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EXPLORING THE POTENTIALS OF TELEMEDICINE AND OTHER NON-CONTACT ELECTRONIC HEALTH TECHNOLOGIES IN CONTROLING THE SPREAD OF THE NOVEL CORONAVIRUS DISEASE (COVID-19)

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ABSTRACT
As the novel coronavirus disease (COVID-19) continues to spread to more countries and territories with rising fatalities and global panic, the need for innovative measures to control its spread becomes more imperative. Telemedicine and Telehealth, the use of highspeed telecommunications systems and non-contact technologies for the delivery, management and monitoring of healthcare services have become timely with great potentials to shield health workers from direct contact with COVID-19 patients, as well as limit social mobility of the infected, both of which contribute to curtailing the spread of the virus. This paper analyses the application of telemedicine and related technologies as suitable strategies for controlling the spread of COVID-19 global health pandemic.

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

1.0: INTRODUCTION
Information and Communications Technology (ICT) has completely changed how humans interact with the environment and has positively influenced how basic amenities are delivered to citizens including healthcare. In health emergency situations such as the current COVID-19 outbreak, urgent measures are most inevitable including the innovative application of eHealth which is the use of ICT to deliver and manage healthcare more efficiently. While it is important to exhibit caution in technological choices and behaviours [1], it is even more demanding to put digital initiatives to help in slowing the spread of the virus. Since social distancing has been globally identified as an effective approach to slowing down and possibly halting the spread of COVID-19, technological interventions that limit direct human interaction have come to the centre stage. Telemedicine, Mobile Health and other Digital Health interventions have all become extremely relevant to manage the current global health emergency occasioned by the spreading coronavirus outbreak.

The rest of the paper is structured as follows: **Section 2** gives a brief statistical background of the novel coronavirus disease (COVID-19) and justifies the need to control its global spread. **Section 3** reviews the transmission mode of the virus disease and highlights the implications of direct contact with infected persons. **Section 4** discusses the benefits of Telemedicine in managing COVID-19 patients. **Section 5** reviews several complementing remote eHealth

technological innovations that support the social distancing requirements for controlling the spread of COVID-19. **Section 6** highlights current Telemedicine case studies in the United States, China and Europe. **Section 7** highlights challenges working against the full adoption of telemedicine for COVID-19 management. **Section 8** makes recommendations for tackling the inherent challenges with telemedicine. **Section 9** concludes the paper with summary remarks on the potentials of Telemedicine and non-contact eHealth technologies in combatting the spread of the novel coronavirus pandemic.

2.0: BACKGROUND ON COVID-19

As at 31st March 2020, the global statistics on COVID-19 pandemic which stood at 801,061 infections with a death toll of 38,749 across 199 countries, territories and conveyances [2] remains alarming. More worrisome is the fact that neither a cure nor a vaccine has so far been confirmed. The declaration of the World Health Organization (WHO) on 11th March 2020 elevating COVID-19 outbreak from an epidemic to a pandemic status [3], [4], [5] has escalated global panic as the world struggles for an enduring medical therapy to tackle the disease. Since the mode of transmission of the disease is via direct nasal droplets from an infected person, isolation remains the safest means of curtailing the spread of the virus until a potent vaccine is certified by WHO after a rigorous routine of clinical trials under varied test scenarios. This reality justifies the adoption of controlling further spread of the virus as a global priority.

Although many social adjustment strategies have been applied for slowing the rate of fresh infections including social distancing, restriction of movements, self-isolation, reduction in mass gathering, and closure of educational, religious, and cultural institutions, they all possess inherent challenges that do not particularly guarantee a completely reasonable shield for caregivers, first line health workers and medical personnel who are directly exposed to infected patents. The use of non-contact eHealth technologies appears potentially effective to reduce the possibilities of infections among health workers in the process of treating existing patients.

3.0: 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.

4.0: 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.

5.0: 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.

5.1 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.

