

## Telehealth Applications and its Contribution to the Pandemic Covid-19

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### Abstract

The adoption of telehealth in a wide range of remote care activities has already been established in the light of the COVID-19 pandemic crisis. The pressure on digital system providers for smart solutions and applications for telehealth and telemedicine systems by citizens, health professionals and public bodies as tools to tackle the pandemic is enormous. Fear of transmitting the virus has led to many telemedicine applications and systems with the most important being contact detection, reporting and monitoring of possible or confirmed cases as well as remote psychological support. Technologies such as the development of sophisticated clinical decision support systems and cloud-supported mobile solutions seem to have the best prospects. The use of tele-health seems to be spreading rapidly in the field of health with good prospects for its further spread and its permanent establishment. However, many obstacles remain to be overcome at many levels, such as the risk of personal data breach. The undoubted advantages of telehealth seem to overcome any obstacles, defining a new framework in the immediate and long-term future of healthcare.

**Keywords:** Telehealth; Telemedicine; Applications; COVID-19

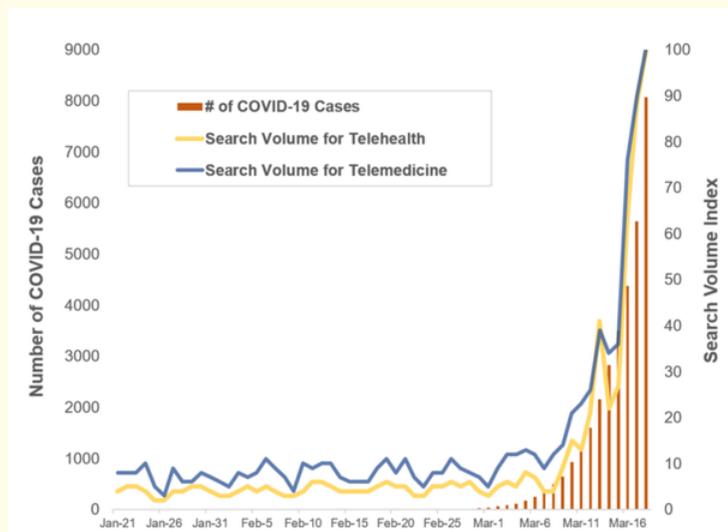
### Introduction

The crisis of the COVID-19 pandemic demonstrates the potential of digital healthcare technology to manage some of our biggest public health challenges. Many national and international organizations, such as the WHO or the Disease Control and Prevention Centers in the United States and Europe, have recognized that technology and monitoring systems can play an integral role in supporting public health through early detection and prevention of stroke transmission. "Curvature smoothing" in reducing the spread of the virus is one of the most important areas in which digital technology is called upon to play a dominant role with innovation and health applications. The pandemic in many countries has already flooded the adoption of tele-health in a wide range of activities in remote care involving the general population, outpatients with COVID-19, hospital treatment, and even recovery after the pandemic [1].

### Growing telehealth demands

The term telemedicine is different from telehealth, but is still used interchangeably and has been used by the WHO as "the provision of health care services by all health care professionals, where distance is a critical factor, using information and communication technologies to exchange valid information for the diagnosis, treatment and prevention of diseases and injuries, research and evaluation, as well as for the ongoing training of health care providers, all for the benefit of improving the health of individuals and their communities" [2]. Studies for the increased demand for tele-health and telemedicine in the United States during the COVID-19 pandemic have shown both an increase in the population's interest in it and in the percentage of hospitals that adopt related technologies (Figure 1) [3]. Recent research

has shown that up to 73% of Americans would feel comfortable using telemedicine to diagnose COVID-19. Tele-health services have the potential to significantly reduce hospital pressure during the pandemic, as remote visits minimize the need for patient care. Providers of telemedicine applications also see an increase in demand for their services, while various remote medical services companies or instructional and tele-visitation applications, introducing only COVID-19 risk assessments remotely based on CDC guidelines, record significant demand rates.



**Figure 1:** The demand growth for telehealth and telemedicine to US in time of Covid-19 pandemic (Adapted with permission) [3].

