

cloudticity

The Once And Future Health Information Exchange

Four pillars for scalable, reliable, secure next-generation infrastructure

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Executive Summary

The healthcare business model is in an unprecedented state of flux. Recent initiatives such as the hospital readmission reduction program and payment models including accountable care, bundled payments, and patient-centered medical homes provide strong incentives for providers to work together to improve care quality and reduce costs. Among other things, working together means sharing critical patient information for both clinical and administrative purposes.

Unfortunately, the current electronic exchange of health information between provider organizations leaves much to be desired. Surveys show that patients are experiencing gaps in health information which can affect the level of care and even treatment outcomes. Barriers to information exchange include diverse methods for identifying patients, lack of standards, and information blocking by vendors and healthcare organizations.

The inability to share crucial health information means that many patients have incomplete medical records or may not receive the best possible care at all times because their doctors aren't aware they need additional tests or services from other providers involved in their care.

Health information exchange (HIE) constitutes a great start toward full interoperability but more must be done. For the most part, legacy infrastructures lack the scalability, flexibility, and adaptability needed for today's healthcare challenges. A cloud-based platform forms the foundation of the next-generation HIE infrastructure and holds great promise for overcoming the data interoperability problems that prevent the industry from reaching optimum levels of quality, velocity, and cost-effectiveness that are possible with HIE.

Mind the (Information) Gap

Over the past decade, the healthcare industry has seen a transformation in the way that patients, providers and payers collect, share, and store protected health information (PHI). Central to this trend is the electronic health record (EHR). In contrast to a paper-based system that is both costly and inefficient in terms of workflow management among employees (especially within an organization), EHRs offer many benefits such as providing detailed patient histories for clinicians at all points during their care cycle while also speeding up processes by communicating with other departments like billing or insurance without any paperwork required on either end. Today, EHR adoption is widespread, with almost 98 percent of health systems using a government-certified EHR.

Integrating EHRs into provider workflows can reduce patient wait times by up to 40%. [1]

1 Information Systems Frontiers

Unfortunately, gaps in healthcare information are still pervasive. A recent study by the Office of the National Coordinator for Health Information Technology (ONC) found that nearly one-third (32%) of people who went to a doctor reported some problem related to information exchange. One in 20 had a lost chart and almost 1 on 5 (19%) were required to carry by hand test results (see figure 1).

