



AWS Outposts bring the power of Amazon Cloud on premises for the healthcare industry

The medical industry is experiencing a paradigm shift, focusing on putting the patient at the center of care and delivering precision healthcare from diagnosis to treatment to wellness. This focus on value lowers costs for patients and, in many cases, is incentivized by the government and insurance companies, encouraging healthcare providers to get and keep their patients healthy. The departure from fee-for-service healthcare requires a new set of technologies and tools that accelerate provider access to patient data.

The rise of electronic health records and innovations in medical diagnostics are giving doctors and research access to critical information that can significantly improve health outcomes for patients. The challenge is extracting value from that data quickly to provide speedy individualized care without overrunning budgets.

In fact

48%



of hospital CEOs say the transition from fee-for-service healthcare to fee-for-value healthcare **is one of their biggest financial challenges.**ⁱ

Healthcare providers want to focus on providing quality care, not managing and monitoring IT solutions. Many providers and research facilities have modernized applications in the cloud to capitalize on rapid pace of innovation, elastic scalability, and robust security. The unprecedented breadth of cloud technologies has driven many advancements, and its potential for use in developing innovative new therapies is enormous. The ability to store information and run workloads without excessive capital outlay benefits all types and sizes of healthcare organizations.

However, much of the data that doctors rely upon to achieve higher levels of service is generated on premises. Clinics and hospitals need to rapidly process patient data such as images from scans to provide quick analysis. Research labs generate TBs of data that needs to be processed on-premises as transmission to the cloud for processing is not efficient. These applications need to run on premises because of latency and real-time data processing requirements.

Managing and maintaining on-premises infrastructure is an undifferentiated heavy lifting for many healthcare organizations. Healthcare solution providers need to manage application deployments, patches, and upgrades across hundreds of sites. Health care providers and research facilities are looking for new ways to manage on-premises IT infrastructure so they can focus on driving innovation and delivering value.

While many medical software solution providers and clinics are innovating rapidly in the cloud, their on-premises environments tend to lag the cloud in innovation. The ability to leverage emerging technologies, including artificial intelligence (AI), machine learning (ML), and analytics seamlessly, in order to develop new applications for their on-premises use cases could allow providers to offer even greater value to the patient. However, there is significant overhead in implementing these modernization initiatives.

In this paper, we will discuss how AWS Outposts is redefining the relationship between cloud and on-premises computing, and revolutionizing hybrid

“A hybrid cloud strategy is now common among healthcare providers. The balance between on-premises and cloud-based services continues to shift toward the cloud as provider organizations take on more IaaS and PaaS solutions.”ⁱⁱ

cloud computing in the process. AWS Outposts delivers a truly seamless hybrid cloud experience that gives healthcare organizations and research institutions all the advantages of the Amazon Cloud—data storage, compute power, advanced technologies, and more—while supporting on-premises requirements for low latency and data processing.

AWS Outposts delivers AWS-designed infrastructure, services, application programming interfaces (APIs), and tools to customers' on-premises locations to support applications that run on premises for low latency or local data processing needs. AWS Outposts is a fully managed service that removes the overhead associated with designing, procuring, and managing infrastructure, thereby improving IT efficiency and reducing operational risk. AWS Outposts delivers the scalable, flexible, and robust infrastructure that healthcare providers and facilities need to be able to provide innovative paths to better healthcare outcomes.

Data is the Driver Behind Better Healthcare Outcomes

2,314
Exabytes

The estimated amount of medical data that will be produced by 2020.ⁱⁱⁱ

\$14B

The value of the healthcare analytics market in 2019.^{iv}

\$50.5B

The estimated value of the healthcare analytics market by 2024.^{iv}

NEED TO RUN APPLICATIONS ON PREMISES



The Cost of Latency

Doctors, lab technicians, and other healthcare providers need rapid access to data, images, and test results. When on-premises equipment has to access the cloud for data processing, the delay between a request for information and the resulting response—latency—may be unacceptable. In addition, patient medical records that need to be accessed on a timely basis often reside in on-site electronic health and medical records systems, where cloud adoption has been slow. To make medical imaging useful for healthcare providers and their patients, the huge data files produced by radiology, scans, mammography, ultrasound, cardiology, and other diagnostic technologies must be processed and analyzed quickly. So, as healthcare providers are moving their traditional datacenters to the cloud, they find that they need to run some applications on premises in order to execute localized workflows for faster response times.



