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Position paper

Adaptive intelligence

The case for focusing AI in healthcare on people, not technology

September 2018

Technology that adapts. People who benefit.

Rapid advances in technology are enabling the capture of more data than ever before about the human body and people's lifestyles, about diseases and their treatments, and about the hospitals and health systems that care for individuals and populations around the globe.

However, there is a growing awareness that only a fraction of this data is being used effectively to improve the quality and efficiency of care, and to empower people to take control of their own health.

More data does not equal more insight. On the contrary: it can be a burden to people.

Consumers with health trackers often don't know what to do with the numbers they're given.[1] Clinicians spend more time with machines than face to face with their patients.[2] Providers are drowning in data but lacking in insights to drive improvements that matter to their patients, staff, and eventually the bottom line.

That's where artificial intelligence (AI) can help.

Thanks to advances in computing power as well as inroads in data science, AI methods like machine learning and deep learning are arriving into the mainstream. They can help to make sense of large amounts of data, turning it into actionable insights.

But in healthcare, which is arguably more complex than any other industry, and where lives are at stake, applying AI in a beneficial and responsible way requires more than just heavy number crunching. It also requires an intimate understanding of the personal, clinical or operational context in which it is used.

At the same time, we need to be sensitive to the fact that there is a relentless demand on people – professionals, patients, and consumers alike – to keep adapting to new technology. AI-enabled solutions should make things easier for them, not more complicated.

It's time for technology to adapt to people, instead of the other way around.

At Philips, we call this adaptive intelligence.

Adaptive intelligence combines the power of AI with human domain knowledge to create solutions that adapt to people's needs and environments – helping consumers to live healthy lifestyles and helping healthcare providers to achieve the quadruple aim of improving patient experiences and the work life of care providers, alongside improved health outcomes for a lower cost of care.

Adaptive intelligence augments people, rather than replacing them. It acts like a personal assistant that can learn and adapt to the skills and preferences of the person that uses it, and to the situation he or she is in. The technology doesn't call attention to itself, but runs in the background – deeply integrated into the interfaces and workflows of hospitals, and almost invisibly embedded into solutions for the consumer environment.

This is not merely a future vision. It is a reality we are shaping today.

We work closely with clinical partners across the globe – healthcare providers, academia, and hospital networks – to develop AI-enabled solutions that are secure, firmly grounded in scientific research, and rigorously validated in clinical practice.

Solutions like wearable vital sign sensors with intelligent software that help a hospital to efficiently monitor large numbers of patients so that doctors can spot emerging risk. Or the app that uses algorithms derived from psychological theories of behavior change to help motivate people to stick to their sleep therapy treatments for longer. Or the intelligent dashboards that combine data from various sources, turning them into relevant information that clinicians need to help reduce their cognitive load.

We know we are at the very beginning of a long journey, where many of the gains of adaptive intelligence lie ahead of us. This paper aims to provide a realistic vision of what we believe adaptive intelligence can and should do in order to accelerate positive and sustainable change in healthcare. Both in the hospital, and beyond the walls of the hospital – where we can empower people to take control of their own health.

US healthcare spend is set to rise more than 5% a year until 2026 to reach

$5.7 trillion[3]

80%

of the EU's current

€700 billion budget

is spent on chronically ill patients[4]

By 2035 there will be a global deficit of about

12.9 million

skilled health professionals (midwives, nurses and physicians)[5]

The US healthcare system wastes around

$750 billion

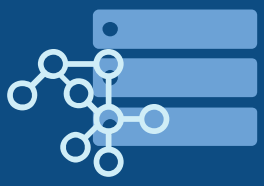
each year, and the two main causes are unnecessary services and inefficient care delivery[6]

Value-based reimbursement will increasingly demand evidence of better patient outcomes at

lower cost[7]

Over the past decade, there has been an exponential growth of computational power, while the cost of data storage has dropped dramatically. As a result, the amount and granularity of stored digital medical and healthcare data has

increased tremendously[8]



Making sense of overwhelming data in hospitals

To support rapid and precise clinical decisions

The doctors, nurses and surgeons working within hospitals are so often the pivotal point around which much of healthcare revolves. Yet clinicians in most specialties are reporting increasing rates of workplace burnout, with classic symptoms like fatigue, and doubts about the ability of consistently delivering quality clinical care.[9] Some of the highest rates are from those in critical care, where doctors need to make split second decisions.

