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How Machine Learning is Driving Better Patient and Business Outcomes

Empowering healthcare and life sciences organizations with intelligence, predictability, and efficiency

Introduction—Powering a new era of clinical excellence

The last few years have seen great advances in healthcare and lifesciences technology, with some of the biggest breakthroughs driven by machine learning and artificial intelligence (AI). Machine learning, AI, and other intelligent technologies are powering devices and software applications that allow us to accelerate drug discovery, development, and approval; create personalized patient treatment plans that lead to healthier outcomes; diagnose diseases and abnormalities earlier and more accurately; and build more efficient infrastructure for healthcare and life sciences organizations.

The healthcare industry is aggressively investing in intelligence: Tractica, a leading market research firm, projects that spending on healthcare AI technology will surpass $34 billion by 2025, compared to $2.1 billion in 2018[1]. And according to Accenture, those investments will pay off, with the top AI healthcare applications predicted to create $150 billion in annual savings by 2026[2]. Healthcare and life sciences organizations are drawn to AI and machine learning because those technologies can quickly and continuously analyze huge sets of data, providing increasingly accurate projections and insights over time.

That's not to say the relationship between healthcare and life sciences and technology is perfect, however. The industry is struggling to adopt innovation quickly and meaningfully, and many providers are frustrated by systems that actually hamper their productivity—with electronic health record (EHR) systems often taking the brunt of the blame.

But machine learning is far from "just another technology in the stack." It has the power to overcome healthcare and life sciences challenges by providing a platform for operational and clinical efficiency, driving costs down, and improving patient care. In this eBook, we'll examine how advances in machine learning can power a stronger relationship between healthcare and technology, paving the way for a new era of clinical excellence.

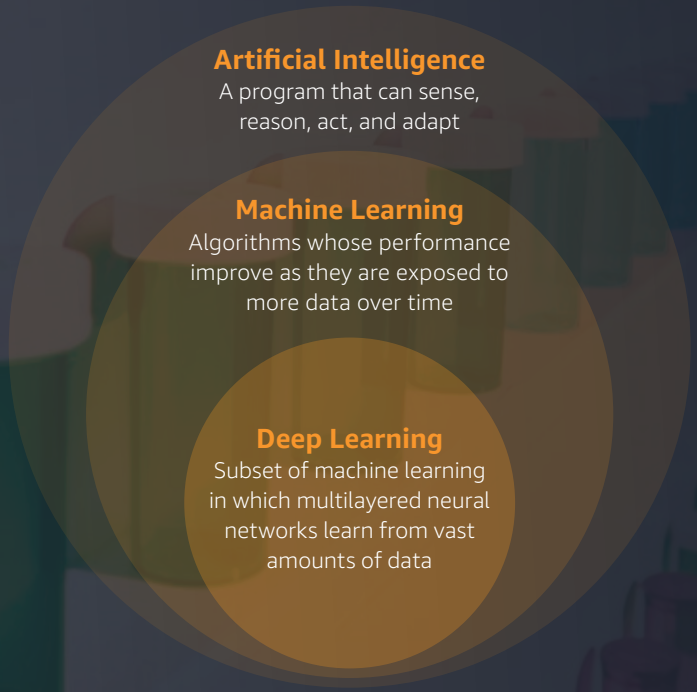
Before we dive into that conversation, however, we'll take a look at some specific success stories that demonstrate how leading healthcare and life sciences organizations are using machine learning to improve efficiency and outcomes today.

[1] https://www.tractica.com/newsroom/press-releases/healthcare-artificial-intelligence-software-hardware-and-services-market-to-surpass-34-billion-worldwide-by-2025/

[2] https://getreferralmd.com/2019/04/10-powerful-examples-of-ai-used-in-healthcare-today/

How today's organizations are revolutionizing medicine with machine learning

Let's take a look at success stories from leading organizations that are leveraging machine learning to accelerate drug discovery, advance detection and diagnosis of diseases and abnormalities, make personalized care a viable reality, and modernize clinical workflows.



What is machine learning?

You've probably heard machine learning described in a number of ways, so let's take a step back and review its exact definition:

- Machine learning is the underlying technology that powers intelligent systems. The term is often used in conjunction with AI. Comprehending the distinction and relationship between the two is critical to understanding either.
- AI is a way to describe any system that can replicate tasks that previously required human intelligence.
- AI is typically deployed to make complex decisions that would normally require human judgment. AI is used to make predictions, classifications, or decisions with a high degree of certainty in ways that are similar to human thinking—but with the ability to do so faster and at a larger scale than humans can achieve.
- Today, almost all AI systems are built with machine learning. Machine learning uses large amounts of data to create and validate decision logic. This is known as a model. In a typical application, the AI system feeds input data into the model, which then outputs human-like predictions or classifications.
- Essentially, AI is a type of logic model, and machine learning is a way to develop that model.

Atomwise helps researchers deliver better medicines faster

Analyzing chemical compounds to evaluate their potential effectiveness in treating various medical conditions is one of the most important tasks in clinical research. Performing this work effectively requires a level of scalability and speed that is exponentially higher than humans can achieve on their own.

