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## THE DIGITAL TRANSFORMATION OF HEALTHCARE
Transformative events and ideas that promise to dramatically change the landscape.

# THE DIGITAL TRANSFORMATION OF HEALTHCARE

"The most exciting 25 years in medicine are coming up."

*—Anthony Chang, MD, MBA, MPH at*

*Exponential Medicine 2016*

The healthcare industry is experiencing a convergence of transformative events and ideas that promise to dramatically change the landscape in years to come. One of the biggest changes is the transformation from a volume-based system of care, where the focus is on treating sick patients, to one that is value-based, where patient outcomes are the main focus. In today's healthcare world, outcomes are more important than actions taken. We are gradually moving from a fee-for-service system that focuses on sick care to an outcome-focused system that centers around well-care and prevention. The focus is on population health control rather than acute and chronic care of issues that were diagnosed after the fact. It's more expensive to treat sick patients than well patients, and the rising cost of healthcare demands that we reevaluate our methods of care.

Along with this change to an outcome-focused system, there is more data in healthcare than ever before. Electronic medical records have become standard for most caregivers and healthcare facilities. Drug and device companies have a wealth of historical and real-time clinical trial data. And now, with the advent of the Internet of Things, a flood of data is being collected by wearable devices, sensors, and even drugs themselves.

As it's more important than ever to be predictive and proactive in medical treatment, big data can help usher in an era of more personalized medicine. It can help doctors make treatment decisions and individualize care to patients. For example, based on genetic testing and data from other similar patients, a physician can determine that a certain course of treatment will be more effective for an individual patient than others.

Big data can also help pharmaceutical companies determine which drug candidates are most likely to be successful in treating patients in market, which will transform which drugs are developed and how they are marketed. For example, a drug that's resoundingly successful with a smaller number of patients may be a better market bet than one that's mildly effective and mass-marketed to a larger population.

Data proliferation can help patients help themselves, by becoming more active participants in their healthcare and well-being. Many people have already embraced wearable trackers that record health and fitness data, and patients and caregivers can co-create customized wellness plans that are easy to follow and complement a patient's needs and lifestyle.

Data also helps hospitals operate more efficiently and effectively, for example helping hospitals know when to admit and release patients according to a combination of individual data and historical data patterns of similar patients. With the proper means to share data while respecting patient privacy, healthcare providers have an opportunity to address the consensus that hospitals are not patient-focused enough. In this sense, hospitals can operate similarly to the hospitality industry in improving and optimizing patient stays.

For pharmaceutical companies, big data and machine learning represent a huge opportunity to be more profitable, create more effective drugs, bring those drugs to market more quickly, and better market those drugs to patients who need them, via more open communication between healthcare channels.

There are challenges. The biggest one is to use this data to be more predictive about the customer journey, in spite of strict HIPAA restrictions on targeting based on sensitive health data. Pharma marketers also need to be able to close the loop with this data when patients actually buy their drugs at the pharmacy. Pharma marketers can do prepurchase branding—get people to land on a site, download coupons, even consult their physicians. But that final piece of the puzzle can be elusive. If companies can know how their drugs fare in market as a result of brand campaigns, that information

can help them model more efficient and effective paths to market for future drugs and campaigns for existing drugs.

In addition, pharma marketers are often catering to three or more separate audiences—the patient, healthcare or insurance provider, and the regulators, each with unique value drivers and incentives. Messaging challenges can be arduous and complex for companies juggling these different players.

In the pharmaceutical industry, there are three distinct macro themes that will define industry growth and transformation in the next decade:

- Big data and machine learning is driving healthcare diagnostics and drug development.

- Personalization is the new expectation in healthcare.

- Connected ecosystems are the key to innovation and patient care.

These changes will pave the way for an environment in which predictive technologies facilitate more data, visibility, and agility to determine what clinicians and patients need, how to deliver, and how to capture share of both mind and wallet. Pharmaceutical companies are beginning to realize that the data they collect and the way they leverage this data will give them competitive advantage, but will also revolutionize what they deliver and how they deliver it, changing the face of healthcare forever.

