Investigating the feasibility of non-contact electronic health technologies, such as telemedicine, for the purpose of containing the novel coronavirus disease (COVID-19)

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ABSTRACT
Innovative approaches to stop the spread of the new coronavirus illness (COVID-19) are becoming more urgent as the number of deaths rises and worldwide concern ensues. The use of high-speed telecommunications systems and non-contact technologies in healthcare delivery, management, and monitoring—also known as telemedicine and telehealth—has recently gained popularity and holds great promise for preventing the spread of the COVID-19 virus by limiting the social mobility of infected individuals and protecting healthcare workers from direct contact with patients. The potential of telemedicine and associated technologies as tools in the fight against the worldwide spread of the COVID-19 pandemic is examined in this article.

Keywords: *Control, Coronavirus, COVID-19, Remote, Spread, Technology, Telemedicine.*

: INTRODUCTION

The advent of modern information and communication technologies has revolutionised human interaction with the natural world and improved the provision of essential services, such as healthcare, to the general public. In times of public health crisis, like the present COVID-19 pandemic, swift action is required. One such remedy is the novel use of eHealth, or the integration of information and communication technologies to improve healthcare delivery and administration. Although being cautious with technology choices and habits is crucial, taking digital measures to assist curb the virus's spread is much more demanding. In light of the widespread consensus that physical separation from infected people is the best way to reduce the transmission of the Covid-19 virus, technological solutions that restrict face-to-face contact have assumed the spotlight. The present worldwide health emergency caused by the expanding coronavirus epidemic has made telemedicine, mobile health, and other digital health treatments highly essential.

The remaining sections of the document are organised as follows: The need to prevent the worldwide spread of the new coronavirus illness (COVID-19) is justified by Section 2, which provides a short statistical backdrop of the disease. The third section discusses the virus's route of transmission and the consequences of coming into close touch with sick people. The advantages of telemedicine in the management of COVID-19 patients are covered in Section 4. To aid with the social distance necessary for COVID-19 management, Section 5 discusses several supplementary distant eHealth technical advancements. In Section 6, we looked at several recent case studies of telemedicine in the US, China, and Europe. In Section 7, we see some of the obstacles that prevent COVID-19 telemedicine from being widely used. Solutions to the problems that telemedicine inevitably has are discussed in Section 8. Summary comments on the possibilities of Telemedicine and non-contact eHealth technologies in preventing the spread of the next coronavirus pandemic are included in Section 9, which closes the article.

: BACKGROUND ON COVID-19

Alarmingly, as of March 31, 2020, there were 801,061 confirmed illnesses and 38,749 fatalities due to the Covid-19 pandemic in 199 different nations, regions, and modes of transportation [2]. Even more concerning is the lack of a verified vaccination or treatment. Concern

over the lack of a long-term medical solution to the COVID-19 pandemic has intensified after the World Health Organization (WHO) upgraded the outbreak from an epidemic to a pandemic on March 11, 2020 [3, 4, 5]. Isolation is still the best way to prevent the spread of the virus until the World Health Organization certifies a vaccine following extensive clinical trials in a variety of settings, as the virus is most easily transmitted by direct nasal droplets from an infected individual. Because of this, stopping the virus's spread should be a top concern for countries all around the world.

Caretakers, first-line health workers, and medical personnel are directly exposed to infected patients, and despite numerous social adjustment strategies—including social distancing, movement restrictions, self-isolation, mass gathering reduction, and the closure of educational, religious, and cultural institutions—none of them provide a completely reasonable shield. In order to lessen the likelihood of infections among healthcare personnel as they treat current patients, non-contact eHealth technologies show promise.

