

WHITE PAPER

Digital therapeutics:

How cloud technology is enhancing patient experience and outcomes



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Digital therapeutics are becoming an increasingly important tool for how life sciences companies bring products to market. Investors and pharma companies alike are entering the sector, attracted by mounting evidence that digital technologies drive clinically meaningful improvements in patient outcomes. New entrants, like the pioneers before them, are learning patient-facing digital therapeutics are only part of the solution in supporting the patient journey. To succeed, companies also need a secure, scalable and interoperable system for handling large volumes of potentially sensitive patient data. The amount of data generated from biosensors, wearables and mobile devices will continue to accelerate.

The definition of digital therapeutics encompasses several subcategories. Smart pills and connected inhalers support pharmacological interventions by improving adherence and generating insights into patient behavior. Companion apps leverage mobile technology to enhance the patient experience through coaching, feedback on their condition, and actionable insights.

Researchers have validated the effectiveness of such interventions. A randomized clinical trial of Propeller Health's digital health platform for asthma and COPD linked the combination to a significant drop in use of short-acting b-agonists and improved asthma control.¹ Standalone digital therapeutics can improve health outcomes independently of drug regimens.

Researchers found that Omada Health's product reduced the risk of type 2 diabetes by 30%.² Akili Interactive won FDA approval for its therapeutic video game by showing children with ADHD had improved sustained attention and inhibitory control after four weeks of use.^{3,4}



The sector-validating studies and regulatory approvals are driving interest in the field. Investment in U.S. digital therapeutics companies topped \$1 billion in 2018 following seven years in which annual growth averaged 40%.⁵ In parallel, pharma companies have entered the sector through internal investments and partnerships with digital therapeutic startups.

AstraZeneca, Novartis, Novo Nordisk and Sanofi now have digital therapeutic groups, as do smaller drugmakers such as Orexo, as well as healthcare centers like Cedars-Sinai. Many of the internal pharma groups are collaborating with digital therapeutic specialists, examples including AstraZeneca's partnership with Voluntas and Sanofi's alliance with Happify.^{6,7} Like all emerging areas, the field has faced setbacks such as a filing for bankruptcy protection by pioneering smart pill player Proteus Digital Health, but overall the sector is growing and generating positive outcomes.⁸

Pairing the medical knowledge and infrastructure of pharma companies with the digital capabilities of specialized startups could turbocharge the field. However, the collaborators will need to overcome new challenges to deliver on that potential. Excellent safety, quality and efficacy remain key, but the actions needed to achieve those outcomes are new and traditional biopharma companies are operationally not set up in a way to support success.

"Can you imagine being treated for schizophrenia and your app is too slow? It's just not acceptable. It's like going to see your therapist and he suddenly speaks a different language," Joris van Dam, head of digital therapeutics at Novartis, said.⁹

Smart ancillary devices

The opportunities and challenges posed by digital therapeutics are illustrated by the relatively well established subcategory of smart pills and connected inhalers. The core idea behind these devices is to use sensors to capture data on when and how patients take medicines. That data can help patients take drugs on time and show their physicians whether non-adherence is affecting outcomes. When pooled and analyzed, the data also yield insights that support personalized care recommendations and population-scale revelations.

Propeller Health is applying those ideas to the management of asthma and COPD using a sensor that attaches to patients' inhalers for daily controller medication and rescue medications. Once in



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place, the sensor tracks when a patient uses their inhaler. By analyzing the sensor data and other variables such as air quality, the app generates insights that improve care. The use of the companion device has improved adherence by up to 50% and reduced asthma attacks by 79%.¹⁰

Other companies have had successes with similar devices. A study of Teva Pharmaceutical's ProAir Digihaler®, a digital rescue inhaler with built-in flow sensors, found incorrect use of the delivery device resulted in no or very low inhalation flow 13% of the time. The data from the Digihaler device may enable healthcare providers to identify if their patients' inhaler technique may need improvement.¹¹ EteectRx is applying the concept to oral drugs with a FDA-cleared embedded ingestible wireless sensor that has been used to track compliance with opioids and antiretroviral therapies.¹²⁻¹⁴

In each case, the sensor is just part of a wider offering. Companies need safe, secure and compliant Internet of Things (IoT) capabilities to effectively handle data generated by smart devices. Propeller CTO and co-founder Greg Tracy explained IoT capabilities must be equipped to handle the major demands of smart ancillary devices and their associated analytics platforms.

