

Transformation of Digital Health Care Environment: A Solution for Pandemic

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ABSTRACT

The epidemic is a doorway. It has created a new portal that involves re-defining of living styles, working habits, health care, and socialization among people and nonhuman species. The World health organization has announced publically that novel coronavirus as a pandemic. The problem is to overcome the situation of this pandemic which involves the social distancing issues, by transforming the conventional medical health care systems to digital health care system. Post pandemic demands a fundamental change of healthcare systems that have the abilities to handle those issues. Meanwhile, as the pandemic becomes more severe, the most important objective is the paradigm shift in conventional health systems to combat the pandemic by proposing the taxonomy on the basis of digital technologies. Thus, an Artificial intelligence (AI) and Internet of things (IoT) based digital healthcare system model is proposed. Moreover, a thorough investigation is conducted, ensuring in a timely guide to the possibilities of digital health transformation as a current and future response to pandemic issues.

Keywords: COVID-19; Health Care Systems; Post COVID-19, Digital Transformation, Digital Health, Telehealth, Artificial Intelligence, Internet of Things, Virtual Care

1. INTRODUCTION

Over the previous 100 years, there has never been a quick spread of disease that had a large impact on communities around the globe. A prominent effect on all communities of the world has been observed due to the rapid spread of COVID-19 disease. An emergency is grown up and needs robust actions that cop the crises on economic and political setups. A virus from the family of Coronaviridae is named Coronavirus or COVID-19. The world health organization (WHO) nominated that virus as 2019-nCoV. Further, an in-depth name is announced as Sever Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) by International Committee [1]. As noticeable death are reporting with exponential growth makes a red warning. On emergency grounds, the researchers and developers have started investigating the technological based solutions to reduce the impact of infection.

The COVID-19 pandemic has prompted a worldwide lockdown, which has resulted in a paradigm shift in that how doctors communicate and counsel their patients [2]–[4]. There is a need for closely observing the safety of the public, the movement of the public among the countries, and also the exchange of information based on transportation and health organization across states as well as countries. A spurt in COVID-19 can be controlled with prevention under the supervision of medical health care unless an approved medication is available for its cure. The virus proliferation can be prevented based on the norms of dense population, age, and public gatherings. Moreover, significant preventions are observed based on avoiding the social gatherings and distances [5]–[6].

Due to country-specific restrictions and lockdowns, medical practitioners are increasingly using virtual consultation to speed up the implementation and uptake of public health programs [7]. The challenges that existing information communication technology systems face today are extraordinary, and there are bolstering attempts to extend digital infrastructure throughout health systems to improve performance. There is a definite need to manage surges in demand for preventive measures, remote care, supply chain and logistics efficiency, and the development of innovative digital health care delivery systems that assure meaningful patient connectivity [8]. As the pandemic becomes more severe, the most important objective is the paradigm shift in conventional health systems to combat the pandemic by proposing the taxonomy on the basis of digital technologies. Thus, an AI and IoT based digital healthcare system model is proposed. Moreover, a detailed investigation is carried out that provides well time guidelines for the transformation of digital health.

2. LITERATURE REVIEW

Although nations all over the globe have adopted strict quarantine policies along with the travel ban to limit the spread of the virus, an increase in the epidemic led us to affirm that still long-life solution is not proven. Khylstedt et al. [9], did their study and reported that accurate, safe and reliable diagnosis can be accomplished by developing improved information technology-based tools and technologies for disease management and digital health. Singer [10], highlight the problems that induce health and safety that are caused due to incompetent healthcare sectors that could not provide better monitoring and digital health solutions.

Haxhihamza K et al. [11], reported that due to the pandemic there is higher interest developing in telemedicine rather than face-to-face contact. Moreover, Ramaswamy A et al. [12], suggested that video-based consultation is preferred over traditional physical clinic visits, especially during the pandemic. Meanwhile, he also recommends improved parameters to be added to telemedicine so it has a larger scale of adoption. Andrew et al.[13], reported that telehealth provided a higher level of satisfaction for health care persons and patients during COVID-19. Further, he also reported that patients have the willingness to continue telehealth services even after the pandemic ends. Gillman-Wells et al. [14], highlighted particularly the features of telemedicine especially in virtual consultation for plastic surgery.