: TRANSMISSION MODE OF COVID-19

Direct inhalation of the nasal droplets from an infected person has been identified as the primary mode of transmission of the virus. Secondary modes include direct contact with live droplets left on shared surfaces such as door handles, key holders, shopping carts, currency notes, tabletops, fabrics, fingerprint biometric scanners, ATM buttons, touch screen computer monitors, touch screen phone buttons, etc. Essentially, anything that limits direct inhalation from infected persons or direct contact with exposed surfaces will certainly restrict the movement of the virus and curtail its spread. The WHO maintains that mass gatherings are highly visible events with the potential for serious public health consequences if they are not properly planned or carefully managed. Mass gatherings can amplify the spread of infectious diseases including coronavirus disease (COVID-19) [6]. The challenge remains that among the critically infected patients are the elderly who require more direct assistance with therapy and other medical support. This leaves a vital question; *how can caregivers and first line medical personnel avoid contracting the disease in the line of their duty?* The answer lies in the application of remote technologies that prevent direct human contacts and interactions, particularly Telemedicine.

: TELEMEDICINE AS A MEDIUM FOR CURTAILING COVID-19 SPREAD The word *"Tele"* is derived from the Greek word meaning *"at a distance"* or *"remotely"*. Telemedicine is the use of Telecommunications and computer technologies to provide medical care and exchange healthcare information where distance is a critical factor, [7], [8], [9]. Although Telemedicine is sometimes used interchangeably with Telehealth [10], Telemonitoring and Telecare, each of them refers to different ways of using ICT to deliver health services. The major distinction is in how ICT is used to support health care, social care, public health and health education. National Health Service [11] describes Telemedicine as the use of ICT to support the exchange of health information between health care professionals for diagnosis or referral, and tends to focus on specific clinical applications such as Teledermatology or Teleradiology. Telemedicine uses real-time interactive textual audio, visual, and data communications to deliver healthcare, diagnosis, consultation, treatment, transfer of medical data and education [12], [13], [14].

In specific terms, Telecare is the use of ICT to bring health and social care services directly to a health service user. It is a collection of means or methods for enhancing healthcare, public health, and health education delivery and support using telecommunications technologies [15]. Telemonitoring combines Telecare and Telehealth [16]. Telemedicine and Telehealth are used to manage long term conditions remotely, including the provision of health services at a distance using a range of technologies such as

telephone, Internet Relay Chat and video consultations to support diagnosis and management, in addition to clinical networks and health professional education [17] and to minimize the exposure of caregivers and health professionals to infections from the patients they are managing.

Prior to COVID-19, the application of Telemedicine in emergency situations has been a known practice although with different variants of use in different scenarios. In epidemic situations, [17] reveals five circumstances where telemedicine is applicable as follows:

Home-based healthcare for asymptomatic individuals
Follow-up health services for asymptomatic individuals
Specialized healthcare to symptomatic and isolated individuals
Specialized health services from a referral centre to a local health facility
Health services from a healthcare facility under quarantine to treat patients that cannot access the facility.

For its ability to bring healthcare services to or from remote locations across geographic boundaries, Telemedicine is certainly a resourceful tool during pandemics of COVID-19 proportion.

: OTHER COMPLEMENTORY NON-CONTACT TECHNOLOGIES AGAINST CORONAVIRUS SPREAD

Telemedicine rides on a broad foundation made up of innovative systems that provide assisted eHealth with combined potentials supporting remote healthcare services and limiting COVID-19 spread. The following form part of the technologies and concepts that complement the effective application of Telemedicine and related systems for dealing with direct contact infections, particularly the novel coronavirus disease.

Mobile Health

Mobile health (mHealth) involves the use of mobile communication systems to manage healthcare operations, share medical data, analyse health-related information [18] and improve overall patient experience [19]. Due to perceived usefulness and ease of use [20], mobile phones and handheld devices with appropriate software applications and access to health database/records are suitable for remote communications and exchange of relevant information for the effective management of COVID-19 cases. Since they support communication at a distance, they would facilitate faster exchange of information among health workers, caregivers and medical personnel for exchange of patient information via real-time connections to Electronic Medical Records (EMR) and Patients Medical Records (PMR). All mobile communication devices support real-time full-duplex Short Message Service (SMS), Internet Relay Chat (IRC) and Voice Over Internet Protocol (VOIP) capabilities.

Teleconferencing

Telemedicine relies on teleconferencing [21] capabilities, which allow for the establishment and maintenance of real-time video sessions between both parties while also enabling the simultaneous exchange of other critical data. By using video conferencing, medical professionals may check on patients remotely without risking exposure to the illness they are treating, according to references [22], [23]. As a component of case management ethics, all parts of teleconferencing may be recorded and shared within a closed loop of healthcare experts for expert evaluation and quick decision-making.