Founded in 2012, Atomwise developed a solution powered by AI and machine learning that can analyze compounds faster and more intelligently than previous systems. Narrowing billions of compounds down to the small subset with high specificity for synthesis and testing—a process that traditionally takes years to complete—can be performed by Atomwise in a matter of weeks.

"We're talking about a scale of synthesizing trillions of compounds. It's a scale that's very different than tech companies have encountered in the past," said Izhar Wallach, CTO of Atomwise.

Atomwise's technology autonomously identifies patterns in chemical compounds, virtually eliminating the slow, error-prone manual guesswork that typifies older computational methods. This helps researchers not only discover drugs faster but also determine ways to make drugs more potent, reduce side effects, and repurpose existing and approved drugs for new indications.

The company's solution has improved hit rates by up to 10,000 times compared to wet lab experiments. It delivers 100 times faster results and screens more than 100 million compounds every day[3].

Atomwise is also seeking to improve drug discovery and effectiveness through collaboration. The company's AIMS (artificial intelligence molecular screen) program gives academics and nonprofit organizations open and free access to Atomwise technology, helping them share their findings and use AI to work on joint projects more effectively.

"We try to democratize the discovery process to enable professors and researchers to do the kind of discovery that they have not been able to do before and create new opportunities to find new treatments," Wallach said.

The program is resonating with researchers across a wide range of medical disciplines, including oncology, infectious diseases, neurology, cardiology, endocrinology, and immunology.

"We've done three rounds of applications. Right from the start, there was huge enthusiasm, and by round three, we saw a huge uptick in number of applications, number of researchers, and number of institutions," Wallach said. "We want to give as many molecules as possible out for free all around the world."

View the success story »

[3] https://www.atomwise.com/

Cerner simplifies delivery of personalized care

Cerner, the world's largest publicly traded healthcare IT (HIT) company, uses machine learning and other technologies to gain actionable, real-time insights that simplify and personalize healthcare delivery while reducing costs for payers, providers, and patients.

Cerner's goal is to create sustainable healthcare business models for its 27,000+ provider facility customers, helping them overcome market pressures such as declining reimbursements, aging populations, physician shortages, and confusion over reforms and regulations.

The company employs machine learning to build complex analytical tools that aggregate and analyze anonymized patient data from EHRs, claims, diagnostics, billing tools, and more. The resulting insights inform predictive models that forecast diagnosis and treatment outcomes, financial implications, and hospital staffing needs.[4]

Cerner also uses machine learning in its efforts to simplify delivery and effectiveness of personalized care.

"We need to add a new layer to healthcare—focused not on the venue of care, but optimized around the unique needs of the individual, the ability to create a lifetime relationship, and then match their unique needs to the resources in their community," said Ryan Hamilton, senior vice president of population health.

One way in which Cerner is currently accelerating the viability of personalized medicine is through natural language processing (NLP) software. The company is developing NLP technology that will be able to intelligently listen and respond to doctor/patient conversations within the exam room. The objective, according to Hamilton, is "to get to a conversational healthcare workflow, not a visit-oriented, venue-oriented workflow."

Cerner views its personalized care initiatives through a wide lens, envisioning applications that go beyond traditional clinical venues. With insights and predictions powered by machine learning, Cerner and its clients are now able to recognize new patient needs and offer services other than treatment or medicine—such as free transportation programs or personalized nutrition plans.

"We believe we can transform how each of us manages our own health and care," Hamilton said.

View the success story »

[4] https://pages.awscloud.com/rs/112-TZM-766/images/AWS_WiredArticle_Healthcare.pdf

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Aidoc brings lifesaving advancements to medical imaging

Advances in imaging technologies such as CT, X-ray, and MRI are resulting in more scans being performed per patient. This is good news because it increases the likelihood of catching abnormalities that might previously have gone undetected. But as radiologists shoulder the resulting heavier workloads, they require new tools to help analyze scans faster and more efficiently.

Founded in 2015 by three Israel Defense Forces veterans with experience building AI solutions for military intelligence applications, Aidoc created a solution that uses AI and image-recognition tools to augment radiologists' expertise. The company's always-on decision-support software analyzes CT scans to flag acute abnormalities, prioritize life-threatening cases, and expedite patient care.

"We are getting new algorithms into production faster, bringing products to market faster, and helping treat patients and increase value for hospitals faster," said Guy Reiner, vice president of research and development at Aidoc.

Aidoc's solution, which to date has analyzed more than 3.2 million cases at more than 300 medical facilities around the world, is benefiting both patient care and radiologist well-being. At one major U.S. medical center, the Aidoc solution reduced patient emergency department (ED) visits by 59 minutes and overall hospitalization time by 18 hours, on average. At another similar medical facility, the Aidoc solution helped radiologists reduce the average turnaround time for CT scans of intracranial hemorrhages from 53 minutes to 46 minutes, or 13 percent.

"Aidoc's solutions are shortening patient wait times from days to hours for scheduled cases and from hours to minutes in the emergency department," said Ariella Shoham, vice president of marketing. "It is very gratifying to have doctors who use our solution say things like 'Today your solution helped us save a life.'"