Kumar et al. [3], suggested the challenges of health care systems during a pandemic and proposed the solution in the internet of things and artificial intelligence-based eminent technologies. Gadzinski et al. [15], proposed a telemedicine-based health care system on video and electronic consultation to get emergency-based admission to a hospital. Moreover, he also described the procedure for billing, prescription, and virtual consultation types. Watson et al. [16], suggested a study on gathering data and developing the monitoring in real-time, as it become a global need, especially in the pandemic. Bokolo [17], suggested the adoption of telemedicine and virtual-based software to reduce the impact of COVID-19 all along and later because of reducing hospital visits, protecting health care systems, and minimizing the spread of that virus.

Smith et al. [18], highlighted the ways to establish and used telehealth care on the highest priority basis along with conventional health systems to have better results in health systems during and after the pandemic. Kojima et al.[19], reported that the use of telemedicine come to light with a success rate of 95% more than the conventional health care approach. Similarly, Basil et al. [20], reported the usage of telemedicine was 70% increased during the peak COVID-19 pandemic period. Further, Khan [21] presented the methodology to manage COVID-19 infections with the help of telemedicine. Grimes et al. [22], reviewed and suggested the recommendation for telemedicine, especially for patients related to urogynecology during pandemics. Hong et al. [23], evaluated the use of telemedicine, especially in western china, and showed better performance during the pandemic. Moreover, during COVID-19. Leite et al. [24] investigated telemedicine along with e-health technologies. Stefano Omboni [25], highlighted the worst crises that happened in the health care system of Italy because of less awareness regarding telemedicine services.

3. DIGITAL HEALTH-A PARADIGM SHIFT

Digital transformation for the health care system in a strategic direction, exhibits great performance by utilizing and leveraging technology in a variety of ways and through a variety of channels, all the while keeping an eye on current and future demands for health care. During COVID -19 pandemic countries were bound to lockdowns so that they can manage and control this virus from spreading. Previously telehealth and remote care facilities were used for emergency purposes [26]-[27]. In the situation of COVID 19, the use of these digital technologies has increased. Nowadays with the help of digital health care systems out of sight, medical experts can deal with patients at home. In this pandemic use of this technology has been increased for the routine check-ups of patients [28]-[29]. Inaccessible monitoring and the large number of patients are facilitated through this digital health care system because of its higher convenience and better diagnoses of diseases.

3.1. Internet of Things (IoT)

The patient and health care consultant interactions were only restricted to physical check-ups before the IoT. Before IoT health consultants and health care systems had no way to keep things safe or on track continuously and take action on time. With the help of IoT devices remote monitoring in the health care systems becomes more efficient and because of their efficiency health consultants can take better care of patients [3]. In this way, patients keep themselves healthy and safe. IoT has made interactions with health consultants efficient and easier, it also has improved the satisfaction and involvement of patients with their health care consultants. In this pandemic, remote monitoring of patients helps in reducing the stay of the patient in hospitals and preventing re-admissions. IoT improves the results of treatments and reduce health care costs [30].

By remodeling people's interactions, IoT is changing the healthcare systems by providing better healthcare solutions. The deployment of IoT has benefits for health care systems, insurance companies, medical consultants, and patients [31]. IoT-based health monitoring systems have the feature of the control of infections and real-time tracking [32]. Moreover, an IoT can help and be used to recognize the outbreaks at early stages when it is combined with any other technology.

AI-based digital health systems are proposed that have the capabilities of self-test, self-tracking, and procedure to identify the symptoms [3]. Moreover, the application of various technology (IoT, AI, Big data, sensors, etc.) based on digital health is investigated that have the capabilities of preventing the spread of coronavirus. The IoT is a

well-defined digital technique, interdependent computing tactics, and mechanical devices implementing the capacity of transmission of data over a specific network without having any kind of human involvement at any level [2]. IoT act as a connection to the countless tactics, the idea of machine learning, immediate analytics, sensory products, etc.

