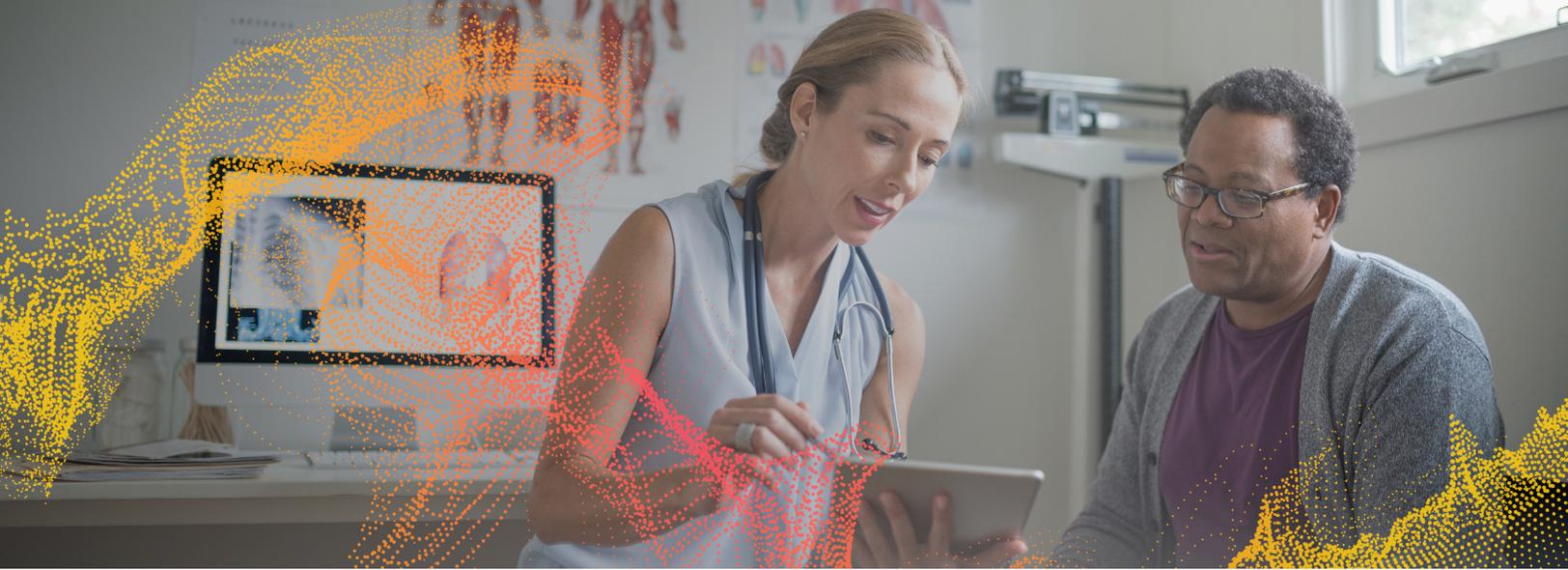


# From Diagnosis to Holistic Patient Care, Machine Learning is Transforming Healthcare





*Cerner's voice recognition tool passively listens to clinician and patient conversations. Users speak without interruption, while the solution processes what's said and returns essential data. The tool provides diagnoses, one-click ordering, as well as potential allergies, all based on the conversation between the patient and clinician.*

### **Picture family members escorting a shaky elderly relative into the**

hospital emergency department after a fall down the stairs. The patient is complaining of a headache, but a crisis doesn't look imminent. It's a Friday, a busy night in the local ER. There are 85 patients already on the radiologist's work list, and a likely two-hour wait before the patient's massive—and massively dangerous—pulmonary embolism is discovered on the scans.

That is, until now. After years of digitizing patient records and leveraging the cloud, the healthcare industry has created a massive and still-growing pool of data. That data, used by analytical tools and increasingly machine learning, can drive everything from streamlining hospital workflows to promoting early detection of cancer or a pulmonary embolism.

“**Digitization was really the first step. The real power is in how you get second-order effects out of that digitization.**”

Ryan Hamilton, Senior Vice President of Population Health, Cerner Corp.

Companies like Cerner, Aidoc, and Arterys are taking advantage of Amazon Web Service's (AWS) high-speed, high-volume data storage, processing and retrieval in the cloud, and machine learning tools to develop and apply machine learning algorithms—driving positive outcomes for patients and medical staff alike.

# The Rise of Machine Learning Algorithms in Healthcare



## Machine Learning Algorithms

Hamilton says now that machine learning has proven to be a viable resource for healthcare providers, the next step is scaling the creation of intelligence and its integration back into the workflow at the point of decision-making. Cerner itself is building complex analytical tools that draw on the volumes of secure, anonymized patient data it already has access to: medical diagnosis and treatment outcomes, financial outcomes from claims and coding, billing tools, predictive hospital staffing models, and more. Take, for example, an ER like the one the embolism patient visited. Facilities across the U.S. struggle with staffing challenges. With one of its machine learning algorithms, Cerner can draw on historical data to predict patient volumes and staff the ER accordingly, days in advance. This proactive algorithm helps ensure that doctors and nurses aren't stretched thin during their shifts, and that patients are seen more quickly and receive quality care.



## Building Blocks

Cerner hopes to leverage rapidly advancing machine learning through Amazon SageMaker to explore additional applications, using its anonymized, HIPAA-compliant records.

