


# The **Hospital of the Future** Starts Today

A surgeon in a blue scrubs and mask is performing surgery in an operating room. The scene is overlaid with a network diagram consisting of blue lines and nodes, symbolizing technology and data. In the background, another surgeon is visible, and the operating room lights are on. The overall color scheme is blue and white.

From electronic health records to the practice of precision medicine, **technology has fundamentally changed the way we practice patient care.**

## WHERE WE WERE

Scalpels, syringes, stethoscopes, and microscopes, all are examples of significant technical advances in medical care for their time. These instruments were developed to not only help doctors with efficiency but also to improve patient treatment.

Today, this practice remains unchanged. Advancements in the medical industry are still based on the principle of bettering patient care while increasing efficiencies for physicians and healthcare providers.

## Where we're going

**Technology enables us to leap forward in the way healthcare professionals deliver patient care.** From quickly pulling up patient health records to sequencing genomes, to digitizing pathology slides, technology is driving progress forward.

**Data managed in the healthcare industry grew by 878% from 2016 to 2018.**

Source: 2019 Dell EMC Global Data Protection Index Survey

2016

2018

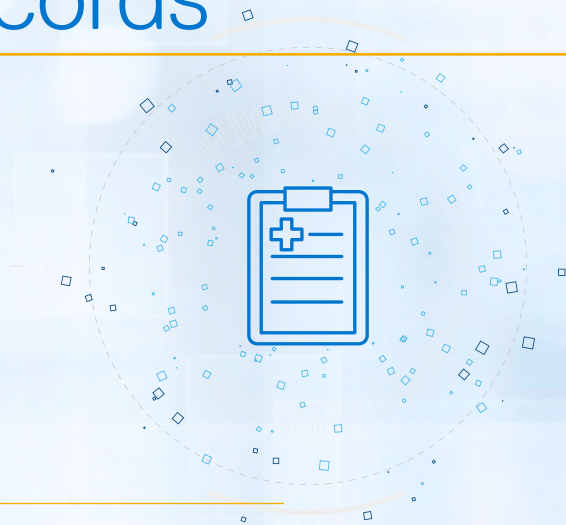
One of the most powerful components of medical advancement is data, which is comprised of health records, medical imaging, and analytical data being sent from Edge, Internet of Things (IoT) devices, and wearables.

The information gathered in this way is one of the greatest resources a health institution can have. However, it would be nearly impossible for an individual to analyze all the data for one patient, never mind all the patients they treat.

**When it comes to data, technologies like Artificial Intelligence (AI) and Machine Learning (ML) make a substantial impact on the speed in which we collect and analyze data.** Deep Learning thrives off processing more and more data and continues to learn, making algorithms even smarter. So, what does this mean in healthcare? This paper will outline the emerging workloads we see in healthcare institutions today and how AI and ML, along with new technology, can change patient care.

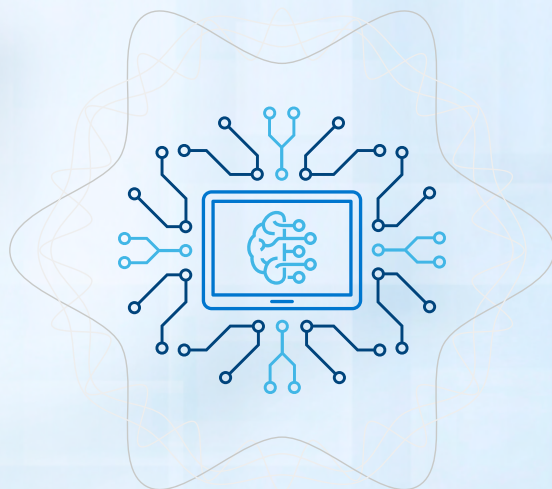
# Electronic health records

**When technology in healthcare is mentioned, most people think about Electronic Health Records (EHR).** EHRs have become the standard for storing patient records, greatly increasing the quantity of data that physicians have on a patient at any given time. This portfolio of patient data encompasses a large portion, if not their entire medical history, and it enables physicians to make an educated diagnosis and treatment plan.