Aidoc's next steps include releasing a package of algorithms to support the work of oncology radiologists. "Our oncology package helps radiologists flag, compare, and perform volumetric measurement of kidney and liver lesions as well as lung and lymph nodules, reducing the bandwidth required for this demanding, time-consuming work," Reiner said.

Read the full success story »

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Qventus forecasts clinical needs to improve workflows and outcomes

Qventus, a software company that bills its platform as "air traffic control for health systems," uses machine learning to help healthcare workers manage their professional environment while reducing the strain of simultaneously handling patient care and process workflows.

The Qventus platform gathers and analyzes data from EHRs, including test results, admissions information, medications, transfers, diagnoses, procedures, risks, and discharges. Machine learning powered models then use that data to predict potential issues and make recommendations for resolving them. The platform can, for instance, predict the chances of a certain patient suffering a fall, even estimating the time the fall is most likely to occur and the severity of the resulting damage.

The software can also factor in data outside clinical workflows, such as government-issued disease alerts and hazardous weather reports, enabling organizations to staff up or down as risks intensify and recede.

Healthcare organizations use the intelligence and predictions provided by Qventus to ensure their resources match or exceed public need, reducing wait times and unnecessary tests, improving quality of care, and mitigating capacity issues such as bed and operating room availability.

According to Qventus Cofounder and CEO Mudit Garg, some hospitals using the company's platform have reduced the number of patients who leave a facility without receiving care by 35 percent and patient falls by 35 percent to 40 percent.

"We have a whole library of recipes, a playbook of things that can happen and countermeasures that can be put in place in the moment to prevent situations from getting really bad," Garg said.

Mudit Garg, Qventus Cofounder and CEO

Learn more about Qventus and other game-changing healthcare innovations »

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Realizing the full potential of machine learning in healthcare and lifesciences

Now that we've seen how Atomwise, Cerner, Aidoc, and Qventus are using machine learning to improve outcomes for organizations and patients, let's take a step back and examine the potential of the technology in the industry as a whole.

In the introduction, we cited a Tractica study that projected spending on healthcare AI technology to exceed $34 billion by 2025. Technology firm Benhamou Global Ventures (BGV) offers a more near-term prediction, reporting that the total public and private sector investment in healthcare AI is expected to reach $6.6 billion by 2021. BGV and Tractica agree that this number will grow exponentially in the coming years, with BGV projecting a 40% compound annual growth rate (CAGR) in healthcare AI spending.[5]

But will these investments bear fruit? Consulting firm McKinsey & Company seems to think so, offering bullish projections for machine learning and intelligent technology in the healthcare industry. In a 2019 report, McKinsey wrote that "technology-driven innovation holds the potential to improve our understanding of patients, enable the delivery of more convenient, individualized care—and create $350 billion–$410 billion in annual value by 2025."[6]

When properly implemented and utilized, machine learning can help healthcare and life sciences organizations overcome some of their biggest challenges—while creating new efficiencies and capabilities along the way. In the next section, we'll take a look at some of those challenges in detail and demonstrate how specific machine learning solutions from AWS can help mitigate their impact, or, in some cases, conquer them entirely.

[5] https://benhamouglobalventures.com/2018/08/02/digital-transformation-of-healthcare-state-of-the-union/

[6] https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/the-era-of-exponential-improvement-in-healthcare

Solving today's biggest healthcare and life sciences challenges through machine learning

Today's healthcare and life sciences organizations are increasingly challenged to do more with less, facing climbing costs, shrinking budgets, and ever-stricter regulatory requirements.

Machine learning powered technologies can help shoulder the burden, informing better decisions with data-driven predictions and giving executives and providers more time to focus on improving outcomes. Let's take a look at some of the top challenges in the industry, examine how machine learning solves them or lessens their impact, and explore benefits associated with those solutions that go beyond problem-solving to create additional value for businesses and patients.

Challenge: Inefficient research lifecycles

Low accuracy and long experimentation cycles in drug discovery prevent patients from receiving the most advanced care—while also driving up costs for healthcare organizations. Digital and machine learning powered solutions can drastically accelerate these processes, but adoption has been slow. Electronic data collection tools have been available for over 20 years, yet 75 perfecnt of clinical trials still rely on paper-based data collection as their primary means of gathering research.[7]

[7] https://www.patientcentra.com/patient-recruitment-insights/data-inefficiencies-crippling-clinical-trial-outcomes

Solution: Amazon SageMaker + AWS Partner Network

Amazon SageMaker is a fully managed service that empowers developers and data scientists to build, train, and deploy machine learning models quickly. SageMaker removes the heavy lifting from each step of the machine learning process to make it easier to develop high-quality models.

Models built with Amazon SageMaker can help organizations streamline research and drug discovery lifecycles by analyzing data and predicting results exponentially faster and more accurately than humans or traditional computing methods. Organizations are using these models to experiment more freely and with less risk, power devices that aggregate and analyze previously unknowable health data, identify compounds with potential medical applications more efficiently, and streamline revenue cycle and clinical trials management.

Effective medical research requires collaboration between academia, pharmaceutical companies, healthcare and life sciences organizations, and even patients. AWS Machine Learning and the AWS Partner Network can help facilitate efficient cooperation between these entities. AWS maintains the largest global community of customers and partners, with millions of active users on our platform and tens of thousands of APN partners across the globe.