Most humans are capable of processing a handful of pieces of information simultaneously in order to reach a decision. Yet patients in critical care each generate around 1200 data points per day.[10] Unfiltered data can lead to alarm fatigue, and clinical errors, the third highest cause of death in the US.[11]

Adaptive intelligence can support quick action to address patient needs at the bedside. We have developed Philips IntelliSpace Console, a clinical decision support dashboard that uses analytics to extract data from electronic health records and patient devices, to give clinicians a dynamic display of a patient's condition, using an organ body system view.

Our customers are using intelligent solutions to care for patients in the general ward too. In low-acuity settings, large patient volumes and limited staffing can make it hard for care providers to know which patients to watch more closely. The late detection of patient deterioration such as respiratory failure, sepsis or cardiac arrest, which can lead to a late transfer to the intensive care unit, might increase the chance of death by four times.[12]

The general hospital Ysbyty Gwynedd, in Bangor, Wales, deployed an electronic automated advisory vital signs monitoring and notification system, using Philips IntelliVue Guardian Software with early warning scoring, in their department. Guardian with EWS is clinical decision support software that helps aid in the detection of patients at risk of deterioration on the general floor hospital. The implementation of this system was associated with a reduction in the occurrence of serious adverse events by 35%, and a cardiac arrest reduction of more than 86%.[13]

Dr Chris Subbe, Consultant in Acute, Respiratory and Intensive Care Medicine at Ysbyty Gwynedd says: "Philips uses a philosophy of care with the early warning score that was already familiar to our teams, and the workflow was modeled on what we would normally do."

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To break down silos and improve workflows

Adaptive intelligence is also helping to improve workflows in radiology, by integrating medical images and other information that is currently siloed in disparate systems and delivering them to clinicians in a personalized and context-aware view.

To reconnect both its systems and its staff, US healthcare network Augusta University Health partnered with Philips. As part of the project, they installed an advanced visualization platform called IntelliSpace Portal to give physicians access to images and information virtually anywhere they need it, including access to prior studies of patients within their network.

This connected working environment allowed radiologists to work smarter and more efficiently, and provide diagnoses faster. “Our radiologists can now sit down at virtually any machine in the hospital or even at home. The average turnaround time has decreased 22%,” says James Rawson, MD at AU Health. That faster turnaround time could release some of the mounting pressure on radiologists to work longer hours.

The latest version of IntelliSpace Portal uses machine learning capabilities to gather data about the clinician’s workflow to predict usage patterns and pre-process patient data before the study is opened. Intelligent prior selection for follow-up highlights prior examinations with results that are relevant to the current study

Radiologists face some of the highest burnout rates among any medical specialty[14], which is why we are building diagnostic solutions to make their life easier. For example, IntelliSpace PACS with Illumeo, our clinically intelligent software, changes the way radiologists seek, see and share clinical information, by using adaptive intelligence to provide them with the most relevant case-related information and tool sets so they can more quickly pinpoint regions of interest and critical findings – which is especially critical in complex cancer cases.

Illumeo adapts to and enhances the radiologist’s experience, integrates patient data, facilitates care coordination with referring physicians, to help reduce the errors that result from manual data entry.

However, truly transforming diagnosis goes beyond improving imaging technology. Reimbursements are slowly shifting away from Fee For Service and toward outcomes, which means providers need to find smart ways to deliver more efficient care.

To help providers, Philips created a flexible suite of continuous improvement solutions called PerformanceBridge, which enables them to identify areas for performance improvement and efficiency.

PerformanceBridge Practice is a vendor-agnostic solution within the portfolio that gives healthcare professionals access to near real-time data on departmental performance through an easy-to-use, interactive and adaptive dashboard which can be tailored to unique customer data sets and workflows. It supports radiology department administrators in prioritizing operational improvements in asset management, equipment uptime and utilization, peer-to-peer collaboration, accreditation compliance, and practice management, and also enables better daily management of radiology operations.

Banner Health, one of the largest non-profit health systems in the US, has recently partnered with Philips to leverage PerformanceBridge Practice across all of its 28 radiology departments, to optimize and further deliver on its goal of improving care for its patients.

“The pressure to reduce costs while increasing operational efficiency in the current healthcare environment is intense, which requires us to look at performance improvement in imaging very differently,” said Becky Kuhn, Chief Operating Officer for Banner Health.

“Investing in the right tools and technologies helps us to provide better service to our customers. Connecting our radiology assets, and getting a better view into the performance of our radiology departments, will help us to become more efficient, elevate patient safety, and save on capital investments.

“Ultimately this allows us to reinvest in what matters most – our patients.”

