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Integration of Advanced Health Technology Within the Healthcare System to Fight the Global Pandemic: Current Challenges and Future Opportunities

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ABSTRACT

The COVID-19 pandemic presents a significant challenge for providing adequate healthcare services in the context of patient isolation.

Discussion: The ability of our current healthcare system to cope with the current situation

is mainly dependent on advanced health technology, such as telehealth, chatbots, virtual reality (VR), and artificial intelligence (AI).

Telehealth can be a novel tool for improving our current healthcare system and allowing for greater delivery of healthcare services during global crises (i.e., the COVID-19 pandemic).

Technology, such as chatbots, VR, and AI, could be utilized to reduce the burden of both communicable and noncommunicable diseases, as well as to build a patient-centered decision-making healthcare system. **Objectives:**

Understanding the various methods of enhancing healthcare services using advanced health technology will help to develop new applications that can be integrated into regular healthcare and in time of healthcare crises.

Conclusion: Advanced health technology is a main tool to face a pandemic that decreased the burden on physicians and patients as well as the entire healthcare system.

KEYWORDS: Health technology, telehealth, health system, COVID-19, pandemic

Health systems all over the world face an unprecedented challenge with the novel coronavirus (COVID-19), which originated in late 2019.¹ The COVID-19 pandemic presented additional threats to the fragile relationship between community health, medical care, and health technology.² By the end of November 2020, the number of positive COVID-19 cases surpassed 59 million worldwide, with 1,397,000 deaths; it is approaching 12.5 million in the United States (US), claiming 261,387 deaths.³ A national emergency was declared in the US followed by a stay-at-home government order on March 20, 2020, prompting the implementation of social (physical) distancing measures to slow the spread of the virus. This was a strategy that negatively impacted the economy, social life, and healthcare, as it has reduced access to support from family and friends; it has degraded social support systems and has thus increased the risk for anxiety and depressive symptoms.⁴ It raised the challenge of providing adequate healthcare services in the context of patient isolation, prompting the implementation of protocols that address both the physiological and psychological needs of patients and providers.⁴ Furthermore, it has increased the need for more medical staff to face

this pandemic, including bringing back retired physicians, many of whom fall into the high-risk categories.⁵

The healthcare system had utilized telephone triage and advice to prioritize high demand and facilitate access to appropriate services.^{6,7} Previous studies have shown that patients' compliance with triage advice varied according to the patient's need, where higher compliance was reported in patients receiving advice to attend the emergency department compared to those advised to seek primary care.⁸ The healthcare system has been introduced to new and compelling innovations created in the past few years following the significant recent advances in technology, such as telehealth.^{9–11} Telehealth can play an important role in facing the current situation.

A variety of options to assist telehealth implementation include phones, computers (laptops and desktops), and tablets. Many virtual formats became available recently such as chatbots, embodied conversational agents, and three-dimensional avatars.¹² Moreover, telehealth, particularly video consultations, has been promoted to reduce both the risk of infectious transmission and the workload on medical staff, especially those in the United

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Kingdom and the US.^{13–15} Furthermore, telehealth services, in particular for mental health, have been expanding in China and Australia as well.^{16,4}

Compared to telephone triage, online video consultation enables a feeling of presence between patients and providers and enhances nonverbal or body language communication. Research has shown psychologist and psychiatrist satisfaction with providing telehealth by being able to read patients' body language cues.¹⁷ Participants were also satisfied with the feeling of presence during their online psychotherapy sessions.¹⁸ Moreover, studies reported satisfaction and improved chronic disease management when patients used home telehealth system, which empowered them to participate in their own health management.¹⁹ Results from semi-structured interviews with patients with diabetes using telehealth for disease management reported patients' appreciation of the continuity of monitoring and care, which boosted their comfort and sense of security.²⁰

Understanding the challenges facing telehealth, in general, will help to identify ways to improve upon it and to thus make it available for everyone sooner rather than later, especially with the increased need for effective telehealth services during the COVID-19 pandemic. The use of telehealth to provide mental health services still has a lot of drawbacks to successful application.²¹ Such barriers are sometimes technological, as well as cultural both for patients and mental health professionals.²²

The fast progress in telehealth might soon replace the traditional face to face practice in our daily life. A 2010 meta-analysis argued that computer therapy for anxiety and depressive disorders was effective, acceptable, and practical healthcare tool.²³ Since that time, many researchers worked on this field till in 2018, when Andrews et al²³ published a meta-analysis of 4,423 abstracts. The results had shown that face-to-face cognitive behavioral therapy (CBT), iCBT, and bibliotherapy are equally effective for anxiety and depressive disorders treatment, but face-to-face CBT is more time consuming while iCBT has higher rates of satisfaction, acceptability, and moderate adherence. iCBT is more privileged by being more convenient to use and more private form or treatment. The iCBT needs more standardization, as the current available forms are diverse and the content

varies according to the diagnosis; moreover, the range of topics are different, which might affect the quality of the service. When it comes to medication prescription, this process becomes more complicated.²³

A detailed and practical telehealth experience was presented during the COVID-19 outbreak in Italy using free applications.²⁴ According to this experience, the challenges of implementation included technology unavailability, breakdowns, poor connections, privacy concerns, informed consents, payment-related problems, and human diffidence.²⁵ On the other hand, the successes of implementation included a reduction in patient isolation, reduced costs of healthcare services, and increased overall patient and health professional satisfaction.²⁵