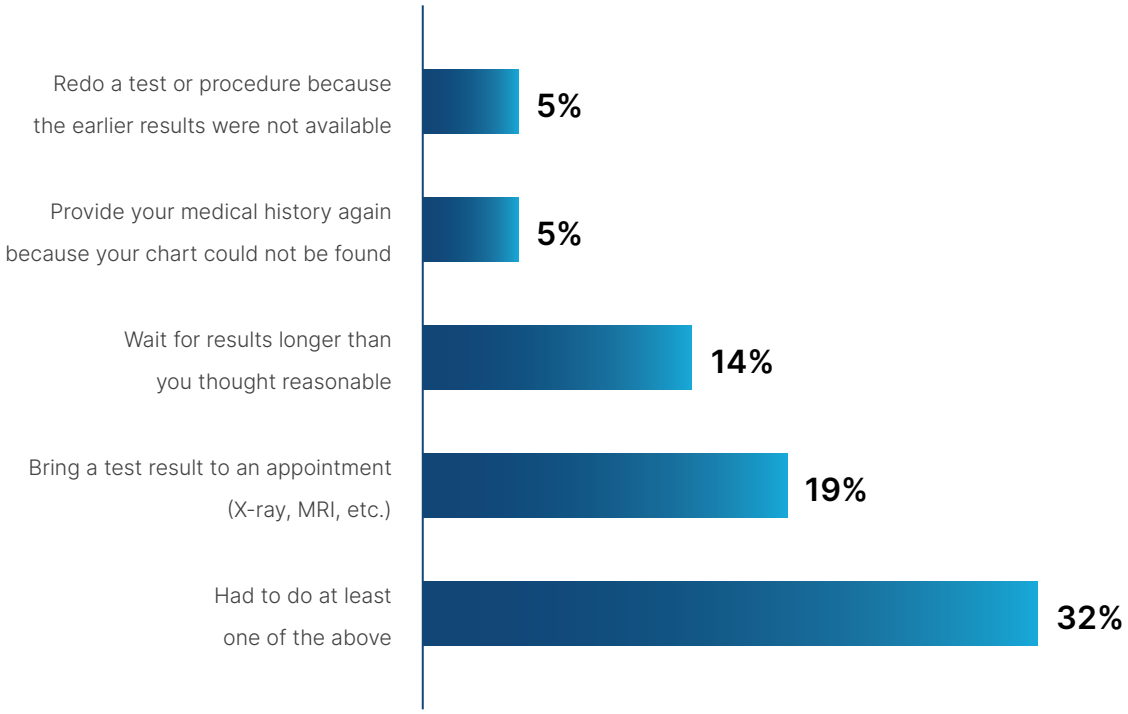


Figure 1. Survey of patients showing gaps in healthcare information[2]

2 ONC

Taking the HIE Road

This is where HIE comes in. HIE is a methodology for the secure and reliable exchange of patient information. With HIE, doctors, nurses, pharmacists, other healthcare providers and patients can appropriately access and securely share a patient's vital medical information electronically – improving the speed, quality, safety and cost of patient care. The benefits of HIE have been well documented and include lower readmission rates, fewer diagnostic tests, and shorter wait times (table 1).

Table 1. Selected documented benefits of HIE

Kim Fecher et al	Assessing the Benefits of Integrating Health Information Exchange Services into the Medical Practices' Workflow	• 13% reduction in ED visits • 10% reduction in unplanned readmissions • Up to 40% reduction in patient wait times
University of Michigan	When Hospitals Share Patient Records, Emergency Patients Benefit	• 59% less likely to have a redundant CT scan • 44% less likely to get a duplicate ultrasound • 67% less likely to have a repeated chest X-ray
St. Luke's, Cedar Rapids, IA	How Heart Failure Patients Can Reduce Readmissions With Transitional Care	• 14% reduction in readmissions

HIE supports three primary use cases. In directed exchange, care providers can send and receive information electronically to better coordinate patient care. Query-based exchange refers to the ability of a provider to request information from other providers, often used for unplanned care such as an emergency room visit. Consumer-mediated exchange gives patients a mechanism for aggregating and controlling the use of their health information among providers.

Confusingly, the term HIE can also apply to the organization that facilitates health information exchange and even to the software that drives HIE. HIEs started with a small number of providers at the local level and have steadily grown to encompass state, regional, and even national HIEs. The national versions are essentially meta-HIEs that aggregate and unify information from state and regional HIEs and providers. According to one source, more than 50% of the nation's HIEs connect to the eHealth Exchange network. Additionally, 75% of all US hospitals, 61 regional or state HIEs, 70,000 medical groups, and over 8,000 pharmacies link to the nationwide exchange. In total, eHealth Exchange accounts for over 120 million patient records.



Use Case: Care Coordination at Discharge

To illustrate the role of HIEs, let's look at a typical scenario (see figure 2). A patient is discharged from the hospital into the care of her primary physician who is located in the patient's local clinic. ① Both the hospital and the clinic must have previously subscribed to the HIE. ② The hospital discharges the patient. The hospital ③ creates an admit-discharge transfer (ADT) message and ④ pushes the ADT message to the HIE. ⑤ The HIE pushes the message to the clinic. The clinic ⑥ adds the ADT information to the patient's EHR, ⑦ making it available to the primary care physician and ensuring that the treating physician has a complete picture of the patient's health, including the recent hospitalization.

