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THE CHANGING FACE OF CONNECTED HEALTH IN THE TIME OF COVID-19

In this article, Neil Williams, Director of Front-End Innovation and Head of Connected Health, and Angela R Eder, PhD, Healthcare Content Creation Manager, both of Phillips-Medisize, discuss how the current pandemic is transforming the adoption of connected health.

Three years ago, it was recognised that, while technology and data analytics had the ability to revolutionise healthcare, and that major technology companies were making investments in this area, the entire healthcare industry was resistant to changing in a way that adopted and integrated these technologies.¹ At the time, technology readiness, patient acceptance, data security, regulatory challenges and the difficulty of justifying financial investment in connected health devices were all key impediments to the adoption of connected health technologies.

However, the emergence of SARS-CoV-2 (Figure 1),² the virus that causes covid-19, has changed nearly every aspect of modern society, including the way healthcare

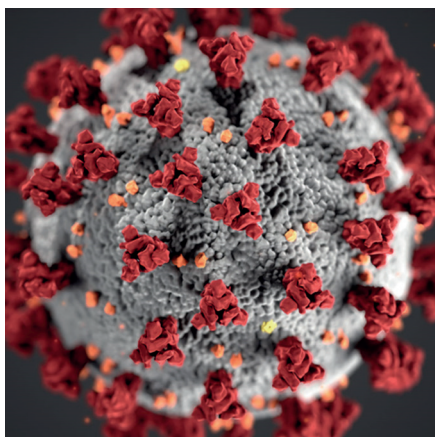


Figure 1: Rendition of SARS-CoV-2.

is delivered, emerging medical needs and the acceptance of connected devices by both patients and healthcare providers. In response, the US FDA³ and other regulatory bodies have modified guidance around the use of telehealth and connected devices, for the duration of the pandemic at least. Despite the emerging availability of vaccines, leading economists are emphasising that other covid-19 prevention measures, including social distancing and mask wearing, will be with us for a long time,⁴ in all likelihood making telehealth and medical device connectivity permanent fixtures in the way we provide and receive healthcare.

At the time of this publication, there have been more than 64 million cases of covid-19, with over 1.49 million deaths attributed to the virus globally.⁵ The deaths have been tragic, but the impact of covid-19 on the health of patients, both those affected by the virus and those who have not contracted it, has extended well beyond mortality figures and has been profound. For the nearly 64.5 million global survivors of covid-19, chronic health conditions will persist. “Long covid” syndrome and “long haulers” are widely accepted in the medical community, even as the full range of effects are only now being understood. Even mild cases of covid-19 create a cascade of symptoms that will require long-term management: headaches, gastrointestinal issues, cardiac arrhythmias, fatigue and pulmonary dysfunction.⁶



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While the full nature of covid-19-related chronic health conditions is not completely understood, there is widespread acceptance in the medical community that covid-19 will have chronic effects for many, if not most, survivors of the acute illness. These patients will require both short- and long-term care to monitor symptoms and recovery, and to evaluate the efficacy of physical therapy and medication regimens, preferably in a remote care setting.

Beyond patients recovering from covid-19, those who have not contracted the virus will still require remote care for long-term health conditions – those that existed prior to covid-19 and those that resulted as secondary conditions stemming from the effects of living through a pandemic. Prior to covid-19, it was estimated that nearly half of all adults manage one or more chronic health conditions, for which there is no cure, but which are managed through daily medication and/or treatment.^{7,8} Common examples of long-term conditions include: diabetes, certain mental health conditions (e.g. depression, PTSD), respiratory illness (e.g. COPD, asthma), cardiovascular disease, osteoporosis, HIV/AIDS and Alzheimer's disease. Increases in the incidence of cardiovascular diseases and respiratory illnesses are expected for covid-19 survivors; for those who care for these patients, it is anticipated that chronic mental health conditions will increase in the coming months and the post-covid-19 era. In one study, Mount Sinai Hospital (NY, US) estimated that 25–40% of medical personnel and emergency workers will suffer from PTSD due to covid-19, requiring long-term management of associated symptoms.⁹ Symptom tracking, adherence to medication regimens and counselling will all be critical elements of successful recovery for affected medical personnel.