Benefit: Activating a partner network for better drugs, shorter trials, and stronger bottom lines

Companies leverage AWS Machine Learning to improve a wide variety of outcomes in medical research. Knowledgent uses AWS Machine Learning to predict the feasibility of clinical trials and to forecast recruitment times, shortening overall trial timelines and accelerating drug approval.[8] Novartis and Moderna[9] use it to modernize drug manufacturing and supply chains, leading to faster and more efficient formulation and transportation of medicines. Propeller Health[10] and others use it to help people live healthier lives through advancements in digital therapeutics, such as behavioral modification tools and applications that act as personal health companions.

No single company or organization has the capability to transform healthcare and life sciences research. AWS has a thriving partner network of global innovators that have deep domain expertise to support academics, nonprofit organizations, and for-profit enterprises. The breadth and depth of these solutions built on AWS allow organizations to focus more on their mission: getting better drugs and treatments to people faster, thus improving public health and quality of life.

[8] https://d1.awsstatic.com/Industries/HCLS/AWS_ClinicalTrials_Whitepaper_Final.pdf

[9] https://www.youtube.com/watch?v=dczU1w1BiJk

[10] https://www.youtube.com/watch?v=txtbBu-Skwo

Challenge: Greater expectations for consumer and patient engagement

Consumerism in healthcare is expected to transform historically transactional engagements with patients and consumers into more collaborative and intimate relationships. Whether through personalized engagement channels or precision therapies, consumers are demanding more—and healthcare organizations that fall behind risk losing market share to nimble startups and forward-thinking enterprises.

Solution: Amazon Comprehend Medical + Amazon SageMaker

Amazon Comprehend Medical helps organizations analyze information "trapped" in free-form medical text and transform it into helpful insights that can enable stronger patient/provider relationships—while better addressing data privacy and protected health information (PHI) requirements.

Most of today's organizations perform that analysis by writing and maintaining a set of customized rules for natural-language processing software. These systems are complicated to build, time-consuming to maintain, and notoriously fragile—a change to a single classification code name can impact dozens of hard-coded rules, and failing to update a single one of them can result in missed or incorrect data. Comprehend Medical eliminates these issues with models that reliably understand the medical information in unstructured text and identify meaningful relationships, continuously learning and improving over time.

Models built with Amazon SageMaker can also help organizations and patients interact more effectively and efficiently. By intelligently predicting activity and automatically suggesting treatments and remedies with minimal provider input, machine learning models built with Amazon SageMaker have the potential to accelerate personalized medicine at scale—from a holistic view of the entire body to the genomic level.

Benefit: Enabling personalized digital relationships with patients and consumer

AWS provides services that allow professionals to engage with their patients and consumers at every major touch point of the healthcare journey. We can help transform the healthcare consumer experience from a transactional one to a personalized engagement, using tools that create a digital front door—with your customers at the center.

More specifically, AWS Machine Learning improves consumer and patient experiences by accelerating and enhancing personalized care—reducing re-admissions and, in some cases, preventing patients from needing to visit the doctor at all. Zocdoc uses AWS Machine Learning to aid patients in navigating the complex maze of provider and insurance networks, allowing them to make more informed choices and find care that fits their needs. The company's solution matches patients and doctors more efficiently and enables patients to get in to see a provider earlier—often within 24 hours, compared to a national average wait time of 24 days for new patients.[11]

[11] https://aws.amazon.com/blogs/machine-learning/zocdoc-builds-patient-confidence-using-tensorflow-on-aws/[9] https://www.youtube.com/watch?v=dczU1w1BiJk

Challenge: Lacking innovation in care delivery

Promoting and scaling innovation in the healthcare industry has been problematic for a long time, and the issue appears to be an ongoing one. In a 2019 study by the Center for Connected Medicine, two-thirds of surveyed health system leaders reported that their organizations implement and scale innovation somewhat or very slowly. Fewer than half said they had formal innovation departments.[12] A 2018 report found that the two largest factors impeding innovation in healthcare are lack of budget and regulatory burdens.[13]

Attributing the problem solely to financial shortages and institutional red tape doesn't go far enough, however. A more subtle culprit is afoot. The slow pace of innovation in healthcare is due in part to a misunderstanding of innovation's primary benefits.

While other industries seem better able to recognize and champion the positive effects of innovation—such as improvements in employee productivity, workflow efficiency, and decision making—many healthcare organizations look to innovation for fast financial returns and become frustrated when those benefits don't materialize quickly enough.

Succeeding with innovation requires big-picture focus, unwavering vigilance through temporary setbacks, and confidence that continued experimentation will ultimately yield desired outcomes. Unfortunately, healthcare executives may be under pressure to deliver near-term financial return, which can deter longer-term investment strategies in innovation—even when efforts do yield advances in areas other than fast ROI, such as provider and patient satisfaction.[14]

[12] https://www.connectedmed.com/blog/content/trends-for-scaling-healthcare-innovation-research

[13] https://www.healthcareitnews.com/news/focus-innovation-3-charts-explain-where-healthcare-headed

[14] https://www.connectedmed.com/documents/reports/ccm-research-trends.pdf

Solution: Amazon SageMaker

With the right tools in place, healthcare and life sciences organizations can easily build and integrate machine learning powered solutions that use intelligent forecasts and data analysis to recognize opportunities for financial gains and create new efficiencies that increase profitability. These solutions enable businesses to drive faster, more predictable, and easier-to-measure ROI—helping executives make stronger cases for accelerating innovation.