The Limitations of Local Data

Many healthcare organizations have limited bandwidth back to the AWS Cloud from their clinics, labs, or other data-producing sites. They need to be able to store data files locally for low-latency, high-throughput data analysis. In the case of storage-intensive workloads that produce hundreds of terabytes of data each day, the transmission of large volumes of data to the cloud can be both time-consuming and expensive. Additionally, medical facilities and research institutions have certain data sets that must be anonymized or normalized on premises prior to transmission to the cloud.



Workload Migration and Application Modernization

Many medical industry applications developed on premises, including mission-critical solutions such as electronic medical records (EMR) systems, have not been modernized in the cloud. While organizational leadership recognizes the value of application modernization, custom-built, legacy applications that have monolithic, traditional architectures cannot be migrated to the cloud in one go. Additionally, many of these applications have low-latency dependency on datastores that must remain on premises.

Many healthcare technology providers have modernized their solutions in the cloud using industry-leading AWS services and practices, and healthcare organizations want to take advantage of these innovative solutions. To use these solutions, providers need to migrate their applications to the cloud or find ways to run those cloud-driven solutions on premises.

Use Cases for Running Health Care Applications On Premises

MEDICAL IMAGING & CLINICAL DIAGNOSTICS

CT, MRI, PET Scans, mammography, ultrasound, and other scanning technologies produce huge data files that need to be processed quickly. With the volumes of data being generated through these medical imaging procedures and the constant shortage of physicians to interpret this data, healthcare providers need to find ways to accelerate their current staff's productivity and accuracy. Due the size of these data sets, time to value is impacted if the data has to be moved back and forth to the cloud where the latest services such as AI/ML and analytics tools and infrastructure are available today.

Data generated by diagnostic equipment, such as by equipment monitoring patients in intensive care units, needs to be ingested and analyzed in real time to identify critical patient information.

HEALTHCARE RECORDS MANAGEMENT

Electronic health record (EHR) and EMR systems are the core transactional systems in provider healthcare operations. There has been minimal cloud adoption in EHR/EMR due to on-premises dependencies, including low-latency processing and protected health information [PHI] management. These systems could be used to provide significant benefits in the form of patient self-service, AI/ML training, and data analytics, but any modernization effort must adhere to on-premises requirements.

GENOMIC SEQUENCING

The genomic sequencing pipeline starts with capturing raw instrument output, processing on field programmable gate arrays (FPGAs) such as Illumina DRAGEN, and then downstream processing for research. Large-sequence collections can reach the petabyte range, necessitating vast amounts of elastic, local storage, and low-latency access for rapid processing and analysis.

Today, to support these applications, healthcare providers run and maintain on-premises datacenters that use different infrastructures, tools, and APIs than are used in the cloud. When organizations need to rely on a heterogeneous mix of hardware and software solutions, the resulting complexity means increased management costs and decreased innovative potential. IT teams need to manage two disparate environments, and developers have the added burden of using different development and deployment tools for application development.

Most hybrid solutions today use different APIs, tools, infrastructure, and operational models to run their on premises and cloud environments. This results in inconsistent developer experience and added operational risk.

The optimum solution is a hybrid cloud solution where developers build applications once, using one set of APIs, software development kits (SDKs), services, and tools, and deploy in the cloud or on premises. IT teams have a common set of management tools and can utilize common skills to manage across their cloud and on-premises environments. Healthcare organizations looking to modernize their proprietary applications, whether or not they wish to migrate them to the cloud, need to support hybrid applications that need tight integration between components that reside in the cloud and those that remain on premises. With the right hybrid solution, they can have tight integration between applications and data that reside on premises and their centralized operations in the cloud. AWS Outposts has the answer to these challenges and more, with a fully managed solution that brings the power and innovation of the Amazon Cloud on premises to support applications that remain on premises for low latency and local data processing. AWS Outposts is the hybrid cloud solution that lets healthcare organizations maximize the potential of their data to deliver the high-quality care that patients want and need.

