Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Telemedicine applications for pandemic diseases, with a focus on COVID-19

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1. Introduction

In history, many people have suffered from pandemic and epidemic diseases such as smallpox, plague, cholera, and influenza. For instance, it is estimated that 50 million people died because of the bubonic plague during the 14th century; 120,000 people die every year due to cholera [1]; and 50 million people have died because of influenza in the 1918 pandemic. Until 2019, the coronavirus disease 2019 (COVID-19) was an unknown threat to human life. Although it first appeared in China as an epidemic, it started to spread worldwide within months. COVID-19 was declared as a pandemic in March 2020, and in the middle of May, more than 4 million people were infected and nearly 300,000 deaths were reported worldwide [2]. To call a disease pandemic, it has to spread worldwide through people [3]. On the other hand, the epidemic is a disease that occurs in a certain location and the cases increase temporarily. According to the World Health Organization (WHO), phases of pandemic alert for H1N1 (influenza A virus) are separated into six phases and two periods. In phase 1, the virus spread among animals does not cause infections in humans. In phase 2, the animal influenza virus is considered a potential pandemic risk because it is known that it will cause infections in humans. In phase 3, animal influenza causes a low number of diseases in people, but it does not spread at a community level. This limited transmission cannot be called a pandemic. In phase 4, human-to-human transmission occurs as a community-level outbreak. This can be a sign of risk for a pandemic if there is an increase in the number of cases, and precautions should be taken countrywide. In phase 5, human-to-human spreads occur in at least two countries. This is a sign of a pandemic, and precautions should be taken to reduce the spread. In phase 6 the disease spreads from one country to another country, and this can be considered as a pandemic phase. The identification of phase 6 indicates the global pandemic. These phases are important for determining the risk of pandemic

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diseases. The phases of recovery and evaluation are necessary during a pandemic [4]. In pandemics, such as COVID-19, it is important to process the data to determine these phases, control the number of cases, and take necessary precautions quickly.

In the cases of pandemics and epidemics, the congestion in emergency services can collapse the healthcare system. Inadequate data transmission, limited resources, unplanned management of resources, and application of old-fashioned technologies lead to an increase in the number of cases and unprecedented deaths [5]. It is important to prevent the close interaction between infected and uninfected people to avoid the spread of the disease. Hence, remote monitoring of the disease and the patient is more vital in pandemics and epidemics [6].

Information and Communication Technologies (ICT) have an important role in the diagnosis, monitoring, and treatment of diseases and the delivery of health services to all patients. Today, governments are looking for solutions that combine health systems and information technologies [6]. Telemedicine (Fig. 10.1), which aims to overcome geographic barriers and provide remote and continuous healthcare and clinical support to large populations using ICT [7], is defined, according to the European Commission, as the science of transferring data, images, and voice of the patient to the doctor remotely using computer-based or smartphone-based technologies [8]. Telemedicine uses ICT for giving affordable and low-cost healthcare services [9]. Patient data can be collected remotely [10] and can easily be transferred across to different medical specialists [11]. Thanks to telemedicine, the interaction between healthcare providers can increase for highly accurate patient assessment. Telemedicine provides online communications between doctors and patients [8,12]. Hence, telemedicine can help introduce cost-effective patient-oriented care [9]. Applications of telemedicine are growing continuously in many medical fields and clinical applications. Teleradiology [13], telecardiology [14],

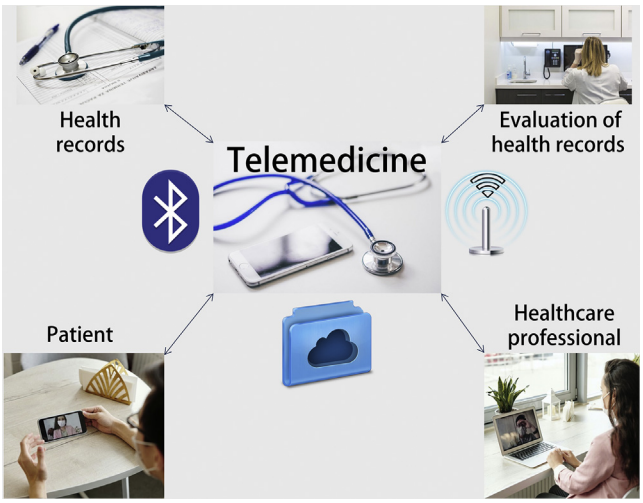

FIGURE 10.1 General workflow of telemedicine.

telepsychiatry [15], teledermatology [16], telepediatry [17], teletrauma [18], teleemergency [19], telepathology [20], and telesurgery [21] are some examples of the use of telemedicine in diverse medical fields. Telemedicine offers great benefits of diminishing costs, reducing travel, and increasing patient satisfaction [21]. Telemedicine has also the capacity to play a key role in pandemics, such as COVID-19, as the social distance can be preserved, and the spread of infections can be reduced by using telemedicine [22].