"There is so much data that is coming into Propeller, not just from the sensors, but behaviors on the app, how we're recruiting patients, analytics from GA and segments, and other things," Tracy said.¹⁵

Early in Propeller's history, increases in the volume and diversity of data exposed a bottleneck in its core architecture. Propeller cleared the bottleneck by migrating to a system built on Amazon Kinesis, an Amazon Web Services (AWS) product for collecting and processing large streams of data in real time and in a HIPAA eligible manner. In doing so, Propeller did more than just fix a weakness; it created a scalable system that is unlocking new use cases and opportunities to analyze its ever-growing repository of real-world data.

"It's a relief actually that we can leverage the services in AWS and then focus really just on what our patients need in helping them manage asthma and COPD in a more effective way. Our partners have confidence that when patients are giving us their data that we're going to store it in a secure way and be good custodians for that data," Tracy said.¹⁶

The system is now equipped to deliver personalized insights, supporting the decrease in asthma attacks, and to scale up



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Greg Tracy , Propeller CTO and co-founder



to analyze data from entire cities. Propeller demonstrated the population-scale applications in a collaboration with the Louisville Metro Government that generated recommendations for how the city could improve air quality.¹⁷

Companion apps

Smart pills and connected inhalers include companion apps to house the collected data and allow them to share it with their healthcare provider if they choose. Teva includes a companion app with its Digihaler family of inhalers to help patients track medication use, inhaler technique, and stay informed about environmental factors relevant to their respiratory conditions.¹⁸ Novartis worked with Propeller to introduce an asthma therapy, Enerzair Breezhaler, that is co-prescribed with an app that performs a similar role to Teva's product in terms of tracking how often the inhaler is used.¹⁹

Producers of conventional medicines have also recognized the opportunity, leading to mobile apps designed to help patients manage conditions including diabetes, asthma and cancer. AstraZeneca partnered with Voluntis to create an app that helps women manage symptoms of hypertension and diarrhea that can occur when they take an ovarian cancer treatment. Cutanea Life Sciences advanced the idea with an app that uses the smartphone camera to help patients track their response to its acne drug.²⁰

The specific features of each app are as diverse as the conditions they address, but they are united by a focus on personalizing the patient experience to improve engagement and outcomes. Cutanea achieves that goal using selfies and AstraZeneca does so by providing real-time recommendations based on symptoms shared by the user. In each case, a secure, scalable data system is essential.

Teva's Digihaler companion app demonstrates what that means in practice. The app tells users if their inhaler technique may need improvement, informs them if they have exceeded the recommended use of their rescue inhaler and reminds them to check if they need to refill their prescription. With certain versions users can also set reminders to take their maintenance treatment and share data on their inhaler use with their healthcare provider if they choose.

All the features are made possible by their AWS cloud-based platform that supports dynamic personalization and mobile connectivity. The platform securely ingests data from the inhaler,



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geolocation data from the patient's phone and environmental and weather data from other sources. The platform securely retrieves the data from the patient's or caregivers' devices and, with the user's consent and enrollment in a care management program, makes it available on a dashboard accessible by their healthcare provider.

In doing so, the platform gives patients and physicians an objective look at their medication use, potentially facilitating recommendations that may improve outcomes. Now, Teva wants to go beyond that manual, reactive approach by working with AWS to combine the data with an algorithm that may predict exacerbations so patients can prevent them from happening.

