

Accelerating Innovation in Healthcare

The benefits of unlocking EHR data with AWS

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Abstract

Migrating Electronic Health Record (EHR) environments to AWS offers advantages that go well beyond infrastructure. Organizations can radically enhance their clinician, patient, and employee experiences by leveraging the broad portfolio of AWS services. This paper describes a pragmatic process for organizations to accelerate innovation by migrating their EHR environments to AWS.

Introduction

Hospitals have implemented Electronic Health Record (EHR) applications for a variety of reasons, such as enhancing clinician and patient experiences, improving workflows, and care coordination. For hospitals, the EHR is at the core of clinical and business operations. It is essential that infrastructure powering a hospital's EHR is not only reliable, secure, and provides the ability to keep Protected Health Information (PHI) private. It should also provide tools for healthcare organizations to transform their organization beyond the EHR. AWS has significantly more services, and more features within those services, than any other cloud provider. AWS works with EHR vendors around the globe to regularly validate deployment architectures so healthcare provider organizations have the latest recommendations. Doing so allows healthcare organizations to migrate their environments to AWS to gain advantages from AWS.

Innovation on AWS

Healthcare organizations generate tremendous amounts of data. In fact, the average hospital has 10 - 15 connected medical devices per bed¹. These medical devices generate data that can be used for activities like predicting patient outcomes, creating better care plans, monitoring patients, managing supplies, or identifying trends among the patient population. Today, many of these systems operate in silos where data is stored in different formats and databases. Data Interoperability, or the ability of systems to exchange healthcare data while understanding the context and meaning of the data, is key to unlocking this data to gain more intelligent insights.

Putting Data to Work

Healthcare organizations own their data whether they run their EHR system on-premises or on AWS. Data can also be accessed outside the EHR. For historical data, all major EHR vendors offer tools for exporting, migrating, and transforming data to other locations. For real-time data, EHR vendors typically offer a service of SOAP and REST API calls. While FHIR server endpoints (using the standard HL7 FHIR protocol) are becoming more commonly supported across EHR vendors, there are also some EHRs that have custom SOAP and REST APIs that offer immediate access to application-specific data (such as department wait times). Because these services vary depending on the EHR, organizations should consult their vendor's documentation related to data exporting and interoperability services.

When accessing real-time data, start within your DEV environment and use your vendor's documentation to research all available API endpoints. From there, have a Subject Matter Expert (SME) from your EHR's application team work closely with your developers to test API calls in your DEV environment. It is important to have an EHR application team member work closely with your dev team, as they may need to login to the DEV EHR environment to create test data. For example, when testing something like wait times, someone will need to check in fake patients, move them through departments, discharge them, and repeat, while the dev team tests API calls and code. Your organization's SMEs can also help to identify the correct places to pull data from. For example, allergy or

current medications are common datasets and can normally be pulled through FHIR or custom EHR APIs.

Customers should follow their vendor's guidance for migrating code changes to each environment and deploying your application. There will be specific requirements when making API calls, so review your vendor's documentation for the latest requirements. If assistance is needed during this process, reach out to your organization's AWS account team and EHR vendor. The end result is that your data will be accessible, secure, and in compliance with applicable laws and guidelines, so that you can move forward with creating ancillary applications in your environment.

Utilizing data lakes in a secure and compliant way is a primary use case we see customers interested in. A data lake is a centralized, curated, and secured repository that stores all your data, both in its original form and prepared for analysis. A data lake lets you to break down data silos and combine different types of analytics to gain insights and guide better business decisions. Data lakes also democratize your data by removing bottlenecks and expediting access while allowing granular security controls around permissions. By using [AWS Lake Formation](#), a service that makes it easy to set up a secure data lake in days, a healthcare organization can enable access to data not only from their EHR, but also all other applications in one central place.

