

Predictive Clinical Analytics Improve Healthcare Resource Allocation and Care Delivery Models

Identifying high-risk clinical populations helps providers and payers improve patient safety, increase operational efficiency, and boost patient satisfaction

This solution brief describes how to solve business challenges and enable digital transformation through investment in innovative technologies.

If you are responsible for...

- **Business strategy:**
You will better understand how a predictive clinical analytics solution will enable you to successfully meet your business outcomes.
- **Technology decisions:**
You will learn how a predictive clinical analytics solution works to deliver IT and business value.
- **Clinical decisions:**
You will learn how a predictive clinical analytics solution can help you better align care delivery resources to targeted patient populations.

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Executive Summary

As healthcare systems around the world transition from paper-based to digital workflows, they now have access to data that can be used to improve the quality of patient care, while achieving greater cost and resource efficiencies. Recent innovations in predictive clinical analytics are progressing clinical operations with unique and timely connection of evolving risk factors in a dynamic way. These self-learning predictions improve an organization's ability to deliver high-touch clinical resources where they are needed most. An innovative predictive clinical analytics solution based on Intel® architecture and software from industry leaders enables providers to consolidate information from a wide range of sources—including structured and unstructured data—to give a more complete picture of patient health and risk factors. Examples of new and innovative applications of predictive clinical analytics include:

Resource Allocation (Clinical Efficiency):

- Anticipating and staging rapid response teams for patients with specialized needs or risks, whether for an inpatient or outpatient visit.
- Preventing duplicate or unnecessary testing.
- Recommending bundling of services for clinical care and billing for streamlined payment from payers.

Population Health Risks and Trends:

- Early detection of hospital-acquired infections that can increase lengths of stay and negatively impact outcomes.
- Establishing proactive wellness programs to manage provider population health.
- Identifying and evolving metrics for preventable admissions and readmissions from individual patient records.

Patient Safety and Satisfaction (Precision Medicine):

- Enabling predictive symptom treatment sequence for disease progression.
- Designing specialized plans with micro-segmentation recommendations for better care and efficiency.
- Recommending sequences of chronic care treatments and management.

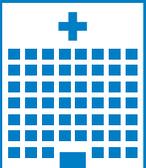
These predictive clinical analytics are aiding operational cost efficiency and proactive care management. One hospital group¹ uses a scale-out data platform powered by Intel® Xeon® processors and Intel® Solid State Drives (Intel® SSDs), combined with a data analytics platform, to identify patients with a high readmission risk. Sophisticated mathematical models leverage Intel® hardware and software performance to analyze different data types, which are stored in disparate systems, to provide fast and actionable insights about a patient's health and to predict healthcare outcomes. This business intelligence is helping hospitals reduce costs, improve quality of care, and enhance the patient experience.

Business Challenge: Matching Resources to the Patients' Needs

Over the past several decades, healthcare systems globally have been shifting from paper-based to digital workflows. While this shift is far from complete, organizations that have adopted digital workflows are finding that the data collected by key clinical applications such as Electronic Health Records (EHRs)² can be used to build powerful predictive models to help them improve patient care and business efficiency. One emerging use case for predictive modeling is characterizing patient populations across a variety of factors to identify high-risk patient groups (also called patient segments). Once these patient segments are identified, providers can allocate expensive, high-touch resources to those patients who need them most, such as those at risk of being readmitted within 30 days of discharge. It is important to note that historical EHR data systems and tracking were not set up for predicting overall health risks and predicting patients' unique dispositions. With new innovations in the speed and interconnectivity of these data sources and streams, Intel® technology-based solutions exist today which give insights in predicting operational inefficiencies, such as premature or delayed patient discharge, redundant testing, or patient safety risks with history of cause.

Typically, clinical data that is analyzed as part of existing healthcare systems consists only of the structured data fields in the EHR, leaving unstructured data untapped and ignored by most business intelligence tools.

PENALTIES HURT HOSPITALS



60.2% of U.S. hospitals lose up to 0.9% of their reimbursements due to hospital readmissions and preventable adverse events.³

Putting Predictive Clinical Analytics to Work

To adapt to the market pressures facing healthcare, hospitals and providers are seeking ways to improve processes, decrease budgets, and improve quality of care. Three broad categories of use cases benefit from predictive clinical analytics:

- **Patient safety.** Predictive clinical analytics can aid in proactive care management. For example, it may identify patients who might develop a septic infection that requires specialized care. Such information can be used to help medical teams be proactive by performing special monitoring or assigning rapid response team members.
- **Operational and cost efficiency.** Predictive analytics help identify which patients are at risk for longer hospital stays or are likely to be readmitted within 30 days. Hospitals can assign

remote monitoring or specialized caregivers to at-risk patients to protect already-razor-thin profit margins and stay within Centers for Medicare & Medicaid Services (CMS) guidelines to maximize efficiency and receive the maximum payment.