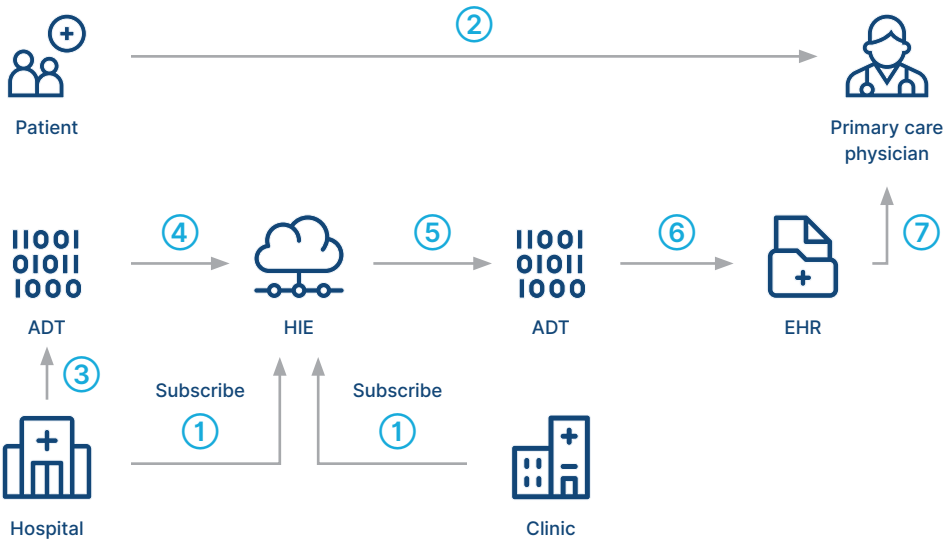


Figure 2. Patient transfer process showing role of HIE in exchanging ADT messages

Do You Read Me?

As discussed earlier, the effective and efficient exchange of health information faces a number of challenges. In particular, each of the hundreds of EHR systems in use today has its own set of technical specifications, clinical terminologies, and even unique customizations that prevent true interoperability and data sharing across systems.

The need is for data interoperability: the ability for HIEs and providers to exchange and use health information to the benefit of the patient. When information passes between parties, for example, from hospital to clinic, the only way to ensure that the receiving system can correctly interpret the transmitted information is to use standardized coding. Unfortunately, the landscape today is one of multiple standards such as ICD, CPT, LOINC, and SNOMED. The lack of a single agreed-upon standard for information exchange has plagued the U.S. healthcare system for decades and limits the ability to share data electronically for patient care.



However, the most intractable challenge in data interoperability is cultural, not technical. As standards work in other industries have shown, interoperability requires close coordination and collaboration of patients, providers, software vendors, legislators, and health information technology (HIT) professionals. To date, healthcare has not taken up that challenge. As a result, the culture of the U.S. healthcare delivery system is still defined by silos, fragmented processes, and disparate stakeholders.

Competitive considerations create additional barriers. Providers and vendors often see electronic health information as an asset to be restricted for competitive advantage instead of a necessary element for effective care coordination. Healthcare organizations may fear – with some justification – that competitors will use patient information to learn more about their standards of care and workflows.

The View from the Ivory Tower

In response to the data interoperability problem, the Harvard Business Review advocates for a complete overhaul of digital health recordkeeping. Their specific proposal includes a plan-centric EHR system with a library of care plans, algorithms to tailor plans to patients, task management tools, decision logic, and data analytics. HBR also calls for plan transportability, a key element of which is data interoperability.

Gentlemen, Start Your (Integration) Engines

The traditional approach to data interoperability has been the integration engine, a software application that receives messages from different systems, modifies them into formats that can be understood by receiving systems, and subsequently distributes the messages (figure 3). In a typical hospital environment, a substantial amount of information is generated by sophisticated clinical systems such as the picture archiving and communication system (PACS), radiology information system (RIS), hospital information system (HIS), and a laboratory information management system (LIMS). These systems are usually provided by different software vendors and transmit data in a number of standards including HL7v2, Digital Imaging Communications and Management (DICOM), Fast Healthcare Interoperability Resources (FHIR), and HTTP-based requests.



