Artificial Intelligence in Healthcare

November 2018

eHEALTH INITIATIVE

Cerner

THE CASE FOR INTELLIGENCE

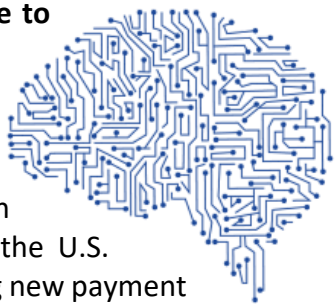
> "As a field drowning in information with a life-or-death need to understand it, healthcare is ripe to benefit from AI."[1]
>
> *-John Glaser, Ph.D. Senior Vice President of Population Health, Cerner*

Since the inception of electronic health record (EHR) systems, volumes of patient data have been collected, creating an atmosphere suitable for translating data into actionable intelligence. The growing field of artificial intelligence (AI) has created new technology that can tackle large data sets, solving complex problems that previously required human intelligence. As healthcare stakeholders search for innovative solutions to support clinical decision-making and manage patient information across the continuum, AI has the potential to transform care delivery. Early application of AI promotes greater accessibility and actionability of healthcare information, which can result in more clinical breakthroughs, developments in cybersecurity, advances in radiology and the early detection of chronic conditions. Currently, healthcare organizations are poised to use AI to align their outcomes with achieving the triple aim – improved care experiences, improved population health and reduced per capita costs of care.[2]

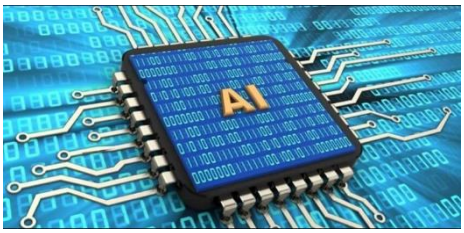
This paper discusses:

- AI market drivers
- AI types
- Advances and examples from the field
- Considerations for successful adoption of AI

AI MARKET DRIVERS – ECONOMICS & BIG DATA



Two key factors are driving the AI market in healthcare and will continue to impact its expansion: economics and the advent of big data analytics. Although the United States spends more on healthcare than other high-income countries, it has worse health outcomes.[3] Costs, new payment options and a desire to improve health outcomes are the primary economic drivers of the intelligence market. Accenture estimates that key clinical health AI applications can potentially create $150 billion in annual savings for the U.S. healthcare economy by 2026.[4] As the healthcare system transforms, bringing new payment models that reward providers based on the value, rather than the volume, of services provided, government and commercial payers are requiring providers to assume greater risk. Providers are incentivized to move from reactive "sick care" to proactive "health management," ideally resulting in fewer hospitalizations and readmissions and fewer trips to the emergency department. Providers and healthcare organizations have recognized the importance of AI and are tapping into intelligence tools. Growth in the AI health market is expected to reach $6.6 billion by 2021[5] and to exceed $10 billion by 2024.[6] Big data analytics and machine learning (ML) markets are projected to see huge gains in the next 4-5 years. [7]



We are in the age of "big data," where organizations are adopting tools for data orchestration and data mining and analyzing volumes of structured and unstructured data. An improved capacity to collect huge sums of information through EHRs and the Internet of Things (IoT) has led to a demand for big data analytics and AI integration in healthcare services. More organizations are able to develop and use intelligence applications because it is possible to outsource data storage, leverage advanced theoretical understanding of data, and take advantage of computers that can execute complex tasks at high speeds and low costs. There is also greater demand for enterprise-level tools, as well as a desire for single platforms that combine real-time events and streaming data with other stored data. In a recent Healthcare IT News/HIMSS Analytics survey, healthcare organizations indicated their belief that AI will have the most substantial initial impact in the areas of population health, clinical decision support, patient diagnosis and precision medicine.[8]

Types of Artificial Intelligence

Artificial intelligence (AI), machine learning (ML) and deep learning (DL) enable healthcare organizations to analyze an immense volume and variety of data. They also facilitate progressively deeper insights which lead to proactive care, reduced future risk and streamlined work processes. While interrelated and often used interchangeably, the terms AI, ML and DL refer to distinct aspects of intelligence. AI is a broad concept that houses ML but includes other applications, while DL is a subset of ML. It is important to understand the relationship between the technologies.

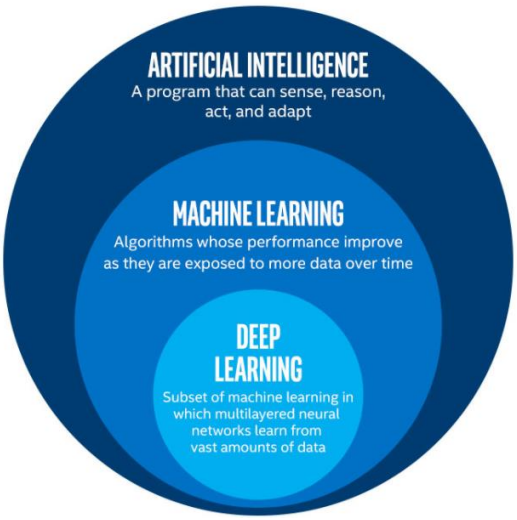


Photo Source: Seema Singh

Artificial intelligence (AI)

AI technologies enable computers to sense, comprehend, act and learn in a manner more analogous to humans. AI is the overarching term for multiple technologies which allow machines to independently solve problems they have not been programmed to address.

