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Internet of Medical Things (IoMT) for Covid-19 Epidemic Affected People

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ABSTRACT

i. Purpose of the study: Due to the rapid increase of COVID-19 cases, it has become challenging for the entire world to identify and treat infected patients at existing hospitals. In order to stop the spread of COVID-19, diseased persons need to be isolated for treatment. Hence, there is an enormous necessity to identify, monitor, and isolate patients to analyze their current situation and improve diagnostic accuracy to prevent more spread and deaths.
ii. Methodology: Providentially, the recent advances in Information and communications technology (ICT) like the Internet of Medical Things (IoMT) bring us opportunities to win the battle against the COVID-19 crisis. The exploratory research distributes practical assistance to the researcher for the rudimentary work. In this study, the exploratory research method was executed to explore the existing literature intensively and recognize the COVID-19 affected patients' issues or challenges.
iii. Main Findings: A new approach of IoMT-based E-Health has been designed and proposed for affected patient's treatment in real-time. IoMT based E-Health model venture a prodigious promise to treat isolated patients where it applies existing technologies to increase quality control and access to patient healthcare centers in this COVID-19 pandemic effectively.
iv. Applications of this study: IoMT-based E-Health involves significant components to track, identify, monitor, manage, store, and analyze patient information for the ongoing COVID-19 pandemic. With the help of the proposed approach, existing hospitals and healthcare centers can manage many infected patients, suggest treatment, and respond quickly according to their emergency alerts.
v. Novelty/Originality of this study: This study aims to identify current health systems' challenges and design a specialized model for the IoMT based E-Health systems by focusing mainly on the challenges that surfaced during COVID-19.

KEYWORDS: Dairy sub-sector, Dairy value chain, Milk production, Agricultural Productivity, White Revolution, Pull-Push factors.

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INTRODUCTION

In December 2019, an epidemic causing Severe Acute Respiratory Syndrome (SARS) activated by a novel coronavirus designated as COVID-19 broke out in Wuhan, China (Feng, Grifoll, & Zheng) and spread speedily to more than 200 countries in the world (WHO, 2020). Wuhan is a metropolis of more than 11 million people and thousands of foreigners and a significant national and international transport center, which became the primary source of spreading this coronavirus (Khan et al., 2020). Despite the 2002/2003 outbreak of SARS-like coronavirus and the 2012 outbreak of MERS coronavirus infection, COVID-19 is the world's third most common coronavirus that has warned international health agencies (Jiang, Xia, Ying, & Lu, 2020; Munster, Koopmans, van Doremalen, van Riel, & de Wit, 2020). COVID-19 has become a foremost public health challenge not only for China other countries around the world. The World Health Organization (WHO) has professed COVID-19 as a global pandemic on March 20, 2020, and declared its contingency level from high to very high. WHO declared the outbreaks of the COVID-19 as a public health emergency for the whole world. Globally, 198,022,041 cases of this coronavirus have been registered between December 2019 and August 02, 2021 (WHO, 2020). Firstly, most reported cases were in China, followed by Italy, which affects all European Union, Iran, and the USA with the highest positive cases (Remuzzi & Remuzzi, 2020; Zheng, Boni, & Fingerhut, 2020). COVID-19 caused the sudden and rapid exponential importation of patients in mild or intensive care, or simple instruction to quarantine at home, has become the omnipresent and an urgent preoccupation of hospitals and healthcare centers that need continuous management. To handle massive patients, China builds makeshift hospitals in incomparable periods, whereas Europe formed external shelters, internal reshuffling of patient beds, and considerably changed the architecture of present health amenities (Chen & Zhao, 2020; Zheng et al., 2020).

With the massive increase in patients daily, it has become a challenge for the world to handle and treat patients, so doctors advise patients to stay at home and isolate themselves, only if they feel any severe symptoms related to COVID-19 then visit the hospital. The developing countries with the least health facilities advise nations to stay at home and isolate themselves to stop this spread. The world is in a lockdown situation, and hospitals are full of patients. There is no space for new patients. In this situation, we need to handle COVID-19 with new emerging technologies like the Internet of Things (IoT) so that doctors can identify and treat COVID-19 patients at quarantine with real-time monitoring. IoT technology is praiseworthy that collects real-time information and