**But some doctors have struggled to adopt EHRs, which require extensive IT integration into the patient and physician relationship.** The real-time availability of patient data has forced doctors and other clinicians to interact with devices in front of their patients, which can lead to feelings of disconnect. If this practice is completed after the exam, crucial information can be left out of the record by mistake and can distract doctors from effectively running their practice.

**With the introduction of a type of AI called Natural Language Processing (NLP), doctors can use spoken language to add information to EHRs.** NLP is a computer's ability to comprehend natural language intelligently. It is not much different than your smart speaker, which processes questions you are presenting to provide an answer. While AI is working in the background populating the patient's record, doctors can engage with their patients instead of a computer. A crucial aspect of this advancement is the time it would give doctors back to spend with patients and avoid burn-out.

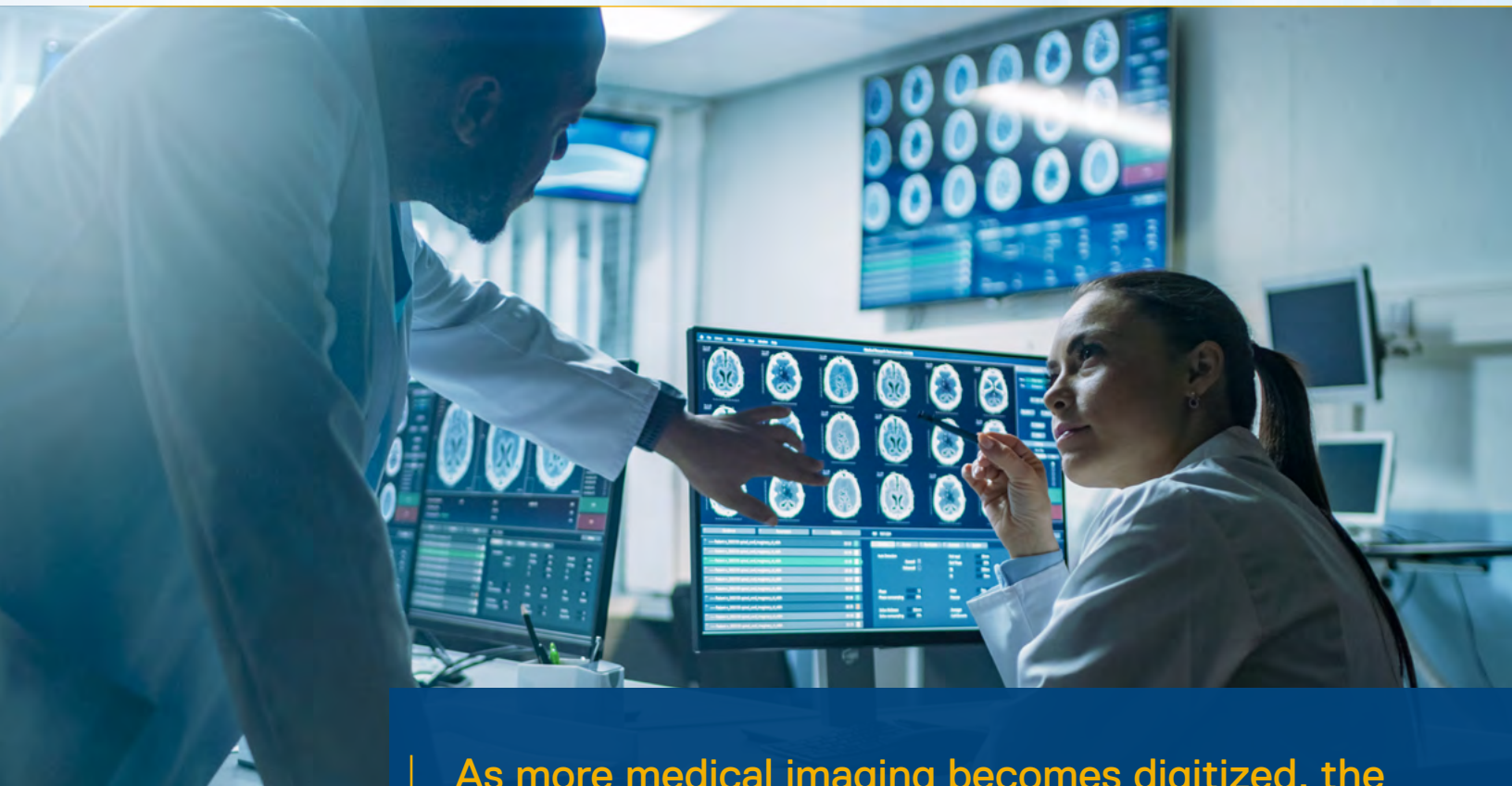


# Medical imaging

**Electronic imaging, or the digitizing of medical imaging, changed the world of radiology.** The idea of shifting from film to filmless was as disruptive as changing from paper charts and folders to EHRs. Skip ahead to the current day, and the advances in medical imaging have been vast. Hospitals have entire Picture Archiving and Communication Systems (PACS) devoted to storing and accessing departmental medical images.

**A common practice with medical imaging has been the deployment of vendor-neutral archives or VNAs.** The shift from departmental siloed imaging storage to a VNA allows for physicians to look at inter-disciplinary images within the patient's records — meaning a doctor can get a full view of the patient in their care.

**Medical imaging encompasses everything from MRIs, CT scans, and X-rays to sonograms, mammograms, bedside imaging, and now even pathology.**



**As more medical imaging becomes digitized, the doors open to more advancements in healthcare.