

How Should We Prepare for the Post-Pandemic World of Telehealth and Digital Medicine?

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The novel coronavirus pandemic (COVID-19) has stressed the U.S. health care system in an unprecedented manner, highlighting both the system's resilience and fragility. The National Academy of Medicine's (NAM) Health and Technology Interest Group sponsored a program at the 2020 NAM Annual Meeting focused on "Telehealth and Telemedicine: Accelerated Change in the Era of a Pandemic", which emphasized both the promises and challenges observed during this recent period of accelerated innovation [1,2]. Stress points exposed by the diffusion of established and nascent telehealth technology uniquely reflect existing ethical, legal, and financial frameworks that have yet to fully evolve in order to meet these new and changing demands. These areas of fragility, which the pandemic exposed, underscore that much work remains to be done to ensure that protections, which apply to in-person health care, are thoughtfully extended to telehealth systems of care, while at the same time catalyzing experimentation, innovation, and engagement by technologists, providers, and the communities that health and health care providers serve.

The widespread adoption of telemedicine clinic visits has revolutionized health care and improved accessibility, and the emergence of digital biomarkers facilitates longitudinal monitoring with significant benefit during a global pandemic [3]. For example, patient-generated recordings of heart rate, temperature, sleep patterns, and digital traces of purchases can be harnessed for early detection of symptoms, monitoring responses to specific treatments, and supporting behavioral modifications. Together with existing technologies, opportunities have expanded for applications of artificial intelligence (AI) in medicine. The implications for AI integration extend beyond the pandemic, with machine learning algorithms and smart sensors employed to augment the effectiveness of providers

and improve patient outcomes under a variety of settings. As one such example, deploying AI in health care may provide an enhanced capacity to support aging-in-place by employing home-based thermal imaging to detect deteriorating balance early so as to intervene before a fall occurs [4,5].

The benefits derived from the rapid advancement of telehealth and digital technologies throughout 2020 have been balanced by a greater understanding of real-world limitations and deficiencies. Technological innovation has undoubtedly ameliorated certain aspects of access to care, but has exacerbated others—particularly the ability to address the health care needs of racial and ethnic minorities and underserved communities. The unstated substrate of telehealth is access to Internet services. Yet, nearly one in three adults in the U.S. do not have access to broadband internet at home [6]. Moreover, machine learning algorithms trained on digital biomarkers are susceptible to embedded biases if underserved populations are unable to participate or contribute to the source data or algorithm development, which in turn perpetuates pre-existing health disparities.

Despite the initial framework established by the Interstate Medical Licensure Compact [7], uncertainty continues to surround appropriate licensure and reimbursement for telehealth services. Furthermore, lapses in storing individuals' monitoring data, from which digital biomarkers are computed, pose significant legal challenges. It is important to emphasize that these data are commonly sourced in intimate and personal settings, subsequently capturing incidental data that is not usually observed in clinical settings. As a result, without regulation to cover the broad spectrum of data now leveraged for telehealth, significant potential patient vulnerability to data misuse will remain, including identity theft; employment and insurance discrimi-

nation; invasive marketing; and cultural stigma. All of these issues remain closely intertwined. For example, without intentional intervention, ambiguity in reimbursement will only exacerbate inequitable access to a myriad of services that over time will only be available through a telehealth medium.

Privacy, security, and ethical concerns will need to be addressed to mitigate patient and provider risk without stifling health care innovation. Ethically, patients should benefit from the use of their data with minimal risk. Mechanisms should be implemented to minimize algorithmic bias that could exacerbate existing racial health disparities, and marginalized communities' equal access to telehealth must become a priority. Rules promoting enhanced data stewardship are necessary to mitigate risk and encourage telehealth innovation, with such statutes striking an appropriate balance between over- and under-protection, as both can be harmful to patients and providers alike. Addressing the public mistrust of "big tech" and AI mandates a high level of transparency for patients and providers regarding data collection, use, dissemination, and ultimately, destruction. Establishing trust will be critical for clinically meaningful advancements to continue and flourish.

The COVID-19 pandemic unmasked the fragility of our nation's health care system, but also illuminated the promise of telehealth and digital medicine. This important societal inflection point warrants careful reflection to determine those aspects of telehealth which succeeded in advancing health care delivery and those that fell short, particularly with respect to racial and ethnic minorities, so that future telehealth approaches are fair, efficient, and equitable.

It is to be hoped that these insights will lead to the development of a multi-sectoral, inclusive framework that facilitates collaboration and engagement to embrace the challenges arising from this time of destabilized health care delivery systems, accelerated innovation, and rapid change. Collectively, our nation must leverage the full benefits of telehealth and digital medicine with equity and purpose; in so doing, we may not only regain lost ground but progress in achieving balanced and accessible health care delivery nationwide.

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