COSTS OF MEDICATION NON-COMPLIANCE

Adherence to medication regimens is a critical component of managing symptoms and effects from these chronic conditions. When patients do not take medications as prescribed, it can lead to A&E visits, hospitalisations, adverse health outcomes and death. The effects of medication non-adherence and lack of effective remote healthcare have been particularly stark with the advent of covid-19. In 2020, to date, more than 299,000 Americans and

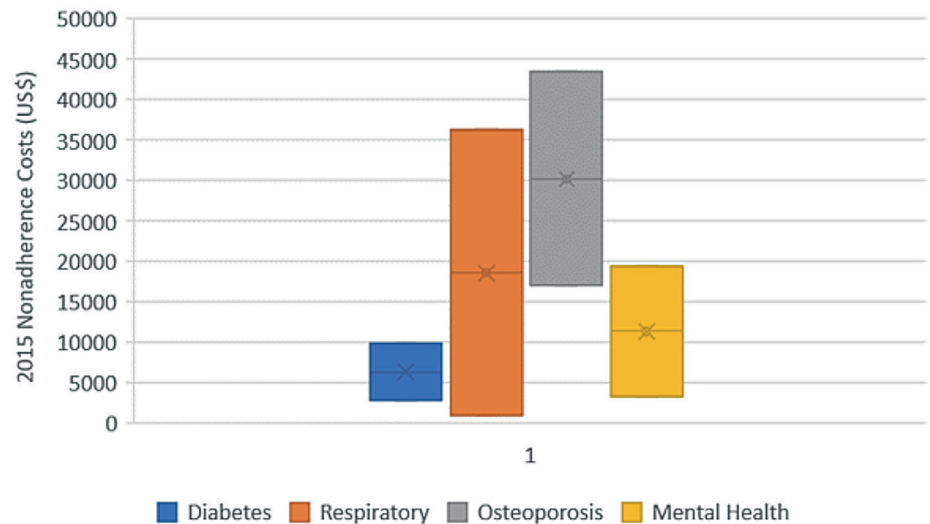


Figure 2: Non-adherence costs of select chronic healthcare conditions.

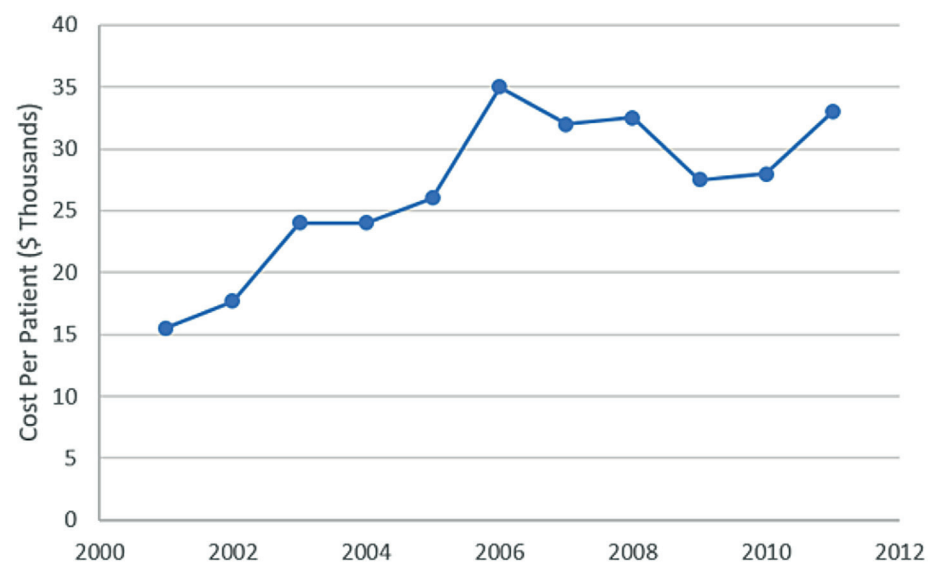


Figure 3: Cost per patient of hypoglycaemic events for unmanaged diabetes (US dollars).