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communicates data through smart sensing devices faster yet accurately for processing and storage (Aksu, Babun, Conti, Tolomei, & Uluagac, 2018; Atzori, Iera, & Morabito, 2010; Pattar, Buyya, Venugopal, Iyengar, & Patnaik, 2018). IoT integrated Electronic Health (E-Health) has an ever-growing demand for efficient coverage, medical facilities, and timeliness in healthcare centers. Inorder to improve the efficiency and effectiveness of the existing health systems, the idea of IoT has been embedded with E-Health. Figure. 1 exhibits the surviving healthcare systems and IoT technology. Present healthcare systems are working as self-governing bodies and managing the hospitals with centralized technologies to treat patients. IoT technology connects smart devices empowered for computing with other devices, it allows smart devices to communicate efficiently and securely. There is an ominous need to adopt and implement IoT technology in existing health systems to tackle the current situation created by COVID-19. This research aims to provide a novel IoT-based E-Health model to diagnose COVID-19 patients faster and progress its treatment by applying IoT technology to strengthen healthcare systems. IoT integrated E-Health systems use embedded technologies for better services, care, and association with infected patients and increase the efficiency of current healthcare systems. This deployment of IoT in E-Health will bring ease to the doctors and patients by enabling real-time identification, monitoring, and keeping track of the COVID-19 patients from anywhere while improving the health and wellbeing of the patients. IoT-based E-Health system will establish online real-time communication with the patients to improve diagnostic accuracy. Additionally, doctors like physicians and experts can link together to guide treatment and perform consultation and prevention.

This paper is structured as after the introduction section 2 explores the detail of literature review regarding COVID-19 and existing health systems challenges. Section 3 clarifies the methodology adopted for this study, and Section 4 evaluates the proposed model. Section 5 provides a detailed discussion and the scenario of the model. Section 6 gives limitations and future directions. In the end, section 7 concludes this paper.

MOTIVATION

IoT is a praiseworthy, distributed network of interrelated smart sensing devices deployed in any dynamic environment for real-time information sharing (Dorsemaine, Gaulier, Wary, Kheir, & Urien, 2015). The interconnected things in IoT are small and low-cost sensing devices that participate in creating a smart environment. IoT has improved moving, working, and overall life

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in every field, including industries, institutes, homes, transportation, and monitoring systems (Haller, Karnouskos, & Schroth, 2008). IoT benefits hospitals to identify and track patients to enhance the medical services of healthcare centers and maintain patients' records through real-time monitoring from anywhere. To summarize, this study aims to design a specialized IoT-based E-Health model for the COVID-19 situation to monitor and treat isolated people effectively. The designed model uses IoT layered approach to address key issues of existing healthcare centers and provides a wide-ranging data collection mechanism, processing, and storing from the patient to E-Health centers.

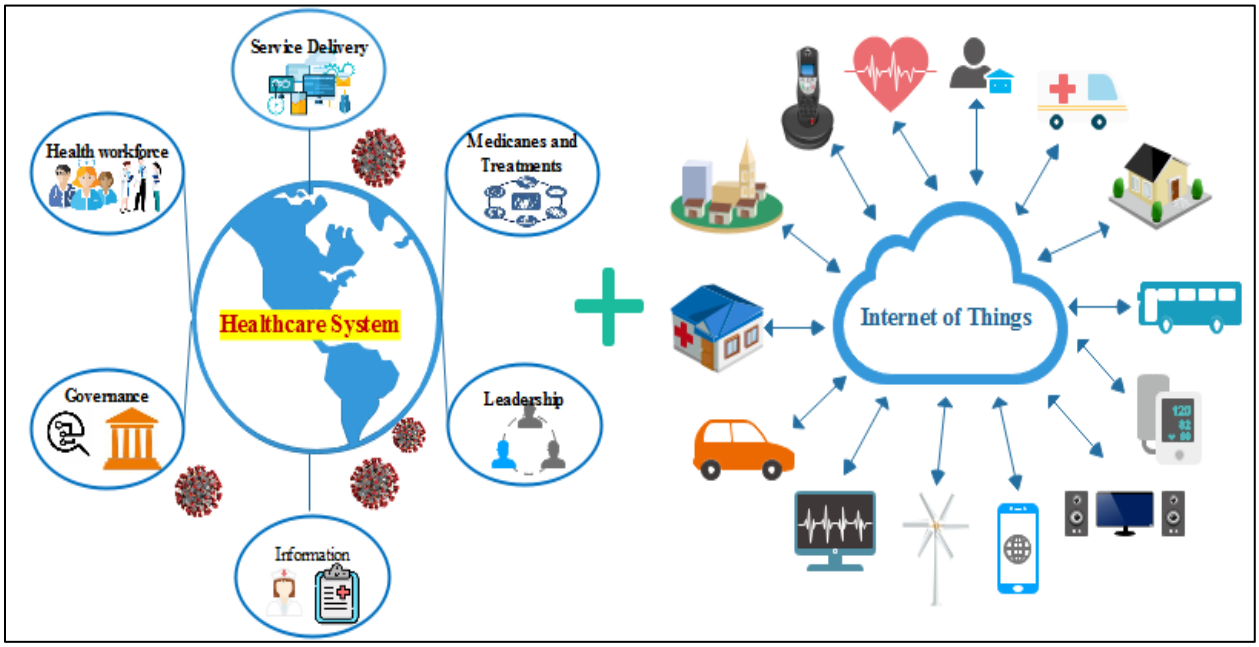

Figure. 1. Existing HealthCare System and Internet of Medical Things (IoMT)