With the emergence of COVID-19, the use of telemedicine applications is increased rapidly on a worldwide scale [23]. Thanks to telemedicine, patients can reach healthcare providers rapidly for an initial assessment of the disease through online consultations. Wireless medical devices can also be integrated into telemedicine systems, and in this way, healthcare professionals can diagnose and monitor patients easily by remotely evaluating symptoms of the disease [24]. Furthermore, treatments can be better managed by real-time monitoring of patients during the course of the disease. The obtained data can also play a huge role in the successful treatment of new patients [25].

Home care and home treatment services are important elements in pandemic and epidemic disease management [26]. By these services, the risk of contamination can be minimized and the elements that threaten public health can be eliminated. Quarantine and isolation applications also have importance in the management of pandemic and epidemic diseases [27]. However, continuous health support should be provided to patients. In this context, telemedicine applications can facilitate home care services and provide remote healthcare support for patients by staying connected with caregivers.

In this chapter, telemedicine applications developed especially for epidemic and pandemic situations will be discussed, and current telemedicine practices dealing with the COVID-19 pandemic in different countries will be introduced. It will focus on how countries reacted to this epidemic and how telemedicine and communication technology relieved the health sector. In the epidemic and pandemic section, the patient monitoring applications, case prediction models related to human mobility, and telemedicine applications that enable real-time communication between patients and healthcare providers will be mentioned. In the section on worldwide telemedicine application for COVID-19, applications offered by countries and companies, basic workflows of these applications, and some companies that offer applications for free during COVID-19 will be presented. In this regard, the proposed solutions for telemedicine applications and the COVID-19 crisis will be discussed throughout different countries.

2. Telemedicine applications during epidemic/pandemic

It is reported that there were 28,616 Ebola cases in Guinea, Liberia, and Sierra Leone with 11,310 deaths in 2014–16 [28]; 120,000 deaths because of cholera every year [1]; and more than 100,000 deaths globally during the influenza pandemic in 2009 [4]. By May 16, 2020, COVID-19 has spread to 216 countries resulting in 4,425,485 cases with 302,059

deaths [2]. Early detection of these disease outbreaks plays an important role in the process of controlling them. It is also critical to control the spread of epidemic and pandemic diseases by preventing the interaction of uninfected and infected people. As traditional methods are challenging for massive data collection from patients, the healthcare system calls for faster, reliable, and easy data collection tools such as telemedicine [29].

ICT provides detection and reporting of potential pandemic diseases by using digital data transmission. Short message service (SMS)-based applications were applied to surveillance-based mobileHealth (mHealth) system in the case of the influenza pandemic [30]. This system provided information to healthcare professionals about the locations of cases, the number of cases, and the number of deaths. Another study for influenza surveillance was based on the smartphone-driven thermometer [5]. Thermometer recordings and influenzalike illness reports were collected from the Centers for Disease Control and Prevention (CDC) and correlated with age group and region. For this purpose, the Kinsa Smart Thermometer (San Francisco, California, USA) was used and the recordings were stored using the Kinsa smartphone application. Readings were also geocoded using either the Global Positioning System or Internet Protocol address. The autoregressive integrated moving average (ARIMA) model was used to analyze the progress of the disease, and suspected cases could be confirmed remotely [5].

In the 2014 Ebola epidemic, Surveillance and Outbreak Response Management and Analysis System (SORMAS) allowed people to send free text messages to seek medical advice [31]. From October 2014 to May 2015, 6063 live chats were conducted, and 20 suspicious cases were detected with these chats. In Western Australia, the EbolaTracks system (Fig. 10.2) was used for monitoring people coming from Ebola-affected countries [31]. With this automated SMS system, two messages were sent twice a day to ask people