The outbreak of the pandemic made it clear that tele-health is an important tool for public health management while at the same time there is a high probability of its use by patients after the pandemic, as it is estimated that most users will be accustomed to accessing medical care from their homes [4]. Many organizations, corporations and public services have made telemedicine and tele-health and development opportunities a high priority, if not the first, each through its own perspective. It is no coincidence that among the key services to strengthen the policy for responding to health systems in COVID-19, the World Health Organization cites telemedicine as one of the alternative models for clinical services and clinical decision support, among a total of ten proposed strategic actions (strategic action 2) [5].

### Telehealth over time

Without a doubt, telemedicine and tele-health in general have shown many innovations and solutions in this pandemic, but their use is not something new. Today, we consider telemedicine as a method for remote prevention, diagnosis, counselling and even treatment, taking into account modern equipment with high definition cameras and screens, with advanced two-way communication programs and with peripheral devices that can help in physical examination of the patient. However, telemedicine and tele-health have been used in clinical practice in much simpler forms for decades. For example, a publication in *Lancet* in 1879 referred to the use of the telephone to reduce unnecessary visits to the doctor's office. In 1925, a cover of *Science and Invention* magazine showed a doctor diagnosing a patient by radio and envisioned a device that would allow a patient to be televised remotely. In 1906, the inventor of the electrocardiogram published a paper on telegraphy, and since the 1920s, radio has been used to provide medical advice to ship clinics [6].

In recent times, various government agencies and healthcare providers have turned to telemedicine as a solution, mainly to mass and emergency events. As early as 2000, the North Atlantic Treaty Organization (NATO) developed a Multinational Telemedicine System for

the needs of the military in various missions [7]. Telemedicine companies were also active during Hurricanes Harvey and Irma, and after the 2003 SARS pandemic. China began exploring and developing telemedicine and integrated electronic medical systems for use in similar future situations. Another recent example was mental health services through teleconference during prolonged droughts and fires in 2019 in Australia [8]. These are just a few paradigms of how tele-healthcare has made huge changes in people's lives without emphasizing its value and contribution.

### Telehealth at time of social distancing

Today, the growing demand for telecommunications technology in the treatment of pandemics has focused on slowing the transmission and spread of the disease and reducing the incidence of cases. Telehealth seems to be the ideal solution for the management of communicable diseases. In order to slow down the transmission of the virus, almost all states have imposed "social distancing" in order to avoid contact and transmission of the virus. For patients with COVID-19, for potential cases, and for those who are concerned that they may become infected, the proposed telehealth solutions were to detect and prevent transmission, and to remotely evaluate and provide care. In this context, high-risk COVID-19 applications and monitoring subsystems have already been developed [8]. One such example is a surveillance application - a digital data package for detecting, reporting and monitoring COVID-19 optimized for use on Android phones - based on the District Health Information Software 2 (DHIS2) platform, one of the largest platforms in the field. Health Management Information Systems in the world. The application collects information (demographics, symptoms of disease, contact data) of high-risk individuals entering a country from other countries at higher risk, in order to actively monitor individuals to prevent the transmission of COVID-19 virus. The information can be passed on to health managers in their respective geographical areas for the purpose of detection, reporting, active monitoring and rapid intervention in cases of COVID-19 infection [9]. By the same token, TraceTogether, was developed to support Singapore's efforts to reduce the spread of COVID-19 by locating contacts via Bluetooth on mobile phones to determine and control the distance between users. The data is encrypted and stored only on the user's personal mobile phone while the competent Ministry of Health of the country can transfer the personal data (only with the consent of the user), so that he can locate his contacts and call in time to provide guidance and care. TraceTogether, as its creators claim, helps protect loved ones and their families from being unknowingly infected. It also helps support the work of teams tasked with detecting contacts and healthcare workers by fighting COVID-19 transmission. According to its website, the operation of TraceTogether will be suspended after the outbreak of the epidemic in the country [10]. The Chinese government, respectively, has launched a new mobile application ("close contact detector") to help citizens check if they have come in contact with the virus. To do this, users will need to enter a phone number, a name and an ID number. According to the application's reference company (XINHUANET), users can obtain it by scanning a code (Code Reader: QR) through platforms such as WeChat, Alipay and QQ, which are already very popular mobile applications in China. The application gives end users information based on government data on whether they came into "close contact" with a person with the disease, whether they are within walking distance of someone who has no protection, or someone who is confirmed or suspected. The application also serves as a means of educating citizens about what to do if they have had some "close contact" with the virus, either staying home or receiving instructions from the health authorities [11].