There are significant problems with this approach to data interoperability. First, integration engines come with high costs, including software licensing fees, maintenance fees, and professional services. Also, integration engines take a long time to deploy and require substantial customization, a definite drawback for fast-moving developments such as public health emergencies. Designed for the data center of the past, the current generation of integration engines does not scale well in a cloud environment and represents a single point of failure that can effectively take down operations. Finally, even the best integration requires a substantial amount of ongoing manual data transformation.

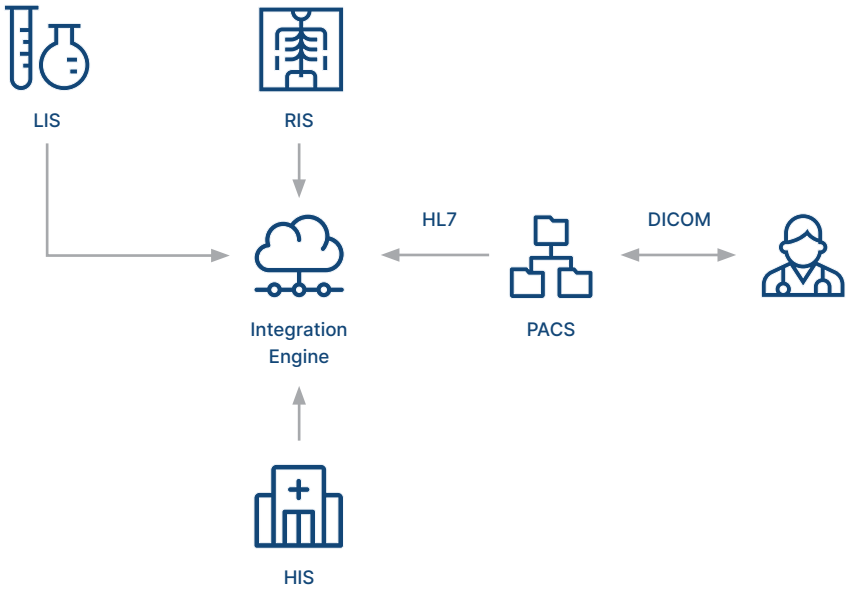


Figure 3. Typical integration engine deployment in healthcare IT

Talking About My (Next) Generation

To date, most HIE development has been based on what came before, building new products on top of legacy integration engines. This approach works for a while, but eventually falls apart when the underlying technology platform can no longer keep up.

HIEs find themselves at the crossroads. Legacy architectures simply cannot support today's use cases. We believe that the time is ripe to start over with a blank sheet of paper and design a scalable, secure infrastructure that can deliver on the promise of shared health information. The pillars of the next-generation infrastructure are cloud-native platform, data consolidation, high-volume data ingestion, and data science/machine learning.





Pillar 1. Cloud-Native Platform

As noted earlier, integration engines – the traditional approach to data interoperability – struggle to adapt to the cloud environment. The solution is to migrate to a cloud-native architecture as a platform for service delivery. Healthcare organizations that adopt cloud computing gain virtually unlimited scalability, high availability, global access to information, and a shift from capital investment to operational expenses. Initial concerns regarding data privacy and security are greatly diminished and cloud adoption rates are accelerating.

The optimum approach to cloud computing in healthcare is to build the infrastructure using services described in the cloud service provider's (CSP) catalog. Services can be simple encapsulations of compute and storage resources but can also implement high-level constructs such as database, format conversions, and ETL operations. As an added plus, the interfaces between services are well-defined and usually require little or no customization.

Don't try this at home. Despite their seemingly simple modularity, CSP services are not Legos that anyone can snap together. Instead, they are complex modules that must be carefully interconnected and configured based on extensive knowledge of how the service works, the functionality exposed in APIs, and the technical requirements of each use case. Beyond those considerations, most installations require some level of customization to meet all of the customer's requirements.

When it comes to planning the migration, the move to the cloud involves much more than simply relocating applications and data to a public cloud services provider (CSP) such as AWS, Google Cloud, or Microsoft Azure. Organizations need to design a cloud architecture that satisfies three key healthcare requirements.