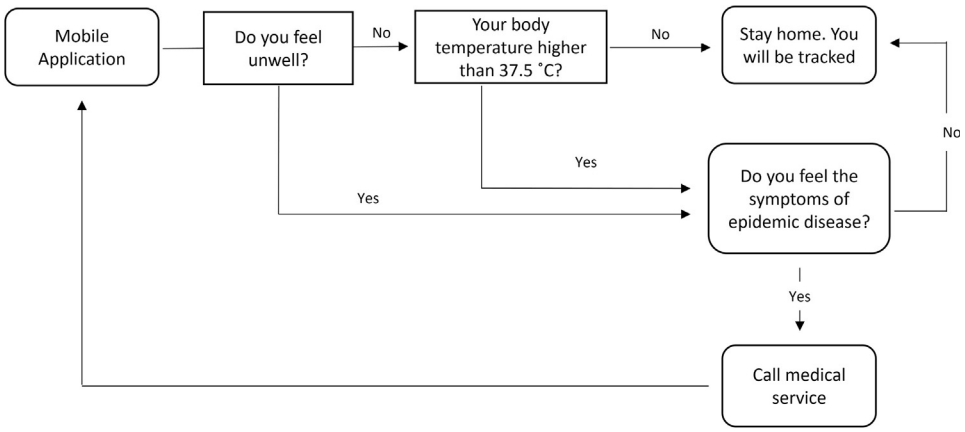

FIGURE 10.2 The EbolaTracks monitoring system [32] based on automated short message service (SMS) to check user's health status.

about their health status and their body temperature. If a person felt unwell and had a body temperature above 37.5°C or if a person did not respond to the messages, healthcare providers were informed about the situation via either SMS or e-mail [32].

The most infectious diseases, such as severe acute respiratory syndrome (SARS), tuberculosis, and buffalopox, spread from animals. Therefore preventive measures were taken in Sri Lanka by monitoring animal health using a mobile phone frontline surveillance system [33]. Veterinarians reported location, age, sex, clinical syndrome, the health status of animals (such as chicken, cattle, and buffalo) to build a baseline pattern in animal health and to provide key information for early warning of epidemics.

In Senegal, the cholera epidemic started from hundreds of cases per week until the first 3 months of 2005 [34]. Cases jumped to thousands at the end of March through other regions related to the religious pilgrimage that took place in late March. To analyze the spread of the cholera epidemic depending on human mobility and mass gathering, 150,000 mobile phone users' datasets were tracked using the mobility matrix model. The model revealed that increased human mobility could elevate the number of cases. Hence, case peaks would be predicted using human mobility data with this model [35].

The "Outbreaks Near Me" application developed in 2006 at Boston Children's Hospital (Boston, Massachusetts, USA) was used to inform users about latest real-time updates and information about outbreaks. Users could search and browse outbreak reports, and they could also set up a notification to be informed about outbreaks occurring in their neighborhood. Furthermore, in this content, an interactive map called HealthMap was developed in collaboration with Boston Children's Hospital and New England Journal of Medicine's H1N1 Influenza Center in response to the H1N1 outbreak [29].

3. Telemedicine applications for COVID-19

With the beginning of COVID-19, telemedicine-based services have been adapted in many countries to provide essential healthcare services [6]. New solutions have been found for relieving the health systems, and these solutions are used for diagnosis, monitoring, and treatment of COVID-19 with telemedicine (Fig. 10.3). In addition, the importance of using telemedicine services during and after the pandemic has been understood worldwide. The United States of America has started to provide telemedicine services to its citizens through its health systems. Also, many private companies have accelerated their studies in the field of telemedicine, and they have developed specific applications for COVID-19. Although these applications have different features, the main feature is to provide remote services for COVID-19 and other diseases at the time of pandemic. According to One Medical (San Francisco, California, USA), the use of telemedicine applications of the company increased by 51% compared to the same period last year [36]. Amwell (Boston, Massachusetts, USA), which provides telemedicine services, stated that there is a huge demand for digital health services [36]. Here, we will focus on telemedicine solutions offered in different countries during the COVID-19 pandemic (Fig. 10.4).