Machine Learning (ML)

ML is a subset of AI that uses algorithm models to achieve the concept of AI. As the algorithms are exposed to new data, they independently adapt over time and modify themselves to perform better in the future. The machines are literally learning as they process information. This process enables AI algorithms to choose activities with the highest likelihood of success. Sources of data for ML include, but are not limited to, medical claims, EHRs and biometric readings.

Deep Learning (DL)

DL is a type of machine learning that uses multiple layers of networks, including abstract layers not designed by human engineers, to discover patterns in data. This technique helps to give structure to unstructured data and enables machines to learn to classify data without assistance.

ADVANCES AND EXAMPLES FROM THE FIELD

According to JASON, an independent scientific advisory group that advises the government, AI is playing a growing role in transformative changes in health and healthcare, both in and out of the clinical setting. AI is shaping the future of public health, community health and healthcare delivery from a personal level to a system level. JASON's 2017 study stated that the extent of the opportunities and limitations of AI are just beginning to be explored, but AI is already playing a significant role in medical imaging and clinical practice. The report details AI's uses for diabetic retinopathy, dermatological classification of skin cancer and computational advances in coronary artery disease.[9]

> "AI will not be competing with humans but augmenting what they do best."[12]
>
> *-Jim Massey, Innovator Healthcare Advisory Practice Cerner Middle East*

Experts stress the role of AI in healthcare to supplement and enhance human judgment, not replace physicians and staff. With the automation of clinical documentation, administrative workflow assistance, image analysis, virtual observation and patient outreach, AI is ready to support physicians, customer service representatives and administrative staff. AI can augment processes using automation, to reduce the staff required to monitor patients, while filling gaps in healthcare labor shortages. It can also lower operational costs and make patient care more efficient. In addition to imaging and workflows, Forbes believes AI will be most beneficial in three other areas, physician's clinical judgment and diagnosis, AI-assisted robotic surgery and virtual nursing assistants.[10] These areas dovetail with Accenture's finding of the top ten AI applications to create healthcare *savings* by 2026.[11] [12]

Top AI Applications that Could Change Healthcare

APPLICATION	POTENTIAL ANNUAL VALUE BY 2026
Robot-assisted surgery	$40B
Virtual nursing assistants	20
Administrative workflow	18

Source: Accenture

Identifying patients at risk of disease, readmissions and hospitalizations; deciphering appropriate interventions based on clinical information; exploring alternative care plans; monitoring and supporting the management of high-risk populations; and detecting correlative risk factors for better disease management are all areas intelligence can greatly impact. Intelligence affords the ability to spot trends and patterns across certain groups, monitor overall plan performance across populations and take advantage of a variety of data types, such as social determinants of health, environmental, genomic and behavioral health. Predictive and descriptive analytics, in particular, can improve efficiency of care and population and disease management.

Robotics in surgical procedures

As robotic-guidance becomes more common in spine surgery, there has been a growing body of literature on the technology's accuracy, reduction of intraoperative radiation and surgical efficiency. A study of 379 orthopedic patients showed that Mazor Robotics' AI-assisted robotic technology reduced surgical complications five-fold compared to freehand surgeons. [13]

Researchers from the University of Oxford completed the first successful trial of robot-assisted retinal surgery. Twelve patients that required dissection of the retina were randomly assigned to either undergo robot-assisted or manual surgery under general anesthesia. Although the AI assisted surgery took longer, surgical outcomes were equally successful in the robotic and manual surgery groups.[14]

Analytics to reduce readmission rates

Children's Hospital of Orange County (CHOC) developed a machine learning model to identify patients at risk for unplanned 30-day readmission. The tool enables CHOC's care management staff, physicians and others on the care team to proactively focus on patients categorized as having a high or moderate risk of being readmitted, prior to their initial hospital discharge. Their model outperforms any other readmission model in pediatrics.[15] In the context of CHOC's patient population, more than 50 percent of patients labeled as a high readmission risk were in fact readmitted. Moving forward, CHOC is developing interventions for these patients and evaluating which interventions are most effective in preventing readmissions.[16]

Virtual observations to reduce patient falls and operational costs

Between 700,00 and 1,000,000 people in the United States suffer from preventable falls in the hospital every year. These falls contribute to a range of complications and increased healthcare utilization.[17] In 2016, Atrium Health implemented a 3D-motion tracking camera system, based on AI that monitors fall-risk patients at Carolinas Rehabilitation hospitals. The system enables the hospital to observe 12 patients at a time with one staff member at the centralized monitoring station, reducing costs of sitters, restraints and net beds. The motion detector alerts the monitoring technician of patient movement, prompting a recording asking the patient to return to bed; two-way audio communication with nurses; and bedside assistance with the care team. Since implementation of the system, there have been zero falls for the patients observed, while the overall unassisted fall rate fell 51 percent.[18]