- **High availability** including robust backup and disaster recovery/business continuity (DR/BC) systems that adhere to service-level agreements for recovery time and recovery point. CSPs have the building blocks but it is the responsibility of the HIE to assemble DR/BC systems with enough redundancy to meet their SLAs for availability.
- **Enterprise-grade security** to prevent unauthorized access to information, thwart ransomware attacks, and respond quickly and effectively to intrusions. CSPs can certify the security of the infrastructure but the HIE is responsible for application and data security.
- **Compliance with regulations** such as the US Health Insurance Portability and Accountability Act (HIPAA), EU General Data Protection Regulation (GDPR), Health Information Technology for Economic and Clinical Health (HITECH) Act, and the patient protection guidelines of the Affordable Care Act (ACA). The CSP can provide proof of compliance for their part of the architecture but in the end, the burden of demonstrating full compliance falls on the chief compliance officer at the HIE.

Many organizations rely on managed services providers (MSPs) and other third parties to provide the specialized expertise required for cloud architecture design and migration.

Pillar 2. Data Consolidation

HIEs have seen a steady increase in the amount of data that their systems and outside sources generate. Once considered a nuisance, these mountains of information hold highly valuable insights and secrets that can be unlocked by data scientists using business intelligence and other tools. Unfortunately, legacy storage systems are often a hodge-podge of shared drives, public cloud applications, and even laptop hard drives and USB devices.

Cloudticity helps our customers implement a data flow that can consolidate massive amounts of information and make it available to business analysts and others. In this data flow, HIEs aggregate electronic data from thousands of providers and labs and continuously push the information into a data lake. As the data are ingested, real-time translations take place, for example, matching patient IDs across different data formats. Business analysts access the data lake to get the information they need for reporting and data analytics. Finally, the data are made available to downstream applications like contact tracing programs.

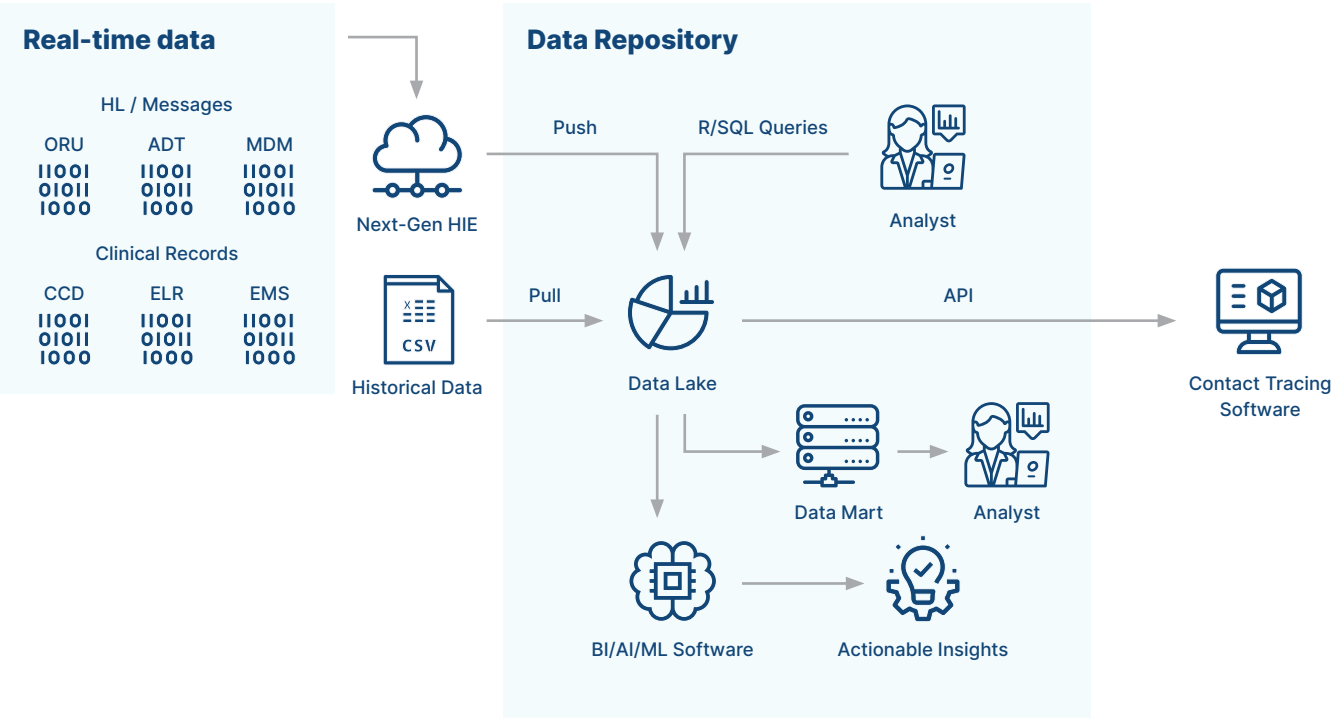
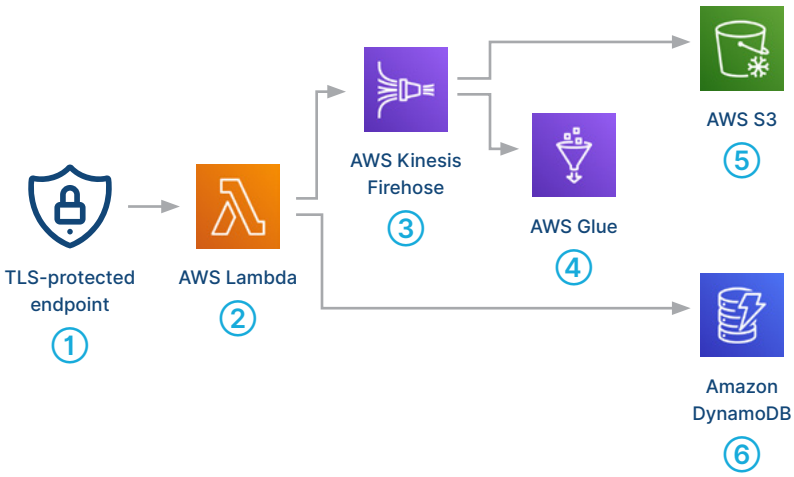