# BIG DATA AND MACHINE LEARNING:

## DRIVING HEALTHCARE DIAGNOSTICS AND DRUG DEVELOPMENT

Like most complex businesses, pharma is experiencing an explosion in the types and volume of data. This data comes from a combination of the research and development process, retailers, patients, and caregivers. More and more, the Internet of Things—everything from the Apple Watch and the FitBit to sensor technology to monitor, treat, and better understand Parkinson's disease to digital medicines that feature a stomach-activated sensor that provides information on how a patient is taking and responding to medication[1]—will become commonplace in the next decade.

However, even without the voluminous amount of data that will flood pharmaceutical companies from the Internet of Things, the sheer volume of data that exists and is needed for comprehensive analysis is already far more than the human brain can process. In 2015[2], more than 800 vaccines and medicines to treat cancer were in trial. And in the bioscience industry,[3] 10,000 new publications are uploaded globally on daily basis. It's impossible for even a large team of people to find and read them all, let alone in a timely manner.

Pharmaceutical companies need a better way to work with that data. There is a difference between merely capturing billions of signals across devices, and using that data to cure illness, develop drugs, and improve the patient experience overall. These data signals need to be converged, and a data activation and augmentation strategy is necessary to properly set the stage for garnering the kind of intelligence that changes the industry.

### The age of artificial intelligence

Artificial intelligence (AI) can help harness, govern, and process this data, using it to better inform decision-making and bring data into context that would otherwise be left in the dark. McKinsey[4] estimates that applying big-data strategies to better inform decision-making could generate up to USD100 billion in value annually across the US healthcare system, by

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1   "The Era of Living Services," Accenture and Fjord, 2015

2   "7 applications of machine learning in pharma and medicine," Techemergence, March 22, 2017

3   "How artificial intelligence is the future of pharma," Drug Target Review, December 5, 2016

4   "How big data can revolutionize pharmaceutical R&D," McKinsey & Company, April 2013

optimizing innovation, improving the efficiency of research and clinical trials, and building new tools for physicians, consumers, insurers, and regulators to meet the promise of more individualized approaches.

Some of the biggest players in AI and machine learning are already working in the pharmaceutical arena. IBM Watson[5] currently has multiple initiatives in machine learning research in the pharmaceutical industry. IBM Watson Genomics, a partnership initiative with Quest Diagnostics, integrates cognitive computing and genomic tumor sequencing. IBM Watson Oncology is pursuing supervised learning in cancer treatment, where Watson uses patient medical information and history to optimize treatment paths.

AI can play a multitude of roles in the pharmaceutical industry. It can aid in drug discovery, helping identify molecules with the highest likelihood of success as drug candidates. AI can ingest everything from papers to molecular structures to genomic sequences to images. Then it can learn, make connections, and form hypotheses—often suggesting molecules and combinations that humans might overlook due to sheer volume, or their own bias.

For example, the Economist spoke to Richard Mead, a neuroscientist at the University of Sheffield in England who is researching ALS with the help of a London-based firm called Benevolent AI. Benevolent AI's machine learning capabilities yielded two different molecules that could be potential drugs

5  Techemergence, 2017

for ALS. One is an obvious hit, right in the middle of the research that he and his team are already doing. The other is complicated and not obvious, but interesting. Without AI to prompt him, the less obvious molecule is one that his team might have ignored, likely as a result of their bias.[6]

Artificial intelligence can help researchers and companies identify patients with biomarkers that make them more likely candidates for clinical trials, so they are testing the right drugs on the right patients. It's anticipated that AI helping to find the right molecule and the right patient to test it on will help to make clinical trials shorter, less expensive, and more impactful. In a business where drugs often take up to 15 years to come to market, that's a significant innovation.

In terms of marketing, there could be an opportunity to map aggregate consumer digital and purchasing behaviors to patients prone to certain long-term diseases. For instance, there was a study that drew a strong correlation between people that grew up on farms and patients that had Parkinson's disease—pesticides and various chemicals being the triggers.[7] Theoretically, you could create a cluster of cookie profiles that combined geographic data from rural areas, strung together with IP addresses in those regions, and tied with mobile device ID data to approximate levels of exposure to long-term predictive models.