Standalone digital therapeutics

The digital therapeutics space has now advanced to the point that software is improving outcomes independent of pharmacological interventions. By delivering coaching, cognitive behavioral therapy and other services digitally, companies are clearing scalability barriers that limited patient access to effective support.

There is good, long-standing evidence that nonpharmacological interventions can improve outcomes. In 2002, Diabetes Prevention Program researchers showed a lifestyle-modification program reduced incidence of type 2 diabetes in high-risk patients by 58% compared to placebo.²¹ The lifestyle modifications were more effective than first-line diabetes drug metformin. Similarly, meta-analyses published in 2008 and 2009 found a link between cognitive-behavioral therapy (CBT) and improved outcomes in people with substance use disorders.^{22,23}

However, access to these safe, effective interventions is limited as they require one healthcare coach or provider to interact face-to-face with patients, either individually or in small groups. With the CBT meta-analyses showing some patients underwent two sessions a week for a year, capacity remains below the level needed to treat the 20 million people in the U.S. with substance use disorders.²⁴

Companies such as Pear Therapeutics and Omada Health are using digital technologies to overcome the scalability barrier while standardizing practices so every patient receives the best care possible.

At Pear, that thinking has manifested in a portfolio of approved



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and experimental patient-facing apps that use forms of CBT and other types of support such as social skills training to treat conditions including substance use disorder, insomnia and schizophrenia. The FDA authorized Pear's substance use disorder app reSET in 2017 on the strength of clinical data showing it doubled abstinence rates.²⁵

Omada is using similar technology to create non-prescription digital therapeutics that deliver lifestyle modifications at scale. By connecting users to coaches digitally, providing connected health devices and delivering personalized feedback based on real-time data, Omada is enabling many more people to access the sort of support that can improve care. Omada is tailoring the technology to address hypertension, obesity and type 2 diabetes.

As with other types of digital therapeutics, the outcomes achieved by users of Pear and Omada's apps are underpinned by cloud-based platforms capable of securely handling data at scale. Omada, for example, knew it needed to be able to quickly process vast amounts of data to ensure its system could engage users at the optimal moment and thereby drive improved outcomes. Equally, Omada wanted infrastructure capable of supporting rapid experiments to drive continuous improvement.

None of those features would matter if people stopped using the product. With that in mind, Omada prioritized security, availability and performance to ensure patients trusted it to handle their data and could access the system whenever they needed support. The need to realize these priorities led Omada to work with AWS.

"The powerful compute platform and big-data capabilities of AWS help us build tools that engage users at the right time to have a positive impact on outcomes," Adam Brickman, senior director of strategic communications and public policy at Omada, said.²⁶ "As the system gets smarter, it can prompt coaches to engage with participants at critical moments that drive positive outcomes, such as when participants weigh in less frequently than they have in the past."

Building a digital toolbox for physicians

The early successes achieved by companies such as Omada, Pear and Propeller only hint at the potential of digital therapeutics. Unlike pharmacological interventions, digital therapeutics support iterative improvements, enabling companies to make existing products better every day. At the same time, companies are moving into



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new indications to build a toolbox of digital therapeutics that can become an important part of the broader care landscape.

“In the non-digital world, you can go to any Walgreens, Rite Aid, CVS to find anything and everything for your health. You can find healthy foods, you can find nutritional supplements, you can get your flu shot, you can find your over-the-counter medicine, you can pick up your prescription. We will see the same ... in the digital health world,” van Dam said.

Van Dam foresees a world in which patients receive a single prescription covering whatever digital therapeutics, pharmaceuticals or medical devices they need to treat and monitor their condition. A cloud-based pharmacy will process the prescription and ship everything the patient needs. In that world, digital therapeutics will connect to health records to help providers and payers.

To realize that vision, and every step along the way, companies will need to combine understanding of diseases and patient-facing digital products with backend data platforms capable of delivering the interventions securely and at scale. As the short history of digital therapeutics has shown, the security and scalability of cloud technology will make it the go-to system to empower developers to create products that change lives. ■

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