Traditional machine learning development is a complex, expensive, iterative process made even harder because there are no integrated tools for the entire machine learning workflow. Developers must stitch together tools and workflows, which is time-consuming and subject to errors. Amazon SageMaker solves this challenge by providing all of the components used for machine learning in a single toolset, so models get to production faster, with much less effort and at a lower cost.

Benefit: Increasing the speed of innovation

AWS provides the trusted technology infrastructure that removes the barrier of budget cycles needed to innovate and scale. Our unique culture of customer-centric innovation—combined with a willingness to work closely with our customers and partners to co-develop new products—provides a significant strategic advantage.

Healthcare and life science organizations are using AWS Machine Learning to accelerate innovation in a wide variety of disciplines—including drug discovery. Market leader AstraZeneca uses AWS Machine Learning to label data for specific tasks, dramatically accelerating the pace of drug discovery, reducing failure rates, and freeing researchers to dedicate more time to critical work. The company's researchers have also gained access to better data and more accurate analysis in areas such as patient imaging, enabling labs to identify relationships and patterns in ways that are impossible for humans to do alone. By speeding the pace of innovation, AWS Machine Learning has—among other benefits—helped AstraZeneca accurately identify the main areas affected by diabetic injury with a success rate of 95 percent and with minimal false negatives.[15]

[15] https://www.wired.com/brandlab/2019/07/machine-learning-is-transforming-drug-development/

Challenge: Growing provider burnout

Today's healthcare providers are experiencing professional burnout at an alarming rate. A growing number of doctors, nurses, and technicians are retiring earlier or abandoning the practice entirely, citing inefficient technology and stricter reporting requirements as key motivators.

Physicians spend an average of five additional hours per day performing EHR data entry. Not only is this process inefficient, but also it has the potential to distract physicians from providing the highest quality of care. Senior physicians in particular report displeasure with the "cumbersome, time-consuming data entry" that comes with using EHRs.[16]

According to a study published in the Annals of Internal Medicine, physician burnout is costing the healthcare system roughly $4.6 billion a year.[17]

[16] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5687935/ [15] https://www.wired.com/brandlab/2019/07/machine-learning-is-transforming-drug-development/

[17] https://annals.org/aim/article-abstract/2734784/estimating-attributable-cost-physician-burnout-united-states

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Solution: Amazon Comprehend Medical + Amazon Transcribe Medical

While no single solution can resolve all the factors leading to provider burnout, there are specific machine learning powered tools organizations can deploy to help providers be more productive and put time back into their days—ultimately leading to higher job satisfaction.

Amazon Comprehend Medical helps providers improve clinical decision support, streamlining workflows to accelerate productivity and helping professionals make better use of their time. Amazon Comprehend Medical is a HIPAA-eligible machine learning service that allows developers to process unstructured medical text and identify information such as patient diagnosis, treatments, dosages, symptoms, and signs.

Amazon Transcribe Medical is a machine learning service that makes it easy to quickly create accurate transcriptions from medical consultations between patients and physicians. With Amazon Transcribe Medical, the medical and pharmacological terms used in physician-dictated notes, practitioner/patient consultations, and telemedicine activities are automatically converted from speech to text for use in clinical documentation applications. By streamlining this process, Amazon Transcribe Medical provides another way to reduce the administrative burden that leads to physician overwork and burnout.

"We can easily integrate our clinical digital assistant with Amazon Transcribe Medical, allowing physicians to dictate medical notes, thus cutting energy spent on clinical documentation by 76 percent on average," said Punit Soni, CEO of Suki AI. "Their time is better spent focusing on caring for patients, rather than doing data entry work."

Benefit: Enabling clinical and operational excellence

AWS customers are able to transform their data into strategic assets that support clinical and operational efficiencies. From forecasting diseases in patients to automating revenue cycle management workflows, providers are able to leverage a comprehensive set of services across advanced analytics and machine learning to help them do their jobs more easily and effectively. These tools allow providers to concentrate less on paperwork and more on what they do best—caring for their patients.

Fred Hutchinson Cancer Research Center uses AWS Machine Learning solutions (specifically Comprehend Medical) to evaluate millions of clinical notes to identify and index medical conditions, medications, and choice of cancer therapeutic options—reducing the time needed to process each document from hours to seconds[18]. That's exactly the type of benefit that organizations need to prevent their providers from becoming overburdened—and a perfect example of how AWS Machine Learning can reduce provider burnout rates.