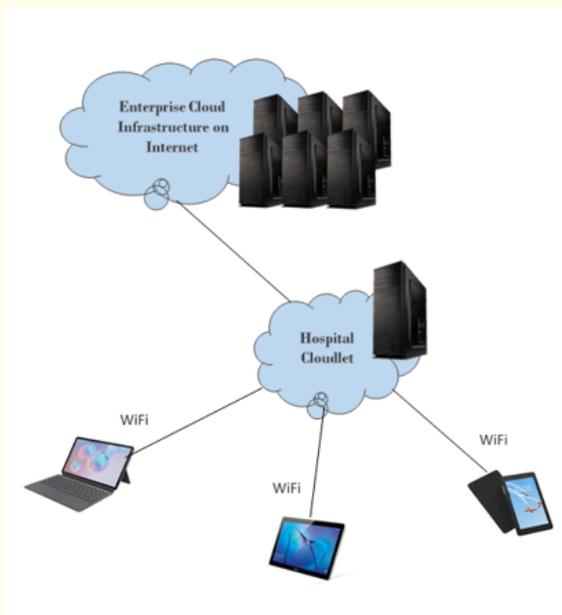
### Telehealth apps

Plenty of other applications that are developed show the relation and wide range of demand and supply to the current pandemic. The above list can include 1) Virtual chatbots that through virtual visits can evaluate and interact with COVID-19 patients to protect health professionals, 2) Robotic telemedicine applications, equipped with cameras, interactive screens and medical equipment to be sent to quarantine areas for patient evaluation, 3) "Virtual visit" technologies for ICU patients, 4) Artificial intelligence (AI) applications based on conversation algorithm to identify symptoms and diagnose possible cases, 5) Virtual doctor applications in which users answer specific questions about possible symptoms and are guided by instructions on what to do to stay safe, 6) Applications e.g. information dissemination and public awareness about the spread of COVID-19 (forums websites and mobile applications), 7) Administrative support applications for healthcare workers using digital tools such as communication between healthcare workers and administrative gates or

ministries even in remote areas to share common resources and data to combat virus, 8) Applications detection of citizens’ movements according to anonymous data, based on maps of popular destinations and popular hours. The list is not exhaustive as new applications are constantly being presented with inventive solutions for every telehealth need that arises.

**Cloud computing**

However, the penetration of all these applications into the lives of more and more people highlights one of the most obvious challenges in telehealth that concerns the scalability of systems in order to increase the number of users. The adoption of cloud computing is a solution to the modern demands of telehealth to become an easy-to-use tool through all existing user devices (computers, laptops, smartphones and tablets). Even though cloud-computing promises to provide an affordable, efficient, and cost-effective way to implement telemedicine, there are significant challenges that need to be addressed in the near future. These include interoperability, security, confidentiality, reliability and adaptability of digital storage spaces. In addition, the development of multicenter health care information requires the integration and convergence of multiple technologies (cloud computing, mobile computing and wearable computing) as they can combine lower costs with powerful computing resources. The mobile telemedicine cloud is a solution that balances these benefits. Jin and Chen in their review find that “even though mobile devices are obviously not designed for high-intensity computing work or tasks, external assignment of all raw data to remote cloud servers is not always optimal” [12]. A solution is the Mobile Cloud Computing hybrid telemedicine architecture, where mobile devices collect signals from environmental sensors (or the individual’s body) and perform routine light diagnostic work on site while the more complex processes are send and executed on cloud servers [13]. Another interesting approach is Cloudlets technology (Figure 2). This type of hybrid architecture introduces an intermediate level between mobile devices and remote Cloud servers by minimizing communication time and allowing the best combination between work allocation and computing resources [14].



