Livongo®

Silencing Noisy Healthcare

LIVONGO'S MANIFESTO FOR THE NEW ERA OF HEALTH

SILENCING NOISY HEALTHCARE: LIVONGO'S MANIFESTO FOR THE NEW ERA OF HEALTH

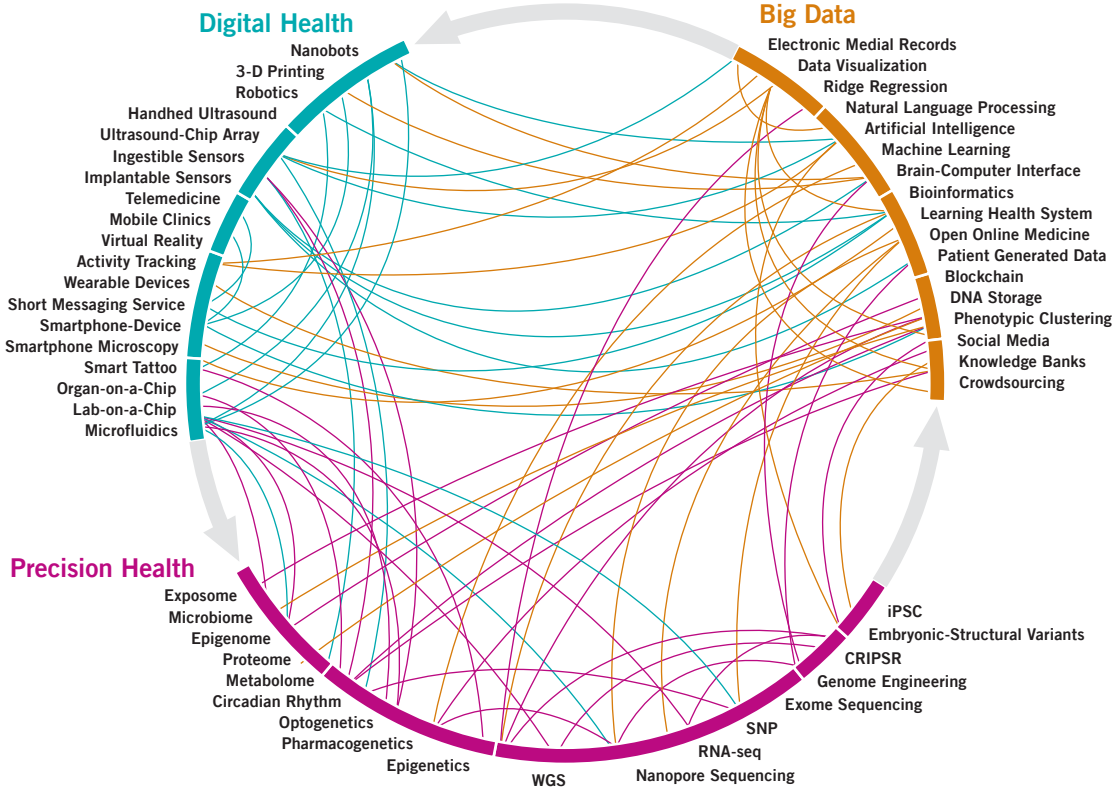
Healthcare Is in the Process of an Important Digital Transformation, in Need of a Breakthrough

Healthcare is undergoing a seismic shift that is being called the Healthcare Digital Transformation. The Healthcare Digital Transformation includes novel data sets being created and manipulated; the escalating speed with which data is generated; the intelligence and machine learning being applied to data; and the myriad devices, applications, and entities creating and using data to deliver health and drive important health outcomes.

In its recent "Roadmap for Innovation," the American College of Cardiology noted three key converging innovation trends:

- **Digital Health:** Wearable, smartphone, and sensor-based technologies
- **Big Data:** Aggregation of large quantities of structured and unstructured health information and sophisticated analyses with artificial intelligence, machine learning, and natural language processing techniques
- **Precision Health:** Approaches to identify individual-level risk and the determinants of wellness and pathogenicity

This infographic from its report (below) describes how these three elements work together to deliver clinical innovations, consumer health, and cost savings.