- **Patient experience and satisfaction.** In addition to helping improve the quality of patient care,⁴ predictive analytics help ensure that payers are billed appropriately for services. Reducing billing errors and the overall clinical experience can help improve patient satisfaction.

Solution Value: Improving Care and Metrics

One of the first steps in implementing a predictive clinical analytics program is to expand access to information across a variety of data sources such as EHRs, payer systems, clinical trials, labs, radiology, and imaging as well as information about the patient's health or socio-economic status. Figure 1 shows some of the common data sources that will be combined to enable predictive analytics applications. This previously untapped data—combined with new mathematical models and hardware and software that are capable of analyzing data stored in disparate systems and formats—can better determine information about a patient's health and predict healthcare outcomes.

The value from implementing a predictive clinical analytics solution can be significant. For example, one hospital group¹ uses a scale-out data platform powered by Intel® Xeon® processors and Intel® Solid State Drives (Intel® SSDs), combined with a data analytics platform and tools that can proactively identify patients with a high readmission risk. This business intelligence can help healthcare providers reduce costs,

Personal Health with Integrated Predictive Clinical Analytics

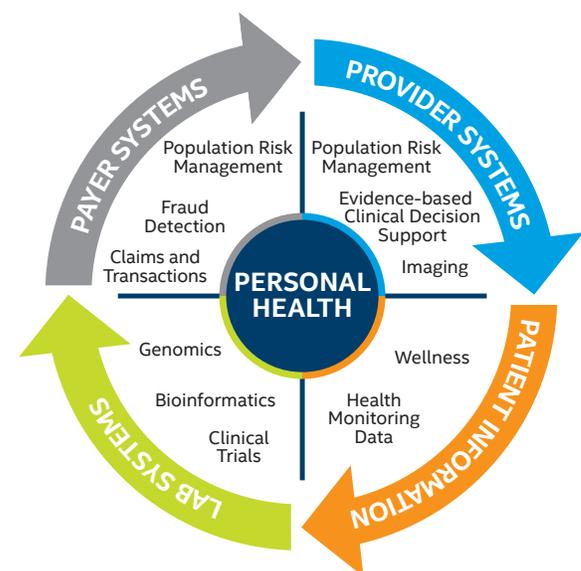


Figure 1. Increasingly, healthcare providers are now able to integrate disparate sources of data, which is foundational to predictive clinical analytical insights.

improve quality of care, and enhance the patient experience. Furthermore, the data and predictive clinical analytics platform can be used to identify insights about patients who are at risk for hospital-acquired conditions (HACs)—such as sepsis or pneumonia—while at the hospital, or which patients are likely to have longer than average length of stays. These types of solutions help healthcare organizations adhere to new value-based reimbursement models and improve allocation of provider resources, which can lead to better operational and cost efficiencies and improved care outcomes.

Solution Architecture: Enabling Predictive Clinical Analytics

The predictive clinical analytics solution architecture stack consists of layers containing offerings from a variety of vendors. As shown in Figure 2, the data repository layer includes a number of customer data sources that may contain both structured and unstructured data. This consists of data repositories that are both internal and external to the enterprise. Examples include EHR data that contain demographics, treatment and diagnosis codes, claims data, clinical notes (unstructured), call center logs, and external data such as environmental data or social media data.

The predictive clinical analytics reference architecture includes the following components:

- Powerful Intel® architecture-based servers
- A data processing layer that performs data ingestion, ETL (extract, transform, and load), cleansing, and storage
- A scale-out analytics platform
- Data visualization

Through the use of sophisticated mathematical models, powerful servers, and advanced software applications, providers can analyze extensive amounts of data stored in a wide variety of formats. The resulting insights into patient risk and resource allocation lead to cost-efficiency gains, increased patient safety, a better patient experience, and heightened quality of care.

The solution architecture shown in Figure 2 provides four primary benefits:

- It accommodates many different data types and formats (structured and unstructured data), which directly addresses the disparate data storage issue.
- It is flexible enough to support new applications and analytics to discover new insights or improve predictive models by combining multiple data sets today and in the future.
- It is easily scalable, due to new data processing software such as Apache Hadoop* and Intel® Enterprise Edition for Lustre* software (Intel® EE for Lustre* software).
- It is based on open source technologies to help avoid vendor lock in, making the solution cost effective for the long term.

At the foundational scale-out data platform layer, a tuned cluster of servers, network, and storage is used to ingest, connect, and hold the data at speed for direct analysis.

Predictive Clinical Analytics in Action: Reducing Hospital Readmissions

In an analysis of more than 15 countries, the United States had the highest rate of hospital readmissions in patients who experienced heart attacks.⁵ Patients with multi-vessel disease had almost twice the odds of readmission compared to those without the condition, and heart attack patients in the United States had a 68-percent increased chance of readmission versus patients in other countries. However, although readmission rates were higher among patients in the United States, the median length of stay in the hospital was also the shortest, at three days. In Germany, the median length of stay was the longest, at eight days for patients with a heart attack.