70,000 citizens of the UK have died due to ordinarily preventable illnesses and chronic health conditions that were left untreated or were improperly managed due to patient fear of entering healthcare facilities.^{10,11} The majority of these excess deaths occurred in the age bracket of 25–44, which corresponds to a significant negative economic impact.¹²

The financial cost of non-adherence to a medication regimen is variable (Figure 2), and can cost as much as US\$43,000 (£32,000) in per-patient costs for unexpected treatment stemming from a patient failing to take medication.¹³ While no single chronic health condition is more important than another, diabetes serves as an illustrative example of the importance of medication adherence, irrespective of the current pandemic. Within the US and UK, diabetes is one of the most common chronic

medical conditions in adults. It is estimated that 34.2 million Americans have diabetes and another 88 million Americans have pre-diabetes.¹⁴

According to the International Diabetes Federation's Diabetes Atlas, by 2030, worldwide, diabetes is predicted to affect 7,578 million people.¹⁵ Patients living with diabetes can experience both hyperglycaemic and hypoglycaemic events, although it is hypoglycaemic events that are more common when patients do not take medication as prescribed. Per patient, it is estimated that each hypoglycaemic event caused by medication non-adherence costs around \$30,000, with the costs only increasing over time (Figure 3).¹⁶ Each year, total costs for non-adherence for diabetes alone are over \$5 billion; for all chronic illnesses, costs of non-adherence are approximately \$290 billion.

“The importance of remotely monitoring patient well-being and medication adherence is increasing – since March 2020, in-person medical appointments have decreased by 60%, whereas telehealth appointments have increased by 14%.”

Clearly, a means of helping patients to better manage medication for chronic conditions is critical to not only improving patient health, but to ensure they don't miss doses of their medications, saving both patients and healthcare payers significant sums of money by preventing non-adherence A&E visits and hospitalisations. The importance of remotely monitoring patient well-being and medication adherence is increasing – since March 2020, in-person medical appointments have decreased by 60%, whereas telehealth appointments have increased by 14%.¹⁷ It is likely that connected medication delivery devices and home health monitoring will not only improve the quality of life for patients and health professionals conducting telehealth appointments, but may additionally serve to bridge the gap of the current ~46% of patient appointments that are not being served either in person or via telehealth.

PATIENT INSIGHT

Patient behaviour has been a key stumbling block, both in terms of medication non-adherence and the willingness to adapt to connected device technologies. However, even prior to 2020, key technological changes have occurred that were leading to significant mindset changes towards connected device technology. Since 2017, adults have been increasingly turning to smart, or connected, devices to help manage their daily routines. It is estimated that half of all homes will

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be connected by 2020.¹⁸ Often controlled through smartphone apps, these connected devices manage everything from grocery lists and lightbulbs to summer reading lists and thermostats.

Due to increased familiarity with connected devices in daily life, adults managing chronic health conditions are beginning to turn to this technology to manage their own health. Devices are now able to monitor heart rate, pulse oximetry, peak flow and tidal volume, blood glucose, body temperature and much more.¹⁹ Improved engagement in individual health management has been demonstrated through adoption of covid-19-tracking application programming interfaces (APIs) recently launched in the UK,²⁰ Ireland and

Germany,²¹ among other countries; powered by Google and Apple healthcare technology, 20 of 50 US states have, or will have, APIs for contact tracing by the end of 2020.^{22,23} In the UK, the NHS contact tracing app is the most popular download to smartphones, second only to Zoom.