Figure 4. Role of data lake in healthcare data flow

Pillar 3. High-Volume Data Ingestion

For many healthcare providers, the onslaught of COVID-19 showed the limitations of legacy systems to handle massive surges in data volumes. Telemedicine providers were hit particularly hard, with many experiencing orders-of-magnitude increases of traffic in just days. One provider of services for doctor-patient video visits saw its call volume increase 30-fold almost overnight. As a result, infrastructure that worked well for a fairly stable level of baseline traffic was suddenly plagued by reliability, performance, and scalability problems. Customers who had used the system reliably for a long time suddenly had a new experience and were unable to connect consistently after COVID due to insufficient performance.

To help this customer and many others with similar needs, Cloudticity designed and implemented a data ingestion architecture that can be brought up in a matter of minutes (see figure 5).



1. TLS-protected endpoints send healthcare messages such as HL7 to Cloudticity
2. AWS Lambda parses the messages and converts to JSON
3. AWS Kinesis Firehouse converts JSON into Parquet and streams large datasets to S3 at scale
4. AWS Glue performs ETL operations on Parquet data
5. AWS S3 stores raw JSON and Hadoop-format data
6. Amazon DynamoDB stores JSON document data

Figure 5. Data ingestion architecture and workflow

Pillar 4. Data Science and Machine Learning

Today, the healthcare space is ripe for machine learning and data science due to the high volume of healthcare data and the many applicable use cases for public health outcomes. AI holds great potential to improve diagnosis, care delivery, and other aspects of healthcare operations (see figure 6)