And there is an explosion of new companies driving this Healthcare Digital Transformation. A recent McKinsey report identified more than a thousand enterprises developing new digital and mobile healthcare technologies. Moreover, mergers of existing healthcare behemoths (such as the upcoming CVS Health - Aetna merger), partnerships of global corporations moving into the healthcare space (including the closely watched Amazon-Berkshire Hathaway-JP Morgan joint venture), and technology companies making key strategic investments in healthcare (like Google's recent investment of $40M in Quartet to support machine learning in the mental health space and Apple's marketing of the Apple Watch 4 as a health tool) are fundamentally changing the enterprise landscape in healthcare.

MEANWHILE IN THE CONSUMER TECHNOLOGY WORLD…. MAGIC IS AFOOT

> "Any sufficiently advanced technology is indistinguishable from magic."
>
> — FUTURIST ARTHUR C. CLARKE

A fundamental shift is also occurring in the consumer tech world. In the past decade, broadband devices and data storage have become ubiquitous and cheap. As a result, millions of technologies (e.g., apps, social media, sensors in our cars and home appliances) emit signals that carry small, useful bits of information about us and the way we live. Consumer giants such as Amazon, Netflix, and Uber, among countless others, collect diverse consumer signals, process and use them to provide addictively helpful services. At their best, these experiences feel … well, magical.

We've all had technology-enabled magical moments as consumers. Livongo's CEO, Glen Tullman, recently experienced this when his dishwasher broke. He took a picture of the QR code on the machine, thereby sending a signal to GE that it needed to be fixed. GE emailed him instantaneously with options for times to send a repairman to his home. The repairman came, charged Glen's credit card, and his dishwasher was up and running again with virtually no effort on his part. Of course, it wasn't *actually* magic. In the background, his dishwasher's hardware and software sent signals to GE's support system, which algorithmically determined the best course of action and took the necessary steps to arrange for those actions to happen — all the while keeping him informed.

Unfortunately, technology-enabled magic hasn't existed in healthcare. The explosion of data, devices, apps, and services has simply created noise and *not a magical experience*. Until now.

HEALTHCARE CAN ALSO DELIVER MAGICAL EXPERIENCES BY HARNESSING THE POWER OF SIGNALS

Just as robust data, devices, and services all working together are delivering satisfying consumer technology experiences, highly personalized data coupled with thoughtful data science and behavioral economics can enable healthcare technology magic, but heretofore has not.

A signal is defined as "a gesture, action, or sound that is used to convey information or instructions." Signals naturally occur in nature (between mother and baby birds, as part of mating and attraction rituals, to alert others to danger) and influence behavior in fluid and subtle ways.

Health data are generated, often passively, every fraction of a second of the day, by our actions, our health, our devices, apps, and sensors. Health Signals are different than health data. Health Signals are identified by sifting through the vast and often noisy piles of health data. Health Signals are also created by combining individual signals into unique and impactful combinations in order to develop actionable, personalized, and timely insights.

We are in the early days of the Healthcare Digital Transformation. Seriously magical experiences will happen as our health signals and ability to derive insights from them become more robust. We are making some strides in both domains. For example, data are readily available to provide a signal when a doctor's appointment or prescription renewal has been missed. But the real magic will come when you no longer need to call and make a doctor's appointment — when the doctor identifies that you're due for an appointment, reaches out to you over SMS with a link to your calendar appointment (scheduled based on your preferences and your current calendar availability), and they've already ensured your dose-calibrated prescription refill is on its way to your house. Oh, and you never are presented a doctor's bill or an overwhelmingly complex insurance explanation of benefits; there's a seamless handling of the financial transactions behind the scenes.

THE REALITY OF LIVING WITH A CHRONIC CONDITION … IT'S NOT SO MAGICAL YET

Despite all the advances in health data and technology, the daily life for a person with chronic conditions hasn't improved much at all in the last decades. Every day there are more people with chronic conditions, spending more, and the rate of health complications due to chronic conditions continues to rise.

The statistics are appalling:

- Chronic conditions are a leading cause of U.S. bankruptcy for consumers. In 2003, more than 1 in 5, or 12.3 million, people with chronic conditions lived in families with problems paying medical bills.
- Chronic conditions are destroying lives (not just health, but also mental health): Major depression is present for almost a third of all people with diabetes.
- People experiencing major depression and 3+ complications from diabetes have an unemployment rate over 50%.

