Sensors and Healthcare 5.0: A Revolution in Virtual Care Enabled by Emerging Digital Health Technologies

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Abstract

Emerging digital technologies are continuing to advance, presenting unprecedented prospects for improving healthcare service delivery in health systems throughout the world. Substantial progress has been made in the field of healthcare. However, the absence of emotional recognition, along with a scarcity of tailored and ubiquitous health apps and emotive smart devices, necessitates the use of developing technologies to integrate intelligent sensors into health systems. Although great progress has been made in smart and connected health care, more research innovation, dissemination, and technology are required to unbundle new prospects and advance towards healthcare 5.0. Healthcare is on the verge of a paradigm shift that will usher in a new era of smart illness diagnosis and control, virtual care, smart health management, smart monitoring, and smart decision-making. As a result, this research investigates the roles and capabilities of sensors as well as other new technologies, including nanotechnology, 5G, drone technology, blockchain, robots, big data, the internet of things, artificial intelligence, and cloud computing. Patient remote monitoring, tracking, and virtual clinics; emotional telemedicine; ambient supported living; smart self-management; wellness monitoring and control; smart treatment reminders; compliance and adherence; and tailored and linked health care are all available through Healthcare 5.0. Building a resilient and robust healthcare 5.0, on the other hand, is not without its difficulties. Individual attitudes, mismatch with hospitals' goals, lack of money, and religious and cultural hurdles have all been mentioned as potential barriers to the successful adoption of healthcare 5.0. As a result, robust, technology-driven healthcare systems are required. Expanding technological infrastructure, providing budgetary support based on sustainable business models, developing appropriate legal and e-health policies, standardising and synchronising protocols, improving stakeholders' engagement and involvement, and establishing private and public partnerships and investments are all needed to achieve this.

Introduction

A movement in digital technology from traditional to smart healthcare is poised to transform healthcare systems throughout the world. Smart healthcare uses digital technology to make it easier to browse health information, connect people, resources, and organisations, and then intelligently handle and respond to health-related needs [1]. Patients, healthcare professionals, organisations, and regulators are all linked together in the smart healthcare system. Artificial Intelligence (AI), the Internet of Things (IoT), fog computing, cloud computing, blockchain, sensors, 5G technology, and the Internet of Medical Things (IoMT) are examples of emergent technologies that are still evolving [2]. These technologies are critical to the development of the healthcare 5.0 idea, which is an emerging innovative concept.

The healthcare system, like the auto industry, has gone through generations, from healthcare 1.0 to smart healthcare, with revolutions in a variety of supporting businesses. For example, due to a lack of digital technology, many healthcare institutions employed paper-based systems from 1970 to 1990 [3]. This is regarded as the period of healthcare 1.0, in which individuals and healthcare professionals manually gather health data and medical prescriptions through consultation, testing, and diagnosis [4]. For many years, this concept has been widely used in healthcare [5]. Patients' records, on the other hand, were vulnerable to wear and tear over time, putting patient privacy and confidentiality at risk. Healthcare 2.0, also known as e-Health, was adopted between 1991 and 2005 to offer improved privacy and security of health information while also enhancing maintenance and scalability [5]. Digital technology has revolutionised various healthcare systems by increasing data capture, accessibility, and sharing efficiency [6]. New advanced medical gadgets and equipment, as well as key manufacturing industry breakthroughs, were developed during this generation. Healthcare 2.0.4 created digital imaging test equipment including magnetic resonance imaging and computed tomography scans, digital tracking devices like pulse oximeters and arterial lines, and surgical and life support equipment like the da Vinci robot and chest tubes. Telehealth and electronic health records were introduced to healthcare 2.0 between 2006 and 2015 as a result of technology advancements in the medical industry, resulting in the introduction of healthcare 3.0 [7]. Healthcare workers may use electronic health records to upload, share, and access health data in the cloud at any time. Cloud servers, on the other hand, were vulnerable to active security assaults by criminal groups attempting to get access to patients' sensitive information, which was then likely sold or used for personal benefit. AI and developing digital technologies such as the Internet of Things (IoT), fog computing, mobile technologies, blockchain, machine learning, virtual reality and augmented reality, robots, big data analytics, and high-tech smart devices have all been incorporated into Healthcare 3.0 since 2016. Healthcare 4.0 refers to this change. Through smart care, linked care, and tailored medicine, the ultimate objective of healthcare 4.0 is to deliver patient-centric healthcare services. Notably, healthcare-related companies have embraced Industry 4.0 and are now transitioning to Industry 5.0. Modern digital high-tech organisations are continuing to rethink how they enhance company operations and increase efficiency across the value chain as a result of this transformation. Healthcare delivery, like manufacturing, is undergoing a paradigm shift to usher in the new era of healthcare 5.0. Smart illness prevention and detection, virtual care, smart health management, smart monitoring, decision-making, and medical research are all part of a complicated period. However, the absence of emotional recognition, along with a scarcity of tailored and ubiquitous health apps and emotive smart gadgets, necessitates the use of intelligent sensors in healthcare 5.0. Regulatory compliance is particularly burdensome for new digital health technologies. As a result, many healthcare systems rely heavily on paper-based processes to gather, analyse, and maintain health data, particularly in poor nations. Accessing, storing, processing, and analysing massive amounts of health data kept in paper-based health systems is becoming increasingly complex, especially during pandemics like the coronavirus illness of 2019. (COVID-19) [8]. COVID-19 emerged with a bang, posing unprecedented problems and the potential to reform healthcare systems throughout the world, such as the need to provide healthcare despite the growing number of verified COVID-19 cases and fatalities [9]. Furthermore, social separation, lockdown, wearing face masks, travelling limitations, and staying at home are rigorous COVID-19 methods that partially, if not totally, inhibit in-person care [10]. As a result, the use of developing digital technologies to support the delivery of virtual healthcare services has become a foregone conclusion. As a result, sensors in healthcare, particularly in healthcare 5.0, are required to enable virtual healthcare. Despite tremendous advances in smart and connected healthcare, further research ideas, dissemination, and technologies are required to unbundle new prospects and proceed towards healthcare 5.0.