5.2 Teleconferencing

An important component of Telemedicine is the Teleconferencing [21] capacity which facilitates the ability of both parties to establish and maintain a real-time video session of each other while also exchanging other vital data simultaneously. Video conferencing [22], [23] affords the health worker the capacity to perform remote visual inspections of patient's condition without necessarily having to make direct contact that can expose him to the disease being treated. All aspects of Teleconferencing can be recorded and shared among a closed loop of medical specialists for professional review and prompt decisions as part of case management ethics.

Teleconferencing relies on other subtle technologies and systems including collaboration software and applications, Global Positioning Satellites (GPS) Technologies, high speed point-to-multipoint radio communications systems, smartwatch transmitters, and VOIP. VOIP (Voice Over Internet Protocol) is the use of conventional internet connectivity to transmit normal voice telephone traffic thereby breaking the barriers of geography and terrestrial congestions.

5.3 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.

5.4 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.

5.5 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.

6.0: 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.

6.1 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].

6.2 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].

6.3 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.

6.4 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].

7.0: 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.

7.1 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]

7.2 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.

7.3 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.

7.4 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.

7.5 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.

7.6 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 RECOMMENDATIONS

8.1 Opportunity to Generate Big Data Health Intelligence with Analytics Tools

The huge data generated by various real-time Telecare implementations, Mobile Health operations, Collaboration Apps, and all chat products can be stored as big data in a hypothetical **COVID-19 Health Information Exchange** for on-going and future referencing, accessible among relevant stakeholders. The variety and volume of documentation acquired from multiple Telemedicine-related platforms can be analysed by special Apps to determine unlimited trends and patterns for policy and decision-making on the COVID-19, example the extent of spread, growth rate of new infections per region, determinants of recovery statistics, impacts of treatment, etc. Furthermore, the intelligence obtained from analysing the **COVID-19 Health Information Exchange** can help in speeding up contact tracing in locations where repeated waves of fresh infections are most prevalent.

8.2 Opportunity to Establish Healthcare Facilities and Acquire Medical Infrastructure

Developing countries can take advantage of emergency bailout funds arising from the management of COVID-19 to deploy Telemedicine implementations and acquire medical intervention that were previously deficient prior to the global outbreak. The outbreak seems to have momentarily defeated the prevailing economic realities as well as undeniable self-centered beliefs of philanthropists and donors by bringing health services to the front burner for both primary cases and referred individuals in need of specialty care. This requires a well-coordinated rollout plan for Telemedicine

Applications with less emphasis on long term maturity. Even beyond the current pandemic, such acquired assets will continue to exhibit relevance, as they encourage a hybrid mix of legacy hospital facilities with Telemedicine advancements.

9.0 CONCLUSION

In addition to digital behavioural changes which the coronavirus outbreak brings as well as its significant impacts on user privacy and computer security [1], the pandemic has also made the search for technology solutions inevitable. Searching for faster means of limiting its spread is as important as the quest for its cure even as research efforts in vaccine development continue. Technological advances in Telemedicine, Telecare, Telehealth and Telemonitoring have proven to possess huge potentials in meeting the social distancing requirements of controlling the spread COVID-19, in addition to providing remote management of patients which ultimately protects caregivers, medical personnel and the general public from contracting the virus. This paper reviewed many remote technology options available for controlling the spread of COVID-19. Since available options go beyond telemedicine, the paper also analysed inherent challenges in applying them, and reviewed the factors militating against their adoption, use and sustainability. Since an epidemic is one of the many events that bring about societal change, the endemic status of the disease meets that profile. Therefore, controlling the spread of COVID-19 must include technology-based societal adjustments that rely on techniques that prevent direct contact with infected persons, with such adjustments becoming long lasting and a way of life.

While the use of Telemedicine alone does not guarantee protection against contracting the novel coronavirus, it becomes useful for caregivers and frontline medical personnel as part of national response. Telemedicine gives additional assurance to health workers that the risks of a cross-infection based on direct contact with patients are optimally reduced.

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