Other nuanced systems and technologies are essential to teleconferencing, such as collaborative apps and software, GPS technologies, high-speed point-to-multipoint radio communications systems, wristwatch transmitters, and voice over Internet Protocol (VOIP). By using standard internet access to transmit regular voice telephone traffic, VOIP

(Voice Over Internet Protocol) eliminates the obstacles of location and terrestrial congestion.

Collaboration Apps for Virtual Meetings

Constant interaction and cross-sharing of ideas among healthcare professionals are essential requirements given the nature, impact and global magnitude of the outbreak. With collaboration Apps, the need for direct collection of data from patients is eliminated and substituted with remote aggregation and exchange of medical records using data collection and analysis tools. Technology-assisted virtual meetings facilitate professional discussions on several topics including but not limited to disease demographics, clinical trials, updates on progress on vaccines development and drug tests, as well as logistics challenges and prospects.

Typically, technology-assisted remote collaboration brings together participation from multiple stakeholders and practitioners across geographic distances to offer in-depth analysis of topical issues affecting the disease. The use of technology to coordinate such interactions and meetings provides for wider participations and inclusion. It also helps to disseminate the outcome of such interactions faster to all beneficiaries and target recipients in a coordinated manner with impeccable documentations.

Robotics and Artificial Intelligence

Robotic technologies [24], take the centre stage to provide direct and simultaneous support to several incapacitated patients faster and with emphasis on the safety of medical personnel and volunteers attending to them. Artificial intelligence (AI) has the potential to significantly transform the role of the doctor and other caregivers and revolutionise the practice of medicine [25]. Of the three domains of robotic technology for healthcare purposes (medical, assistive, and rehabilitation robotics), medical robotics deals with the systems that provide support in medical diagnosis and patient care [26]. To avoid increased chances of virus transmission at this time, health workers and caregivers require a reasonable shield from direct patient-to-caregiver interaction often involving proximity and inevitable body contact. In the absence of, or as a substitute to real humans wearing protective clothing that do not guarantee 100% shield against infections, robots come to the rescue. With the help of Artificial Intelligence, robots work faster and serve many patients simultaneously with accuracy across a wide area of applications in an isolation facility or quarantine centre. Furthermore, with in-built mood interpreters, robots can read and interpret patients‟ facial expressions, obtain feedbacks and requests, perform voice recognition and automate drug administration accurately with near perfect precision.

World Health Organization (WHO) WhatsApp Auto Responder

The WHO recently launched a chatbot using the WhatsApp platform to provide global users with the latest information and guidance on the current COVID-19 outbreak. A health chatbot interacts with humans by conducting conversation via audio or textual methods to provide users with human level information on health and medical matters [27], [28]. Users are asked to simply reply with a number (or emoji) corresponding with a topic of interest at any time to get the latest information on the health topic. This easy-to-use messaging service has the potential to reach over 2 billion people and enables WHO to get relevant information directly into the hands of the people that need them. The WHO chatbot provides the latest news and information on the coronavirus pandemic including details on symptoms and how people can protect themselves and others. It also provides the latest situation reports and numbers in real-time to help caregivers, health workers and government decision-makers to protect the health of their patients and populations respectively.

: CASE STUDIES OF TELEMEDICINE AND RELATED TECHNOLOGIES IN THE COVID-19

LOCKDOWN ERA

Prior to the current COVID-19 outbreak, Telemedicine has been used in previous large scale epidemics especially the Ebola virus disease outbreak in Africa 2015, the Severe Acute Respiratory Syndrome (SARS) epidemic in Taiwan in 2003, H1N1 pandemic influenza in 2009, H7N9 influenza outbreak in 2013, and the Middle East Respiratory Syndrome (MERS) coronavirus epidemic in Seoul in 2015. In the present circumstances, healthcare professionals recognize Telemedicine as one of the right tools to address COVID-19 outbreak globally, as a result many countries have already embraced the use of Telemedicine to combat the scourge. A few case studies are highlighted below.