In this article, we address the roles and capabilities of sensors, as well as other new technologies, in the transition to healthcare 5.0. We also describe virtual healthcare services that may be provided using sensors and healthcare 5.0. Barriers to effective healthcare 5.0 implementation, uptake and usage are also discussed.

Conclusion

Emerging digital technologies are continuing to expand, presenting unprecedented prospects for improving healthcare service delivery and virtual care in health systems throughout the world. Significant progress has been made in the field of healthcare. However, the absence of emotional recognition, along with a scarcity of tailored and ubiquitous health apps and emotive smart devices, necessitates the use of developing technologies to integrate intelligent sensor health systems. Such technologies are crucial in the development of the healthcare 5.0 idea, which is a new revolutionary concept in the making. The advent of a new era of smart disease control and detection, virtual care, smart health management, smart monitoring, decision-making, and precision medicine is approaching. Through smart care, linked care, and customised medicine, such a revolution continues to redefine how contemporary digital high-tech firms enhance healthcare operations and boost efficiency across diverse health systems to deliver patient-centric healthcare services. Building a resilient and robust healthcare 5.0, on the other hand, is not without its constraints and problems. Individual attitudes, a lack of resources, and religious and cultural hurdles have all been cited as potential impediments to the successful adoption of healthcare 5.0. There are also constraints in healthcare 5.0, including ethical concerns like security and privacy, as well as legal ones. Despite these obstacles, legislators, healthcare experts, high-tech businesses, and regulators must work together to create technology-driven healthcare systems that are durable. There is also a need to improve stakeholders' engagement and involvement, as well as expand technological infrastructure, provide budgetary support based on sustainable business models, develop appropriate legal and e-health policies, standardise and synchronise protocols, and develop appropriate legal and e-health policies. Furthermore, healthcare 5.0 will improve healthcare service delivery by providing emotional recognition through sensors, pervasive health apps, and emotive smart gadgets. On the other hand, healthcare 5.0 has a long way to go, providing enormous prospects for improving remote treatment, particularly during natural catastrophes and pandemics like COVID-19. As a result, future research should concentrate on the development of new technologies that will enable healthcare 5.0.

In order to establish highly dependable healthcare 5.0 frameworks, numerous regional and worldwide players from diverse domains, such as the medical, commercial, legal, and political sectors, must be included. Healthcare specialists should discover smart strategies to promote healthcare 5.0 services in developing nations as part of their future efforts.

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