SO WHERE'S THE MAGIC IN THE HEALTHCARE SYSTEM? IT'S HIDDEN BY ALL THE NOISE

Why is it so hard — with all of the investment in health tech and with all of the new technology — to help people with chronic conditions get and stay healthy for as long as possible? The truth is that we all know this answer.

The healthcare industry still has a very "noisy" healthcare experience. Unlike in the consumer tech world, data and devices, apps, and live support haven't all magically been brought together by a set of companies offering bespoke and useful moments. On the contrary, the experience for people with chronic conditions is confusing, complex, and costly.

Noisy Healthcare confusion is when we don't understand our new diagnosis or even where to start. When we are told to measure our blood pressure but are given no guidance on what to do with that data, how often to measure it, or what to look for.

Noisy Healthcare complexity is when we have a bunch of new regimens to follow endless appointments to go to, and with utter lack of coordination between our providers' data records.

Noisy Healthcare's cost burdens are when we are struggling to understand how to pay for all the things our doctor has prescribed or the out-of-network specialist who was recommended to us that we really should see.

DEBUNKING THE MYTH OF MORE

Unfortunately, the way that the U.S. healthcare system has responded to the chronic condition epidemic is by generating more *stuff and noise*: devices, apps, advice, medications, and more to do … just what people don't want or need.

There's a myth in the world of healthcare that chronic conditions can be solved with more. We call it the Myth of More. It's the approach the healthcare system has taken to managing chronic conditions in the past decade. The Myth of More makes us believe that simply adding "more" will magically help us do the things we need to manage our conditions. But unfortunately, it's a myth. More isn't always better. In fact, for people with chronic conditions, it's worse.

Even technologies that have the potential to solve pervasive health problems can inadvertently create tremendous noise and even escalate costs in the U.S. healthcare system. Take, for example, the recent backlash and concern when Apple announced its new single-lead ECG monitor in the Apple Watch®. Numerous physicians and health tech proponents acknowledge the inherent value for a small percentage of individuals with atrial fibrillation (AF). However, the value of this new innovation is offset by the very real risk that such 24/7 heart monitoring will cause a lot of false alarms for healthy consumers, and will lead to an influx of appointments that are unnecessary, which in turn may lead to additional unnecessary screening and costs.

Cardiac electrophysiologist John Mandrola was quoted succinctly in an article in The Atlantic ("Should Your Watch Monitor Your Heart?"):

Apple Watch® is a registered trademarks of Apple Inc.

> *"At least in the U.S., the upcoming watch-driven explosion of AF diagnoses will happen in a fee-for-service environment that pays doctors and hospitals to test and treat,"* Mandrola wrote in the trade publication Medscape. *"Diagnosis by watch not only generates an expensive trip to the doctor, he argued, but introduces the possibility that a person will proceed unnecessarily down the medicalization path."*

More just creates noise.

SILENCE NOISY HEALTHCARE™

It is time for the next era in healthcare. This new era can only occur if we first take healthcare data, generate meaningful health signals, and apply these health signals to improve both the lives of people and the healthcare system.

And lest we think Noisy Healthcare is a problem "just" for people living with chronic conditions, we have evidence that noise is all around us impacting the healthcare system writ large. On the provider side, a study led by the Office of the National Coordinator for Health Information Technology identified that 17% of physicians with electronic health record systems reported that they have overlooked something due to too many alerts from their EHR system.

> Science
>
> A recent **Science** magazine article noted, *"Separating the true signal from the gigantic amount of noise is neither easy nor straightforward, but it is a challenge that must be tackled if information is ever to be translated into societal well-being."*

It's time to silence Noisy Healthcare. It's time to take that noise and turn it into something clear, actionable, and personal. Something useful. Something that costs less.