Data Lake Overview

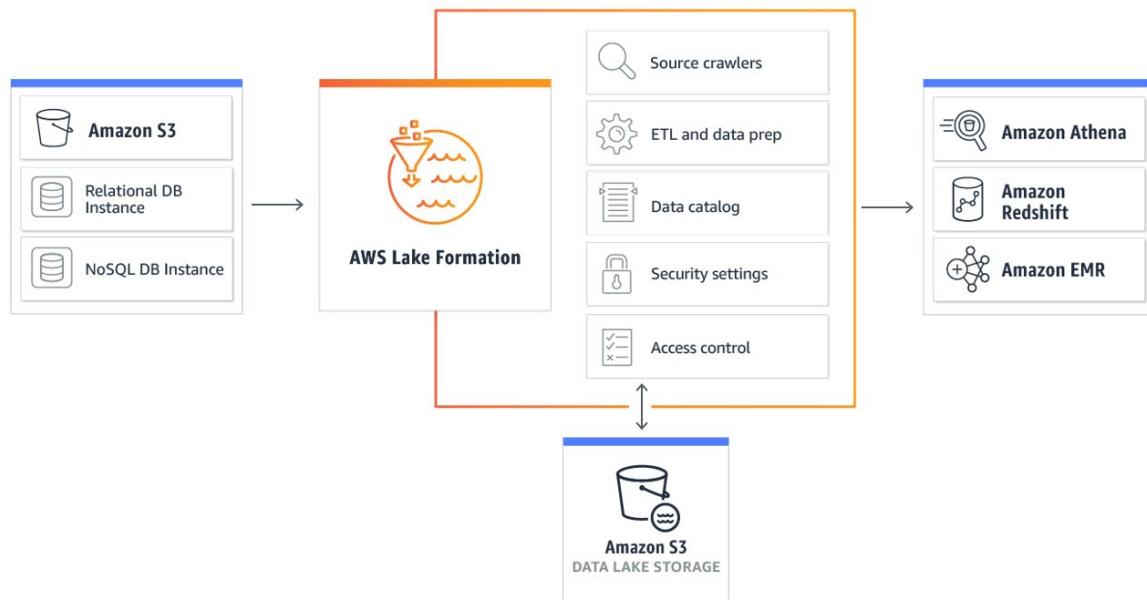


Figure 1 – AWS Lake Formation makes it easy to combine your data

Combining data from the multitude of applications in a healthcare environment opens up a new world of insights into your organization. Patient falls can be researched by combining medical histories with building maintenance logs. Supply usage can be optimized. Patient population data can be studied and combined with organizational and environmental data. [AWS Data Exchange](#), a service for subscribing to anonymized and de-identified datasets, can be used to enrich data for even more insights. Healthcare organizations can even publish their own data to AWS Data Exchange, either for free or using private pricing, so that other healthcare organizations can exchange data for medical research. The list of clinical and business insights from an organizational data lake are virtually unlimited.

Improving the Healthcare Experience

With your EHR environment and data accessible from AWS, organizations can imagine new ways to use the growing number of AWS HIPAA-eligible services to transform everyone's experiences in healthcare.

Patient Experience

Patients are the core of everything in healthcare, and their experience is vital to the success of any healthcare organization. Patients today expect the latest technology in their care, including voice, mobile, digital assistants, AI/ML predictions, and ease of access to their own healthcare data. Amazon and AWS have been at the forefront of this innovation, and our services are used in many cutting-edge solutions that patients already use and have come to expect in their daily lives.

For patients, the beginning of their experience with an organization is at the digital front door. The digital front door is a strategy for engaging patients at every touchpoint of their journey. [Amazon Connect](#) (an omnichannel cloud contact center for voice and chat) and [Amazon Lex](#) (a service for building conversational interfaces into any application using voice and text) are services customers turn to for creating a digital front door experience. These services allow customers to call, text, and chat with a bot that can help automate and assist providers with addressing patient queries, requests, and then directing them to the next best action. This becomes even more powerful when you query the EHR directly for information. For example, if a patient asks about an upcoming appointment, Amazon Lex can query the EHR to get information and reply with the answer using [Amazon Polly](#), a text-to-speech engine.

Improving search capabilities for patients is another challenge that organizations are regularly tasked with. Healthcare environments are complex and contain numerous data repositories. [Amazon Kendra](#), a highly accurate and easy to use enterprise search service powered by machine learning, can curate information from a multitude of data sources and provide answers to patients. By using Amazon Kendra, healthcare organizations can add search capabilities to data such as office locations and hours, clinician availability, physician biographies, clinic directions, and other elements, to create powerful organizational searches that provide the most accurate information.

When patients receive care, the EHR contains a vast amount of data that can be used to update patient families. [Amazon Simple Notification Service](#) (Amazon SNS), a fully managed messaging service, can be used to build notifications based on patient events. For example, SMS messages can be used as patient movement notifications for patients undergoing procedures. [Amazon Chime](#), a communications service, can allow family and patients to connect through video calls. For digital assistants and patient entertainment, healthcare organizations with an Amazon Alexa BAA can build HIPAA-eligible skills to create custom interactions, games, or enhance patient education using Alexa. Both Amazon Alexa and Amazon Lex can use [AWS Lambda](#), a service that lets you run code without managing servers, to query data from any backend system using API calls. Hospitals can even create augmented reality games for patients using [Amazon Sumerian](#).

