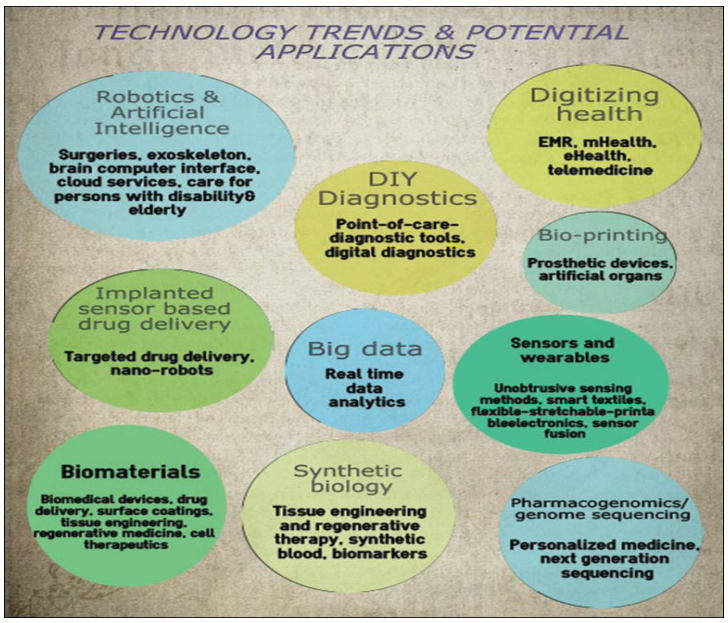

Figure 1: Technology trends and potential applications.

Digitizing health

Information and Communication Technology (ICT) has made significant contributions in general and particularly, in the medical industry. The increased use of electronic medical records (EMR), telehealth services, and mobile technologies have not only led to the effective and efficient utilization of information by health professionals but also empowered the users. Telecommunication has also established a direct connection between health care providers and patients which saves time and money normally spent on travelling to another geographic location for treatment. It is sending health information (like drug information, research and studies, patient history or records, etc.) instantaneously to any specialist or doctor in the world [3]. Digital India is an initiative, in this context which is using the National Knowledge Network (NKN) as an effective tool for creating networks amongst healthcare delivery systems and medical institutions across the country. It is expected that in the next few years, India will witness a rapid development in network structures between medical institutions through dedicated POTS (Plain Old Telephone Service), ISDN (Integrated Services Digital Network), DSL (Digital subscriber line), T1, T2, Internet with WAN (Wide Area Network) and VPN (Virtual Private Network) and also a high bandwidth catering to these requirements.

DIY (Do-It-Yourself) diagnostics

DIY diagnostics have become more popular nowadays, as self-test kits are available in the market that reduces the visit of patients to hospitals. There are a variety of home tests for an array of conditions including high cholesterol levels, gluten intolerance and sexually transmitted infections like HIV and syphilis. These are quick and easy to use, generally requiring only a finger-prick, or a urine sample. However, the challenge lies in indigenous manufacturing of these quality diagnostic kits, adopting standard procedures and providing them at an affordable price to Indian population [4].

Synthetic biology

Synthetic biology, a resourceful blend of science and engineering that can broadly be described as the design and construction of novel artificial biological pathways, organisms or devices, or the redesign of existing natural biological systems. It has the potential to drive significant advances in biomedicine by allowing the "systems approach" to epitomize to biological sciences, using computational power and data analysis for better understanding of complex diseases like cancer and speed-up the development of therapeutics and new vaccines. It opens the way for personalized treatment to an individual by recognizing biomarker of a certain disease and release pertinent drugs upon detection of the marker [5].

Biomaterials

Biomaterial is a biological or synthetic substance which can be introduced into body tissue as part of an implanted medical device or used to replace an organ, bodily function, etc. These are generally classified by type into metals, ceramics, polymers, natural materials and composites, and by applications into, orthopedic, spine, cardiovascular, neural, dental, cancer, ocular and other organ or tissue specific biomaterials. Often, biomaterials and medical devices are implanted inside the body for prolonged duration, and hence, their efficacy and biological safety need to be ensured. The development of biomaterials hence becomes a multi-disciplinary endeavor that is subjected to quality control, professional reviews and market regulations. Biomaterials can explore new routes of biotechnology, nano-bio-info technology, cell therapeutics, gene therapy, tissue engineering, regenerative medicine, and pharmaceuticals. The key elements governing the progress of biomaterials in the medical field are material synthesis, processing, engineering and design, standards, governmental support, R and D support and Innovation.