**

# Digital pathology

Traditionally, samples from patients were taken and sent to the pathology department, where they were placed on glass slides and examined under a microscope. This process worked well, but it suffered from a few downfalls. Second opinions were completed by sending glass slides in the mail from one location to another, with all of the risks associated with sending medical samples in the mail. Slide retention meant keeping glass slides at a secure site for a predetermined amount of time. In today's digital world, this is not an appropriate allocation of resources.

With digital pathology, whole slide imaging scanners can read and digitize samples. This gives pathologists a high-resolution image that can be viewed on large monitors by multiple doctors at once. These images can also be sent electronically anywhere in the world in a matter of seconds for expert analysis, which reduces time to diagnosis and accelerates time to treatment.

The diagnostic pathology process is long and complicated. AI can improve the accuracy of diagnosis and help automate many of the manual time-intensive steps, such as sample identification, disease pattern recognition, and clinical pathology classification. The final decision still rests with pathologists, but AI/ML augmented decision trees gives them time to focus on more challenging cases, reducing the administrative work associated with handling every sample, even the ones that are disease-free.

Convolutional Neural Networks are mostly used for image classification. As an AI algorithm analyzes medical images, they can be flagged for a review by a medical professional if the algorithm spots any missed abnormalities, which is a more efficient use of specialists' valuable time.

**An emerging imaging workload for healthcare and research institutions across the globe is digital pathology.**

**Like most medical imaging, digitizing whole slide images produces enormous file sizes, which requires data storage.**

But once stored, these digital images open the door for AI/ML analysis.

**According to a study in 2016 by PathAI, Pathologists who leveraged AI to help them analyze and diagnose were more accurate in their findings than pathologists alone.**

Therefore, by working with AI and ML, doctors can provide better care.