A predictive AI marketing platform can also enable efficient marketing of the right drugs to the right patients at the right time. Information on drugs and more targeted treatment information can be delivered with the help of real-time information systems that doctors and patients can consult during appointments.

In a sense, the patient journey is like a customer journey, through which touchpoints along the way can be used to educate patients about treatments and health risks, and where patient data can give insights into which paths they want to take so that pharma companies can act in a more predictive manner in suggesting treatment.

In an era of HIPAA regulations and patient privacy concerns around data, AI can help gather valuable information from anonymous data. With signals from new data locations such as mobile or loyalty programs, AI can help bridge the gap in today's privacy compliant world.

The combination of AI and access to all kinds of data with which it can process and learn will revolutionize the way that we make and sell drugs. For example, it will enable pharmacogenomics, or custom drug dosages and combinations for patients, that can treat diseases such as cancer, diabetes, and heart disease based on the genetic makeup and type of ailment.

The data is already here, and there is more coming, year over year, especially as wearable devices and sensors become more prevalent in the healthcare industry. Pharma companies just need the machine learning capabilities to make sense of it all.

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6   "Will artificial intelligence help crack biology?" The Economist, January 7, 2017
7   DiClementi, Anthony, The Biohacker's Guide

# PERSONALIZATION: THE NEXT BIG EXPECTATION IN HEALTHCARE

In other industries, the customer is king and expects nothing less than instant, exceptional service. From banking to retail to the automotive industry, companies recognize the high expectations and fickle nature of today's customers and are using machine learning technology to know their customers and predictively identify opportunities to provide exceptional experiences.

In healthcare, the dynamic is slightly different—unlike with a retailer, patients don't always have a choice to walk away from treatment if they're not satisfied, or to shop around for doctors. Insurance companies and providers often dictate the terms of service and limit choices that patients have.

**That will change.**

Healthcare is becoming more personalized and will only continue to do so. Doctors are tailoring treatments more toward patients' personal genetic makeup and needs. Patients are becoming more invested in their care. Consultations will become more like collaborations between doctor and patient as streaming, personalized information becomes more readily available in the treatment room.

As outcome-based medicine becomes more of the norm, patients will begin to take a more active role in healthcare—by being incentivized or by their own volition, wearing devices that monitor their health, participating in genetic testing, and communicating more openly and frequently with providers via telemedicine and other technologies. Just as drug companies are incentivized to improve outcomes, patients will be incentivized and encouraged to be consistent with treatment, take medications, track vital signs, and more. As doctors and patients begin to see improved outcomes and lower costs, expectations from patients will rise for more collaborative care and better results.

## Pay for performance

Drug companies will have expectations on them as well. The industry will want to see drugs that actually affect outcomes for groups of patients, rather than mass-produced products that may or may not work for a large number of people. As personalized treatment becomes the norm, doctors and patients will want to see drugs that can be personalized based on genetics and other factors. With AI and machine learning playing a part in drug discovery and R & D, pharma companies will have shorter cycles and more effective trials to produce these custom drugs more quickly and at some volume. There will be higher expectations that drugs will work.

To create these custom drugs, companies will need to employ data capture strategies through marketing observations, so intelligence can be created in real time about the right patients. Search behaviors, lifestyle preferences, and purchase habits are all potentially rich signals that can reveal insights about various illnesses and highlight ways in which people can take preventive measures to decrease a preexisting propensity to develop a particular illness. This cultural ripple effect will raise the bar for all.