INTRODUCING THE SOLUTION TO THE NOISY HEALTHCARE PROBLEM: APPLIED HEALTH SIGNALS

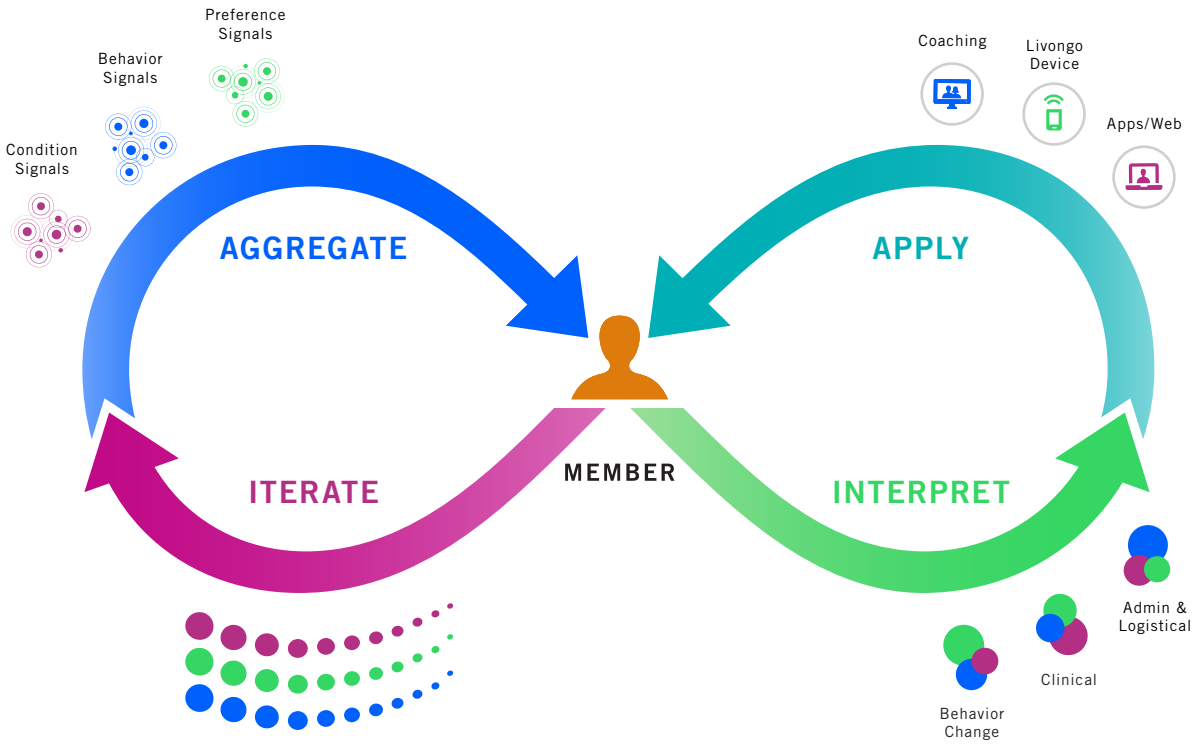
Livongo pioneered the category of Applied Health Signals to empower people with chronic conditions to live better and healthier lives. Livongo's team of data scientists aggregate and interpret substantial amounts of health data and information to create actionable, personalized, and timely health signals. Livongo is the first company at the intersection of data science, behavior enablement, and clinical impact with the technologies and capabilities to Silence Noisy Healthcare. Our approach is leading to better clinical and financial outcomes while helping to create a better and different experience for people with chronic conditions.

At the heart of Livongo's Applied Health Signals solution is a core set of four technologies and capabilities called AI+AI™: **A**ggregate, **I**nterpret, **A**pply, and **I**terate. Only companies who deliver excellence on all four pillars are true Applied Health Signals companies.

Today, Livongo aggregates dozens of data sets and combines them to interpret and extract the drivers of behavior change on a personal member-by-member level, just like an Amazon or Netflix experience. And we deliver actionable, personalized, and timely recommendations through a broad set of applications to our members. And finally, using advanced data science tools (whether that's A/B testing, reinforcement learning, regressions, clustering, or other techniques), we observe and iterate in order to create clarity and silence Noisy Healthcare. At the core of this engine is a team of data scientists, behavior specialists, and clinicians that helps empower health for the members the AI+AI engine serves.

WHAT DOES AI+AI MEAN?

AI+AI stands for Aggregate, Interpret, Apply, and Iterate. Below, we describe the capabilities of each pillar.