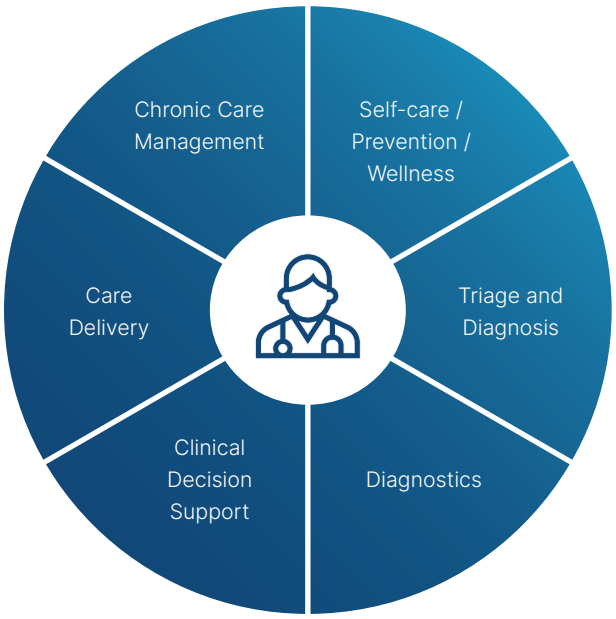
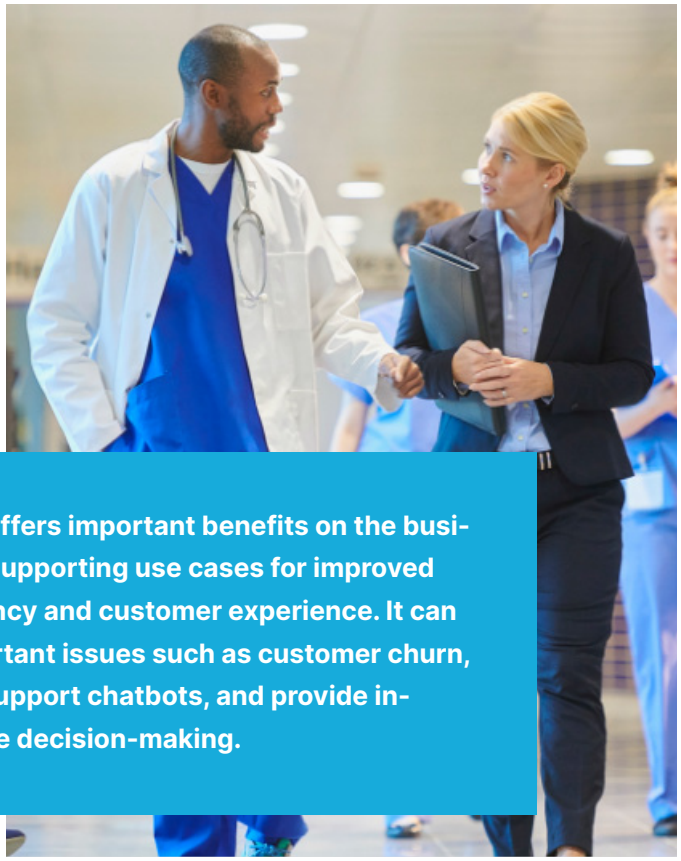


Figure 6. Typical domains where AI can improve healthcare[3]

3 McKinsey

A recent analyst report shows how data science and machine learning can be integrated across the complete care lifecycle. For example, individuals can leverage wearables and personalized applications for early disease detection and prevention, or experience shorter wait times for test results with deep learning powered medical imagery analysis. The research and development space is also gearing up to create massive gains in health outcomes, from automated drug discovery to DeepMind's progress on protein folding with its AlphaFold algorithm.

On the clinical side, data science and machine learning use cases can improve health outcomes for individuals and automate time-consuming administrative tasks for healthcare professionals. A primary use case is assisting in the interpretation of MRIs, CAT scans, X-rays, and other medical imaging technologies. Additional applications include appointment management, early diagnostics and prevention, and patient triage.



Machine learning offers important benefits on the business side as well, supporting use cases for improved operational efficiency and customer experience. It can shed light on important issues such as customer churn, power customer-support chatbots, and provide insights for executive decision-making.