Challenges in Maintaining Disparate Environments

INFRASTRUCTURE TEAMS	DEVELOPERS	LINE OF BUSINESS
<p>Complex procurement and provisioning cycles across six to 12 vendors and approximately three to six months to get servers installed on premises.</p>	<p>The services and APIs used to build applications on premises may not be the same as those used in the cloud.</p>	<p>The pace of innovation on premises lags the pace in the cloud. Legacy systems and complex architectures mean that on-premises infrastructure lags the pace of innovation in the cloud.</p>
<p>Significant overhead to patch and upgrade on-premises infrastructure against a complex "compatibility matrix" across various hardware and software components.</p>	<p>The tools used for on-premises automation, deployment, and security controls may not be the same as those used in the cloud.</p>	<p>Businesses would like to leverage the latest cloud infrastructure and services, such as AI, ML, analytics, and container orchestration to build new and innovative applications on premises.</p>
<p>The application maintenance downtime required to safely upgrade negatively impacts business continuity and operations.</p>	<p>Having different code and processes for on premises and cloud applications creates friction and operational risk impacting developer efficiency.</p>	

AWS OUTPOSTS: A TRULY CONSISTENT HYBRID EXPERIENCE

AWS Outposts provides healthcare organizations with the same infrastructure and operating model on premises that they rely upon in the public cloud. It delivers the same AWS infrastructure, services, APIs, and tools that run in the Amazon Cloud to virtually any on-premises or colocation facility.

Customers can choose from a variety of Amazon Elastic Compute (EC2) instance types and Amazon Elastic Block Storage (EBS) storage options best suited for their applications. They can seamlessly extend their Amazon Virtual Private Cloud (VPC) on premises and run some AWS services locally on AWS Outposts or connect to a broad range of services available in the local AWS Region. They can use the same AWS tools and security controls to run, manage, and secure applications on premises and in the cloud.

For healthcare solution providers, Outposts delivers a consistent environment for applications running in the cloud and on premises, simplifying deployment of applications and ongoing management across many different sites where a solution is deployed. Hospitals and research institutions can use Outposts to analyze large volumes of data, or high resolution images on premises rather than having to stream it to the cloud. Outposts also enables healthcare customers to benefit from the innovative services available in AWS such as AI/ML, analytics, container orchestration services in scenarios when they need to process data that remains on premises, thereby improving diagnostic time, accuracy, and efficiency.

CONSISTENT

AWS Outposts provides a consistent AWS experience and a seamless extension of services across the data center and cloud.

Developers can build applications once, then deploy in the cloud or on premises across hundreds of hospitals across the country using the same APIs, services, tools, and partner solutions, with consistent developer experience. This **accelerates developer velocity and productivity**.

With AWS Outposts, customers' on-premises applications run on the same infrastructure and are able to access the entire range of AWS services, providing a consistent experience wherever their applications are deployed.

IT can standardize infrastructure, security policies, and development, provisioning, and management tools across their datacenters and their cloud environments, resulting in **enhanced efficiency**.

CLOUD INNOVATION ON PREMISES

AWS Outposts brings the pace of innovation and service delivery capability of the world's largest public cloud provider into customer sites.

Customers can access this portfolio of innovative services either locally on their AWS Outposts or in region and run applications to support their on-premises use cases.

This helps health care organizations accelerate the pace of innovation on premises with enhanced application performance and improved developer productivity for faster delivery of services to their end users.

FULLY MANAGED

With AWS Outposts, infrastructure teams have **improved operational efficiency** with automated infrastructure management, transparent updates and patching, and a single point of support for infrastructure procurement, installation, and maintenance.

Healthcare organizations no longer have to bear the overhead of infrastructure upgrades and management, infrastructure enabling them to focus resources on developing healthcare solutions to improve patient outcomes.

A LOOK INSIDE

AWS Outposts are offered in pre-validated configurations that are a mix of Amazon EC2 compute and storage capacity. It is the same infrastructure AWS uses in their datacenters. It offers AWS Nitro-based, general purpose, compute optimized, memory optimized, or GPU optimized Amazon EC2 instance families (C5, M5, R5, I3en, and G4dn). Storage options include local instance storage or Amazon EBS gp2 volumes for persistent block storage. AWS has optimized its rack design for efficiency and performance in its regional datacenters. Now, that efficiency and performance are available to customers on premises.