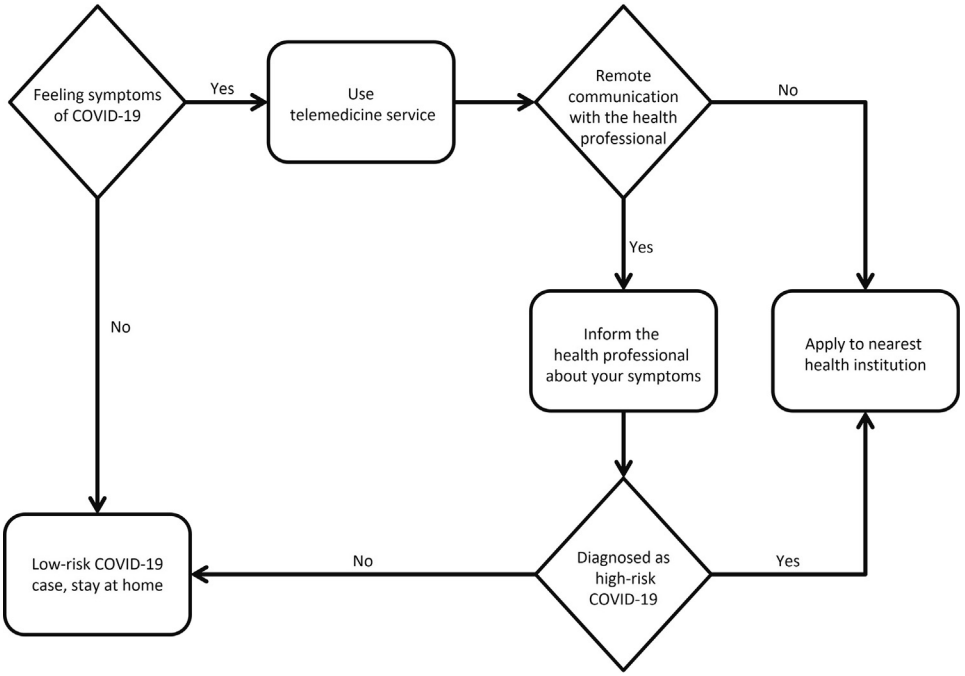

FIGURE 10.3 Basic telemedicine flowchart for coronavirus disease 2019 (COVID-19) patient assessment. If a symptom of COVID-19 is detected, the telemedicine application can be used to remotely connect to a healthcare professional.

3.1 Brazil

The Brazilian Government Ministry of Health developed an application called "Coronavirus SUS" and presented it to its citizens [6]. In this application, patients use a self-assessment tool that encourages people with the risk of disease to go to the nearest health institution. This application informs people not only about COVID-19 symptoms, diagnosis, and healthcare but also about misinformation and disinformation on the outbreak.

3.2 China

With the emergence and sudden spread of COVID-19 in China, telehealth services became essential by allowing patients to reach healthcare without traveling. AliHealth (Hong Kong), JD Health (Hong Kong), and WeDoctor (Hong Kong) are some of the companies offering telehealth systems to patients [41]. The Chinese government cooperated with China's largest internet corporations to provide virtual care consultations. By using this technology, physicians were able to deal with more than 100 patients per day [42]. In cooperation with the West China Hospital of Sichuan University, ZTE (Shenzhen,