[18] https://aws.amazon.com/comprehend/customers/

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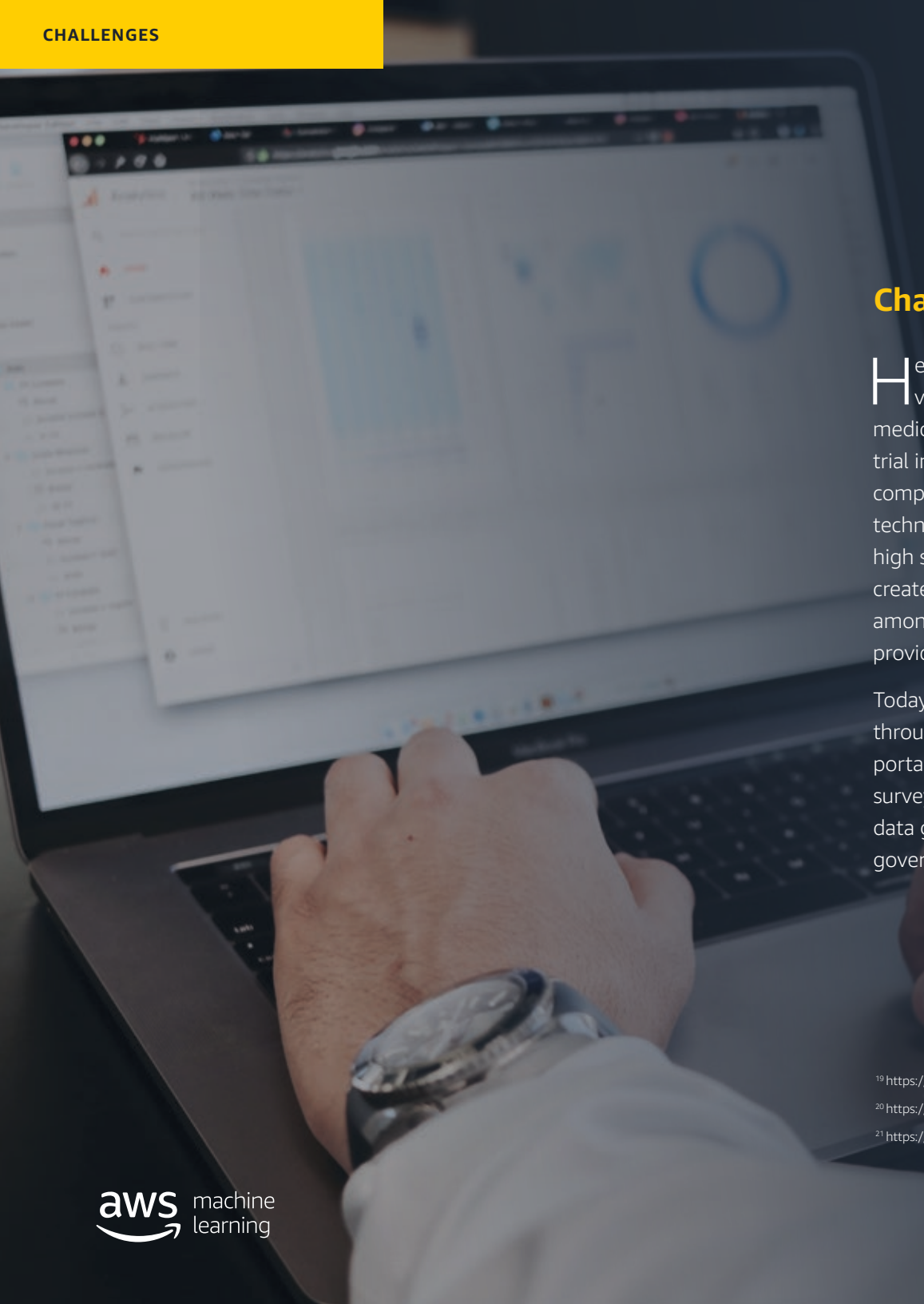

Challenge: Complexities of analyzing health data

Healthcare and life science organizations are finding it difficult to extract valuable insights and drive decisions using the data generated from medical health records, medical devices, mobile health applications, clinical trial information, and population health management solutions. Factors complicating the use of health data include hesitancy over introducing new technology into processes that may have life or death consequences, overly high standards for analytics solutions, privacy concerns and regulations that create resistance against open and shared data, and misaligned incentives among the various parties that control the data—such as insurers, multiple providers, and patients themselves.[19]

Today's healthcare providers are striving to make better use of their data through solutions that enhance patient engagement, like interactive patient portals.[20] But adoption of data-driven technologies has been slow: A 2017 survey found that 56 percent of U.S. hospitals had incomplete or nonexistent data governance processes in place (or were unaware of what, if any, data governance their organizations had implemented.)[21]

[19] https://www.brookings.edu/research/the-opportunities-and-challenges-of-data-analytics-in-health-care/

[20] https://hitinfrastructure.com/news/healthcare-data-integration-continues-to-challenge-entities

[21] https://aws.amazon.com/machine-learning/elastic-inference/

Solution: Amazon Comprehend Medical + Amazon Forecast

Amazon Comprehend Medical makes it easy to use machine learning to extract relevant medical information from unstructured text. Using Amazon Comprehend Medical, organizations can quickly and accurately aggregate data—such as medical condition, medication, dosage, strength, and frequency—from a variety of sources like doctors' notes, clinical trial reports, and patient health records. The solution then prepares the information so that it's ready to be plugged into analytic and predictive models that empower organizations to make better use of data, prompting better decisions that lead to healthier outcomes for provider and patient alike.