United States Telemedicine Approach to COVID-19

The US approach to Telemedicine is focused on legislative adjustments and backing for the unhindered use of Telemedicine. Interestingly, this is in recognition that distance monitoring of patients is usually not adequately addressed with current regulatory frameworks [9] The Connect for Health Act, which lifts restrictions on Medicare Telehealth coverage during emergencies in the US allows the use of Telemedicine to expand access to care and enable timely treatment limiting the risk of person-to-person transmission [29]. Hospitals and healthcare providers have totally adjusted and activated full use of Telemedicine for the remote management of coronavirus patients. The Donald Trump administration recently announced expanded Medicare coverage via Telehealth and related technologies that allow patients to communicate with their doctors through live video conferencing initiated from their homes thereby limiting the risk of exposure and spread of the virus. This has given clinicians on the frontlines greater flexibility to safely treat patients [30]. The American Medical Association has also created a new resource for doctors to turn to for advice on Telehealth. It recently launched the AMA Telemedicine Quick Reference Guide, aimed at helping clinicians figure out best practices for implementing a broad range of technologies including Telecare, Telehealth and Telemonitoring. The guidelines cover everything from policy and coding to implementation [31].

Chinese Telemedicine Approach to COVID-19

The Chinese strategy to Telemedicine in the wake of the COVID-19 pandemic is centred on practical activation of multiple variants of Telehealth systems adapted for patients‟ management. Zhai et al reported the use Telemedicine to Combat the COVID-
19 outbreak in China [32], while JD Health experienced a tenfold monthly consultations growth for its online health platform [33]. As a result, the demand for Telemedicine and related technologies rose exponentially in China, especially after Day-1 of the two months‟ lockdown of Wuhan city in Hubei Province on January 23rd, 2020. Hospitals in Wuhan are administered through smart medical devices connected to big data analysis systems and monitored by remote controlled surveillance cameras from the central administration centre in the Chinese capital Beijing. This enables medical team to monitor patients' health without direct exposure. In addition, the National Telemedicine Centre of China (NTCC) located in Zhengzhou also established the Emergency Telemedicine Consultation System (ETCS) to address the rising need for remote administration of patients, Medicare and the monitoring of health outcomes thereof [34]. China also uses Telemedicine supported by robots and Fifth Generation (5G) Technologies which enable medical professionals to communicate with patients remotely, saving time and allowing quarantined patients to stay safely confined [35].

South Korean Telemedicine Approach to COVID-19

The South Korean approach takes advantage of social media data to aggregate useful Telemedical indicators/data to profile patients‟ history and generate automated pointers for the populace. For example, whenever someone tests positive for COVID-19, all the residents in the vicinity are provided

with the infected person's travel details, activities, and social interaction mobility records trace for the previous two weeks through mobile notifications that are sent as an automatic push system [36]. This shapes the cohabitation and behaviour of residents and communities and provides additional shield against the spread of the virus.

European Telemedicine Approach to COVID-19

Amidst rising Italian cases [37] and worried over the spike in new infections, the European multi-faceted approach saw the UK‟s National Health Service (NHS) introduce the use of video consultations by hospitals to reduce the number of people in hospitals and lower the potential for transmission [11]. Accordingly, the European Union expanded its use of Telemedicine to help track and communicate with those in quarantine, administer treatments and gather data for monitoring and evaluation of health outcomes. In accordance with coordinated regional approach, Italy activated its Telemedicine initiatives which were proactively put in place in 2018 to facilitate greater use of Telehealth technologies throughout the country," the study states. The measures proved critically effective in increasing access to healthcare services for patients who were otherwise stuck in conventional healthcare facilities located in low-resource areas, some of which were uncertain to access conventional services for fear of exposure" [38].

: CHALLENGES WITH USING TELEMEDICINE TO COMBAT COVID-19 Much as the response of a few economies notably Europe, Asia, America in adopting the use of Telemedicine to combat the spread of COVID-19 has been commendable, developing nations are recording low patronage despite the potentials of these technologies. Several drawbacks are responsible for the poor adoption.