Intel works with many other industry leaders, such as Cerner*, ProKarma*, CDW*, Big Cloud Analytics*, Cloudera*, Oracle*, and SAP* to develop new data source interconnects and mathematical models to more accurately identify the high-risk factors that bring recently released patients back to hospitals. In particular, Cloudera innovated a new data repository for patient lifestyle information and unstructured data outside of traditional Electronic Health Record (EHR) systems and opens up new contributing factors to determine the risk of the patients returning to the hospital. Cloudera Enterprise⁶ has been jointly developed with Intel to optimize the speed at which the analytics can return insights from these new data sources.

Integrated Predictive Clinical Analytics Reference Architecture

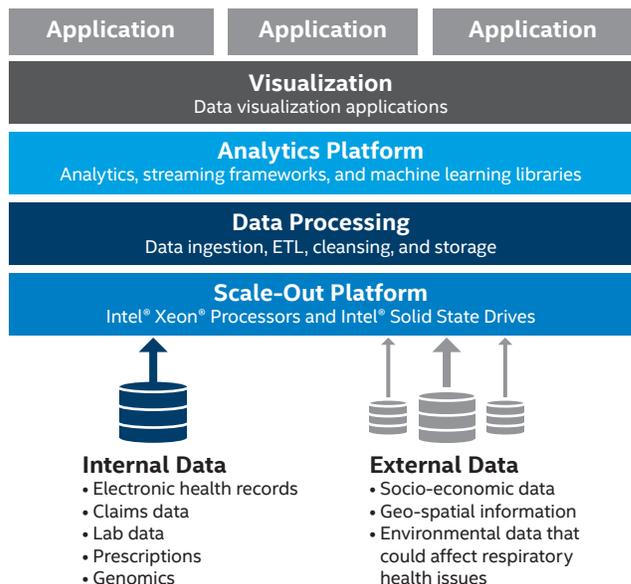


Figure 2. The predictive clinical analytics reference architecture provides a method for analyzing disparate data sources to deliver insights into clinical data.

Ideally, this architecture uses the analytics performance and query compute capacity of Intel Xeon processors and Intel SSDs for big data platforms such as Hadoop to open up and interconnect new data sources and patient EHR information.

An analytics platform layer includes advanced analytics applications, scalable machine learning libraries, and streaming frameworks such as Apache MLlib*, SAS*, or Apache Spark/Spark Streaming*. The visualization layer includes applications such as Tableau* or Qlik*, which make it easy to combine multiple views of data to get richer insight. Finally, the business logic/application layer uses the underlying platform capabilities to implement business use cases.

Conclusion

The digital transformation that is occurring throughout healthcare systems around the world has created an unprecedented opportunity to apply predictive analytics in order to improve operational efficiency and care delivery. Healthcare leaders, industry partners, and Intel are using predictive clinical analytics built on scale-out data platforms to combine information from a wide range of sources and gain a more complete picture of patient health and risk factors. This information can aid in proactive care management and operational cost efficiency by identifying patients who need specialized care or who are at risk for various scenarios such as early readmission or HACs. As technology barriers continue to fall and the penalties associated with non-value-based care models continue to increase, predictive clinical analytics will play an increasingly important role in how successful hospitals deliver high-quality care and continue to grow.

Find the solution that is right for your organization.
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Learn More

You may also find the following resources useful:

- [Intel and Cloudera Use Predictive Analytics to Help a Large Hospital Group Reduce Readmission Rates paper](#)
- [Intel and Cloudera Help a Large Hospital Group Allocate Resources by Predicting Patient Length-of-Stay paper](#)
- [Penn Signals Big Data Analytics Helps Penn Medicine Improve Patient Care case study](#)

¹ Intel and Cloudera Use Predictive Analytics to Help a Large Hospital Reduce Readmission Rates, 2015, intel.com/content/www/us/en/healthcare-it/solutions/documents/predictive-analytics-reduce-hospital-readmission-rates-white-paper

² Electronic Health Record (EHR) and Electronic Medical Record (EMR) are synonymous. This solution brief uses the term EHR.

³ Source: CMS FY 2015 Table 15B

⁴ Healthcare Informatics, UCHealth Deploying Predictive Analytics Tool to Improve OR Utilization and Enhance Patient Care, healthcare-informatics.com/article/uchealth-deploying-predictive-analytics-tool-improve-operating-room-utilization

⁵ U.S. Readmission Rates Dwarf Foreign Countries, dorlandhealth.com/dorland-health-articles/u-s-readmission-rates-dwarf-foreign-countries-says-jama

⁶ For more information about Cloudera Enterprise, see cloudera.com/products

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System configurations, SSD configurations and performance tests conducted are discussed in detail within the body of this paper. For more information go to intel.com/performance.

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