AGGREGATE:

Today, Livongo aggregates data and information from a variety of sources (without extra work for the individuals with chronic conditions whom AI+AI serves). Inputs come from Livongo devices, including cellular-enabled blood glucose meters, blood pressure monitoring systems, and digital scales for real-time readings. Other inputs can come from human interactions, such as with Livongo coaches, as well as from more traditional data stores, such as medical claims and pharmacy claims. We also aggregate data from a diverse set of partners.

Just a few of the data that we already aggregate today include gender, age, zip code, medical claims, and pharmacy claims. Some of the signals that are proprietary to Livongo are real-time blood pressure readings, communication preferences (when does someone want to be contacted, and with which modality — text/phone call), and meals logged.

It is in that aggregate capability that we are also parsing the data to determine the most important signals to feed into the AI+AI engine, extracting signals from the data we have aggregated and normalizing the signals to make them usable.

INTERPRET:

To interpret the aggregated data, a set of critical steps occur that are driven by our unique team of data scientists, behavior specialists, and clinicians. They include:

1. **Dimensionalizing the signals** to ascertain which ones are the most meaningful for a specific use (reducing the noise from the signal), and establishing which key models and algorithms should be used for those signals.

2. **Combining individual signals** to create a new class of health signals that have never existed before — these are called Livongo Health Signals. Livongo Health Signals are proprietary combinations of signals aggregated from various input sources combined with Livongo's own signals from our applications, devices, coaches, members, and iteration loops.

3. **Mapping signals** into what we already know about the people we are serving to deliver more impact.

4. **Interpreting the full range of signal-to-application possibilities** through the lens of a set of clinical requirements and protocols to determine the right applications to deliver a specific signal for a specific person.

5. **Building the most relevant healthcare messages and outputs** to be delivered via the applications, taking into consideration condition and cross-condition clinical requirements, as well as mapping the specific messages that will work for the specific individuals.

APPLY:

Apply is the broad set of ways (modalities) that signals get applied to certain individuals for a specific action and/or behavior support. This set of technologies is where we make things actionable and real. We don't limit our thinking of "applications" to the software applications one has on a smartphone to perform various tasks. Instead, applications are the modalities by which a specific health signal gets provided to a specific member or key stakeholder at the right time with the right format and context, to help shape behavior change and deliver an actionable impact.

Examples of just a few of the many modalities we already support today include:

Livongo Devices Applications

- Livongo Blood Glucose Meter:feedback after every blood glucose reading and nudges based off of longitudinal patterns
- Livongo Blood Pressure Cuff
- Livongo Digital Scale

Human Applications

- Live Coaching:can serve up personalized coaching and guidance, suggestions
- Live Calls: enabled voice-based reminders
- Pharmacist Connection:provides warm transfer to your preferred pharmacist to support medication optimization
- Care Team Connection:supports a warm transfer to the appropriate care teams where needed
- Provider Doctor Connection: delivers connections for medication optimization

Enrollment modalities including: email, multimedia, and web, as well as things like "floor clings" in a manufacturing environment

Web, SMS, and text-based modalities for a broad set of signals that can be delivered for multiple uses (supports digital coaching, reminders, etc.)

ITERATE:

Iterate describes the way that Livongo brings signals back into the AI+AI engine from the channels described in Apply. Livongo's Iterate capability is unique in three key ways:

1. **Contextual Iteration:** "Machine learning" has become a sexy buzzword but is often used synonymously with a richer data science capability and set of "tools." In reality, there's a breadth of actual tools within the broad realm of data science. Truly excellent data scientists can evaluate the enormous variety of problems and match the right data science tool or technique to the problem, whether that "tool" is A/B testing, reinforcement learning, Bayesian approaches, neural networks, or other essential tools. "Contextual iteration" is Livongo's ability to identify and use the right type of data science "tool" for the right type of signal we are iterating back into the AI+AI engine.

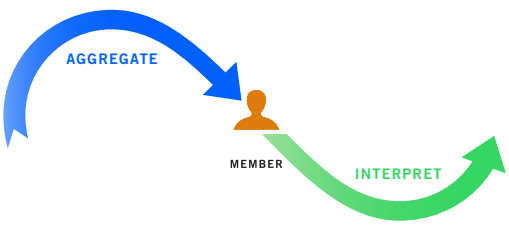
2. **Real-time Iteration:** We are iterating in real-time as members and other parts of the healthcare ecosystem are using the channels described in Apply.