LITERATURE REVIEW

At the end of 2019, a novel coronavirus earlier known as 2019-nCoV, a severe acute respiratory syndrome coronavirus, emerged in Wuhan, China, as mysterious pneumonia (Bai et al., 2020). The diagnosis of coronavirus in human beings has aroused concerns as it was not testified in humans previously on a wide scale. The World Health Organization (WHO) named 2019-nCoV disease Coronavirus Disease 2019 (COVID-19). The coronavirus transmission is through infected human droplets, which happens in close contact with the infected person (Tian et al., 2020; Wickramasinghe et al., 2020). The coronavirus is highly contagious, and its incubation period is two weeks or longer. Coronavirus targets the patient's lungs, due to which the patients with severe

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infection gradually grow respiratory failure or several organ failures and eventually die (Bai et al., 2020). COVID-19 presents a global pandemic challenge for critically ill patients with pneumonia and the absence of definitive treatment. As of August 02, 2020, the confirmed cases are 198,022,041 of this respirational disease and 4,223,460 confirmed deaths (WHO, 2020). The death rate appears to be around 2%, 25.9% required ICU admission, and 20.1% developed acute respiratory distress syndrome (Cunningham, Goh, & Koh, 2020). Currently, there is no vaccine to treat patients diagnosed with COVID-19; the treatments given to the patients include oxygen, ventilators, and fluid management. It has been suggested to implement social distancing, avoid gatherings, and quarantine to stop the spread of this virus (Hopman, Allegranzi, & Mehtar, 2020). Even patients with very low symptoms of COVID-19 are suggested to isolate themselves in their homes.

The state-of-the-art literature states that it is vital to identify, report, isolate, and treat patients at the early stage of the disease to control its spread and treat patients. With the massive increase in patients daily, it has become an immense challenge for the world to handle and treat patients, so; doctors are advising patients to stay at home and isolate them if they feel any severe symptoms then visit the hospital. The world is in a lockdown situation, and hospitals are full of patients; there is no space for new patients. Hospitals are in shortage of Personal Protection Equipment (PPE) that is very dangerous for the workers of healthcare centers; many doctors are getting infected by this virus while treating patients (Newman, 2020; Tanne et al., 2020) that is creating another challenge. It has become a challenge for the world to treat many patients at hospitals without staff protection equipment, less staff, and medical equipment (Anelli et al., 2020; Misra, 2020). Expressly developing countries with great variations in healthcare departments are struggling with this pandemic. The developing countries have run shortage of health facilities and advising the public to stay at home and isolate themselves to stop this spread of COVID-19 (Raza, Rasheed, & Rashid, 2020).

Many countries have E-Health systems to improve access to healthcare units and to provide delivery services in metropolitan areas and telemedicine in the form of E-Health, where applications are deployed to connect doctors and patients through video chats to treat patients from other areas ("e-ilaj," 2017; Farooq, 2017). This system connects specialized doctors to patients in the hospitals through internet connections where doctors suggest treatments to patients that cannot travel to hospitals. Currently, we need a system to track and identify COVID-19 positive people

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and treat them at their location wherever they are. This research is carried out to integrate E-Health systems with IoT to overcome this COVID-19 pandemic using sensing devices so that patients can be treated at their locations without traveling to hospitals. Due to the perilous improvements in computing and its concurrence innovations are the novel vast rise in the computerized world which have raised a term called the Internet of Things (IoT) (Kopetz, 2011; Wortmann & Flüchter, 2015; Xia, Yang, Wang, & Vinel, 2012). Kevin Ashton firstly used the idea of IoT in 1998 where, he labeled it as a global internet-based architecture for the excellent amenities like linking things or objects for the exchange of information (Aazam, Khan, Alsaffar, & Huh, 2014; Wu, Lu, Ling, Sun, & Du, 2010). Things in IoT are identified as vigorous participants or objects in numerous areas like industries, homes, and social events where they are permitted to interconnect subordinate and transfer information within the existing smart environment.