**Figure 2:** Schematic representation of Cloudlets technology.

Healthcare applications require large computing and communication resources as well as dynamic access to data inside and outside the organization. Mobile Cloud Computing could provide the necessary computing resources in the right place and at the right time through architectures based on Cloud and Cloudlets (Cloudlet-based Mobile Cloud Computing Infrastructure) [15]. In addition, their combination with “big data” technologies, which refer to huge volume and variety data management with speed and accuracy, could provide data management and analysis solutions that are necessary for the implementation of telemedicine applications and reducing the cost of health care and improving systems and clinics [16]. The architecture of data integration and their connection to analytical clinical and administrative data platforms for decision making can help to quickly compose complex and varied integrated analyses, thus limiting any medical errors, administrative failures and wasted resources and that would not be possible in a manual way. The development of such clinical decision support systems can help transform existing offline, static, guidelines (whichever are evolving almost daily) into interactive, online, up-to-date algorithms, ready for immediate implementation [17]. Similar systems have already begun to be tested and implemented, giving great flexibility in patient management and decision-making in the care unit [18]. One such example is a Zenysis platform. Combining big data and Advanced Analytics technologies, it can accept and analyse geospatial data analysis, reports and therapeutic algorithms, public health data, monitoring and surveillance data, patient EMR data, company supplies, supply chain and airline, aviator immigration, data from mobile devices (mobile phones, laptops, etc.), user travel data and much more. It has been created for African countries and has made a significant contribution to improving awareness and disease surveillance by providing decision-makers with the details they need to coordinate real-time data-limiting efforts. It can also send information and inform the public and partner organizations about developments [19].

### Mental health support tools

The ever-increasing systems, applications and solutions in a wide variety of tele-health and telemedicine dimensions, refer to end users who are patients, health professionals and the general population. For healthcare workers, and especially for nurses, the recent economic crisis that has exacerbated existing staffing shortages and the aging of their workforce has made vulnerable groups vulnerable. This combined with initial inadequate knowledge of the pathogen, long-term exposure to a large number of infected patients, labor intensity, lack of rest, lack of personal protective equipment (MAP), insufficient training to prevent and control Infections were the factors that put these professionals at the highest risk of infection [20]. In all of the above problems, telehealth and telemedicine applications were called upon to provide solutions. Indeed, they have made significant strides in a short period of time to protect and facilitate their work. Two-way interactive communication tools have already been developed between health professionals and the relevant administrative authorities or ministries to exchange information and manage real-time data and resources. An example of such mobile-based digital communication technology is mHero, which was created by IntraHealth International and UNICEF in 2014 in Liberia for the outbreak of Ebola, which is currently being used to inform professionals about COVID-19 health [21]. Telemedicine and telehealth are practically possible and suitable for the support of patients, families and health care providers during the pandemic. Psychological symptoms associated with COVID-19 have already been observed at the population level, with manifestations of panic attacks due to anxiety and paranoia in monitoring international mass events [22]. Large percentages of the population, remaining socially isolated and locked in homes, are expected to have psychological symptoms due to anxiety, reduced autonomy and anxiety about income, work, safety and fear of pandemic. The governments of China, Singapore and Australia have highlighted the psychological side effects of COVID-19 and expressed concern about the long-term effects of isolation and that fear and community panic could cause more harm than COVID-19 [23]. Solutions have been provided with several telehealth tools aimed at controlling and preventing mental effects due to pandemics. Examples include various digital mental health counseling and evaluation platforms such as “betterhelp” [24], the Black Dog Institute’s “Online Clinic” [25], also an online mental health assessment tool for people over the age of 18 that provides screening for various conditions and myCompass [26] another Personalized self-help tool for mental health that includes daily monitoring and strategies to deal with mild to moderate anxiety, stress and depression of the same company. In terms of prevention, the “Doing What Matters in Times of Stress” created by the WHO is one such case [27]. This is an illustrated guide with optional accompanying audio instructions that aims to provide practical skills to people

who are experiencing stress and help deal with it. In portable solutions, the Mindfulness for Apple mobile phones and the CAMH for Android and iOS mobile phones are cases in point of tools that have been around for a few years but have also been developed to manage stress, especially during COVID-19 [28,29].

### Telehealth barriers

It is clear that telehealth systems are taking on enormous potential, and the opportunity for accelerating and promoting developments was given with cause and occasion the current pandemic. However, several studies and reports focus on the various emerging problems and obstacles that arise in the use of telemedicine systems. One such obstacle is the cost and uncertainty of compensation in terms of payments and insurance coverage, issues that concern and concern both patients and health care providers. Also increasingly recognized are application difficulties that are mainly related to the characteristics of individuals or patients with less digital familiarity, such as age and educational background, who are also the most vulnerable [30].