3. **Multifaceted iteration:** We are iterating based on multiple facets of the experience people have with AI+AI, including the type of message or nudge to which they are responding, the day and time they are responding, and the specific offerings (e.g., free supplies, nutrition support, healthy meals) that are most useful in improving an individual's health.

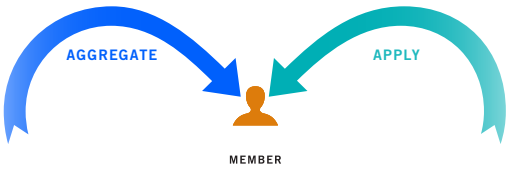
HOW DOES AI+AI DIFFER FROM AI?

Artificial intelligence in its truest form *should actually* contain the four pillars described above: Aggregate, Interpret, Apply, and Iterate. Unfortunately, in their rush to "get one of those AI things," companies are often taking extreme shortcuts, *calling everything AI*, even if it's simply a buzzword to help senior management feel like their company isn't getting left behind in their competitors' dust. And the need for real AI in healthcare is because the existing AI companies do some but not all four of these pillars excellently.

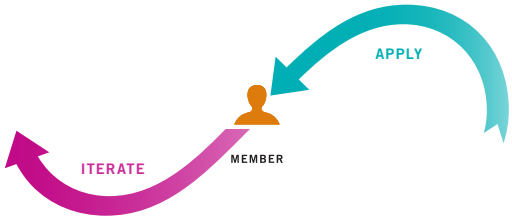
Here are three examples where companies are doing one or two of these AI+AI pillars relatively well, but simply missing the other pillars, and thereby not delivering a full experience that delivers results for people with chronic conditions.



1. **Big data/AI companies** working in healthcare have focused on the Aggregate function and pulling in increasing volumes of data and interpreting those data sets, but they often miss the most valuable real-time, high-quality data and certainly don't have the set of behavior enablement and clinical impact teams in-house to Apply and Iterate signals to deliver behavior change. They also don't have the Apply modalities and Iterate technologies or capabilities that would enable them to support behavior change.



2. **Consumer tech** companies working in healthcare have focused on the Aggregate function and pulling partners into their application ecosystem in the Apply function. But, while they've built a robust platform for healthcare apps to be on their system, they are lacking the integrated team of data scientists, behavior specialists, and clinicians working on interpreting and iterating signals. So they don't deliver deep insights on how to prompt optimal behaviors, or actively iterate algorithms around signals to constantly improve.



3. **Digital condition management** companies are often focused on a single condition or perhaps two related conditions, providing a set of condition-specific applications and iterating the use of those applications, but they are lacking the breadth of data sets to aggregate and support true multi-condition experiences in a unified way. They also lack the in-depth data science capabilities to contextually iterate using the most appropriate data science methods to improve health. This disjointed, condition-siloed approach unfortunately just adds to Noisy Healthcare rather than silencing it.

THREE KEY PREDICTIONS ABOUT THE WORLD WITH APPLIED HEALTH SIGNALS

PREDICTION 1:
Applied Health Signals Companies Will Transform Our Health Experiences in the Way Leading Consumer Companies Have Transformed the Rest of Our Lives

Applied Health Signals manage the system, the signals, and the experience of people with chronic medical conditions to give them freedom to live their lives without the burden of their conditions. Just like using Google Maps doesn't force the user to follow its directions but helps them avoid traffic jams, Applied Health Signals puts the member in control of their conditions with less effort on their part.

Imagine a Livongo member named Mary. Mary is an active user of Livongo for Diabetes and uses the Livongo blood glucose meter. Mary recently went to the doctor and was diagnosed with hypertension.

As an active user of Livongo, we already know Mary's age, gender, name, frequency of use of her blood glucose meter, blood sugar values, that she recently had her first live coaching session, and that (following that session) she managed to keep her blood glucose more often in her targeted range. We also know from recent interactions that she is measuring high on the Diabetes Distress Scale, but is feeling more empowered since she received her initial coaching session.

By aggregating Mary's medical and pharmacy claims data sets, Livongo is able to interpret that Mary has hypertension. We can combine that interpretation, as well as the full set of signals described above, and determine the best applications specific to Mary to help her manage her hypertension in conjunction with her type 2 diabetes. These include: live nutrition-based coaching, messaging a nudge on her blood glucose meter, a Welcome Kit with a cellular connected blood pressure cuff that she can use to monitor her blood pressure values, as well as continued use of her blood glucose meter and Livongo app to track her nutrition information.