Delivering care beyond hospital walls

Motivating different personality types

In value-based care, providers benefit when they can keep people healthier in their homes. At Philips, we are helping people with chronic illnesses, such as sleep apnea, to manage their own condition.

About 10% of the world's adult population suffers from sleep apnea, in which the airway is repeatedly blocked.[15] Untreated, it can cause serious health risks, putting a strain on health systems. Treatment with positive airway pressure (PAP) therapy is effective, but not all patients stick to the therapy as prescribed.

We have developed a mobile app that helps motivate people to take an active role in their treatment via algorithms derived from psychological theories of behavior change.

For example, if the patient starts to struggle with their therapy by dropping below two hours of use each day for several days, then the app will attempt to work out why by asking questions which reflect the patient's own words. This could be something simple such as, "we notice you're having issues with mask fit", together with a suggestion to watch a video on how to fit their mask correctly.

If the app notices that the patient needs more emotional motivation, then it might suggest that the user holds their breath for 10 seconds to see how they feel afterwards. Most sleep apnea patients have not seen themselves or anyone else go through an apnea episode, so sometimes simply showing the patient a video of an apnea episode can motivate them to improve their treatment.

One study showed that 58% more people used their therapy every night when they used DreamMapper[16], and demonstrated a 283% higher success rate for users struggling with adherence to sleep therapy[17].

Reducing costs

We know that reducing care costs is one of the biggest challenges that our customers and society face. Chronic diseases are on the rise, and are a significant cost driver.

So we're applying adaptive intelligence to drive better care for the elderly and people living with multiple chronic conditions.

CareSage is a predictive analytics engine which helps to provide a view into the home by collecting and analyzing data from multiple sources. This supports healthcare organizations to monitor, qualify and assess patient risk remotely, then intervene to potentially avoid hospitalizations and improve patient outcomes and care. CareSage, powered by Philips Lifeline, combines patient demographics and medical condition data with medical alert service data to score a patient's risk of transport to the hospital in an upcoming 30-day period.

The care team can then treat patients in a lower cost of care setting. This may also give patients the opportunity to live more independently at home, which is something that the vast majority[18] of senior patients wish for.

An early study by Partners Connected Health, a division of the US healthcare group Partners Healthcare of Boston, MA, demonstrated projected savings in a retrospective evaluation of the CareSage predictive analytics engine.

In an analysis of five years of data from their population of 2,318 Philips Lifeline subscribers, Partners projected that 224 hospital admissions could potentially be avoided each year, equal to a 40% reduction in admissions or $2.2 million in potential net savings. This study also provided clinical validation of the predictive algorithm.[19]

Identifying people who don't know they're ill

We believe that adaptive intelligence will also enable clinicians to uncover correlations and patterns in health information to provide predictive care for entire populations.

Take diabetes as an example. Around one third of adults with diabetes still don't know they have it.[20] That is around 200 million people worldwide who are at risk of falling desperately ill, or even dying.

Imagine if we could get to people before they even suspect that they might have diabetes.

Our cloud-based population health informatics platform, Wellcentive, is working on solutions that can analyze data from patients in a particular town, and recognize which of them should be similar. For example, if a patient does not have a diagnosis code for diabetes, but shows up in a population with similar indicators of diabetes, then that patient might have diabetes.

We are using advanced data science methods to search for patterns and find groups of patients that can be considered similar; we can then train the algorithm for specific problems to allow clinicians to find the right cluster size and definition.

This population health management tool could enable a local doctor to contact their patient in order to advise them on the best course of action, whether that is taking diagnostic tests, or lifestyle changes. Already today, Wellcentive manages 2.5 billion patient data points per month across 50 US states, driving $700 million in value-based reimbursements in 2017.

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These solutions can support healthcare systems to deliver value-based care across populations, as well as to gain a greater understanding of potential gaps and inefficiencies so that they can thrive in the years to come.

Enabling hospitals to build their own solutions

Philips can provide a wealth of AI-enabled solutions, but we also support customers in finding insights in their own healthcare data. If clinicians and data scientists want to build their own AI models, the HealthSuite Insights platform gives them access to advanced analytic capabilities to curate and analyze the healthcare data gathered in their own institution.

We know that one of the biggest challenges in implementing artificial intelligence is that up to 75% of healthcare data is unstructured.[21] Unlike many other industries where the data is relatively clean and normalized, a large amount of clinical information is currently captured in medical notes of various kinds and formats. The lack of interoperability between systems makes it even more difficult to quickly extract the right data. It also poses challenges for the implementation of solutions into a hospital network.