Telehealth challenges also include privacy concerns despite significant efforts to overcome such a problem. In 2017, a software platform called Epharmix was developed by Washington University in St. Louis, Missouri, with unique high data security protecting both patient and provider's privacy. It was designed to have a built-in combination of security measures including "i-identifier removal, clinically relevant surveys, clinical data reporting, voluntary opt-out, toll-free messaging, customizable message frequency, consent confirmation, and time tracking."²⁶ Privacy regulations during the COVID-19 pandemic were challenged in the face of barriers to medical care access, resulting in the government decision to waive Health Insurance Portability and Accountability Act (HIPAA) business associate agreements for the provision of telehealth services.²⁷ It is interesting to note that commonly used apps such as Skype are not HIPAA compliant, and thus might not provide a high level of security.²⁸ However, Zoom still meets the necessary HIPAA specifications for access and audit control, integrity, person or entity authentication, and transmission security.²⁹ An important standard practice for providers using telehealth to deliver services is to notify patients that these third-party applications might introduce privacy risks.²⁷

Additional telehealth challenges include the inability to perform a proper physical examination, inability to engage certain patient age groups especially at upper and lower limits of age, and physician communication skills.^{30,31} One of the successful experiences that overcame some of these challenges is the TeleBurn app in the Medical University of South Carolina, which

helped patients with burns to heal faster and comply with the treatment better than face-to-face treatment. It involved major collaborations of experts from different fields including burn care, nursing, health communication, information technology (IT), public health, and clinical psychology.³²

The multimodal, multifunctional, recently developed conversational agents (also known as chatbots) can be of great help to the general public, patients, and physicians through automation of a diverse range of health-related activities. Understanding the psychophysiological mechanisms underlying the virtual patient-agent interaction that is a hallmark of telehealth interactions is a great point of interest among researchers.³³ It was suggested that a positive and congruent response by a virtual agent can overcome the belief that the agent is a computer program, hence enhancing such an interaction.³³ Chatbots analyze user inputs by using natural language and respond via auditory or textual methods using human language, a process that mimics human interaction.³⁴ They are designed to offer the ability to learn as they go, in addition to the ability for shifting in conversation structure and flow, while addressing the variability of language, which can help in understanding the described health-related needs.³⁵ Amazon's Alexa is a good example of a widely used voice recognition application used in daily life in many households.³⁶ These conversational agents can perform vital tasks including triage, diagnostics, counseling, health promotion, and training of health care professionals, which decreases the burden on the current healthcare system and enables populations with limited access to these services.¹² Though its use requires tolerance for imperfection and postrelease improvement, it performs mundane tasks in predictable fashion, which offers it a unique ability to handle the level of variation and complexity in medical questions arising in the time of pandemic.³⁷

Since 2018, Buoy Health and the Boston Children's Hospital have been collaboratively working on a web interface-based system that provides advice to parents for their ill children by answering questions about medications and whether symptoms require a doctor visit.³⁶ In January 2020, Herriman et al outlined the creation of a Penn Medicine Chatbot, which was collaboratively created with Verily, Google Cloud, and Quantiphi, a Google Cloud strategic

partner. They started by analyzing incoming patient questions, then designing the chatbot as a symptom checker with the ability to transform information into desired patient actions (after creating a system for ongoing answer verification) while responsibly managing constrained resources.³⁸

Predictive modeling tools that can improve patient safety and outcomes, as well as supporting clinician and patient decision-making capacity, can be developed using the rapidly growing electronic healthcare record (EHR) data, artificial intelligence (AI), and machine learning (ML) approaches.³⁹ Furthermore, the interaction between AI and patients can be based on physical signs of interpretation by conversational agents. The input channels have recently developed to allow body and eye movement perception and analysis of gesture, which collectively get integrated into multimodal signals as in the case of human-human interaction, which might therefore enhance the user-agent interaction.¹² Patient temperature can be collected through a remote assessment of the patient's body temperature.⁴⁰ Patient anxiety can be assessed as well through a newly recommended technique to investigate cortisol dynamics in human sweat using a graphene-based wireless health system, which can be used as one of the parameters in the predictive model.^{12,41} The implementation using digital biomarkers coming from smartphones, wearable sensors, and smart homes. Both physicians and patients need to integrate these programs into routine care as means for increasing empowerment, improving health literacy, and reducing disease burden.

Research into virtual reality (VR) has rapidly developed this method as a possible contribution to therapeutic value in mental health, particularly for anxiety disorders.²¹ These conversational agents became more developed and have personalization features integrated, which improved user satisfaction, engagement, and dialogue quality; this can collectively allow more patients involvement in their healthcare, decision making, and helping to provide patient-centered care.¹²

In conclusion, advanced health technology, such as telehealth, chatbots, VR, and AI, could be utilized to reduce the burden of both communicable and noncommunicable diseases, as well as to build a patient-centered decision-making healthcare system. Understanding

the various methods of enhancing healthcare services using advanced health technology will help to develop new applications that can be integrated into regular healthcare and in time of healthcare crises.

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