mHealth on the periphery

In our previous work in the mHealth domain, we acknowledged that the unholy trinity of policy, regulation, and reimbursement collectively constrained the optimal deployment and scaling of mHealth innovations. We continue to believe in the transformative power of mHealth to improve access to many health resources and services for underserved and vulnerable populations. And, we remain confident that in the post-pandemic environment many of the creative solutions to pandemic-induced barriers to healthcare delivery will continue to be developed and improved, including those that exploited mHealth methods and technologies. Thus, an unexpected benefit of mandated widespread, and long-term, quarantine may prove to be robust assessment and determination of what components of healthcare can be delivered effectively with mHealth devices and approaches.

In this series of papers, we highlight several pilot projects, some of which emerged during the COVID quarantine period as a way to continue providing needed services to home-bound individuals. We're designating these innovations as "on the periphery" of mHealth as some of their valuable contributions aid in improving infrastructure and assessment of mHealth services, although some of the projects provided new categories of services, such as support for stressful life situations, to individuals that might not have pursued them in a non-pandemic environment.

The first paper published in the series (Houser *et al.*) (1) reported an examination of the adequacy of clinical documentation collected during telehealth encounters in physician practices, based on a survey conducted in January and February of 2021. As both providers and patients were constrained from in-person encounters during the quarantine period, an expected increase in remote service delivery occurred, with more than 60% of the provider respondents initiating telehealth options within the year prior to the survey. The authors reported continuation of known patient challenges with telehealth services—inequities in quality of technology, variability in patient understanding and satisfaction—but also acknowledged emerging provider issues. Specifically, providers experienced extreme frustration with rapid changes in payer guidelines and requirements for reimbursement for services, and the obligation for more robust documentation practices to meet those changing requirements. The responding providers expressed strong concern that "technology or reimbursement requirements [could become] the overriding focus of telehealth as opposed to patient care."

Gurupur (2) addresses the issue of data incompleteness, one component of clinical documentation adequacy, from the perspective of scoring actual electronic records against a concept map of "an ideal complete electronic health record." This issue of incomplete documentation is considered with regard to one of our key concerns—improved reimbursement for services provided—as well as contributing to decreased risk for medical errors, reduced staffing requirements, and fewer treatment delays. He provides a diagram of the value propositions for key stakeholders for documentation completeness—CEOs, health information managers, risk managers, CFOs and CIOs, and clinical providers.

Lipscomb *et al.* (3) report using value-based modeling, traditionally used for business development, to explore the net value of transactions in a mobile health application system. Using the PArchitect modeling tool, the authors deconstructed the system components to consider process, information, and value modeling. Their analysis documents the importance of efficient task completion, efficient and reliable information, and effective value exchanges. They also identified a limitation on the value exchange of medical services—constraints related to time, cost, and availability. Responding to these constraints requires making choices between one-to-one and one-to-many (provider to clients) decisions. Planned extensions of this investigation include building a software-focused architectural model, building a prototype, and field-testing the prototype.

Food insecurity, a persistent problem exacerbating poor health for millions of Americans, increased in many communities during the pandemic. For many reasons, screening for food insecurity is not routine among healthcare providers, thus many individuals do not have this social issue addressed in their health care plans, and their health outcomes often are suboptimal. Bernhardt and King's (4) paper explores the effectiveness of using telehealth visits to screen for food insecurity, and identified some limitations that might be lessened with further refinement. There is much evidence that living through the COVID pandemic changed our personal behaviors in many ways, from how we shop for food and other goods to how we engage with our healthcare providers. Although many of the isolation restrictions have been removed, our acceptance of the "new normal" is likely to continue, including accessing social and health services through our smart phones or other devices. With further research and evaluation of mHealth and telehealth approaches, providers will be better prepared to address food insecurity

and other social determinants of health among their individual patients and communities served.

The Rimmer *et al.* (5) paper reports evaluation of a pilot telewellness program designed to enhance resilience in individuals with disabilities. The program was designed to be delivered online, as many disabled individuals have difficulty traveling to access facility-based programming. In this instance, the pandemic environment challenged the care team with regard to the telelogistics support protocol. In addition to managing online enrollment, teleassessment, and implementation of the treatment protocol, the support team needed to match program equipment to participant requirements, package the equipment, and coordinate shipping to participants' homes during a time when the facility was effectively locked down and delivery companies were operating at peak capacity. Recruiting and training health coaches, and orienting participants to the coaching platforms and intervention tools using text messaging, phone calls, and Zoom sessions in a structured research environment produced valuable information to validate the reported anecdotal experiences of workers in multiple industries who were shifted to remote work with very little planning or preparation.