Developments in Biomaterials industry in India is controlled by four factors namely Education, Research, Market and Regulations. The importance of research and development will always be topping the list, with an ongoing focus on continuous innovation leading discoveries to proven technologies. However, joint efforts on Public-Private partnership and developing of newly competent manpower through

the academic route will also govern the success of the endeavours. Even if human life cannot be prolonged infinitely, or a medicine discovered for eternal youth, many unsolved and scary problems can and should be addressed by the emerging Bio-Materials [6].

Pharmacogenomics/genome sequencing

Customized medicine and genome sequencing continues to edge closer to the forefront of the healthcare industry. Pharmacogenomics anticipates the role of genes and genomic variants in clinical treatment response. Although, several drug–gene relationships are characterized to date which is further facilitated by emerging high throughput genotyping technologies, but challenges remain towards its application in clinical settings. The elucidation of these genes/ networks will help in developing genetic tests in future that can predict the patient's response to a particular drug and its required dose, which is currently being in research stage. Before the pharmacogenomics and next generation sequencing comes to maturity, a tool is required to aggregate and analyze all the big data and digital health information [7].

Bioprinting

3D printing is the process of creating a three-dimensional (3D) model by laying down successive layers of material that build upon each other. Printing materials or "ink" can be a variety of substances including plastics, polymers, metal alloys, among others. When the ink being used is a living cell, this is called as 3D bioprinting. According to the recent report, "Applications of 3D Printing 2014-2024: Forecasts, Markets, Players", the global 3D printing market will reach at least $7 billion by 2025, which includes a conservative estimate of $3 billion for bioprinting". 3D bioprinting is being applied to regenerative medicine to address the need for tissues and organs suitable for transplantation. Some success stories include creating artificial living tissue including liver, cartilage, heart, fat tissue and prosthetics are already existed. Other applications include developing high-throughput 3D-bioprinted tissue models for research, drug discovery and toxicology. However, challenges in 3D bioprinting, specially related to keeping the bioprinted tissues nourished, needs to be tackled effectively [8]. The ethical issues of bioprinting, such as justice in access to health care, testing for safety and efficacy, and whether these technologies should be used to enhance the capacity of individuals beyond what is 'normal' for humans, need to be addressed. Currently, this technology is in pre-clinical phase in India.

Implanted sensor based drug delivery

Continuous monitoring is a foremost requirement for numerous diseases. There is growing recognition of superior and responsive drug delivery system that are made of advanced biosensor design. This system acts as a smart biological implant and offers potential solution for therapeutic interventions by reciprocating the physiochemical changes. These sensor-based implants are actually electronic chips loaded with drugs and get activated for releasing the medicine only on reaching the target site [9,10]. It lowers the side-effects (like tissue damage and hepatotoxicity) which are caused by conventional modes of treatment with subsequent improvement in patient compliance and are also able to maneuver into hard-to-reach locations. Today, in India, nanotechnology and nanoscience approaches to particle design and formulation have begun to expand the market for drugs and are forming the basis for a highly profitable niche segment in the industry. The medical conditions like Breast cancer, Parkinson's disease and hydrocephalus are a few examples that are on trial and hope to be benefitted with the progressing Micro Electro Mechanical Systems (MEMS) technology.

Robotics and artificial intelligence

Robotics is the engineering science and technology of robots and their design, manufacturing, applications and also their structural disposition. It is projected that robotics would prove to be a promising technology to handle the surmounting pressures of demanding healthcare requirements for the next few decades. In medical robotics, humans interact with the robots either as doctors, health providers or as patients, health recipients. Introduction of a medical robot as an interface requires deep understanding of anatomy, biology and physiology and principles of engineering and science embedded in it. During the past few decades, researchers worldwide have been working on projects related to robotics in healthcare. Recently, the past few years have witnessed the introduction of medical robotics in surgery. Robotics surgery systems offer much higher accuracy and precision in making incisions or targeting sites for radiotherapy and also avoid the surgeon's hand tremor totally. Moreover, it also facilitates advanced real time imaging techniques during the operation. It is envisaged that robotics have the potential to perform certain pre-programmed operations autonomously, which will be more beneficial to hospitals at rural areas, where there is very less access to doctors/specialists. Patient monitoring before, during, and after a procedure can now include autonomous robots. In elderly care, robots can be employed to collect patient data and monitor signals for preventing emergency situations like cardiac arrest, elevated levels of blood glucose and then simultaneously synthesize the information, assess it clinically and transmit required information to the physician [11,12].