In fact, insurance companies and payers will pay based on performance for new drugs that come to market. With pay for performance, insurers[8] agree to offer reimbursement for a drug at a set price, as long as the drugmaker agrees to pay a penalty if certain metrics aren't met. Merck,[9] Novartis, Lilly, and other major pharma companies have already entered into pay-for-performance agreements with insurance companies for drugs that combat diabetes, hepatitis C, heart

disease, and cancer. In some cases, insurers agree to help ensure that patients take their medications in full and on time. For example, Express Scripts[10] guarantees to plan sponsors that patients will adhere to the regimen for Viekira Pak, AbbVie's hepatitis C drug. Pharma companies need systems that can track that data and the results to ensure that terms of these agreements are being met.

In a data and AI ecosystem that includes all the players—patients, pharma companies, insurers, and more—parameters can be tweaked and incentives broadened as patient and customer data becomes more known and AI continuously works to optimize and improve accuracy.

As drugs are developed in more personalized ways, and as the demand for personalization grows, it becomes more important than ever for pharma companies to understand the triggers for demand among providers and patients. Not only do drug companies need to create and deliver drugs in more personalized ways, more customized sales and marketing efforts using all available data also play a role in getting these drugs from company to patient. For this to happen, it becomes necessary to have a free-flowing exchange of data and information throughout the development and sales process to have a more accurate view of the market and the demands and needs of customers.

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10 Modern Healthcare, 2016

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8  "Pay-for-performance drug pricing: Drugmakers asked to eat costs when
   products don't deliver," Modern Healthcare, December 10, 2016
9  Modern Healthcare, 2016