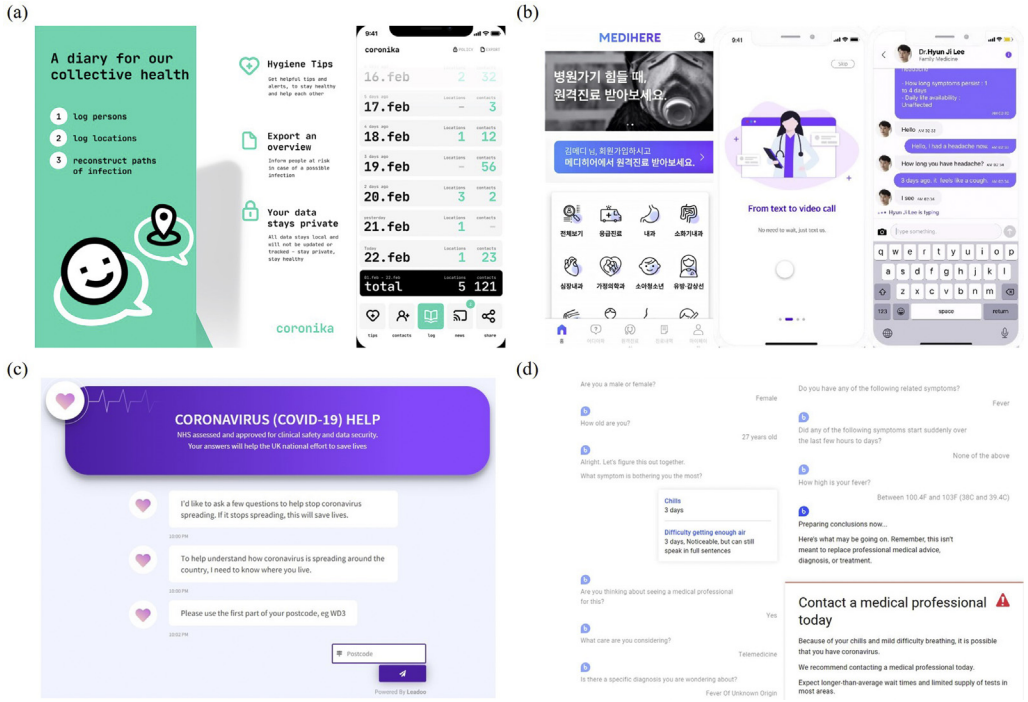

FIGURE 10.4 Some of the telemedicine applications used for coronavirus disease 2019 (COVID-19) pandemic: (A) Coronika [37], (B) MediHere [38], (C) Corona-Help.uk [39], and (D) Buoy Health [40]. *Adapted from Coronika (Internet), Kreativzirkel UG (haftungsbeschränkt), 2020 (Cited 15 May 2020). Available from: https://play.google.com/store/apps/details?id=de.kreativzirkel.coronika; Medihere (Internet), MEDIHERE, 2020 (Cited 15 May 2020). Available from: https://play.google.com/store/apps/details?id=com.medihere.react; Corona-Help.uk (Internet), 2020 (Cited 13 Feb 2021). Available from: https://thekeydata.com/; Buoy Health (Internet), Buoy Health, 2020 (Cited 15 May 2020). Available from: https://www.buoyhealth.com/symptom-checker/.*

Hong Kong) and China Telecom (Beijing) supplied physician-patient communication using the 5G network [43]. By using this system, physicians can remotely check their patients and can also remotely analyze computed tomographic (CT) images [41].

Since 2018, the National Telemedicine Center at the First Affiliated Zhengzhou University Hospital has been helpful by providing remote medical services in Henan. By the collaboration of Huawei (Shenzhen) and the National Telemedicine Center, a remote diagnostic system connecting 147 hospitals was set up. As of March 20, 2020, this system was started to be used for the diagnosis of 2000 COVID-19 cases [44]. Also, by using Huawei Cloud Artificial Intelligence (AI)-assisted system, CT scans can be analyzed automatically. Lung lesions can be observed, and their size can be measured with this system [45]. Since COVID-19 appeared in China, FAHZA Internet + Hospital (Malaysia) has provided 24 h free consultations and more than 10,000 people have been served with this system by March 15, 2020 [46].

3.3 France

As COVID-19 spread through France, people switched to telemedicine practices to preserve their social distances to protect themselves from infection. Video-based online consultation services, such as Doctolib (Levallois-Perret), Médaviz (Paris), MesDocteurs (Paris), and Docavenue (Boulogne-Billancourt), have allowed patients to stay in touch with their healthcare providers during the pandemic even in self-isolation [47,48].

3.4 Germany

The Corona-Bot application developed by DOCYET (Leipzig) is used to screen COVID-19 symptoms with an online chatbot. According to the user's input, the risk is determined and the user can be directed to healthcare professionals if necessary [49]. The University Clinic Charité (Berlin) provides an online self-assessment application called CovApp [50]. This application gives medical advice to patients. Moreover, the Coronika application (Fig. 10.4A) developed by Kreativzirkel Design Studio (Düsseldorf) is a health diary application, where the users can enter the places that they visit and the person that they contact to reveal the infection path [51].

3.5 Spain

The Telemedicine Clinic (Barcelona) supports more than 100 hospitals in Europe. For example, the telemedicine application used in the Barcelona Hospital Clinic facilitates the classification of coronavirus-infected patients and shortens the decision-making process [52,53]. Hospital 12 de Octubre (Madrid) has started to use a telemedicine system where healthcare professionals can easily access patients' data and compare them. This system can assist healthcare professionals to classify patients and making critical decisions [53]. Moreover, a smartphone-based tracking application is used to observe patients' symptoms and responses in adverse situations [22]. Furthermore, patients can easily access their prescriptions and take their medicines via the Patient Electronic Medical Record (PEMR). Meanwhile, a platform called "La meva salut", which facilitates access to patient documents and laboratory results, has been developed [22]. ClinicPoint (Barcelona), a start-up company, also offers a digital platform where patients can consult with healthcare professionals about various diseases, including COVID-19. This telemedicine application offers a free chat service to connect patients to healthcare professionals during the COVID-19 pandemic [54]. Moreover, the use of telemedicine services in Spain provides remote follow-up on recovered patients [22]. These services are also adapted to help isolated patients to communicate with their families.