IoT technology has rehabilitated the regular day-to-day presence of individuals (Wortmann & Flüchter, 2015). IoT has revolutionized moving, working, and fluctuating even the entire urban areas where all the things gust up simply more rapid-witted since the objects communicate with one another, complete the work autonomously, and show the estimation and results. IoT technology empowers interconnected things through the hardware, the program, and the network that permit connectivity to exchange information. IoT springs a new generous administration to everyone with a precise end goal to boost the systematic everyday presence. IoT things gather the data, then exchange it into useful information to create the basic infrastructure and services for homes, buildings, cities, transportation, and efficacies more mindful, intelligent, and industrious information. IoT could be presumed as three principles, including middleware, sensors, and information. Other technologies like big data, cloud computing, ubiquitous computing, pervasive computing, participatory sensing, and visualization are utilized through this innovation. There are insufficient areas that affect the growth of IoT that can be eminent inconvenience, heterogeneity, possibility, and repeatability. This research proposed an IoT-based e-health model to intelligently and efficiently identify, monitor, and analyze coronavirus patients. The proposed model helps diagnose and predict whether a human being has Coronavirus infection or monitor affected patients in isolation centers. IoT was likely to be installed entirely in 2020 for linking tons of things (Aazam et al., 2014; Gubbi, Buyya, Marusic, & Palaniswami, 2013); in this epidemic, there is an ominous need to adopt and implement IoT in the healthcare centers so that IoT-based E-Health systems can help authorities to treat patients.

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METHODOLOGY

Different models are proposed to adopt and deploy IoT technology in health systems; however, a specialized model must address existing healthcare centers' issues to tackle COVID-19 health-related services at the access and isolated consultancy for people of different countries. A wide variety of research approaches can be employed to conduct research to identify the problems or issues and propose the solutions for the gaps in research (Brannen, 2017; Kothari, 2004). The exploratory research method is obliging if the embattled issue has insufficient evidence. So, the investigator aims to examine the research arena (Polonsky & Waller, 2014; Zikmund, Babin, Carr, & Griffin, 2013). The exploratory research distributes practical assistance to the researcher for the rudimentary work**.** In this study, the exploratory research method was executed to explore the existing literature intensively and recognize the COVID-19 affected patients' issues or challenges. Afterward, a specialized IoT-based E-Health model has been proposed to provide health services to COVID-19 isolated patients. The proposed model uses IoT services and provides interoperability amongst different sensing devices and enabled the transformation of information between patients and doctors through Internet. The IoT services also deliver connectivity with backend cloud computing services for data storage.

PROPOSED MODEL

Presently, the world is under a global pandemic for which no one was prepared, COVID-19 disease is damaging every single country very swiftly, and the intensification in its cases is very frightening. The world is in a lockdown situation and has no plan for surge capacity. Currently, there is no treatment for this disease, and the world is losing thousands of people day by day due to this pandemic. The hospitals are full of patients, there is no room to treat newly infected patients, medical equipment is very little, and ventilators are occupied. The health center workers, especially doctors and nurses, are at great risk of getting infected while treating infected patients. The only prevention suggested for this infection is to isolate infected patients.

Moreover, the patients are isolated in their homes, hospitals, and places declared quarantine by government authorities. Therefore, the IoT-based E-Health model is designed especially for healthcare centers to handle current COVID-19 pandemic infected patients (Fig. 2). The proposed model implements IoT layers into the existing healthcare system for rapid data sensing, processing,

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and reports. This model will benefit patients and outpatients to achieve early identification, isolation, and treatment of COVID-19. The integration of IoT in E-Health provides hospital services to isolated patients via specialized doctors. IoT sensing devices establish real-time data transmission that reduces the delay in treating critical patients extending traditional medical services. IoT support wireless connection between small sensing health monitoring devices connected with patients' body and healthcare centers.

COMPONENTS

The proposed model integrates IoT with the existing E-Health system, where IoT has three-layer architecture together with the sensing layer, transmission layer (in this scenario, a processing layer), and application layer. These layers are transparent and process real-time data from sensors to the Application Programming Interface (API) efficiently and densely.

Sensing Layer

This layer subsists of small, low-cost sensing devices that function on a very low power source. These sensing device's process capacity is very limited but contributes to real-time information collection. Various communication technologies like Wi-Fi, Bluetooth, 3G, 4G are utilized to transfer sensory data from the sensing layer towards the transmission layer for processing. The sensing devices for the existing scenario of COVID-19 embrace blood pressure machines, thermometers, respiratory rate checking machines, and others. These sensors are plotted on isolated patients' bodies or near them to continuously monitor or track their health state and transfer important data to the doctor or hospital. Firstly, sensing devices will relate to the specific hospital server after proper verification and validation of the patient. After validation, the sensor will be converted into the network and transfers patients' data to the hospitals for monitoring and treatment.

Sensing Devices

The sensing devices play an important role in visualizing a patient's health; various portable sensing medical devices capable of gathering information are plotted on the patient's body to capture data and send it for further analysis. Based on analyses and aggregation, authorize doctors and nurses can monitor patients from any location and respond accordingly. Sensing devices for

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monitoring symptoms for the existing systems include a 1) thermometer to measure human body temperature. 2) Heart rate wearable, responsible for ECG trace 3) Respiration, for measuring breathing 4) Weight Scale 5) Blood flow, to measure changes in pigmentation 6) Motion analysis and many more depending on patient's health aspects.