This is why HealthSuite Insights covers the end-to-end process of developing and deploying solutions – all the way from collecting the right data, to normalizing it, to building a model, to testing it, and embedding the model into daily practice. The platform promotes collaboration between data scientists and clinical domain experts, to help create clinically validated solutions that combine the strengths of people and technology.

With HealthSuite Insights, we also plan to create an ecosystem that enables the exchange of AI-enabled solutions among healthcare providers and AI startups, and the wider deployment of such solutions in clinical settings. We believe that collaboration in this ecosystem, called the HealthSuite Insights Marketplace, will accelerate innovation.

Bringing the future closer with precision medicine

Perhaps one of the most promising areas of potential for AI and adaptive intelligence in healthcare is in the field of precision medicine.

Since scientists started sequencing the human genome in the 1990s, doctors have predicted the arrival of precision medicine, in which the right patients are matched at the right time with the right therapy to treat their disease. Such an approach, which is still in its infancy, has particularly far-reaching implications for cancer – a catch-all term to describe a multitude of diseases that will affect one out of two men, and one out of three women worldwide in their lifetime.

Scientists are developing an increasingly complex set of options to treat cancer. These range from interventional therapies -- such as surgery, radiation and image-guided therapy -- through an increasingly broad range of pharmaceutical therapies, right up to strategies with no or minimal interventions, such as those involving active surveillance or palliative care.

The optimal treatment choice depends on precise diagnosis. Yet in precision medicine, this is critically dependent on the ability to analyze staggeringly large datasets with multiple and diverse parameters – something far beyond any human's ability.

This is where AI and big data analytics, coupled with clinical insights can play a crucial role.

Take pathologists as an example. To detect the presence of cancer in a patient, they analyze suspicious tissue samples on a glass slide through a microscope to determine if the tissue is malignant. Their typing of the tissue is a crucial component in the staging of the tumor, guiding treatment decisions. But the number of pathologists is falling just as cancer rates are rising.

With the clinical introduction of digital pathology, pioneered by Philips, it has become possible to implement more efficient pathology diagnostic workflows. This can help the pathologist to streamline the diagnostic process, connect a team, even remotely, to enhance competencies and maximize use of resources, unify patient data for informed decision-making, and gain new insights by turning data into knowledge.

Now we're working on the next step -- computational pathology. In computational pathology, the tissue in digitized images is automatically examined by applying deep learning-based image analytics and big data integration. Computational pathology aims to support the pathologist to improve diagnostic accuracy.

Oncology is a complex medical domain, in which multiple disciplines must collaborate to reach accurate diagnoses and effective treatment plans. Unfortunately, information is frequently lost in communications between specialties and care networks, which can lead to critical information being missed.

The Philips IntelliSpace Precision Medicine decision-support solution helps address these issues by bringing siloed patient and medical data together, to provide a clear and comprehensive view of patient status that facilitates data- and outcome-driven clinical decision support.

Prediction models tend to build on non-local patient data, which does not accurately reflect the clinical setting. IntelliSpace Precision Medicine is designed to bring actionable clinical patient information together from disparate data sources, including electronic medical records, lab systems, pathology, and genomics, which takes into account the characteristics of specific patient cohorts, such as the mix of ethnic backgrounds.

Although we are at the beginning of our journey into precision medicine, we believe that AI and adaptive intelligence will help clinicians to find insights in the staggering amount of information produced by an individual patient, including their lifestyle, behaviors, physical characteristics, and multiple genetic and non-genetic biomarkers, as well as personal preferences.

Ultimately, we believe this will support an integrated, dynamic healthcare system, in which the patient is a central stakeholder who contributes data and participates actively in shared decision-making. It will allow clinicians at any given time to make a well-informed, confident diagnosis, and – together with the patient – make responsible decisions about the care pathway, designed to yield the best outcome without wasting time, resources and money.

*Available for US market only

We think people first

At Philips, we believe people's health journey should be a seamless, integrated and highly personalized experience. A journey where every single bit of information adds to a greater body of knowledge which patients, their care professionals, and science and society at large can benefit from.

Adaptive intelligence can help to turn that vision into a reality. By learning from vast amounts of clinical and personal information to bring us all closer to dealing with the sheer complexity of factors that impact patient health and the working lives of doctors and providers.

Above all, adaptive intelligence will extend the abilities of patients, consumers and providers alike. To help them achieve better outcomes and experiences. That's why we believe in the power of adaptive intelligence.

Results are specific to the institution where they were obtained and may not reflect the results achievable at other institutions

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