Amazon Forecast is a fully managed service that uses machine learning to combine time series data with additional variables to build forecasts. The solution can drive better use of patient data by accurately predicting factors like availability of hospital beds, medical supplies, and operating rooms—thereby reducing time and cost issues associated with underbooking or overbooking.

Benefit: Unlocking the potential of healthcare and life sciences data

AWS enables customers and partners to build secure, compliant, and scalable solutions for the delivery and exchange of medical information across the healthcare and life sciences industry. AWS provides the technology and tools needed to facilitate interoperability. These urgent capabilities streamline the structured data exchange needed to improve preventive and value-based care for people, patient safety, predictions, diagnostics, care quality, cost reduction, and clinical research.

Another AWS customer, Matrix Analytics, uses machine learning to find previously undiscovered insights hiding in data for patients diagnosed with pulmonary nodules in their lungs. LungDirect, the company's flagship software application, leverages five machine learning models to predict malignancy risk and automate follow-up care, outperforming previous methods in their ability to diagnose cancer from a CT image.[22]

[22] https://aws.amazon.com/blogs/machine-learning/matrix-analytics-uses-deep-learning-on-aws-to-boost-early-cancer-detection/

Challenge: Increase in financial pressures and shift toward value-based care

Owing to an escalation in chronic conditions—as well as general aging of the population—health systems across the globe are experiencing intense financial pressures. Chronic conditions represent 75 percent of healthcare spending, and the proportion of elderly patients in the population is growing—people age 55 and over made up 29 percent of the population but accounted for 56 percent of all health spending in 2016.[24] This is driving providers around the world to seek new ways to reduce costs, while regulators are providing incentives for (or requiring) providers to implement payment models designed to reduce costs of the system as a whole, such as value-based reimbursement models.

Governments around the world are grappling with systemic issues and are implementing payment reforms to better engage the provider community in cost management and improved outcomes while simultaneously encouraging patient engagement (often referred to as "pay for performance," "value-based care," and/or "accountable care").

[23] https://www.chronicdisease.org/page/whyweneedph2imphc

[24] https://www.healthsystemtracker.org/chart-collection/health-expenditures-vary-across-population/#item-people-age-55-and-over-account-for-over-half-of-total-health-spending_2016

Solution: Amazon Forecast

Amazon Forecast helps organizations manage and reduce costs by accurately predicting the availability of hospital beds, medical supplies, and operating rooms. This eliminates waste by enabling organizations to scale down during periods of low usage and curbs inefficiencies by helping providers ensure they are fully staffed and prepared during the periods of greatest need. By more accurately predicting financial outcomes, Forecast can also help organizations make the shift to value-based care with fewer risks, greater efficiency, and maximum return on investment (ROI).

All of the solutions included in this eBook help relieve financial pressures in their own ways. Amazon SageMaker allows organizations to easily create predictive models that can recognize opportunities for cost savings and potentially ease the transition to value-based care. Amazon Comprehend Medical transforms data into insights that empower smarter financial decisions. Amazon Transcribe Medical enables providers to use their time more efficiently by accelerating the normally slow and costly transcription process. The AWS Partner Network helps organizations create financially best-of-breed solutions from multiple vendors, while AWS Cloud Security and Amazon Fraud Detector mitigate costs associated with cybercriminals and other bad actors.

Benefit: Putting care and costs on the same page

AWS enables both innovation and cost improvements through the use of our services or solutions delivered through the healthcare and life sciences network. AWS Machine Learning—as well as offerings across big data, analytics, and automation—can help organizations reduce costs and improve quality of care by optimizing clinical and operational performance.

More specifically, machine learning on AWS modernizes care infrastructure and reduces costs by automating workflows. It improves decision making by understanding, analyzing, and freeing the insights and relationships that are trapped in free-form medical text across hospital admission notes, patient medical histories, and countless additional systems.

Beth Israel Deaconess Medical Center, a Harvard Medical School-affiliated teaching hospital, uses AWS Machine Learning to enhance clinical care, streamline operations, and eliminate waste. By intelligently automating workflows and more accurately forecasting needs and risks, the hospital can now optimize operating room schedules, save its staff hours of manual work by digitally delivering pre-surgical document packages, and reduce costly procedure delays and rescheduling.[25]

[25] https://aws.amazon.com/blogs/machine-learning/improving-patient-care-with-machine-learning-at-beth-israel-deaconess-medical-center/

Challenge: Increasing cyberattacks and online fraud

In 2018, data breaches resulted in the theft or exposure of more than 13 million healthcare records (a 157 percent increase from 2017), costing the affected organizations a total of nearly $28.7 million in HIPAA fines and settlements alone.[26] Unlike most other industries, the majority of healthcare data breaches (59 percent) are the result of internal actors rather than external attacks.[27] Healthcare and life sciences technology must therefore focus on more than keeping the bad guys out—it must provide widespread protection that can recognize and reduce internal human errors as well.

Solution: AWS Cloud Security + Amazon Fraud Detector

AWS Cloud Security protects healthcare and life sciences organizations from cyberattacks, with the most flexible and secure cloud computing environment available today. Organizations benefit from AWS data centers and a network architected to protect information, identities, applications, and devices.