Sensors and wearable devices

Sensors are being prevalently employed in advanced healthcare practices and wearable market is booming. Sensors enable monitoring of temperatures, pressures, chemical, and biological levels of users and/or patients. Sensors can be weaved or integrated into clothing, accessories, and the living environment, such that health information can be acquired seamlessly and pervasively in daily living. A biosensor is an analytical device, used for the detection of an analyte that combines a biological component with a physiochemical detector. A common example of a commercial biosensor is the blood glucose biosensor, which uses the enzyme glucose oxidase to break blood glucose down. In doing so it first oxidizes glucose. Sensors can even be designed as stick-on electronic tattoos or directly printed onto human skin to enable long-term health monitoring [13]. Wearables are technology devices that can be worn by a person and often includes tracking information related to health and fitness. Wearables in healthcare provide periodic monitoring of ambulatory patients through measurement and storage of respiratory and cardiac parameters. They create health profile during normal daily activities and the embedded sensors collect data on cardiopulmonary function. These wearables combined with optional peripherals also monitors the functions such as blood oxygen saturation, ECG, leg movement, body temperature, blood pressure etc. Examples of some upcoming smart wearables are device for monitoring asthma, back pain management, engineered knee brace, health patch with biosensors, smart contact lenses etc.

Big data

Big Data in healthcare is used to predict epidemics, cure disease, improve quality of life and avoid preventable deaths. With the increasing world's population and life expectancy, novel models of treatment delivery are being created which are largely driven by data at the population, individual and macro levels. In the very near future, patients will be sharing their health data with doctor. This data will be

used as a part of diagnostic toolbox during a patient-doctor visit with an ailment. A huge amount of data will be generated in early prediction and treatment of major diseases, health informatics and management of related issues of health data acquisition, transmission, processing, storage and retrieval data would be instrumental. Even without any ailment, the growing databases of information about the state of the health of the general public will allow problems to be spotted before they occur, and remedies – either medicinal or educational– to be prepared in advance [14] (Figure 1).

Conclusion

India's population is expected to increase to approximately 1.53 billion in the next two decades. It is projected that, of them, a major percentage will be under 40 years of age. Meanwhile, the relative percentage of people in the older age group would decrease in absolute numbers and geriatric population would go upto 223 million by 2035. An inclusive approach would therefore be required to reform healthcare journey and attention needs to be paid towards the unmet health care challenges of present-day society and those likely to be raised in future like prevalence of chronic diseases, aging population, and outbreaks of infectious diseases.

The technologies discussed in the earlier sections possess immense potential to fuel innovation in products and delivery services in our country. In the next few decades, rapid advancement in these identified areas could result in newer opportunities for technology providers, industries (biotechnology, chemical, pharmaceutical), doctors, patients, start-ups, in particular and to society, in general. An effective synergy between the prime stakeholders namely research institutions, academia, industry and government is essential to ensure development, technology transfer and deployment of these technologies and also to facilitate advent of affordable products in the market.

Initiatives need to be taken for creating awareness and educating people for adopting healthy lifestyle towards prevention of onset of diseases. Likewise, scales of investments made by private players in the healthcare sector through public – private partnerships needs to enhance manifold to assure delivery of healthcare services to all. An ideal situation would be the convergence of advanced technologies, backed by conducive policy framework to strengthen healthcare practices to achieve the sustainable development in a holistic manner.

References

1. Medical technology (2014) Healthcare business andtechnology.
2. Technology Roadmap on Medical Sciences and Healthcare draft document, Technology vision 2035.
3. Akanksha Jayanthi (2014)10 Biggest Technological Advancements for Healthcare in the Last Decade. Becker's Health IT and CIO review.
4. Hynes V (2013) The trend toward self-diagnosis. CMAJ 185: E149-150.
5. Robert Wells (2010) Synthetic biology: A challenge for healthcare. OECD observer.
6. Technology vision 2035: Technology Roadmap on Materials draft document.
7. Katsila T, Patrinos GP (2015) Whole genome sequencing in pharmacogenomics. Front Pharmacol 6: 61.
8. Jon Harrop (2014) Applications of 3D Printing 2014-2024: Forecasts, Markets, Players. ID Tech Ex.
9. Ngoepe M, Choonara YE, Tyagi C, Tomar LK, du Toit LC, et al. (2013) Integration of biosensors and drug delivery technologies for early detection and chronic management of illness. Sensors (Basel) 13: 7680-7713.
10. Drug-Delivery and Smart Biological Implants (2014) Smart Sensors and Integrated Microsystems (SSIM).
11. Healthcare robotics (2011) Digitome: accelerating digital health.
12. Robert J Szczerba (2014) Tech trends shaping the future of medicine (part 1). Forbes/ Tech.
13. Zheng YL, Ding XR, Poon CC, Lo BP, Zhang H, et al. (2014) Unobtrusive sensing and wearable devices for health informatics. IEEE Trans Biomed Eng 61: 1538-1554.
14. Bernard Marr (2015) How Big Data Is Changing Healthcare. Forbes/ Tech.