Post-COVID pandemic ensures that IoT is an innovative technology that identifies that all the patients who are suffering from this virus are quarantined and during quarantine, it helps to properly monitor the system [32]. IoT-based systems keep track of all the high-risk patients, along with measures of biometric quantities, e.g blood pressure, glucose level, and heartbeat.

The workload of health care consultants is also reduced with the successful deployment of this technique. During COVID-19, this technology also does the same with fewer mistakes and expenses. IoT helps a lot to secure people from COVID variants pandemic and it also manages the challenges during the situation of lockdown in different countries. This technology performs a great role to get real-time data on the infected person. Similarly, IoT is used to get the data from infected patients who are living in various locations, and then it manages all the data through the digital management system.

3.2. Artificial Intelligence (AI)

The health care consultants, patients, and admins of healthcare systems can complete their tasks in less time and free of cost through artificial intelligence [3]. From surveying chronic diseases, conducting risk assessments, and genetic codes to driving surgery assisting robots. AI is improving and reinventing health care machines through machines that can predict, act or learn [33]. Clinical decision-making is revitalized through artificial intelligence. Training data is becoming more accurate and precise through learning algorithms. It permits humans to get treatment variability, diagnostics, and patient outcomes.

- Artificial intelligence can quickly predict irregular patterns and other ‘red flags’, thus alarming the health care authorities and patients [34]. Decision-making gets fast through this technology. Through useful AI algorithms, the management of COVID 19 infected patients becomes easy and helpful in their diagnosis. Moreover, the infected patients can be diagnosed based on the medical images system that is on AI-based techniques [35]. Medical imaging technologies include Magnetic resonance imaging (MRI) and Computed tomography (CT) for the scanning of different human parts.
- AI can also be helpful in the prediction of the spread of this virus. Extraction of visual features for COVID-19 virus is developed with the help of artificial intelligence and this technique helps in proper monitoring and treatment of patients. This system is used for providing updates on a daily basis to the patients and also to provide solutions for the treatment of this virus.
- AI can be used to analyze the intensity of the infection virus and further can help to find out the hot spots [36]. COVID-19 drug is also analyzed through artificial intelligence from available data. Drug design, development, and delivery can also be managed through artificial intelligence. This technology can also speed up real-time drug testing where usual drug testing takes plenty of time. Artificial intelligence accelerates the process of drug testing which is not possible for human beings [37]. This innovation is also useful for identifying the drugs for the early treatment of COVID-19 patients and plays an important role in the development of the vaccine.

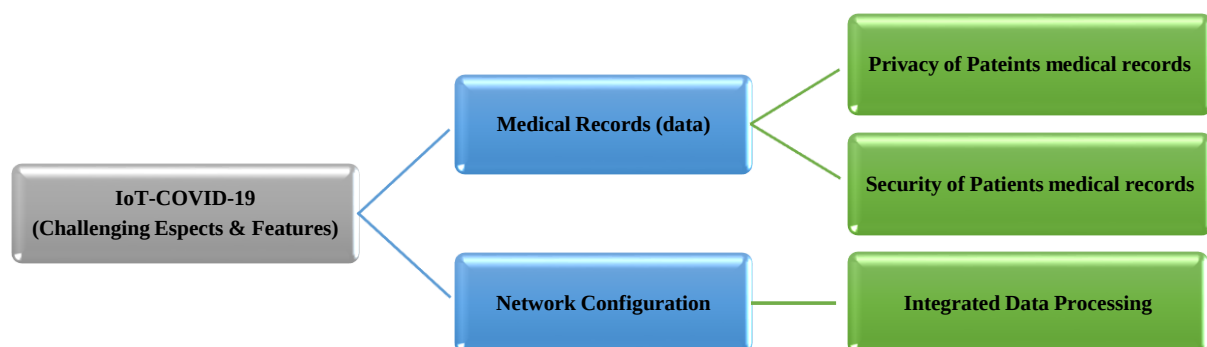


Figure 1: The issues and challenges of IoT based model for the Health Care System [30]