How AWS Outposts Work

Customers can get started with AWS Outposts in three simple steps:

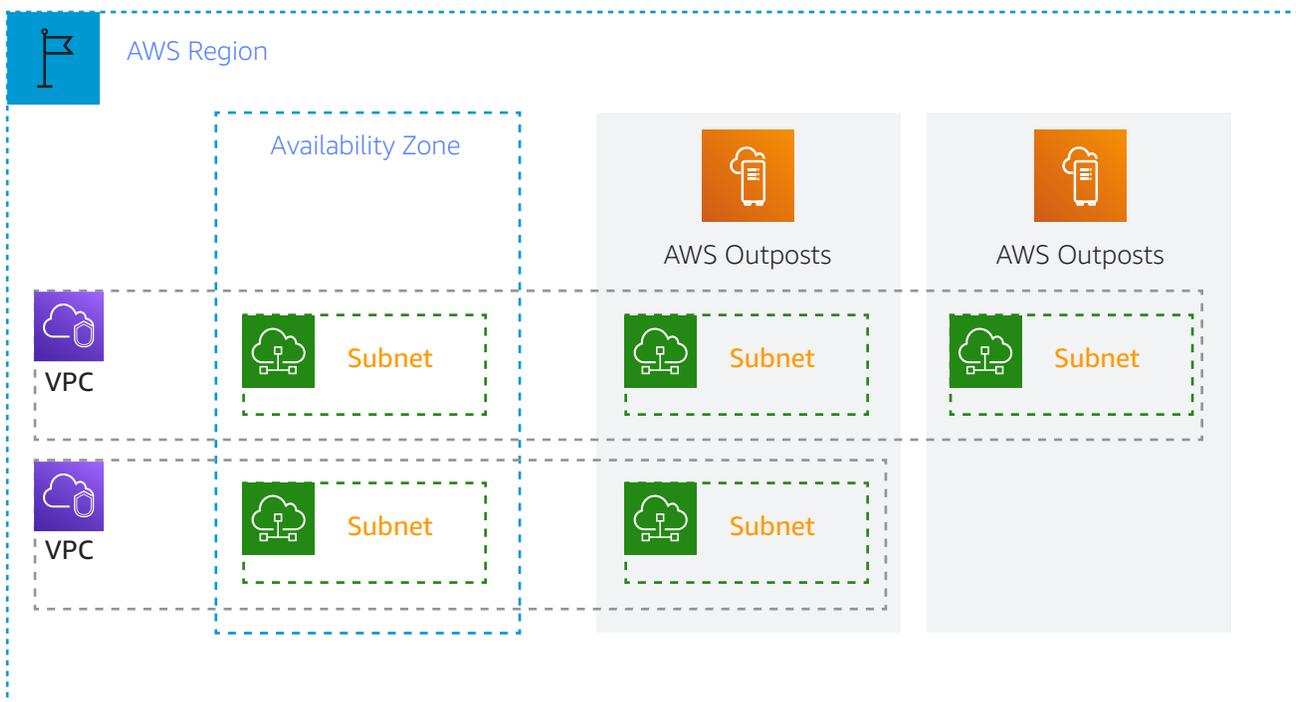
1

Order

Choose from a range of pre-validated AWS Outposts configurations based on intended use cases and site requirements through the AWS Management Console. AWS personnel will deliver and connect the AWS Outposts rack to power. They will also help you configure network connectivity to connect the Outpost to the AWS Region. Once the AWS Outposts rack is connected to power and networking, the build process is completely automated. The installation is complete when your Outpost capacity is available on the AWS Management Console.

Connect

Customers can extend their regional Amazon VPC to AWS Outposts by creating a subnet and associating it with AWS Outposts the same way they associate subnets with an AWS Availability Zone today. When they connect AWS Outposts to the parent region, all existing and newly created Amazon VPCs in their account can span all AWS Availability Zones and associated AWS Outposts locations. This allows seamless extension of their regional VPC to their on-premises location. In addition, each AWS Outposts has a new gateway called a local gateway (LGW). An LGW is a local interconnect virtual router customers can use to connect their AWS Outposts subnets with their local on-premises networks for low latency access to on-premises resources.