Transmission/Processing Layer

This layer entails various communication technologies to transfer sensory data from the sensing layer to hospitals centers for storage and further processing. This layer consists of communication technologies, IoT gateways, cloud services, and data processing for real-time visualization. IoT requires standard communication technology for real-time communication between sensors and hospitals. The proposed model enables wireless technology followed by web technology to transfer data to a specific server for processing. IoT gateways connect local personnel with the remote system. The third layer is the application layer which includes desktop access, smartphone access, local and remote access, and application programming interfaces. This layer also comprises cloud services for better collection, processing, and data storage in secure and compact manners. The transmission layer assembles data and processes it towards hospitals to extract important mining information and manage records of patients for future use. The hospital workers maintain the personal data of patients to respond promptly in emergencies. The hospital's administrations monitor, and they inform the doctors for treatment in case of bad condition.

Server and Cloud Storage

The server systems implement cloud for centered collection of sensory data. It collects data from wearable sensing devices and processes it for hospitals and healthcare centers. The healthcare centers connected with the server access data for quick response and treatments. IoT devices are small and low processing devices that require cloud storage to store data for efficient access, where the cloud plays an important role in processing and storing data. Cloud storage is large centered storage that relates to the internet as the backbone. The server enables cloud services for processing important data quickly and transfers it to the end-users for efficient response.

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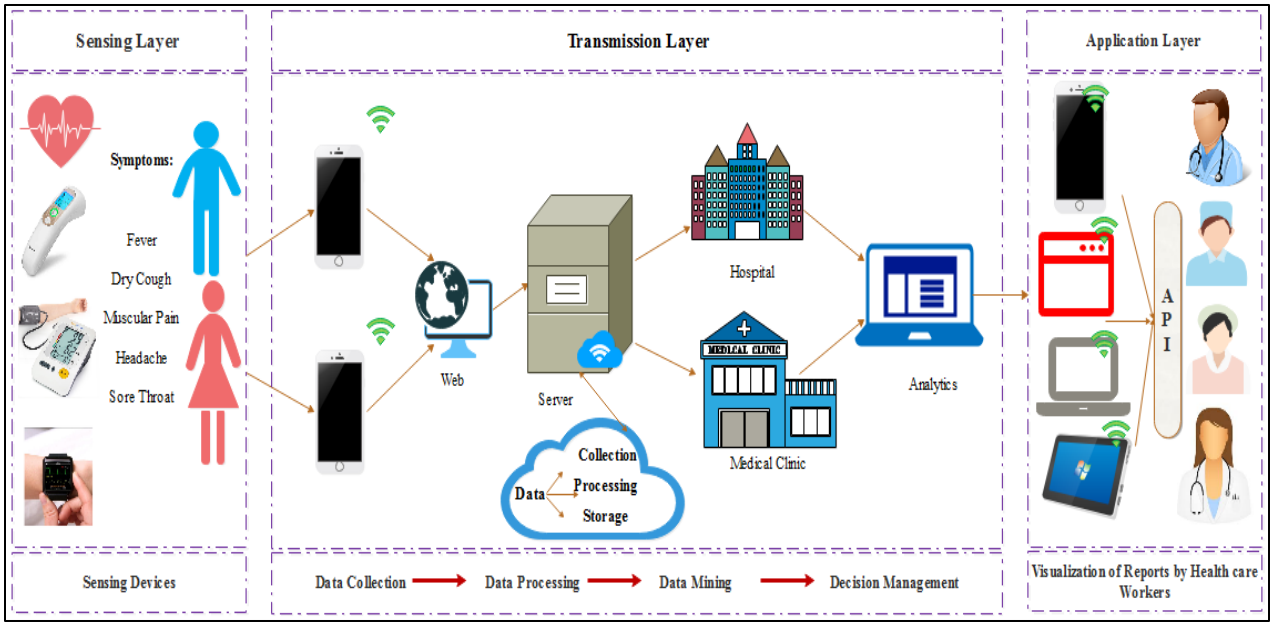

Figure.2. IoT based E-Health Model for COVID-19 Pandemic

Application Layer

This layer oversees Application Programming Interfaces (API) to visualize reports and view data. This layer includes devices that enable APIs for the workers of hospitals like doctors and nurses to see patient's reports and respond to their inquiries. The transmission/Processing layer transfers real-time information to the application layer for the visualization of important data. Servers and management systems further control collected data after the application layer. The application layer offers numerous services to all kinds of its participants that are using the different infrastructures. The E-Health system's main concern is to handle patient's information to provide medical services. The IoT-based e-health systems consist of that works for various stakeholders. The API manages and monitors real-time information, and if there are any changes in patients' condition of patients, it can provide services to save the lives of patients. With the adoption of IoT-based E-health systems, hospitals can facilitate patients with additional services that live far away but need critical attention. Various services provided to the patients include doctor visiting at home, ambulance services on emergency, appointment scheduling, maintenance of records of patients, availability of patient records in case of emergency to other health units, and monitoring patient's health daily.