Complementing changing patient views on remote health monitoring, physicians are likewise increasingly demanding connectivity to their patients. In a 2018 survey, 50% of all physicians felt their access to patient data could be much better (Figure 4); of those, 83% cited patient medication adherence as a priority need.²⁴ Understanding the relationship between medication adherence and healthcare outcomes, physicians wish to be able to provide more meaningful healthcare advice and earlier interventions, if required. Obtaining patient medication data, communicating that data and using it in a timeframe commensurate with when it is obtained, in order to make informed and timely healthcare decisions, are critical to providing meaningful healthcare advice. Connected devices, that communicate directly between the device and the patient's medical file, are a key means to achieving timely data collection and use – and are becoming increasingly cost effective (Figure 5).

CONNECTED HEALTH – IMPROVED OUTCOMES AND DECREASED COSTS

Delivery of medication is a complex ecosystem within the healthcare industry, relying on streamlined interactions between patients, healthcare providers (nurses and physicians) and pharmacists. Related to these primary

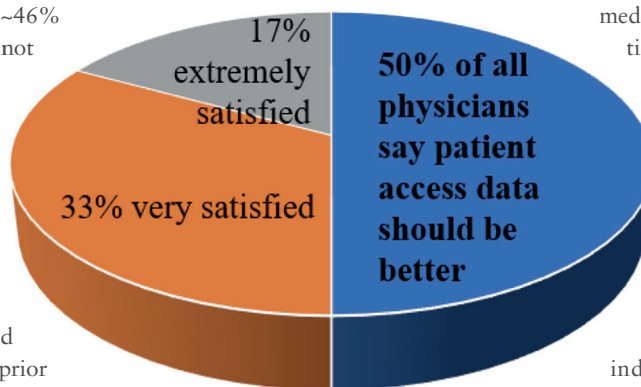


Figure 4: Physician satisfaction with patient data access.

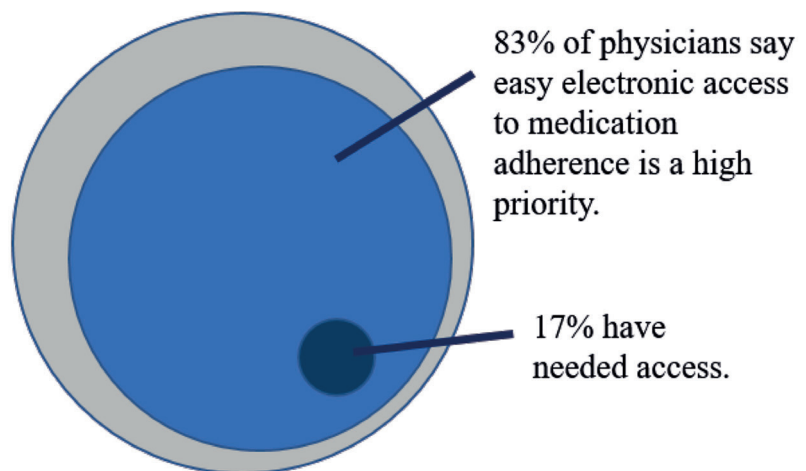


Figure 5: Physician access to medication adherence.

interactions are healthcare payers and pharmaceutical and medical-device developers and, for patients with memory care conditions (e.g. Alzheimer's disease, moderate-to-severe traumatic brain injury), caregivers who directly oversee or check in on medication adherence.¹ Anticipating patients' need for security, and data retention for all dosing events regardless of temporal connectivity, are important features for connected devices to ensure the many data pathways are protected and that all participants in the data interactions have immediate access when the device is connected.

The ideal connected device should be thought of as a system, comprised of both a device and a data storage and transmission method; each aspect of these systems requires regulatory checks to safeguard data and guarantee patient and data fidelity. Effective connected devices ensure no patient-identifiable data is held on the medication delivery device, but rather transmitted securely over Bluetooth to an app or over a network directly to a secure cloud platform. These systems encrypt all data, maintaining a full record of every event over the course of the device lifecycle. Data generated by the medication delivery device or patient input should be stored outside of the smartphone, so that it is not at risk from operating system upgrades or cyber attacks on the operating system. For web access to the patient view or health professional view, all data should be encrypted at rest and in transit. Any data cached on the medication device or mobile app should be secured until the next connection to the cloud platform, at which point the data can be synchronised between device, app and cloud.