Sing et. al.[30] reported several issues and challenges for IoT based COVID-19 health care systems as shown in Figure 1. Firstly, he divided the challenges into categories namely as medical records and network configurations. Further, the author reported the challenging feature of privacy and security of patient's data while handling the medical records on the IoT based digital health systems. Thus, medical data of the patients used in the IoT environment should be treat in highly secure environment. Secondly, the author reported the aspect was network configuration based integrated data processing to be used for the IoT based medical systems. By keeping these challenges and also the aspects from the literature review an AI-IoT based digital health care model is proposed in the next section.

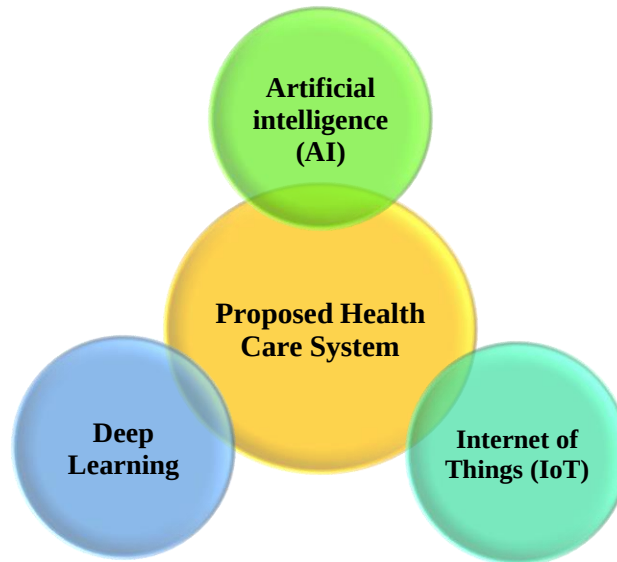


Figure 2: The cyclic view of the proposed model for the Health Care System [38]

4. PROPOSED MODEL FOR COVID VARIANTS

- The proposition of the model is based on the combination of artificial intelligence and the internet of things respectively and its cyclic view is mentioned in Figure 2. The proposed AI technique in the health care systems helps to manage the interaction of data using deep learning. The proposed AI-IoT-based health care model is shown in Figure 3 and follows the steps mentioned below:
- The proposed digital health care systems are based on the combination of artificial intelligence and the internet of things.
- The proposed AI-IoT-based digital health care model can be accessed with the help of smartphones, wearable technologies like digital watches, and by accessing the internet.
- Further, when the patients enter the proposed AI-IoT model, patients are asked about two options namely AI-IoT and virtual physician-based health care systems. Patients can decide among these two options while keeping in mind that when a patient will go for a virtual physician-based health care system get an appointment based on the waiting queue.

Virtual appointments with the physician can take a long time based on the patients in the queue based on the first in and first out mechanism. After getting the virtual appointment from the physician, an online (audio/video) diagnosis can be performed. In that diagnosis, a physician can categorize the patients in the following options chronic cases, daily routine cases, emergency cases, and COVID variants cases. Moreover, the physician suggests medicine or can go for laboratory tests during the examination of the patients.

In AI-IoT-based appointments, machine learning techniques are used, like supervised deep learning technique is used to take the symptoms from the patients. The patients can write or use their voice to record his/her symptoms to the AI-IoT health care systems. Further, deep learning-based digital health care systems compare his/ her medical records and categorised them as chronic, daily routine, emergency, and COVID variants cases. Finally, the AI-IoT-based digital health system decides to use machine learning about the diagnosis like medicine reporting or suggesting the patients go for laboratory tests. Similarly, the patients who have symptoms of COVID variants can be diagnosed at their places by performing the test and delivering the medicine at their doorsteps.