With AWS, providers can improve their ability to meet core security and compliance requirements, such as data locality, protection, and confidentiality.

Amazon Fraud Detector is a fully managed service that makes it easy to identify potentially fraudulent online activities such as online payment fraud and the creation of fake accounts. The solution leverages clinical data, machine learning, and more than 20 years of fraud detection expertise from Amazon to automatically identify potentially fraudulent online activity.

By combining AWS Cloud Security and Amazon Fraud Detector, organizations can leverage machine learning and other intelligent technologies to better keep bad actors in check—from both outside the company and from within. This reduces the frequency and cost of breaches while accelerating regulatory compliance and inspiring confidence and trust in the organization's ability to maintain data privacy.

Benefit: Providing a trusted platform

At AWS, security and privacy remains job zero. We provide a number of global certifications and accreditations (HIPAA, HITRUST, GDPR, and others) that allow customers to store, process, or transmit their most sensitive data in the cloud while improving their security and compliance posture. Most importantly, our shared responsibility model ensures ownership and control of data remain with the customer at all times.

Pharma and biotech company Bigfinite operates an analytics platform that uses machine learning, AI, and other intelligent technologies to improve productivity and compliance at pharmaceutical manufacturing sites. After meeting and collaborating with the AWS healthcare and life sciences team, the company chose to build its platform on AWS because of its demonstrated ability to meet a wide range of compliance needs—particularly the set of best practices known as GxP.[28]

"By taking advantage of AWS, we can analyze huge amounts of data using the most secure platform and the most advanced technology in a 24/7 environment," said Pep Gubau, CEO, CTO, and cofounder of Bigfinite.

[26] https://www.hipaajournal.com/healthcare-data-breach-statistics/

[27] https://enterprise.verizon.com/resources/executivebriefs/2019-dbir-executive-brief-emea.pdf

[28] https://aws.amazon.com/solutions/case-studies/bigfinite/

AWS Machine Learning and Artificial Intelligence solutions

AWS offers the broadest and deepest set of tools for healthcare and life sciences organizations to create impactful machine learning solutions faster.

That's why tens of thousands of customers, from the largest enterprises to the hottest startups, choose AWS Machine Learning—more than any other cloud platform. Here's a list of some of the services we offer:

Artificial intelligence (AI)

Amazon CodeGuru »
Automate code reviews

Amazon Comprehend »
Discover insights and relationships in text

Amazon Comprehend Medical »
Extract information from unstructured medical text

Amazon Forecast »
Accurate time-series forecasting service

Amazon Fraud Detector »
Detect more online fraud faster

Amazon Kendra »
Highly accurate enterprise search service

Amazon Lex »
Conversational interfaces for your apps

Amazon Personalize »
Real-time personalization and recommendation

Amazon Polly »
Turn text into lifelike speech

Amazon Rekognition »
Automate your image and video analysis

Amazon Textract »
Easily extract text and data from virtually any document

Amazon Transcribe »
Automatially convert speech to text

Amazon Transcribe Medical »
Automatically convert medical speech to text

Amazon Translate »
Natural and accurate language translation

Machine learning (ML)

Amazon SageMaker »
ML for every developer and data scientist

Amazon SageMaker Ground Truth »
Build highly accurate training datasets

Amazon SageMaker Neo »
Train models once, run anywhere

Amazon Augmented AI (Amazon A2I) »
Implement human review of ML predictions

Amazon Elastic Inference »
Reduce ML inference costs

AWS Deep Learning AMIs »
Pre-configured environments for building deep learning apps

AWS DeepLens »
Deep learning enabled video camera for developers

AWS DeepRacer »
Racing simulator for hands-on ML training

AWS DeepComposer »
Musical keyboard for hands-on ML training

aws machine learning

Machine learning is improving global health—creating a healthier, happier world

Machine learning is more than just an equalizer that helps organizations to operate at acceptable levels—it's an evolutionary leap in technology that empowers healthcare and life sciences companies to offer higher levels of care and achieve healthier patient outcomes than ever before.

By creating and using solutions powered by AWS Machine Learning, organizations can operate with the confidence of knowing they have a trusted platform that helps them meet regulatory and privacy standards more reliably. AWS Machine Learning enables these organizations to unlock the potential of their data, so they can:

- Uncover potentially lifesaving insights
- Enable clinical and operational excellence
- Drive personalized relationships with consumers and patients
- Increase the speed of innovation
- Activate a healthcare/life sciences partner network
- Achieve better outcomes at lower costs

With AWS Machine Learning, healthcare and life sciences companies and providers are powering a new level of clinical excellence, driving better medical results across the entire patient lifecycle—from the very first stages of research to devices and services that help patients in their daily lives to interactions with providers—and beyond. From there, AWS Machine Learning reaches into executive boardrooms, enabling intelligent, data-driven decision making that improves operations and financial results.

Finding the right balance between patient and business outcomes will always be challenging. But AWS Machine Learning brings us closer, helping executives, providers, and patients all align with the common goal of creating a healthier, happier world.

Learn more at aws.amazon.com/health »

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