Such a system has many benefits to the patient. First, it avoids the need to manually record the data, which may translate to lost data or data that lacks a temporal tag. Second, it allows for the collection of empirical data and for systems to simultaneously correlate symptoms, results and medication. Particularly in light of covid-19, the ability to track and correlate symptoms to medications that are new and under emergency use authorisation allows physicians, pharmaceutical companies and regulators to gain insight into the efficacy of novel medication regimens used on a novel disease vector.^{25,26}

	Range (\$ per unit)
Conventional	3.00–5.00
Current Technology	1.20–1.45
Next Gen Tech	0.85–1.05
2nd Gen Tech	0.75–0.95

Table 1: Price models for adding low-cost connectivity to existing devices.

Important features of any connected device are the cost of both the device and the service, as well as increased revenues due to medication adherence, and the reduction in healthcare costs due to “healthier” patients. Traditional connected devices increase the per-unit cost of a standard device by \$1.20–5.00 (Table 1). However, with emerging demand for connected devices due to covid-19 and subsequent increases in chronic health conditions and the need for remote medical care, increased manufacturing



Figure 6: The smart, reusable autoinjector can handle multiple drugs through a syringe radio frequency identification (RFID) reader and has an intuitive user interface with illuminated user graphics and audible feedback.

volume and emerging technology trends in the field of connected devices are expected to drive the per-unit cost down by between 22% and 80% compared with the technology of just two years ago.²⁷ Even if medication adherence translates to a mere 15% in healthcare cost savings, this translates to approximately \$43.5 billion in annual savings, based on pre-covid-19 data. Given that covid-19 is expected to permanently alter healthcare – requiring increased care for chronic health conditions and a permanent shift to remote healthcare monitoring – these savings are only expected to grow in the coming months and years.

SUMMARY

Connected drug delivery solutions (Figure 6) have demonstrated their potential to revolutionise medication adherence in the community, but the aspirations of a pre-covid-19 era are increasingly becoming a necessity now, and will likely continue to be an essential healthcare tool in the near and long term. Incremental cost is minimised by manufacturing in volume and increased demand for a more engaging digital experience – driving down the cost of care, improving medication adherence and lessening the need for costly urgent and emergency care.

ABOUT THE COMPANY

Phillips-Medisize, a Molex company, is an end-to-end provider of innovation, development and manufacturing solutions to the pharmaceutical, diagnostics and medical device market segments. Backed by the combined global resources of Molex and its parent company Koch Industries, Phillips-Medisize's core advantage is the knowledge of its people to integrate design, moulding, electronics and automation, providing innovative, high-quality manufacturing solutions.

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ABOUT THE AUTHORS

Neil Williams is Director of Front-End Innovation and Head of Connected Health at Phillips-Medisize. Previously he was with Medicom Innovation Partner, which he joined in 2015 and which was acquired by Phillips-Medisize in 2016. One of his key roles is to evolve the company’s third-generation connected health software platform. Having started his career in the clinical setting, working in the critical care faculty with a leading NHS University Hospital, Mr Williams moved into industry where he has focused for many years on healthcare IT including medical devices, clinical decisions support, health analytics and care pathway design.

Angela R Eder, PhD, is a Healthcare Content Creation Manager at Phillips-Medisize, where she is responsible for bringing scientific and engineering innovations to a wider audience. She has more than 20 years’ expertise in research and development in both healthcare and consumer products, bridging the specialties of medical device, food safety, microbial disinfection and drug delivery systems. Dr Eder has augmented her professional experience by serving in academia: teaching collegiate chemistry, volunteering as industrial liaison to graduate programmes and mentor for young female scientists, and developing science and engineering outreach programmes to cultivate future generations of scientists and engineers.

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