**AI can be applied to other medical imaging as well with the use of CNNs.**

# Precision medicine

Precision medicine or personalized medicine indicates a fundamental shift in patient care. The ability to build a specific treatment plan for patients based on their genome was once thought to be impossible. Today, life sciences and healthcare institutions are leveraging Next-Generation Sequencing (NGS) with other practices such as digital pathology to make this a reality. Years ago, it took 10 years and 3 billion dollars to sequence an entire genome. Now, the technology exists that allows institutions to sequence 1,000 whole genomes in a single week with a cost of \$3,000 per genome. These advancements bring this technology to more medical professionals for use with the broader public.

For example, an oncologist can discover a tumor in a cancer patient and send a sample to pathology. Using digital pathology, one of the top pathologists in the world for the specific cancer can quickly analyze the slide and discover the patient needs immediate treatment. Not only can the genome of the patient be sequenced, but so can the tumor. Because of what was found in the genome, the oncologist can create a personalized treatment plan known to be effective on this exact type of cancer. This is not the future; this is happening today due to advancements in human progress and technology.

# 5G/Telemedicine

Many IoT and wearable devices send data over a local network or through the internet on a wireless network. Sending data over a wireless network can be susceptible to bandwidth issues like any other workload. This is what makes the introduction of 5G so crucial to healthcare. As data and analytics are sent and reviewed faster, patient outcomes improve.

**5G will reduce the latency commonly found on 4G networks by 95%, down to 5 milliseconds.**

*Source: Hans Vestber, Verizon CEO, 2019 Consumer Electronic Show*

5G also opens the door to advancements in telehealth. Physicians delivering care in rural parts of the globe can leverage 5G and cloud computing to build out EHRs, treat and communicate with patients, and monitor outcomes regularly. This would bring professional healthcare to even those who it was not accessible to before.



# Wearables & IoT

The Internet of Things, as it relates to healthcare, allows for real-time data monitoring and analysis using medical devices and wearables connected to a network. Like many other industries, internet-enabled medical monitoring devices found in hospital rooms to wearable devices such as fitness trackers provide vast information streams, opening the door for exponential data growth. **The average number of connected devices per hospital bed in the U.S. is 10 to 15.<sup>1</sup>**

IoT in healthcare has led to a massive amount of data production. By 2020, McKinsey estimates that medical data will double every 73 days.<sup>2</sup>

According to BMRC, connected devices allow healthcare providers to do such things as monitor patients from great distances, manage chronic disease, and manage medication dosages.<sup>3</sup> The data can be collected from inside or outside the hospital. Data from these devices may be added to clinical research to give more insight into the participant's experiences. Whether it is a simple data analysis from heart monitors to catching a heart attack before it happens or tracking a patient's blood sugar using a wearable device to keep their diabetes under control, the data can allow institutions to practice preventative medicine.<sup>4</sup>

Analyzing the individual data sent from each of these devices would be impossible. Using AI at the Edge of the network, data streams can be interpreted in real-time with abnormalities flagged for review. This can be seen with video surveillance in hospitals where AI runs against video feeds of hallways and patient rooms, alerting staff to respond to patients that might have fallen or failed to take their medication on time.

Edge gateways reduce transfer and storage costs of large data sets by locally processing, buffering, filtering, and securing data. Using analytics as an aggregator and filter at the Edge can result in the following:



Improving patient safety and monitoring recovery through computer vision solutions in the hospital and at home



Expanding chronic disease management and preventative medicine with sensors that can alert providers to clinically meaningful changes and recommend early intervention



Managing pharmaceuticals and hindering drug diversion by tracking medication from manufacture to consumption

Source: [Dell Technologies, 21 JAN 2020; At the Cutting Edge of Healthcare: IoT Data in Preventative Care. Retrieved 18 FEB 2020.](#)

<sup>1</sup>Marco D. Huesch, MBBS, PhD & Timothy J. Mosher, MD; *Using It or Losing It? The Case for Data Scientists in Healthcare.*

<sup>2</sup>Bernard Marr, *Forbes, The 9 Biggest Technology Trends That Will Transform Medicine And Healthcare In 2020, November 2019, citing McKinsey & Company*