3

Launch

Customers can launch Amazon EC2 instances on their AWS Outposts through the AWS Management Console or command line interface (CLI). Customers can also run AWS services locally on the AWS Outposts and connect to the broad range of AWS services available in the AWS Region. AWS services supported locally on AWS Outposts include:

- Infrastructure Services: Amazon EC2, Amazon EBS, and Amazon VPC
- Database – Amazon Relational Database (RDS) instances
- Containers – Amazon Elastic Container Service (ECS) and Amazon Elastic Container Service for Kubernetes (EKS) clusters
- Data processing – Amazon Elastic Map Reduce (EMR) nodes

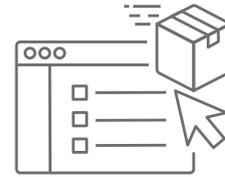
With AWS Outposts, customers can access AWS tools running in the region such as, AWS CloudFormation, Amazon CloudWatch, AWS CloudTrail, Elastic BeanStalk, Cloud 9, and others to run and manage workloads on AWS Outposts the same way they do in the cloud today.

All metrics regarding an AWS Outposts instance's health, activity, and underlying architecture are sent to the control plane in the AWS parent region. This real-time monitoring simplifies systems management, provides detailed capacity utilization and instance health data, and provides alerts on capacity issues before workloads run out of compute, storage, network, or GPU. The resulting simplification of monitoring and expedited system analysis allows IT departments to spend less time maintaining systems and alleviates costly downtime.