Gurupur and Miao's paper (6) speaks to the continuing challenges to robust deployment of remote delivery of health services using information and communication technologies (ICT). Known issues, the availability of wireless/wired networks and variability in access to and skill in using ICT among rural populations, have been mitigated to some extent by pandemic responses, including government funding for infrastructure and expanded use of ICT for social and daily living activities. The authors suggest that rural providers, although incentivized to provide remote services to maintain their client base during the pandemic isolation mandates, still are most likely to invest in the ICT infrastructure for geographical areas where the broadband is sufficiently reliable to support their activities.

The final article in the series, authored by Jenkins and Cunningham (7), reports a mHealth solution that responded to two significant challenges resulting from the pandemic isolation. First, because health care organizations were extremely compromised in care delivery due to staff shortages and increased workload with COVID cases, they necessarily restricted facility access to employees and patients only. Thus, health professions education programs could not send students to fieldwork sites for professional practice experience. Concurrently, academic institutions were limiting both administrative and academic operations to remote activities only. Second, the increased stress caused by disruptions in daily work and lived experiences impelled many individuals to seek emotional and social support services at a time when such services were less available. To enable their occupational therapy students to remain engaged in their professional training, and to provide a venue for aiding individuals to adapt and organize daily activities to reduce stress, the authors guided their students to design and implement a student-led health and wellness program using a virtual platform. The free program, which is supervised by credentialed occupational therapists, meets program accreditation requirements for client assessment, engagement, and intervention to promote a healthy lifestyle.

These exemplar projects are supplemented and complemented by many more that occurred during this same time period without being reported in the literature—in many instances "doing" was essential, but reporting it was not. Perhaps as work arrangements return to pre-pandemic states, telling the stories will add to our accumulating mHealth body of knowledge.

One of the biggest limiting factors for telemedicine and related ICT technologies has been insufficient connectivity. However, dramatic increases in availability of broadband, and ever-increasing bandwidth and speed, will open new frontiers to assure that our global population, post pandemic, can utilize mobile health technology beyond our earlier visions. Elon Musk's Starlink, which uses a satellite system, promises to increase our global connectivity. It relies on a global network of low earth satellites that will offer high speed broadband internet to locations that previously were challenged by access that was unavailable, unreliable, or unaffordable. So, underserved and inaccessible areas, especially disadvantaged rural communities, will find more opportunities for telemedicine and other health support services (8).

We also are interested in opportunities presented by what is occurring in space medicine, the ultimate in remote healthcare. Whether for astronauts at the International Space Station (ISS) or for future space tourists, there will be a need for healthcare in space, as being in space will not eliminate the human condition. Healthcare needs might include routine care for chronic conditions, or response to emergencies such as accidents, heart attacks, strokes, or infections. Thus far, space medicine has used other ICT rather than smartphone technologies. For example, an expert was called from the ISS on his home phone by an astronaut to help diagnose and treat a deep vein thrombosis (blood clot) (9).

Why not use a smartphone as we do for an earth-bound telehealth visit? Smartphones cannot be used in space because of radiation and electromagnetic fields. Ultrasound imaging is the only medical visualization device that can be flown or operated

on a spacecraft because the technology is radiation-free. While there are limitations, as with any innovation, possibilities are being pursued. 3M has worked with the Japanese Aerospace Exploration Agency (JAXA) to equip its astronauts with the 3M Littmann Scope-to-Scope Tele-Auscultation System on-board at the ISS. The system will allow physicians on the ground to hear the actual heartbeat of astronauts in space in real-time. The ability of astronauts to send heart and body sounds in real-time from space with the same sound quality and clarity as if the physician on Earth was in the same room, is a tremendous accomplishment for telemedicine (10).

We acknowledge that taking healthcare applications into space is "on the periphery" in a real sense. But, the needed technologies exist, and are enhanced in each development iteration. While ICT innovation continues to occur, acceptance and utility are ubiquitous, so why shouldn't these innovations diffuse along with human migration? If/when space travel becomes routine, or at least feasible, we look forward to the integration of then-deployed remote healthcare technologies, even beyond the edge of space. Until that time, research and application development reported in this journal contribute to the body of knowledge that enables the advancement of mHealth and related technologies.

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