<sup>3</sup>BMRC-Brandessence Market Research & Consulting Pvt Ltd, *Global Internet of Things (IoT) in Healthcare Market: Global Market Size, Trends, Competitive, Historical & Forecast Analysis, 2019-2025*

<sup>4</sup>Porumb, M., Stranges, S., Pescapè, A. et al. *Precision Medicine and Artificial Intelligence: A Pilot Study on Deep Learning for Hypoglycemic Events Detection based on ECG. Sci Rep 10, 170 (2020).*

# Dell EMC Storage for healthcare

The healthcare industry is developing and changing at an incredible rate, with technology becoming the driving force. Yet, the workloads and emerging technology above only touch the surface of what Health IT and medical professionals are experiencing. By using our technology to improve the accessibility and betterment of healthcare, it is our commitment that by the year 2030, together, we will have helped one billion people.



## DELL EMC POWERMAX

### NVMe Data Storage

When patient data is needed at the point of care, PowerMax gives healthcare providers access at lightning speeds. Architected with Storage Class Memory & NVMe to deliver incredible performance, PowerMax has speeds of up to 15 million IOPS,<sup>1</sup> 350 GB per second bandwidth,<sup>2</sup> and under 100-microseconds read response times.<sup>3</sup>

PowerMax starts as small as 13TB and offers true multi-dimensional scale up to 4PB. With the ability to scale up and out, you have the flexibility to expand capacity and performance for the ever-growing data-driven world of healthcare.

PowerMaxOS offers innovations such as a built-in machine learning engine that ensures maximum performance with no management overhead to allow for consistent SLAs on both EHR and non-EHR workloads.

<sup>1</sup>Based on Dell EMC internal analysis of random read hits max IOs per second within a single array on 2 floor tiles with PowerMax 8000, July 2019.

<sup>2</sup>Based on Dell EMC internal analysis of random read hits max GB per second within a single array with PowerMax 8000, July 2019.

<sup>3</sup>Based on Dell EMC internal analysis using the OLTP2 HW benchmark for a single PowerMax 8000 array, July 2019.



## DELL EMC ISILON

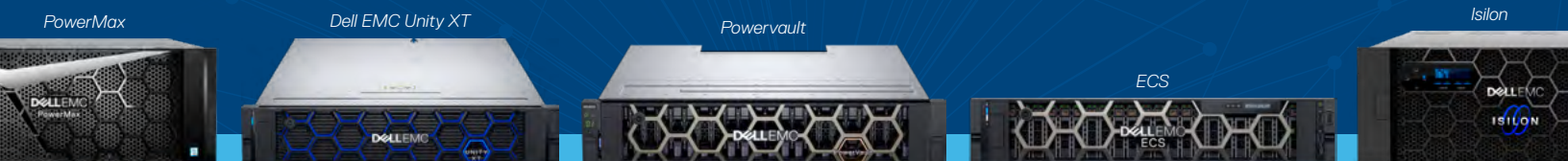
### Scale-Out Network Attached Storage

Dell EMC Isilon scale-out NAS enables you to drive medical and AI initiatives forward with confidence by delivering reliable, performant, and cost-effective storage at nearly any scale. Isilon enables consolidation of medical imaging onto a single storage cluster, including radiology PACS, cardiology PACS, Vendor Neutral Archives, and current digital pathology systems.

Automated tiering with SmartPools<sup>®</sup> can also be configured, enabling intelligent placement of data on cost-effective storage.

With its legendary OneFS operating system, Isilon is incredibly easy to manage. OneFS creates a single shared pool of storage, eliminating multiple volumes or silos. Clinical and research data is kept safe and secure with data at rest encryption (D@RE), self-encrypting drives, and replication.

Multi-cloud connectivity allows you to leverage both on-prem and off-prem solutions.



To learn more about how our storage products enable hospitals to be on the cutting edge of Health IT

visit [DellTechnologies.com/Healthcare](https://DellTechnologies.com/Healthcare)