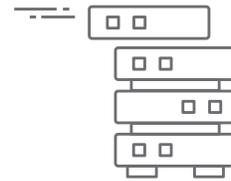
AWS Outposts

Run AWS infrastructure on premises



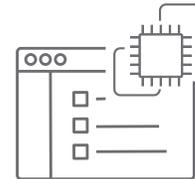
Configure

Configure and order Outposts from AWS Console



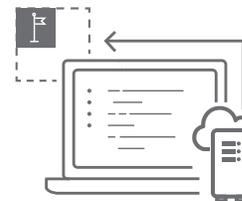
Connect

Connect Outposts to your local power and network



Launch

Use AWS Console to launch Ec2 instances on Outposts

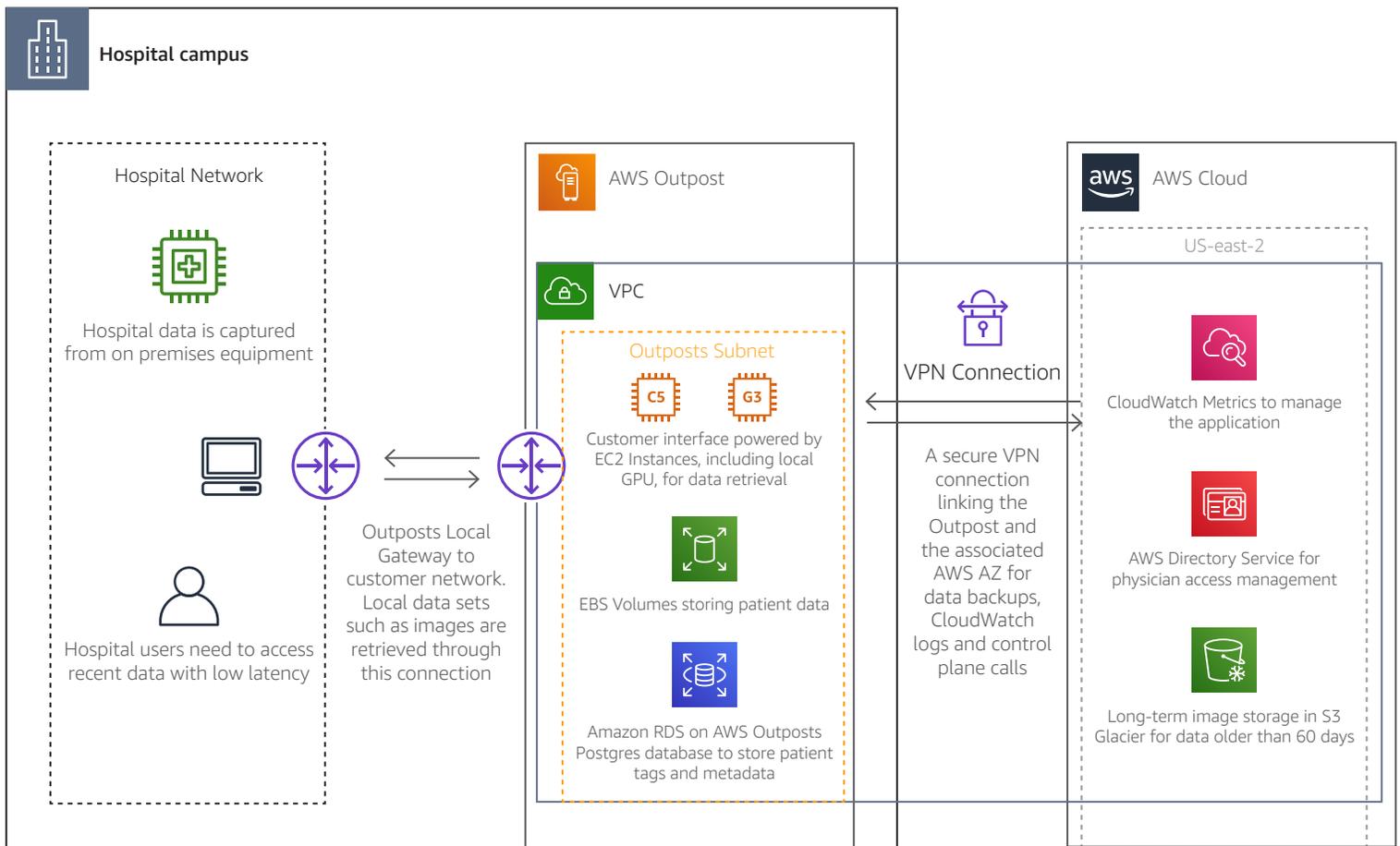


Build

Build and run apps using native AWS services on Outposts and services available in the local region

A Look at a Healthcare Architecture

In this example, a healthcare application provider wants to provide low-latency access to images they process and store for their customers. Doctors need to be able to pull up recent patient images quickly for diagnosis. Their healthcare platform enables users to log in, perform image analytics, and upload new images. With AWS Outposts, the provider can deploy Amazon EC2 instance for image analysis, Amazon EBS volumes for local storage, and configure Amazon RDS on AWS Outposts for PostgreSQL database to store relevant image information. This communicates over a secure virtual private network (VPN) connection to the AWS Cloud to back up image data, verify user credentials, and track metrics from many sites.





SUMMARY AND RECOMMENDATION

Healthcare organizations, from hospitals to clinics to research facilities, can benefit from the low-latency processing, simplified application development, improved security, and streamlined management delivered through AWS Outposts. An ideal solution for organizations that have already modernized on the AWS Cloud, AWS Outposts extends your best solutions on premises so you can expedite data analysis from surgeries, in-clinic operations, bed scheduling, nursing management, ER management, radiology, lab services, digital pathology, genomics, and more. The resulting real-time results enable healthcare organizations to deliver better patient outcomes and differentiated services that set their businesses apart.

Learn more and get started with AWS Outposts at <https://aws.amazon.com/outposts/>.

Additional Resources

What is an AWS Outposts Rack?

AWS Nitro System

Tech Talk: Introduction to AWS Outposts

i American College of Healthcare Executives, "Survey: Healthcare Finance, Governmental Mandates, Personnel Shortages Cited by CEOs as Top Issues Confronting Hospitals in 2018," Jan. 25, 2019, <https://www.ache.org/about-ache/news-and-awards/news-releases/top-issues-confronting-hospitals-in-2018>.

ii Gartner, "Market Guide for Cloud Service Providers to Healthcare Delivery Organizations," Gregg Pessin, June 17, 2019, ID: G00347981.

iii Stanford Medicine, "Harnessing the Power of Data in Health," June 2017, <https://med.stanford.edu/content/dam/sm/sm-news/documents/StanfordMedicineHealthTrendsWhitePaper2017.pdf>.

iv MarketsAndMarkets, "Healthcare Analytics Market worth \$50.5 billion by 2024," Jan. 2019, <https://www.marketsandmarkets.com/PressReleases/healthcare-data-analytics.asp>.