**Digital Nervous System for Predictive Pharma**
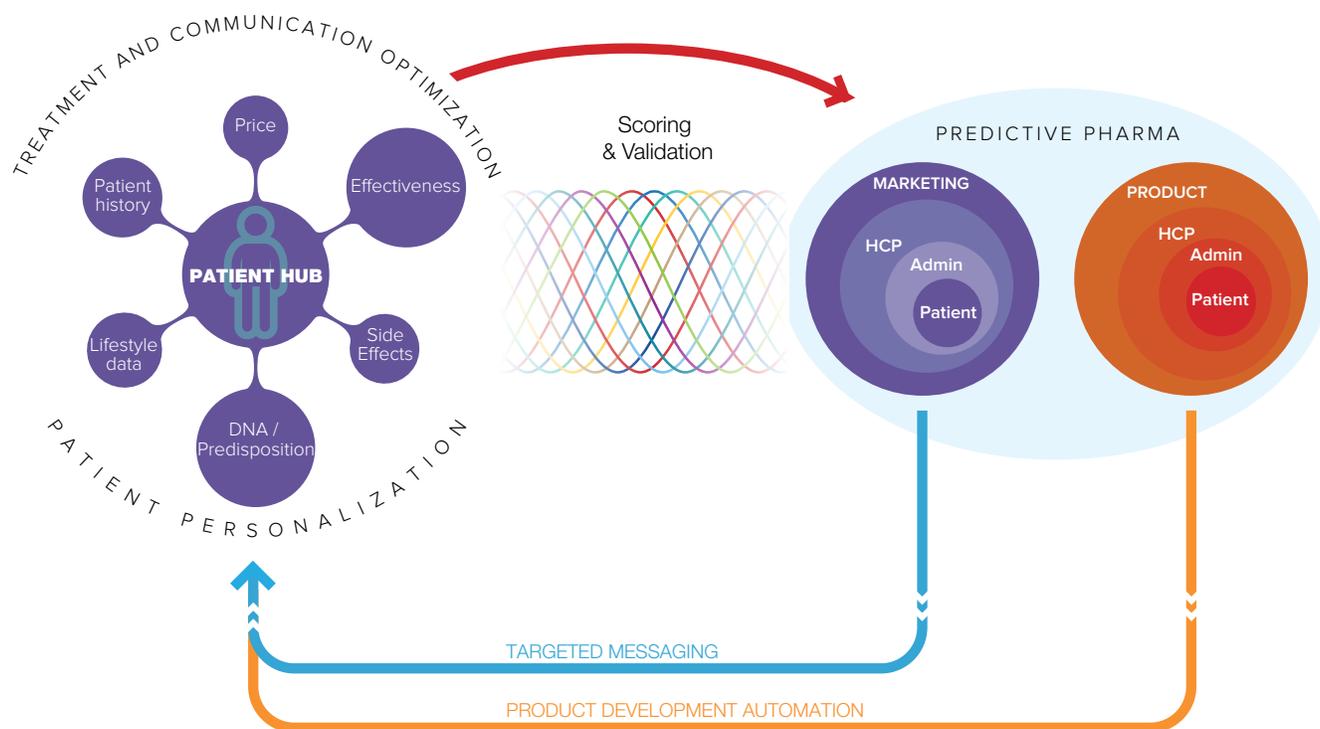


# CONNECTED ECOSYSTEMS ARE THE KEY TO INNOVATION AND PATIENT CARE

To realize this transformation in pharmaceutical innovation, care, and delivery, it's not enough that data exists. Ecosystems need to be created to let this data flow freely from one group to the next. In these ecosystems, we can capture more critical patient data, specific trends around diseases in the field, attributes that indicate symptoms, and more. This vast data ecosystem will span many different data sources to form healthcare data lakes into which pharma companies can dip to gain insight into patient needs. Among the data resources that will flow into this data lake are research and development data, generated at all stages of the value chain, from discovery to real-world use after regulatory approval; anonymous health data from electronic medical records; sales and marketing data from campaigns and physician field visits; and the Internet of Things. For example, shared data across an ecosystem can propel insight pipelines that detect trends for new diseases, much the way Microsoft, with Project Premonition, uses big data from drones and smart traps to gain insights from mosquitoes and predict viruses before they spread.[11] Connected ecosystems, powered by an AI infrastructure, will create new opportunities for growth in decades to come. The entire structure acts as a kind of "digital nervous system," with sensors, nerves, and inputs that can process and interpret relevant information to self-correct, fight foreign agents, and flush out detrimental toxins from the system.

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11  "Drones and smart traps turn mosquitoes into field biologists to detect deadly viruses before they spread," Microsoft blog, January 30, 2017

How can these ecosystems be created? For decades, the status quo in the pharmaceutical industry has been that of closed systems, walled gardens, and data silos, each defending its own territory and even competing with the others in the company. To truly innovate and take advantage of the opportunities that will come with more patient and clinical data, pharma companies need to make some changes, taking down walls and opening pathways to insight and knowledge. As companies in other industries in Silicon Valley and beyond have done, pharma organizations need to invest in external research and development, open-innovation projects, and corporate venture projects. Outside investment will widen the pool of information and ideas. In addition, smaller groups and independent projects within an organization are more agile and work faster, unencumbered by internal processes and rules. This kind of collaboration and radical openness may seem daunting. However, the kind of insight derived from digital data captured through billions of attributes per second can positively affect current marketing initiatives and transform future business models and initiatives that will render the industry remarkably—and positively—changed in the next 25 years.

There are obstacles around data that exist today in the healthcare world. Data governance is one. Medical data is still personal and not easy to access, with much of the public still concerned with data privacy. Still, a March 2016 survey[12] in the UK found that only 17 percent of respondents would never consent to their anonymized data being shared with third parties, including for research. Electronic medical records are still fragmented across databases with a large amount of unstructured data, for example handwritten notes. Breaking down data silos and encouraging a datacentric view, where sectors see the value in sharing and integrating data, is an important shift in mindset that needs to happen.

For machine learning to become a transformative force in the pharmaceutical industry, data needs to be free as air, flowing from one place to the next. Technologies such as artificial intelligence are the electricity that keeps it all moving, gathering and modeling data that flows between pharma companies and care providers and patients, analyzing and optimizing actions and information in a recursive way. In fact, Andrew Ng, former head of AI at Baidu, referred to AI as "the new electricity" in a 2017 talk, saying that AI will have the same impact on life and technology as electricity did more than 100 years ago.[13] After some rocky beginnings, AI is coming into its own. "AI has passed winter and is now in an eternal spring," Ng said, where it will impact business and become a factor in technology development for years to come.[14] With walls down and data flowing freely through systems, pharma companies can begin to realize the tremendous potential for growth and transformation across the industry.