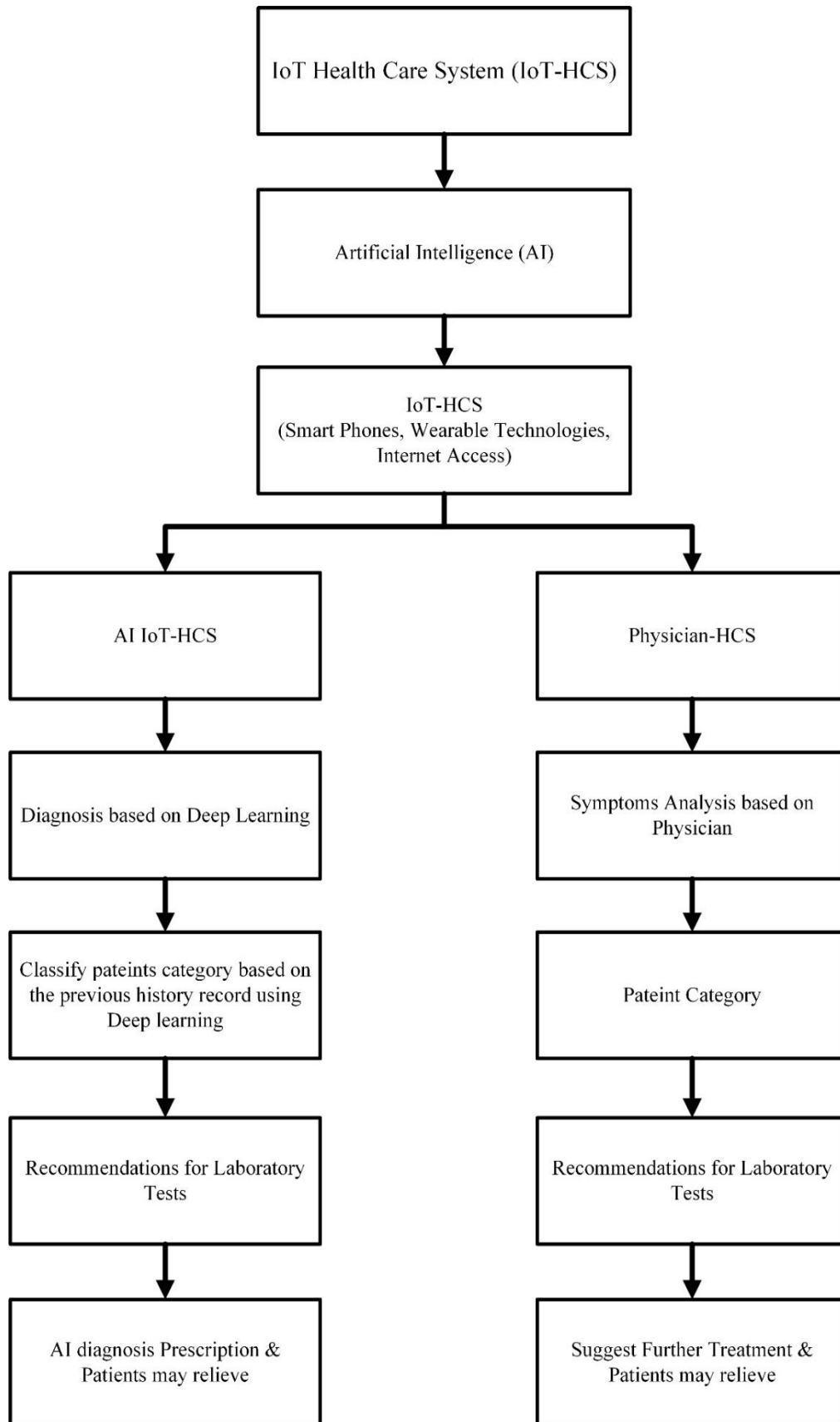


Figure 3: The proposed AI_IOT based model for Digital Health Care System

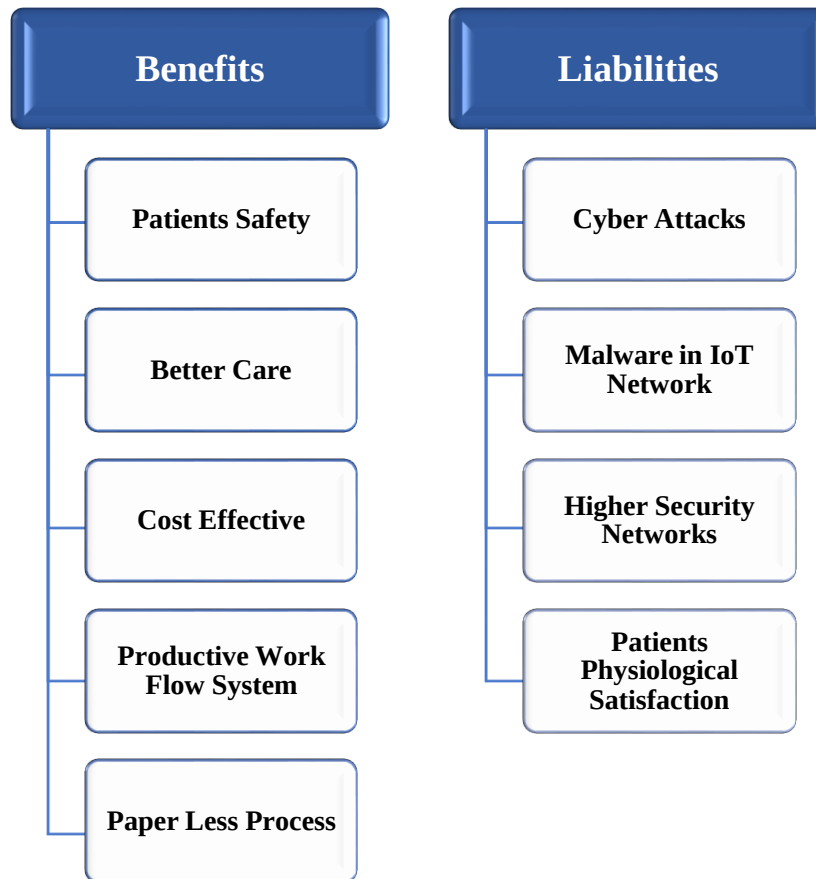


Figure 4: Features and Labilities in the proposed AI_IoT based model for Digital Health Care System [39]

The implementation of AI-IoT proposed solutions in healthcare presents the following benefits and liabilities are listed in Figure 4. Moreover, improved patient safety and quality of life are achieved because of the virtue of monitoring and assessment from remote access. More freedom with proactivity are available for individuals to monitor their health services. A cost-effective digital health system will be implemented based on prevention measures. Cost optimization in terms of patient digital health care, medicine stocks, and equipment stocks. The cyber-attacks on the huge medical healthcare data available on the internet or cloud are the challenges to cater to while implementing the proposed health care model. High-security protocols are required for all the devices used in digital health care in case of any malware. Further, there is a need to have an integrated care system that can handle the safety risk of medical data and can be ensured by the setup of using AI-IoT based proposed model with enabling cloud computing. A strict regulation should be defined for medical devices based on their quality and safety measures as their functionality will provide a key role in the life of patients.

5. CONCLUSION

COVID-19 is a portal it opens up in many ways. It has created new transformations for all fields in which we have to convert all the things to digital systems through which interaction with human beings becomes less. During this pandemic, there is a great need for social distancing and to fulfil this need countries adopt lockdowns to protect people from this life-threatening disease. Post Covid-19 analysis includes the advancement of health care systems to deal with this kind of situation in the future, to keep in mind the catastrophic effects of COVID 19 on healthcare systems are being improved day by day. The proposed digital health care model based on AI-IoT is an innovative contribution towards the transformation of the conventional health care system. Thus, AI-IoT-based digital health care system transformation is a solution for pandemics and beneficial for human beings.

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