We engage Mary with these applications through personalized email-based, SMS, and mail-based member engagement communications (based on her preferences and A/B testing). We also send a "nudge" message over her Livongo blood glucose meter that reads, "We have nutritionists to support both your diabetes and hypertension. Click here to set up a live coaching session with a nutritionist."

Then, the important interactions of Apply and Iterate work in tandem. We observe that after one week, Mary has not scheduled a coaching session. So, in her Livongo application, we provide a one-click link to schedule her nutrition coaching session. When she receives her Hypertension Welcome Kit, we note that she's watching the videos and using the onboarding materials we've provided, so we know she's beginning to engage with her blood pressure cuff. All great signs!

We watch as she checks her blood pressure regularly and see that while her blood pressure is under control, her average blood glucose value is still elevated, especially before she goes to bed. And we note that she rarely checks in the mornings.

So we iterate. Through the blood glucose meter, we nudge her to check her morning sugars and she starts to respond. We share her blood glucose and blood pressure Insights Report with her primary care provider, who adjusts her medications and enrolls her in an insulin dosing algorithm supported by Livongo Certified Diabetes Educators (CDEs).

Behind the scenes, the AI+AI capabilities are working hard. Mary's Livongo blood pressure cuff is providing data and signals back into the "Aggregate" capability, which is combined and "Interpreted" with data about her health plan design and her employer. The Interpret capability identifies Mary as a candidate for a free medication program, based on her health plan design and her recent track record of checking her blood pressure using the Livongo blood pressure cuff. In the course of the interactions ("Apply") where the CDE is supporting Mary for her insulin dosing program, the CDE team notifies Mary that her company has a program where she can receive free blood pressure medication just for checking her blood pressure once a week. Mary is grateful for the financial help. Livongo observes that Mary has received the blood pressure medication and her blood pressure and blood glucose are now more frequently in range.

Increasingly, experiences like this will transform the landscape for people with chronic conditions. They will feel personal and useful. They will happen without extra effort. They will create magic moments.

PREDICTION 2:
Applied Health Signals Will Meaningfully Reduce the 3C's of Noisy Healthcare: Confusion, Complexity, and Cost

This new system of technologies and capabilities will reduce Noisy Healthcare.

1. Where there was confusion, Livongo members using Applied Health Signals will now have clear guidance and advice immediately after their diagnosis and across their chronic conditions. They will have a coach assigned to them who will help them understand their choices and continuously provide new guidance based on combined data and signal analyses over time.

2. Where there was complexity, Livongo members will be supported by a unified system of devices, supplies, and support across their conditions. In using this unified system, Livongo and its partners will learn more about how to support the member and constantly iterate for support of health.

3. Where there was excessive cost, Livongo is making the healthcare system more affordable for members by determining the specific applications that will deliver the highest impact for individual members.

PREDICTION 3:
Companies That Implement Applied Health Signals Have Three Radically Improved Outcomes

By shifting to this new era of health for people with chronic conditions, companies can move onto a different trajectory of health outcomes, employee and member delight, and financial ROI. Specific results for companies will include:

1. Extraordinary health consumer experiences and improved well-being of the individuals being supported (as reported in net promoter scores, satisfaction scores, and other metrics).

2. Demonstrably improved clinical results across a broad set of chronic conditions, including diabetes and diabetes prevention, hypertension, asthma, hyperlipidemia, and behavioral health, among others.

3. Positive financial return on investment for each dollar spent on an Applied Health Signals solution due to reduced costs driven by key health status improvements.

JOIN US AND #SilenceNoisyHealthcare

Livongo is on the forefront of the Digital Healthcare Transformation as the first Applied Health Signals company. We are actively seeking partnerships with companies that provide novel healthcare-related data sets or devices that enable people with chronic conditions to have a less Noisy Healthcare experience. We look forward to a future where healthcare is quieter for our members, even those with complex chronic conditions, because our Applied Health Signals technology combined with their desire to improve their health delivers real magic. Join us and #SilenceNoisyHealthcare.

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