In a recent study in the US, respondents, despite their positive attitude towards telemedicine, stated that there are hesitations in using it as 1) In a moment of need, many people return to what they are used to doing in the way they previously interacted with their well-known healthcare system, 2) Patients would prefer to see their own provider through telemedicine in relation to someone they have not met before and 3) Many patients may not be aware that they have telemedicine options as an option or not they know how to access it [31]. Concerns are also raised about legal issues (mainly due to a lack of institutions) that are more about responsibility in the event of damage or poor practice. Finally, legal or regulatory gaps and strict regulations on the confidentiality of information raise questions about the needs of individuals for personal safety and raise concerns or fears about possible violations of personal freedoms and especially privacy [30,32].

### Telehealth and privacy

However, the speed at which such concerns have been overcome or ignored is typical. In China and South Korea, applications that collect data to detect contacts were the key to stopping the spread of the corona, but at the same time allowed the first and mass monitoring and the second the collection and use of personal data. Although, according to a report in the New York Times, China has launched a bold mass experiment in using data to regulate people's lives by requiring them to use software on their smartphones that dictates whether they should stay in quarantine or be allowed to enter in subways, shopping malls and other public places. Nonetheless, an analysis of the software by the New York Times finds that the system does not recognize in real time the risk of transmission while it seems to share information with the police, setting a standard for new forms of automated social control that could remain long after the decline of the epidemic. Individuals in China sign up for the system, which is already used in 200 cities and is available nationwide through the popular Alipay app and are "marked" as they are given a color code - green, yellow or red - indicating their state of health [33]. In the UK, authorities are developing a contact detection application that only collects location data from users who select it with their consent. In Europe in general, where privacy regulations are stricter, the question arises as to whether such applications should be legally used, while in the United States if the benefits to society as a whole outweigh personal information [34].

The ability of technology to pinpoint the contacts of individuals in order to inform and protect those who have not been exposed has never been greater. After all, in any case - even if the final choice is at the disposal of users - there are real risks in terms of personal data and therefore the design of the solution to prevent abuse and mass surveillance will be questionable. Despite the various technological methods, the risk of abuse cannot be completely eliminated. The dilemma between personal liberties and the health of the population should be considered perhaps more philosophically and decided with great care and common consent.

Until then, digital technology has the means to provide the most painless technological solutions that are possible. In a similar effort by the WHO to launch a related application for mobile phones (Go.Data), those responsible for its development, claim that it will initially

contain only basic functions such as tele-counseling technologies, functionality for case investigation, visualization of transmission chains, tele-education, self-assessment of symptoms (tele-diagnosis) and later geolocation applications (via GPS) and geospatial data [35]. To provide personalized information, the application will ask the user questions about his age, location and preferred language (the original version that will most likely be released by the time this article is published will contain only the six official languages of the WHO) so that it can adapt the information according to the demographic age of the user. Contact detection based on virtual “handshakes” or contact follow-ups, between phones located a few meters apart for at least five minutes is not expected to be included in the first version as technical, legal and ethical issues need to be addressed. To locate contacts, the application will most likely be based on the existing corresponding MIT Media Lab effort already released (SafePaths) for mobile devices [36].

### Conclusion

The pandemic has brought about a global state of emergency that will have a profound effect on the demand for long-distance health services. Tele-health and telemedicine present countless possibilities that facilitate and accelerate the coverage of care needs. As the needs and expectations of citizens increase, providers of tele-health and telemedicine technologies will be pressured for more comprehensive solutions and additional challenges will be created that need to be addressed quickly. The risk of not meeting expectations due to various obstacles can reduce public confidence and prevent the use of telemedicine as an effective means of high quality care. Technological and social barriers exist and will continue to exist, but most of them can be overcome. Fears about the impact and risks of healthcare technology should not be overlooked but may be disproportionately high in relation to the unquestionable benefits and facilities that technology can provide, at least in the management of the current pandemic and in trying to reduce its spread of the virus. Although we cannot accurately predict the time of a future pandemic, we can prepare as best we can with tele-health tools.

### Conflicts of Interest and Source of Funding

None declared.

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