Case Study: New York Tackles COVID-19

When COVID broke out in the United States, New York was one of the hardest hit states. With little information on the novel virus and even less on how to respond, public health officials decided to analyze existing data on COVID-19 patients to gain insights such as frequency of hospitalization, presence of comorbidities, range of symptoms, and response to treatment modalities. In addition, accurate information was needed for contact tracing.

Data interoperability quickly became the gating factor. The New York State Department of Health (NYS DOH) was receiving data from six different HIEs in a range of formats, including HL7v2, CCDAs, and CSV files Overwhelmed by information, they needed a more automated approach to integrate, consolidate, and transform clinical data on COVID-19 patients so they could perform meaningful analysis.

Realizing the need for a new approach, NYS DOH leveraged Amazon Web Services (AWS) and the Cloudticity Healthcare DataHub to unlock COVID-19 data insights, improve response, and develop a comprehensive plan to get the state on track to recovery.

The results have been impressive. Now DOH can process data within five minutes of delivery and aggregate information to provide a clear and accurate picture of comorbidities, symptoms, swells, length of hospitalization, and outcomes. In addition, the new architecture helps manage ventilator inventories and hospital capacity and provides relevant surveillance to the statewide contact tracing program, hospitals, and government agencies to drive real-time response.

The Way Forward

Legacy HIE infrastructures have reached the end of their usefulness, especially in today's brave new world of cloud everything. In particular, data interoperability problems continue to plague patient encounters, a headwind to fully realizing the promise of HIE to improve outcomes and streamline healthcare delivery. HIE organizations can either address this reality proactively now or wait for the inevitable warning signs of customer defections, lower win percentage for bids, and declining revenues.

This white paper outlines a next-generation architecture built on a public cloud platform that reinvents data flows and storage, ingests real-time data at unheard-of speeds, and uses data science and machine learning to extract insights that simply are too subtle for the human eye and mind. The raw capabilities to implement this vision are already out there at CSPs such as AWS, Microsoft, and Google.

HIEs would do well to put Cloudticity on their MSP short list. For one thing, we are passionate about automation and artificial intelligence for healthcare IT. Rather than continue to rely on humans for routine tasks, Cloudticity automates everything that can be automated, speeding up response times, virtually eliminating human error, and freeing staff for other, more strategic projects. Add in our extensive experience in the HIE world and you can see why we are so confident that we can help you, too.

About Cloudticity

When it comes to healthcare IT, Cloudticity is all in – healthcare is our entire practice. Unlike many other MSPs, we have a laser focus on the challenges faced by providers and payers as well as organizations in the public sector, genomics, and life sciences. Cloudticity has helped hundreds of organizations including HIEs to realize significant business value from their cloud investments.

We know the cloud inside and out. Cloudticity is an AWS Advanced Consulting Partner with certified competencies in healthcare and DevOps as well as a Microsoft Gold Partner with extensive training and experience on Azure. Our architects and consultants are experts in the use of public cloud resources and how to integrate them into existing infrastructures for maximum benefit.

Cloudticity has captured our years of experience and extensive in-house expertise in proprietary products that can jumpstart refresh projects and shorten the time and expense of migrating to the cloud, including:

- Cloudticity Healthcare DataHub™, an end-to-end integration, interoperability, and analytics solution, allows you to quickly and easily view all your health data in a common language on a single dashboard – without the need for hardware or integration engines. Now you can gain FHIR-enabled access to patient data within a single cloud environment while meeting stringent compliance requirements and combine real-time and historical data analysis to predict trends, improve care, and drive long-term growth.
- Cloudticity Oxygen™, our fully automated managed services, managed security, and managed compliance platform, can free your team to focus on innovation and product development. Continuously scanning your environment for alignment with cloud best practices and regulatory standards such as HITRUST, HIPAA, CIS, and more, Oxygen automatically detects and mitigates posture drifts when they occur. Gain complete control over your production environments, while maintaining full security and compliance oversight. For the first time, you can have both flexibility and security, all in one place.

For More Information

To learn more about how Cloudticity can help you transform your HIE, read our blogs on HIE modernization and how the cloud improves data interoperability. You can also visit us at www.cloudticity.com or schedule a free consultation.


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