Sensor-aided continuous care and self-management: implications for the post-COVID era

Published Online September 16, 2020 https://doi.org/10.1016/S2589-7500(20)30220-X

As the COVID-19 pandemic sweeps across the world, there has been a rapid adoption of telemedicine in the care of patients. Although telehealth has been around for a few years, the previously slow uptick of this technology has markedly accelerated over the last few months.[1] One of the biggest barriers in the USA, low reimbursement, was eliminated on April 30, 2020, when the Centers for Medicare & Medicaid Services expanded its reimbursement to cover nearly 250 categories of telehealth.[2] Savings in time and cost by the avoidance of travel, adherence to physical distancing, and the elimination of exposure to infectious agents in a congested outpatient waiting room made for easy adoption by most patients.

It is widely believed that in the post-COVID era, a substantial proportion of outpatient visits will continue to be virtual. This change could lower overall health-care expenditure by way of reduced need for staff and space. The economic benefits of increased virtual visits are also indirectly exemplified by e-consults, a form of digital medicine that involve asynchronous electronic consultations between providers for straightforward clinical questions.[3] E-consults expedite clinical decisions by reducing unnecessary outpatient specialty visits, ancillary testing and imaging, and restrict rising health-care costs.[3] However, despite the positive downstream influence of increasing access, digital modalities involving the exchange of information with patients, unlike e-consults between providers, might intensify health-care disparities because not all patients have reliable access to technology or internet.

Telemedicine visits can be considered deficient compared to in-person visits because of difficulty in recording vital signs or doing a physical examination, or both. This insufficiency has created a need for sensor-based approaches to provide real-time data during a virtual visit, adding value and objectivity to the video visit. Some patients have begun recording their own temperature, heart rate, blood pressure, and oxygen saturations before the telemedicine visit. This self-recording of data is akin to diabetics having their continuous glucose monitoring data at the time of their interaction with their primary care doctor or their endocrinologist.[4] The natural evolution of virtual care will involve a greater use of sensor technology to monitor vital functions and specific disease states. Another important example includes patients with heart failure that have implanted devices (defibrillators and pacemakers), where sensor-based data that can help to predict heart failure decompensation to prevent readmissions.[5] These devices have the ability to capture data regarding heart rate, physical activity, respiratory rate, heart sound intensity, and transthoracic impedance (a measure of fluid in the lungs). Integrated sensor measures have been shown to predict heart failure[5] and might have the potential to empower patients to participate in their own care. There are also studies showing that the use of smart technology for blood pressure regulation yields results similar to that of standard care visits.[6] Notably, as sensors continue to evolve, the continuous data acquisition needs to be highly accurate. False positives can overwhelm the clinician and result in the increased use of resources and downstream costs, and false negatives could have detrimental clinical consequences.

In the USA, virtual care in its current form, like conventional outpatient care, is still episodic and transactional via a fee-for-service model. This transactional nature occurs despite the knowledge that disease, or even wellness, is a continuous state and flare ups do not coincide with periodic, predetermined follow up clinic visits. In the peri-pandemic period, medical professionals must develop an economic model that would encourage the delivery of continuous care. Maybe there is something to learn here from the role of remote monitoring with pacemakers, loop recorders, and defibrillators. In the not-so-distant past, patients with implanted devices were evaluated in-person once every 3 months. With the advent of the continuous remote monitoring of wireless devices, patients are now seen once a year, unless there is a problem reported through monitoring that mandates an earlier visit.[7] This method of scheduling visits is tantamount to exception-based care, where a patient is followed up continuously, and treated only as needed, when indicated by sensor data. Beyond these uses, sensors can actively monitor and treat diseases such diabetes, through titrating insulin, and heart failure, through titrating diuretics. Within this developing framework, it is important to emphasise that virtual care and sensor strategies are not a substitute to in-person visits. The in-person connection between a patient and a doctor should continue to be central to the optimal delivery of personalised care.