"AWS is giving us access to tools and techniques, whether they're basic building blocks or complex ecosystems, like SageMaker. Historically, that would have been things we had to invest in and invent on our own," Hamilton says.

Still, Hamilton says, Cerner won't be able to build all the algorithms the market needs. The company already works with partners to build machine learning models within the Cerner ecosystem. To truly see impact at scale, however, he sees a need for a broader collaboration.



## Making Decisions When it Matters: Improving Diagnosis

Luckily, Cerner is far from the only company using AWS machine learning capabilities to develop healthcare models. Developing speed and accuracy in machine learning models is an exciting application of the technology.



***Everything improves if you get to that patient in time."***

Elad Wallach,  
Aidoc CEO

Think again of that elderly patient who was waiting for the results of his CT scan. Smart radiology start-up Aidoc would accelerate the review process. The company's deep learning algorithm draws on knowledge from millions of past records to accurately identify the growing embolism, then immediately places a red flag on the patient's images in the ED radiology queue. Rather than sifting through the scans in chronological order, the anomaly is pushed to the top and the patient is rushed to critical care.

"Everything improves if you get to that patient in time," says Aidoc CEO Elad Wallach. Now deployed in hundreds of facilities worldwide, the Aidoc technology has already seen measurable results: At a major East Coast medical center, machine learning applied to CT images reduced lengths of stay by three-fourths of a day, and reduced time spent in the ED by 59 minutes. A similar prospective study reduced the ER turnaround time of CT scans for intracranial hemorrhages from 53 minutes to 46 minutes.

In addition to being life-saving for patients, this kind of support is sorely needed by doctors as well. Limited staff in radiology departments in particular can cause strain, but some 65% of doctors across disciplines report feeling overworked. Machine learning tools can alert doctors to anomalies in scans and flag possible diagnoses for doctors to review, saving doctors valuable time in the review process.



### Simplifying Doctor's Workflow

Arterys, another groundbreaking firm using AWS to build and host machine learning algorithms in health, is basing its entire platform to help doctors be more efficient with their review and diagnosis of patients' conditions. The company spent years in development of a powerful viewer interface for medical professionals to access medical images, run AI models within a clinical workflow, and do comparative analysis. While the platform has a wide variety of technologies at work through AWS to improve the doctor's workflow (from reporting capabilities to high-resolution imaging), machine learning is improving the diagnostic imaging process.



### Using Machine Learning to Enhance Diagnosis Process

Arterys began exploring diagnostic applications of machine learning with heart defects in newborns and young children. These anomalies were previously detected through ultrasound, which offered only partial views and couldn't calculate blood flow abnormalities. Using AWS Machine Learning and cloud instances, the platform easily handles the massive data crunching needed to create and compare useful pictures of blood flow. Cardiac analysis time has been cut from 40 minutes to six minutes.



***By combining the power of AI and the AWS cloud, everyone around the world can have a chance at early-stage cancer diagnosis and an increased chance of survival."***

Fabien Beckers,  
Arterys Founder  
and CEO

Arterys then explored applications of machine learning diagnosis to cancer—specifically, lung cancer (the leading type of cancer death). Historically, radiologists would painstakingly look through the scans to try differentiate nodules in the lung from cancerous lesions. With AWS, a new image is compared to hundreds of thousands of similar cases almost instantaneously to identify these nodules leading to greater accuracy and productivity. Professionals can then work within the system to access multiple views from multiple time points, and see likely growth models for nodules over time automatically. More than 100 hospitals and imaging centers around the world now use Arterys seamlessly in their imaging workflow.

With thousands of AI models created around the globe, and no easy way to deploy them into the clinical workflow, the Arterys platform enables these to be deployed via a simple web browser. Arterys is building a world where clinical care is data-driven, intelligent, and patient focused.



# Machine Learning Powers a Holistic Approach to Healthcare

All three companies working with machine learning through AWS agree: This is only the beginning. While they've accessed unprecedented levels of scale through AWS Machine Learning, there's plenty of work still to come in applying machine learning's success in diagnosis in other areas of healthcare.

Hamilton envisions machine learning creating more opportunities for patients to have productive conversations with their healthcare providers. The company is currently developing natural language processing (NLP) technology that could free doctors from entering data into their laptops by intelligently listening to the dialogue in the exam room; the NLP model can take notes and pull up relevant test results or images. Background applications might surface alternative diagnoses for the doctor based on millions of records.

"Hey" the doctor texted,



***I thought you would be glad to know that Aidoc just saved one patient's life."***

Ed Wallach,  
Aidoc CEO

And the care doesn't end when the visit is over: Back at home, the patient might receive interactive prompts: "Did you fill your prescription? Would it help if we delivered it?" Remote monitoring of wearable technology could congratulate the patient for reaching 3,000 daily steps or warn case managers that rapid water weight gain indicates pending heart failure.

The goal, Hamilton said, is "trying to get to a conversational healthcare workflow not a visit-oriented, venue-oriented workflow."

While these possibilities continue to drive excitement around machine learning, companies agree that the progress to date is gratifying—especially when it can save a life. Wallach says he's continuously motivated by the direct messages he gets from doctors on a weekly basis—including a recent one about an ER patient with a massive pulmonary embolism.