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13 "Artificial Intelligence is the new electricity," Andrew Ng, Stanford Graduate School of Business Future Forum, January 25, 2017

14 Andrew Ng, 2017

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12 7 applications of machine learning in pharma and medicine

# CONCLUSION

Digital transformation is taking place across healthcare and the rest of the world, and the pharmaceutical industry needs to transform as well. It won't be an overnight metamorphosis, but pharma companies that start making changes now to move toward a more open and predictive environment will come out ahead in the end with more agile processes and better decision-making power to bring the right drugs to the right patients more efficiently and effectively than ever before. There are a few critical steps that companies can begin to take now to help them succeed in the next decade.

## Promote agility

Now is the time to break down barriers and create flexible, agile, integrated operating models. The predictive capabilities of the future will only work with transparency and collaboration between internal stakeholders, a flatter organizational structure, strong, open partnerships with external entities, and an open exchange of data between these groups. The digital nervous system works organically to break down barriers and speed the flow of information and collaboration between groups.

With a more agile operating model, you can adopt a "fail fast and often" mindset within the organization. The current wealth of healthcare data and the coming tsunami of more data, combined with an AI-powered platform that is constantly modeling, analyzing, and optimizing intelligence in real time, provide the ultimate testing ground for new drugs and devices. Don't be afraid to try and fail. Instead of gambling on one giant initiative (the pharma way of doing things), make small bets across your platform that you can revise and refine—or reject—quickly as you gain a greater knowledge of what works and what patients and clinicians want.

## Embrace digital

Data and machine learning will influence everything from drug discovery to clinical trials to the sales and marketing of new drugs to the patients who need them. But it's simply not possible to move to this new age of artificial intelligence without fully embracing digital both in the front and back office. The healthcare industry is becoming overwhelmingly digital. According to McKinsey, nearly 70 percent of US consumers use

an online channel to measure health and wellness.[15] More than 50 percent of US healthcare providers are digital "omnivores" who use three or more connected devices professionally.[16] Out of a total 141 investments and acquisitions in the healthcare space between 2012 and 2017, 63 were in digital health.[17]

Compared to other areas of healthcare, pharma is behind the curve—far behind. When applying McKinsey's Digital Quotient (DQ), a tool for assessing digital maturity, to several different industries, pharma's DQ score was next to last, beating out only the public sector and lagging far behind digital leaders and other industries such as retail and travel.[18]

According to an Accenture study, pharmaceutical companies are more likely to incorporate digital in the front office, for example in commercializing therapies and exploring wearable devices, but are slow to take full advantage of digital in the middle and back offices.[19] According to Accenture, "Bolting on digital capabilities is insufficient. Digital should be infused into your entire business strategy to help reduce operating costs and increase agility."[20]

**Lead, don't follow**

Pharma companies need leaders who understand the potential of a predictive, data-driven business model to move beyond a traditional product-based focus into the new outcome-based focus. However, only 8 percent of pharma execs surveyed by Accenture strongly believe that leadership has the right investments and growth initiatives in progress to achieve business goals.[21]

Pharma company leaders are reluctant to be the first to move in the race to become more agile and data driven. But as Dr. Jeremy Levin, chairman of Ovid Therapeutics, said at Exponential Medicine 2015, "The company that takes the leap will be the one who emerges in the end."[22] And, citing the tendency for pharma companies to jump on the bandwagon, he believes that plenty of followers will pursue the same path once one company takes the leap. He advises pharma leaders:

"Be brave. When one does, you will see a stampede."[23]

22  "The Future of Pharma, Jeremy Levin, Exponential Medicine, 2015
23  Jeremy Levin, 2015

15  "Closing the Digital Gap in Pharma," McKinsey, November 2016
16  McKinsey, 2016
17  "Major Health Insurers' Bets: Where They're Investing Across Digital Health, Elderly Care, & More," CB Health, May 13, 2017
18  McKinsey, 2016
19  Accenture, 2016
20 Accenture, 2016
21  Accenture, 2016