APIs

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Using API services, real-time information from sensing devices can be synchronized and moved within the Internet of Things-based E-Health environment. API services include tracking and identifying connected devices at a specific location without the need for physical touch. Visualization APIs include a result auditor for unloading sensory movement and an event handler for processing sensory information before visualizing the results. The primary purpose of a Graphical User Interface (GUI) is to provide and enable navigation and control of data collected and processed through sensors, among other things.

Hospital Workers

Hospital workers include doctors, nurses, caretakers, and administration responsible for the management of the hospital. The workers can use tablets, smartphones, or web-based systems to monitor and control hospital activities. The authorized doctors can have permission to visualize and monitor their patients 24/7 for an efficient and prompt reply to their needs. The APIs are responsible for the management and monitoring of patient's reports, and if there is any change in the condition of patients, they can provide services to save the lives of patients through hospital workers. IoT-based e-health systems the hospitals ease patients with additional facilities that live far away but need serious care. A health appointment can be directed without see-through doctors and employees using smart mobile phones and tablet computers, permitting communication through an enthusiastic link with the hospital. The authorized doctors can visualize and monitor their patients 24/7 with permission for a well-organized and rapid reply to their requests.

DISCUSSION

The intensity of COVID-19 has taken on pandemic proportions after affecting more than 200 countries in a matter of weeks. COVID-19 has challenged the world's health by a progressive increase in affecting people in a short time. The response of healthcare centers to handle the situation is imperative; the world was not prepared for this epidemic. Mainly, the protection of masses and health workers is a serious global challenge; many healthcare centers got infected by the disease while treating patients (Landry et al., 2020; Misra, 2020; Xiang et al., 2020). Many countries lack personal protection equipment to secure healthcare workers from this virus while treating infected patients (Ranney, Griffeth, & Jha, 2020). Intensive Care Units (ICU) workers' prerequisite is to follow severe isolation protections in the ICU to protect themselves, other

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patients, and companions. Rigorous care of doctors must be certain to keep well-versed of the evolving knowledge and ought to communicate with health authorities to inform local infection control strategies.

Furthermore, some COVID-19 cases acquired symptoms of infection in the hospital were patients already hospitalized for other reasons (Wang & Zhang, 2020). China containment measures abetted to take care of the country's current situation and reduce in new cases. China managed the situation by creating new makeshift hospitals in short periods, but it has become challenging for other countries to handle it (Chen & Zhao, 2020). Many countries receive thousands of cases daily, and the USA exceeds this with almost 25,000 cases daily (WHO, 2020). Existing healthcare centers cannot treat all patients at hospitals as it poses more risks (Remuzzi & Remuzzi, 2020). State of the art research demonstrates that the death ratio of COVID-19 infected people is very low compared to new cases (Baud et al., 2020), and some patients have the very common effect of this virus, so; they can be treated at their homes by following doctors' suggestions.

Many developing countries suggest people stay at home and contact specific authorities for medications (Afsar, 2020; Saqlain, Munir, Ahmed, Tahir, & Kamran, 2020) like Pakistan suggests people dial a special number for any help related to COVID-19; they suggest people not to visit hospitals until they see clear symptoms of the disease. In case of emergency, they can contact for help 1st before traveling to hospitals (Nafees & Khan). Due to the lack of medical and protection equipment's existing healthcare centers are at their maximum capacity to control the recent plague. The number of infected patients remains to charts an exponential trend, and existing healthcare systems are lacking to treat infected patients at hospitals. In order to handle the current state of COVID-19, there is a need to embrace existing technologies to speed up this process of treatment and the extent of COVID-19. IoT technology has been evidenced to empower computers to identify, perceive, assemble, and understand the world's information independently. IoT enables a procedure of communication of anything amongst smart devices and humans from anywhere and anytime connectivity. The state-of-the-art literature has articulated the application of IoT in E-Health systems as a new prototype to revolutionize the way of management for hospitals as well as for the patients. Therefore, to handle the current situation promptly, a specialized model for COVID-19 has been proposed to control the disaster of this pandemic while implementing IoTs in the E-Health systems. The proposed model's foremost concern is to tackle this rapidly increasing COVID-19 disease by helping hospitals and healthcare centers to treat the massive number of

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patients more speedily and quickly. IoT-based E-Health systems have instigated IoT technology into E-Health systems to connect with the doctors/physicians for their concerns related to COVID-19 and treatment from their places. The scenario of the specialized model has been alienated into steps for further understanding (Fig. 3).