3.6 South Korea

South Korea has developed an application that aims to protect "social distance or isolation" by sending emergency alert text messages containing the pathways of the movement of infected patients and general COVID-19 information via the Cellular

Broadcasting Service (CBS). In this way, the spread of the virus is prevented. Moreover, drug prescriptions are provided using telemedicine services without the need to visit a hospital [55]. COVID-19 patients are followed up with telemedicine services in the Seoul National University Hospitals. Infected patients are examined using video calls by healthcare professionals. Using these telemedicine services, medical examinations and treatments can be conducted remotely [56]. The Seoul National University hospital aims to reduce the spread of the outbreak by providing telemedicine services to patients located near the outbreak center. The Digital Health Institution, MediHere (Seoul) (Fig. 10.4B), also supports medical centers with telemedicine application to allow healthcare providers to perform remote treatments [57,58]. On the other hand, South Korea has developed an application for self-diagnosis and self-quarantine [56]. Symptoms from passengers coming from abroad are monitored with this mobile application. These passengers need to report their health conditions (such as cough, fever, and difficult breathing) during the self-quarantine period using this application for about 14 days following their arrival.

3.7 The United Kingdom

In the United Kingdom, a web page called Corona-Help.uk (Fig. 10.4C) is used to question people about the symptoms, staying-home status, and self-isolation status with online forms. These forms help understand the state of the epidemic/pandemic across the country [59,60]. Similarly, using the COVID-19 Care Assistant application offered by Babylon Health (London, UK), people can control their symptoms and get advice about COVID-19 and seek medical counseling, such as mental support [61].

3.8 The Unites States of America

The United States is one of the leading countries in the field of telemedicine. Public health system and companies have provided telemedicine services before the COVID-19 disease in the United States [62,63]. The United States has made financial support and breakthroughs to increase the capacity of telemedicine services and to provide new telemedicine services during the COVID-19 outbreak. Telemedicine applications developed by government agencies such as Medicare and Medicaid are permitted to be used in COVID-19. During the COVID-19 pandemic, evaluation, management visits, mental health counseling, and preventive health screening services are provided to citizens with Medicare accounts [64]. They release the list of telehealth services for which patients can get an appointment from specific clinics and health services [65].

In addition to public services, many hospitals give telemedicine services to support COVID-19 patients. Healthcare professionals at the Massachusetts General Hospital (MGH) in Boston, Massachusetts, create different video portals to communicate with COVID-19 patients in isolation rooms [36]. The MGH also provides online consultations to its patients as an option to access health professionals. The George Washington University Hospital in Washington and the Weill Cornell Medicine in New York plan to

use telemedicine services for providing guidance on patients' coronavirus symptoms and questions. By doing so, they will determine whether a patient should go to a clinic or an emergency department for testing [66,67].

Healthcare and IT companies that provide telemedicine services are focused on providing new applications and services for the COVID-19 pandemic [68]. Some examples of such companies are Solutionreach (Lehi, Utah), Boomi (Chesterbrook, Pennsylvania), Stericycle Communication Solutions (Southfield, Michigan), pMD (San Francisco, California), Bridgecom Solutions (Mira Loma, California), Bluestream Health (New York, New York), Teladoc (Harrison, New York), CPSI (Mobile, Alabama), MedPower (New York, New York), GE Healthcare (Chicago, Illinois), HealthTap (San Francisco, California), and Welby Health (San Diego, California). These companies provide online consultation services to patients via visual, voice, or text communication. They also inform patients about the essentials of COVID-19.

Besides online consultation services, some companies support health services in a different way by using telemedicine technology. For instance, Kno2 (Scottsdale, Arizona) and Consensus Health (Marlton, New Jersey) are online providers to store and supply COVID-19 patient records. CareCognitics (Palo Alto, California) provides healthcare organizations an online COVID-19 scanning tool, which screens patients to identify those at high risk or identifies symptomatic patients who should be tested and provided with information on testing locations. Besides, LiveProcess (Chelmsford, Massachusetts), Zibdy Health (San Diego, California), Epion Health (Hoboken, New Jersey), Open Health Network (Mountain View, California), Buoy Health (Boston, Massachusetts), and Merge Healthcare (Chicago, Illinois) are companies supplying COVID-19 screening applications for checking and monitoring patients from their residences by tracking and checking symptoms of COVID-19 (Fig. 10.4D). Orbita Healthcare (Boston, Massachusetts) developed a chatbot to screen for COVID-19. Repisodic (Philadelphia, Pennsylvania) offers online post-discharge acute care for patients with COVID-19. Moreover, some companies give online trainings and courses for fighting COVID-19. For instance, eDX (Cambridge, Massachusetts) offers free ventilator training, CAE Healthcare (Sarasota, Florida) provides the Blue Phantom Lung Ultrasound Training simulator and online ventilator training, and OmniSYS (Dallas, Texas) gives a COVID-19 test training about how to access COVID-19 tests, how to apply for the appropriate licensing for COVID-19 tests, how to obtain a nasal swab from patients, and about the requirements for communicating positive test results for healthcare professionals.