Continuous Digital data from watches, wearable sensors, and bluetooth-enabled monitoring devices will alert doctors if their patients begin to stray from good health. Rather than waiting for patients to fall sick, the care pathways will be programmed to predict and prevent. This method would be most applicable to chronic diseases. There are estimates that by 2030, 83 million Americans will have three or more chronic health conditions, up from 31 million in 2015.[8] Integrated sensor technologies, via implanted devices or wearables, will become a part of a larger disease management platform. Continuous digital monitoring, with alerts triggered by pre-defined criteria, will enable the proactive care of patients with diabetes, hypertension, chronic obstructive lung disease, atrial fibrillation, and heart failure, among a host of other conditions. Some monitoring is already underway and will involve assessing and monitoring patients during periods of wellness.[4,5] Even though smart watches can detect atrial fibrillation, albeit with high false positive rates,[9] algorithm accuracy was demonstrably enhanced when used to study cohorts at a high risk (eg, patients post-cardiac surgery) with no reported false positives or false negatives.[10]

Stakeholders (payers, providers, and patients) will need to be incentivised to enable this culture shift towards sensor-aided virtual care. Market forces might need to reinforce the value of shared saving strategies, which will continue to grow. Encounters will become less transactional, with a move to establish a target amount of expenditure for each patient. If the amount of monies spent on a patient comes under the mark, but rises to all the required bars of quality, then the savings could be shared by the clinical provider groups. At this moment, the true effect of virtual care on downstream future costs is speculative. Moreover, costs as measured by hospitals and health-care corporations are short term and yearly, as opposed to real-world estimates of costs at the individual and population level, which occur over decades. Virtual care could result in increased access to care and therefore increased costs. There is also the possibility that the absence of personal contact could increase the dependency on lab testing and imaging needs. The hope is that accurate sensors, inexpensive smartphone-assisted testing at the point-of-care and keeping the population healthy could drive down overall health-care costs and improve quality of life.

Beyond this, will incentivising patients for the self-management of their chronic diseases factor into reimbursement models and insurance premiums? There is already a move from employers and insurance agencies to advance self-health through discounts and incentives on wearables that promote exercise.[4] Digital monitoring with a feedback of heart rate and physical activity might play a role in maintaining wellness, but has not been formally evaluated in disease management platforms. As an example, type 2 adult onset diabetes is a lifestyle disease that is correctable in a substantial proportion of patients. The cure lies in modifying lifestyle, with evidence that this change could obviate the need for medications in some patients. There are 1·2 million patients with type 2 diabetes in the USA who could benefit from lifestyle management and potentially need less medication. It is in these situations that sensor technology for continuous glucose monitoring,[4] energy expenditure, and physical activity[4] can provide feedback to patients to amend their diet and tweak their exercise regimens. If patients are incentivised to help manage their own disease (diabetes, heart failure, chronic obstructive lung disease, etc), billions of dollars would be saved on an annual basis. If care was considered only for preset digital alerts, can the model of exception-based care used for implanted devices extend to wearables?

With remote care here to stay, coupled with the unpredictable fiscal status of the post-pandemic health-care world, there are calls for an overall reset of the current care delivery system. Sensor-aided continuous care, with incentives for self-management, might be the next step following the widespread adoption of telehealth. Hospitals, physicians, and administrators should get ready to test these new care platforms and consider innovative sustainable reimbursement models.

JHW reports consulting for Biotronik and Pfizer; grant support from the Harvard Catalyst, National Institutes of Health, and American Heart

Association; being the vice chair of the New England Comparative Effectiveness Public Affairs Council; consulting fees from Pfizer and Biotronik; and travel funded by the American College of Cardiology, all outside the submitted work. JPS reports consulting for Biotronik, Boston Scientific, Medtronic, Abbott, Microport, Elgin B Robertson, Impulse Dynamics, Nopras, Orchestra BioMed, and Toray. MZ declares no competing interests.

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