The same functionality for building logic can be used across solutions with AWS services. Healthcare organizations can use Amazon Connect, Amazon Lex, and Amazon Alexa to use shared logic for reading data from any backend system. At a very high level, the architecture would look similar to the following voice architecture:

Voice Architecture

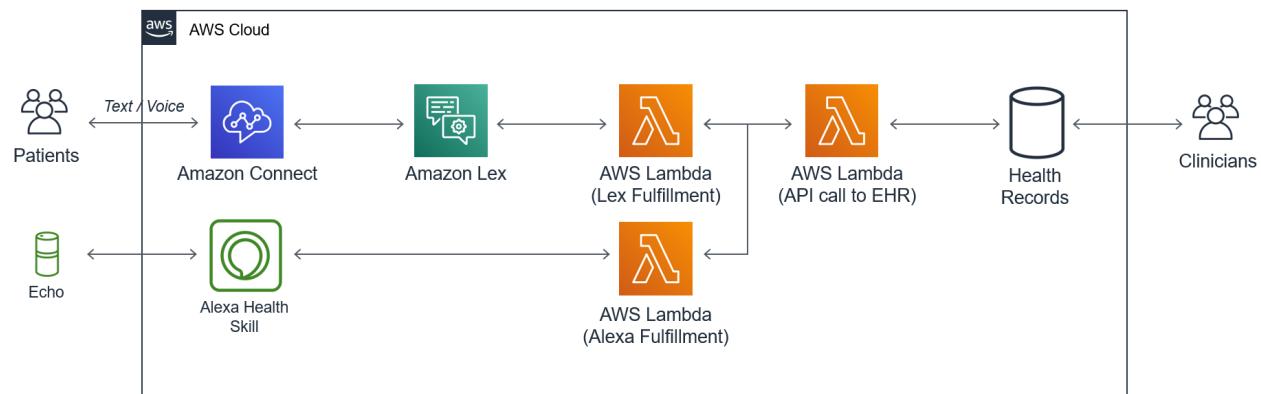


Figure 2 – Patients can use voice or chat to interact with their health record

To engage patients outside of a clinical setting, [Amazon Pinpoint](#), an inbound and outbound marketing communications service, can be configured to engage patients at critical care points with data from an EHR. With Amazon Pinpoint, organizations can create different segments based on diagnoses or surgical data (e.g. diabetic patients, pediatric versus adult patients, transplant recipients, international patients, pre- or post-operative patients). These segments can then be sent meaningful information using email, SMS, or push notifications. This allows for more granular and relevant information to be communicated to patients.

Another area where we've seen interest is telemedicine. Amazon Chime is being used in telehealth solutions for connecting patients to providers. By querying scheduling and appointment data in real-time, healthcare organizations can have standalone and highly scalable video communication and calling solutions in their resilient and secure AWS environment.

Clinician Experience

Clinicians need solutions that offer the most up-to-date information and latest technology. These solutions need to be integrated within their workflows so that everything is convenient and easy to use. With over 100 HIPAA-eligible services available to build with, AWS offers services that can be used to create solutions for any clinical use case. Customers can use these services to transform and customize the clinician's experience within their organization. Some EHR vendors even support embedding custom web applications directly so functionality can be built and integrated in a clinician's workflow.

For innovation teams and clinician builders, an environment can be secured with appropriate guardrails so that members can rapidly innovate and create solutions. For AI/ML work, having clinical data on AWS makes it easy and cost-effective to analyze tremendous amounts of data. [Amazon SageMaker](#) and the growing number of AWS AI/ML services can be used to improve patient care or enhance business and clinical operations. For reporting and clinical research, [Amazon QuickSight](#), a fully managed business intelligence service, allows clinicians to build their own dashboards that can be shared with colleagues or embedded within applications.

Clinicians often ask about image and video tools. [Amazon Rekognition](#) can train models to look for skin abnormalities, cancer, text within referrals, objects, or even analyzing a patient's mood. Medical images can also be de-identified using [Amazon Comprehend Medical](#) and Amazon Rekognition². For simulations, healthcare simulation centers can use Amazon Sumerian to create augmented and virtual environments for training.