Lack of Policy and Legislation on Telemedicine

One apathy in some countries against the use telemedicine to address COVID-19 is lack of policy at federal, state, and local levels. The existence of fewer advocacy groups such as associations for Telemedicine, patient and physician advocacy groups and established industries also contributes to the apathy in such climes. The lack of legislation with Telemedicine components remains a challenge to reimbursement for healthcare. The congressional approval of the $8 billion emergency funding for legislation with Telemedicine component in the US goes a long way to address apathy. Furthermore, poor and uncoordinated technology adoption strategies by developing nations is a major drawback to adopting contemporary technological advancements including Telemedicine and eHealth. On 6th March 2020, the Coronavirus Preparedness and Response Supplemental Appropriations Act was signed into law, which among other things has given the US Department of Health and Human Services (HHS) the authority to temporarily waive certain Medicare requirements for telehealth services [39]

Self-limiting Cultural Beliefs

A major reason why many hospitals have not embraced Telemedicine is because many health administrators and patients are not well-versed in technology, and are initially suspicious of it [39] leading to apathy and resistance to technological change. This and many other cultural beliefs can become chronically self-limiting and counterproductive.

Regional Economic Backwardness

Economic backwardness is a major concern for developing nations some of whom struggle against unpopular leadership regimes amidst political and cultural retrogression. For such governments, managing ethnic crisis and sustaining political supremacy tend to overshadow every justification of seeking ways to use technology to drive growth such as Telemedicine-based healthcare delivery.

Health Insurance Limitations

Existing policy guidelines in many health insurance regulations do not give full

support to Telemedicine as an actuarial service, thereby making it an undesirable option except in emergency situations, but now coronavirus fears have propelled both insurers and patients to be more accepting of it.

Poor Funding for Technology R&D

Pharmaceutical giants are either reluctant to come together and fund R&D in Telemedicine-based drug development, or they are completely overwhelmed by the magnitude of the devastation occasioned by COVID-19. Poor funding affects the availability of Telecare facilities and compels the use of traditional means of administering and monitoring healthcare service across social strata.

Infrastructural Deficit

Telemedicine is not a national priority in countries where no eHealth strategies or policies exist. In some developing countries, inadequate digital infrastructure and high cost of bandwidth constitute huge obstacles for driving the Telemedicine agenda, so much so that alternative and inefficient health delivery options are adopted. Organizational factors at facility levels such as understanding of Telemedicine by healthcare professionals, the IT infrastructure and integration with existing workflow, available equipment and space and added workload due to increase demand for health services could constitute challenges for full use of Telemedicine to manage COVID-19 [8]. The organizational structure of national health systems in some countries may hinder widespread adoption of Telemedicine.

8.0 CONCLUSION

In addition to the changes in digital behaviour brought on by the coronavirus epidemic and the substantial effects it has on user privacy and computer security [1], the pandemic has also made the pursuit of technological remedies unavoidable. While attempts to produce a vaccine continue, it is just as critical to find ways to slow its spread as it is to find a cure. Recent developments in telemedicine, telecare, telehealth, and telemonitoring have great promise for addressing the need for social distance in containing the COVID-19 pandemic and for providing remote patient management, which in turn safeguards healthcare workers, patients, and the public at large from the virus. In order to limit the spread of COVID-19, this article examined several distant technological possibilities. The research also examined the elements working against the acceptance, usage, and sustainability of these alternatives, as well as the inherent obstacles in implementing them, as the available possibilities extend beyond telemedicine. The endemic state of the illness fits that description since it is one of the numerous events that bring about social change—an epidemic. Consequently, in order to stop the spread of COVID-19, society as a whole will need to make adaptations based on technology that emphasise methods to avoid direct contact with infected people. These adjustments will need to be permanent and integrated into people's daily lives.

As part of the country's reaction, telemedicine becomes beneficial for carers and frontline medical staff, but it cannot ensure protection against getting the new coronavirus on its own. Health care providers should rest easier knowing that the chances of cross-infection from direct patient contact are greatly minimised when they use telemedicine.

use mobile devices in the fields of transportation, healthcare IT, and home automation. M2M communications, the IoT, network security, ML, AI, neural networks, and 4G/5G networks are some of her primary areas of interest in the field of modern technology.

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