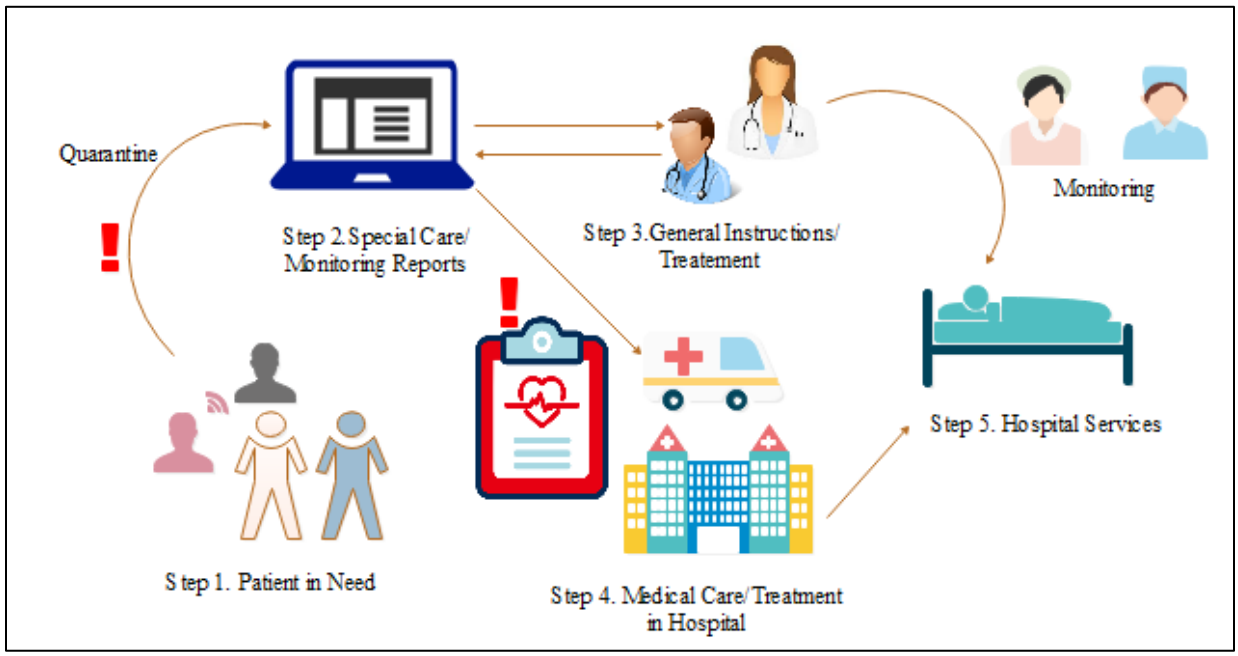

Figure. 3. IoT based E-Health Model Scenario for COVID-19 Patients

Step 1: Patient in Need

The biggest challenge to intensivists at this point is when to suspect someone for COVID-19. Many patients have simple flu and cough symptoms, but they contemplate it as COVID-19, but they might have a simple cold. Identifying COVID-19 patients at their earliest is vital so that important precautions measure can be executed to stop its further spread to humans and treat the patient immediately. Therefore, in this scenario, IoT technology-enabled sensing devices are employed to connect and communicate at a distance by using various internet terminologies to provide real-time information about a patient's condition so that the patients with true symptoms. Here, the first layer of IoT is a sensing layer consisting of small sensors to provide real-time information at the healthcare centers and hospitals about patients' conditions. The sensors can be embedded in the patient's body to monitor the patient's condition during quarantine days. An essential strategy for existing healthcare centers is to sort and control infected patients before they arrive at the hospital isolation or emergency units. The implemented sensors allow helpful patient-focused proficient

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screening and monitoring for self-isolation of infected patients. It confirms patients, doctors, workers, and the community from appearance and protects them from revelation. These sensors will deliver respirational observing (which might be prompt signs of COVID-19), monitoring body temperature, sore throat, and dry cough, and pulse rate for the diagnosis of COVID-19. The people will relate to the health systems 24/7 to communicate with doctors and medical staff for any COVID-19 related concerns, using smartphones or webcam empowered computer systems. Communication technologies like Wi-Fi can transfer user data from the first layer towards the second layer for processing. The sensors plotted on patient's bodies continuously track their health state and transfer the important data to the server for processing and transmission towards the doctor or hospital. Healthcare center workers can certainly acquire comprehensive patients' healthy reports, travel, and disclosure histories. Programmed screening procedures can be assembled into the intake process. Furthermore, indigenous epidemiologic evidence can be utilized to regulate screening and training designs diagonally workers.