Voice is one of the most requested areas that clinicians regularly ask AWS about. At a high level, the architecture is similar to the patient voice architecture shown in figure 2. Amazon Lex can fulfill voice commands. AWS Lambda can then be called to execute APIs on a backend system or interact with other AWS services. For example, Amazon Comprehend Medical can receive unstructured text and identify medical conditions, medication, dosage, and medical ontologies like ICD-10-CM or RxNorm. Text from speech can also be sent to [Amazon Translate](#) for high-quality language translations, or to Amazon Kendra to create an enterprise voice and text search across medical documentation, procedures, unstructured documents, or other data sources.

Employee Experience

From clinical to business staff, the complexity of maintaining a hospital environment can be stressful and time consuming. Interestingly, the five pillars of an [AWS Well-Architected Framework](#)³ are similar to what healthcare employees work towards: operational excellence, security, reliability, performance efficiency, and cost optimization. For hospital staff, AWS provides robust capabilities to deploy

infrastructure as code, automate resource management, improve disaster recovery, and enhance security and monitoring. AWS also provides access to the latest technologies for clinical and business applications. In other words, resilient architectures can be created so that support staff isn't alerted at 3:00 AM that a server has run out of memory.

When it comes to enabling a remote and mobile workforce, [Amazon WorkSpaces](#), a fully managed and secure Desktop-as-a-Service solution, can provide all employees with access to their desktops from any device or location. This allows clinicians access to not only the EHR, but all other applications and documentation they use for clinical care. An organization's entire staff can support, build, and innovate without being tied to a physical machine. Because it can be configured to access resources in the AWS environment with ease, employees can use their own devices to securely access any application they need for their job on Amazon WorkSpaces.

Improving the employee experience does not stop at devices. Voice is another area we see businesses investing in. [Alexa for Business](#) can be used to schedule conference rooms, join meetings, set reminders, take notes, and access other backend applications through API calls. For example, staff can ask about upcoming appointments or staffing questions for a department. AWS offers the tools to build these interactions securely and reliably.

Organizations that run on AWS can also tap into expertise from the [AWS Partner Network](#). We are customer-obsessed, and 90% of what we build comes from customer requests. We offer a plethora of documentation, training, [AWS Quick Starts](#), and other solutions to accelerate your objectives. Today, more than 90% of Fortune 100 companies and the majority of Fortune 500 companies use AWS Partner solutions and services in their organizations.

Migrating to AWS

To migrate to AWS, your organization should first reach out to its AWS account team. Your account team will assess your current environment to provide the best options for migration. AWS has a variety of reference architectures, from hybrid to full cloud deployments, and your situation depends on how your organization prefers to manage your EHR. AWS can also provide various disaster recovery and single versus multi-Region architectures.

Because migrating to AWS offers cost savings, security, and high reliability, customers are encouraged to consider their other ancillary applications (from billing to PACS) when migrating to AWS. This can extend benefits to all areas that touch an EHR environment. Many companies that provide solutions to healthcare organizations are already building on AWS or are in the AWS Partner Network.

Your organization has complete control over how you choose to migrate your environment or build solutions. Customers can choose to work on their own, with [AWS Professional Services](#), or with an AWS Partner who specializes in building on AWS. Your AWS account team will work with you, your EHR vendor, and the migration team to ensure that your environment is optimized, follows the AWS Well-



Architected Framework, and complies with your EHR vendor's recommendations. Migrating to AWS does not stop at infrastructure; it opens up a world of possibilities for innovation to reimagine how healthcare is delivered.

Conclusion

Migrating to AWS is the first step in a long journey to a healthcare organization's digital transformation. As AWS continues to innovate on behalf of customers, the number of HIPAA- and HITRUST-eligible services offered expands. While no one can predict the future, you can be prepared for it by creating a framework and structure to exceed patient demands, deliver superior patient experience, and support providers in new ways. Healthcare organizations can leverage AWS, the cloud provider with the most operational experience, to run their EHR and IT environments so they can focus on improving clinical outcomes and building better patient, clinician, and employee experiences in healthcare.

Contributors

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Document Revisions

Date	Description
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¹ <https://www.healthcareitnews.com/news/cybersecurity-pro-networked-medical-devices-pose-huge-risks-patient-safety>

² <https://aws.amazon.com/blogs/machine-learning/de-identify-medical-images-with-the-help-of-amazon-comprehend-medical-and-amazon-rekognition/>

³ <https://aws.amazon.com/architecture/well-architected/>