Algorithms for chronic condition management

Truman Medical Centers (TMC) of Kansas City Missouri has implemented chronic condition management programs using machine learning predictive models to improve patient engagement and health outcomes. TMC is specifically targeting groups of individuals with conditions such as heart failure and diabetes. Algorithms configured in a population health management program identify select groups of patients that could benefit from enhanced health monitoring. The platform aggregates and analyzes the health information of those participating. Data is collected through remote patient monitoring kits given to participants. The devices are connected to the patient's individual EHR and automated alerts of patterns are sent to care teams. These near real-time analytics provide care teams with a more comprehensive picture of patients' health and help TMC proactively intervene with essential treatment plans.[19]

CONSIDERATIONS FOR SUCCESSFUL ADOPTION OF AI

As the AI market continues to evolve and new best practices are established, there are challenges and unique considerations for the successful technology adoption. Providers must consider how patient privacy and security will be protected and how to:

- Take advantage of unstructured data
- Deal with limited access to high-quality and unbiased data sets
- Utilize high-performing and reliable network capabilities
- Verify performance
- Implement data governance strategies
- Develop and adopt new staffing and training strategies
- Find a balance between costs and potential benefits

Institutional readiness and network capabilities

For AI to be useful, employees and a workforce culture ready to embrace AI are necessary. Employees must be equipped to use the technology and providers must be confident that their network is high-performing and reliable. Advancements in edge computing, personal medical devices and IoT that support AI systems require organizations to consider the ability of their networks to handle data of varying sizes in real-time.

Ethical standards for privacy and safety

As advancements in AI lead to increased vulnerabilities and growth in potential cyberattacks, a clear focus on safeguarding patient information, establishing ethical standards and improving cybersecurity must be maintained. Organizations need to strengthen permission protocols for sharing and using data that flows across disparate systems as much as they need aggressive security measures, such as risk assessments that demonstrate threats, evaluate likelihood of occurrence and recommend changes.

Data governance

Data governance is necessary for all healthcare organizations, regardless of their intelligence status. Developing clear, consistent, and standardized policies and procedures for creating and managing data should be an organizational priority. As AI algorithms are forming and learning, they require trustworthy, reliable, accurate and accessible data. Data governance empowers users to trust the predictions of analytics models in their decision-making because there is certainty that the data and algorithms can be trusted.

Data types

Although most organizations utilize structured data in predictive algorithms, unstructured data is frequently richer and more multifaceted. Unstructured data may be more difficult to navigate, but valuable patient information is often “trapped” in an unstructured format. This type of data includes physician and patient notes, e-mails and audio voice dictations. Unstructured data can lead to a plethora of new insights and, using AI to convert unstructured data to structured data enables

healthcare providers to leverage automation and technology to enhance processes, improve patient care and monitor the AI system for challenges.

Access to high-quality, unbiased data

While quality data may be difficult to access due to privacy concerns, HIPAA regulations, or the pure messiness of data, access to high-quality, unbiased data sets is critical to the success of AI in healthcare. Robust, curated data sets allow for training in particular applications and are essential. A lack of data curating will hinder AI training and cause inaccurate diagnoses. Unbiased data is a safeguard against algorithms that skew data against vulnerable or underrepresented groups.

Evaluation of technology models

Before implementing AI technology into clinical practice, organizations should verify the performance of their models for their settings and question if the technology performs at least as well as the existing, standard approach. The technology should be evaluated for its ability to promote quality of care, improve clinician work satisfaction and lower costs. It can be harder to evaluate intelligence for certain health conditions. For instance, models can be less accurate due to lack of data for rare or recurring forms of cancer. Those training the intelligence may find it difficult to keep up with treatments that are quickly evolving.[20]

Cost

The benefits of AI and advanced analytics can be substantial to some providers. Long-term investments in intelligence technology tend to outweigh the costs of investments to build, maintain and repair emerging technologies. By embracing the future of intelligence, organizations can profit from many benefits, including fast and accurate diagnostics, reductions in human error and lowered administrative costs.

CONCLUSION

In a time of rapid healthcare transformation, health organizations must quickly adapt to evolving technologies, regulations and consumer demands. AI offers the industry incredible potential to learn from past experiences and make better decisions in the future. AI, ML and DL can assist with proactive patient care, reduced future risk and streamlined work processes. The continued emphasis on cost, quality and care outcomes will perpetuate the advancement of AI technology to realize additional adoption and value across healthcare.

ABOUT THIS PAPER

Through the support of the Cerner Corporation, this paper was written by e-Health Initiative. e-Health Initiative a Washington DC-based, independent, non-profit organization whose mission is to drive improvements in the quality, safety, and efficiency of healthcare through information and information technology.

ENDNOTES

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