Step 2: Special Care/Monitoring Reports

All leverage healthcare centers will allow doctors to see infected patients who are at home and enable related health facilities for infected patients by the doctors and medical workers. At present, the major barrier to handle enormous scale COVID-19 patients screening is the management of isolation at hospitals. With the availability of IoT technology, local healthcare centers can suggest isolation to appropriate patients while decreasing disclosure using lively places, tents, or quarantine centers established and unified into IoT-based E-Health systems. Infected patients who screen positive for high-risk features must be isolated proximately to prevent further spread with patients and healthcare workers. In the present scenario, healthcare centers will monitor infected patients connected with them through IoT technology to provide special care and keep an eye on them. The system will generate alert reports for any people with severe COVID-19 symptoms and be advised to isolate immediately. The hospitals will monitor the patients during isolation days. The monitoring system generates and observes patient's descriptions for critical evaluation to deliver any medical services if necessary. The collected sensory data from the sensing layer will be monitored continuously at hospitals for further processing and treatments. The hospitals will manage web systems to transfer data to the specific doctor for further instructions. The doctors can have desktop applications or smartphones to monitor and track patient's reports.

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Step 3: General Instructions/ Treatment

The collected data from sensors will be gathered and transferred to hospitals to extract important information and manage records of patients for future use. As stated in step 2, the doctors can monitor patients who tested positive for COVID-19 and suggest treatment from a distance. The hospital workers maintain the personal data of patients to respond promptly in emergencies. Healthcare centers can establish automated report tracers that identify and generate alerts for high-risk patients to provide prescriptions in isolation. It can also permit patients to schedule video appointments with the specialized doctor to escape in-person communication. In case of an emergency, the patient can be given any required services from the hospital. Allowing a remote worker to execute intake or a video conferencing software can be swiftly implemented for a protected open line from a systematized unit to a doctor. The hospitals' administrations monitor and they inform the doctors for treatment in case of bad conditions. If the patient's situation does not get better and worsens, then the doctor can suggest shifting them in ICU, where they can give them important medical services to save their lives. Such systems can facilitate infected patients' assessment before transferring in-hospital transfer, possibly permitting them to evade the emergency visit and be placed right in a hospital bed, reducing revelation for healthcare and hospital workers and others.

Step 4: Medical Care/ Treatment in Hospital

In case of emergency, the patient whose condition worsens will be suggested to move to the hospital, and the hospital will provide medical services to the patients at the hospital. The APIs manage and monitor patient's reports, and if there is any change in the condition of patients, it can provide services to save the lives of patients. With the adoption of IoT-based e health systems, hospitals can facilitate patients with additional services that live far away but need critical attention. Various services provided to the patients include doctor visiting at home, ambulance services on emergency, appointment scheduling, maintenance of records of patients, availability of patient records in case of emergency to other health units, and monitoring patient's health daily. A health visit can be piloted without revealing doctors and workers using smart mobile phones and tablet computers, permitting communication through a dedicated connection with the hospital. The authorized doctors can visualize and monitor their patients 24/7 with permission for a well-organized and rapid reply to their requests.

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Step 5: Hospital Services

For the patients, who are critically ill, they can be transferred to the hospital, and all necessary services will be given to the patients to save their life. If patient's condition worsens, they can be moved to the ICU and can be given further treatment to save their lives. Monitoring critically infected patients Electronic Intensive Care Unit (E-ICU) programs can be executed for remote monitoring of patients by doctors and workers. This procedure will reduce healthcare workers' interaction with COVID-19 infected patients in the ICU. Hospital workers shall take responsibility for the management of the hospital electronically. The use of smart devices or web-based systems helps to monitor and control hospital events.

LIMITATIONS AND FUTURE DIRECTIONS

Pandemic and tragedies pose irreplaceable issues and challenges for the healthcare centers, IoT-based E-Health systems cannot solve all the issues around the world, but they can help situations where arrangements are complete with doctors and workers' availability to see patients 24/7. The adoption of IoT-based E-Health system is very challenging for developing countries with the least health facilities. The development of new programs and systems is time-consuming, but healthcare centers that have previously devoted in electronic health are well suited to ensure that infected patients of COVID-19 take all necessary care required for them. Adoption challenges of IoT-based E-Health systems for under developing countries should be identified. Moreover, advanced platforms and frameworks should be deployed for the existing environment to enable big data analytics services to the end-users. Patients may be diagnosed and treated by the E-Health-based big data analytics service. Blockchain is another constantly rising ledger that could be connected with the E-Health systems to provide more secure end to end connections

CONCLUSION

Owing to the rapid spread of COVID-19, the world is in a global pandemic situation, and it has become a global challenge to treat and isolate various infected patients at hospitals. This study has proposed a specialized model for aiding health facilities and accessing hospital services in remote areas from patients' areas. IoT-based E-Health system will dramatically transform existing healthcare centers into a security monitoring system for doctors, hospital workers, and infected patients. Implementing an IoT-based E-Health system will revolutionize healthcare centers to

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tackle this outbreak of the COVID-19 pandemic more efficiently and effectively. Through this system, the patients can make appointments and visit doctors through API, and doctors can also keep track of their patient's health remotely. The proposed model embraces IoT three-layer architecture; sensing layer, transmission/processing layer, and application layer to split communication functionality for better understanding and implementation.

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