3.9 Turkey

Turkey has a serious fight with COVID-19, and significant progress has been made in the field of telemedicine with the application called "Hayat Eve Sığar" developed by the Ministry of Health. The application leads the patients and gives recommendations about COVID-19. Moreover, infected patients and risky areas can be monitored with this

application. Users can also view the health status of their families through this application. Mental health support services are also conducted through phone conversations and mobile applications to patients and healthcare providers affected by COVID-19 [69]. Through another application called "e-nabız," healthcare professionals can easily access patient records [70].

3.10 Other countries

For patients infected with the coronavirus, a digital platform called PROHUG has been developed in Switzerland in collaboration with Kaiku Health (Helsinki, Finland) and the Geneva University Hospitals (Geneva, Switzerland). Thereby, they aim to remotely monitor the daily symptoms of the infected patients. Patients can update their symptoms on the platform. Symptoms are automatically monitored, and based on the patient's symptoms, the platform sends automatic notification messages to healthcare providers to take necessary precautions. Thanks to this digital application, symptom screening can be effectively performed and overload in hospitals can be reduced [71]. Medicus AI (Vienna, Austria) and BioneXt Lab (Leudelange, Luxembourg) also launched an application called CoVive for COVID-19, with self-assessment, test interpretation, and self-monitoring features. OpenTeleHealth (Aarhus, Denmark) developed a healthcare platform for monitoring patients remotely (Fig. 10.5). Remote monitoring and screening of infected patients not only enables servicing a huge number of COVID-19 patients but also reduces the workload of healthcare providers [73–75]. TraceTogether is an application developed by the Ministry of Health and Government Technology Agency (GovTech), Singapore. TraceTogether provides proximity information between users by using Bluetooth Relative Signal Strength Indicator (RSSI). Proximity information is stored for 21 days on phone. If a person is infected by COVID-19, the Ministry of Health can observe the infected person's activity and can find contacted people [76]. The Australian Government Department of Health releases the list of COVID-19 temporary telehealth services as a fact sheet [77].

4. Discussion

Telemedicine technology is now used effectively in different areas of medicine. Teleradiology [78], telepathology [79], teleneurology [80], teledermatology [81], and many other telemedicine fields were utilized to serve patients during pandemics. For instance, Betterhelp (Sunnyvale, California, USA), Headspace (London, UK), and Black Dog (Sydney, Australia) provide mental support by text messaging, videoconferencing, and chatting [82]. There are some challenges for the applications of telemedicine, including technical, social, political, or organizational, but the main challenges of telemedicine applications are data security and privacy. Patients' data collected in

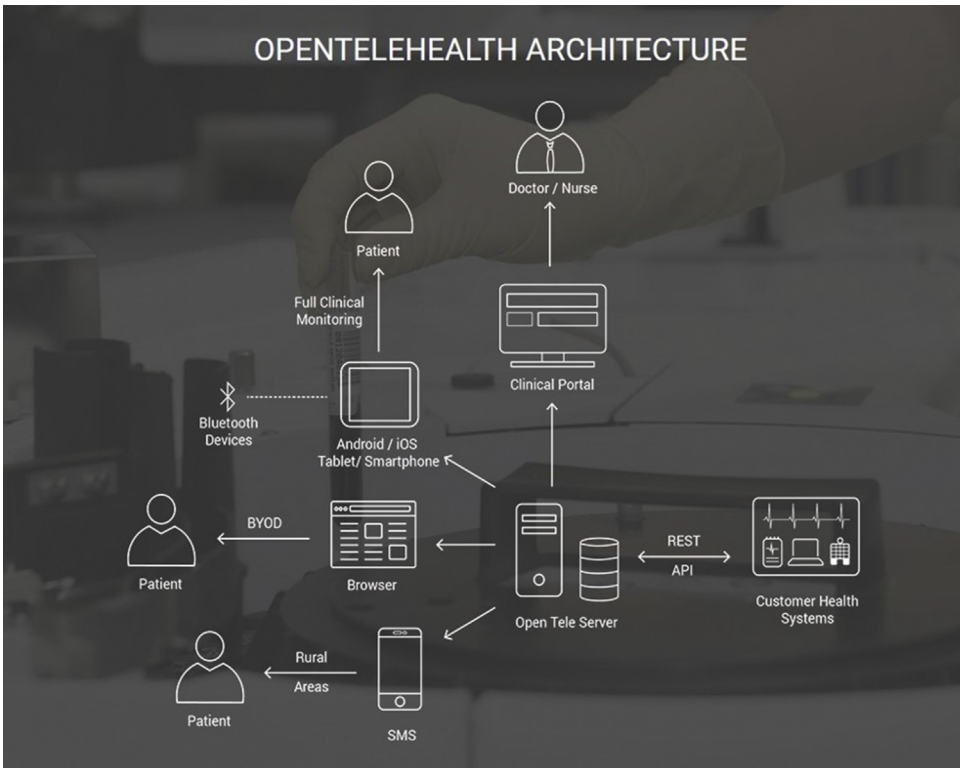

FIGURE 10.5 System architecture of OpenTeleHealth telemedicine platform [72]. *Reprinted from Opentelehealth Architecture (Internet), Opentelehealth. Available from: http://opentelehealth.com/clinical-workflow/.*

telemedicine applications can be protected by applying password policies, client settings, anonymization, and permutation [83]. It is also important to guarantee that only authorized persons can access these data. Biometric systems, SMS text, or fingerprinting, and cryptographic protocols such as transport layer security (TLS) and secure sockets layer (SSL) are used to ensure the authentication [84], and data masking is used to protect personal information such as name, social security number, and zip codes [83]. The policies can restrict the usage of patient data. For instance, states and federal laws of the United States do not allow sharing patients' records between states [85]. However, if telemedicine applications are necessary for health emergencies, the policies can be updated. During the COVID-19 pandemic, the Health and Human Services of the United States allowed healthcare providers to use common video call applications, such as FaceTime, Facebook Messengers, Zoom, Skype, etc., in order to communicate with their patients [86]. This offers a great option to reach many patients, but data privacy will remain a big question for the patients because of these third-party applications.

5. Conclusions and future work

In this chapter, we discussed telemedicine applications used in epidemic and pandemic diseases, with a special focus on recent practices used in different countries for COVID-19. Telemedicine services expand their usage during the COVID-19 pandemic, and they spread to several countries. While telemedicine applications focused on SMS-based systems in the previous epidemics and pandemics, they now focus on online consultations, chatbots, and self-isolation control. As aforementioned, telemedicine is a very important digital technology tool, as it provides easy and fast communication between patients and healthcare professionals and enables remote patient monitoring. Telemedicine can also increase the accuracy in medical decision-making by rapidly connecting to the specialist and this could also improve health outcomes, especially during a pandemic. Telemedicine offers quite comfortable healthcare too. Medical devices can be integrated with telemedicine applications with the Internet of Things (IoT) technology to automatically collect patient data and assess the progress of COVID-19 patients more precisely. Moreover, for precise remote examinations in home settings, patients can be directed by healthcare professionals during online consultation to take measurements with common medical tools. This approach can be expanded further for close monitoring of chronic patients, who are vulnerable to infections with their weak immune systems. For effective usage of telemedicine applications, users should be informed about the security and privacy risks. Data collected in telemedicine applications contain sensitive information, so it should be protected from unauthorized access. Security and privacy issues should be well covered in telemedicine, as their gap can cause a loss of trust in users, which might lead to a decrease in the use of telemedicine systems. The lack of funding, digital literacy, and regulations are the main limitations that restrict the active and extensive usage of telemedicine. Owing to the complexity and limited training availability, acceptance of telemedicine can be difficult for physicians. Moreover, elders can prefer face-to-face medical care, as they might not easily adapt to new technologies. Difficulties in cross-state licensing and cross-hospital credentialing can also limit telemedicine usage [26,87]. Nevertheless, telemedicine offers great benefits for patients by providing patient-centric healthcare. Digital therapeutics can also be applied to patients with this technology. Therefore even if the COVID-19 outbreak disappears, it seems that telemedicine will be inevitable in our lives and it will transform current practices of a healthcare system with updated policies.

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