The Impact of AI Technologies in Healthcare

By Angel F. Valladares, M.P.H.

Just five years ago, healthcare was considered one of the most poorly digitized sectors of the U.S. economy, believe it or not, next to construction and agriculture.[1] Some of the reasons experts attribute to healthcare's lag in digitization versus other sectors are the older workforce, disincentive to expand data access due to strong privacy regulations, lack of financial incentives to exchange data, and an insufficient rate of true disruption witnessed by other industries. However, the COVID-19 pandemic that began in early 2020, may have at least temporarily disrupted that dynamic.[2] That disruption may have been just enough to cause a significant shift in the rate of technology adoption to allow for runaway digitization in healthcare. One technology experiencing exponential growth, and is the industry's latest buzzword, is the domain of artificial intelligence (AI). AI is the term used to describe the use of computers and technology to simulate intelligent behavior and critical thinking comparable to a human being; it is a *domain* of technologies and not one in and of itself.[3]

AI's footprint in North America is seeing massive growth, particularly from the tech sector, which powers many of the consumer-oriented products we all use today. Targeted advertising on social media, app-based car services like Uber or Lyft, and Alexa, Siri, and Google Home are all based on underlying AI technologies. In fact, AI is now involved in almost 15 percent of the economy in North America; that's over $3.7 trillion! However, despite that very large market footprint, estimates of the market size of AI in healthcare *globally* range from only about $4 billion to $10 billion as recently as 2020.[4]

Despite being a relatively small fraction of the healthcare market, AI's footprint is expected to grow by a factor of 10 over the next five years by most accounts. One of the core drivers for AI's growth is the exponential growth of digital data in healthcare (which AI both takes advantage of and has a hand in producing). Due to the volume and complexity of "big data," we increasingly require more advanced data science to interpret and generate valid and meaningful insights that require AI to conduct. While AI in healthcare is most prominently in use in the life science/biotechnology sector, there are technologies already impacting hospital operations and decision making. The projected growth of the AI market makes it a pivotal time for hospital boards and senior leaders to gain a better understanding of where AI is being developed and deployed for use in clinical care and hospital operations.

Key Board Takeaways

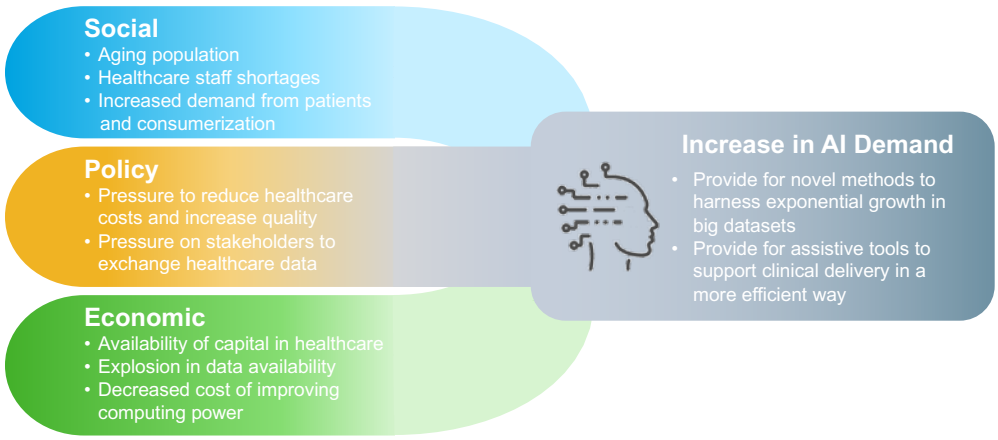
- When considering AI, ensure the ultimate goals of efficient, more cost-effective, patient-centered care guide decision making.
- Prepare for AI's arrival. For example, consider patients' expectations around AI-assisted virtual care options and the data security measures that would need to be put in place.
- Have a fundamental understanding of AI use cases and value propositions and keep track of maturing technologies.
- Be strategic with AI investments. As with any technology, ensure the organization can accurately track and measure the ROI of an AI product.

Market Pressures Driving Growth of AI in Healthcare

Before providing an overview of what AI in healthcare looks like, it is important to understand the drivers of its growth. The healthcare industry is facing considerable pressures due to several social, policy, and economic developments and trends. Socially, the U.S. population is aging. In fact, seniors will outnumber children by 2035 according to the U.S. Census Bureau.[5] Given that as we age, we tend to need more healthcare services, an aging population will have more demand for care.

On the policy front, the federal government has consistently moved forward across administrations with payment, delivery, and data infrastructure reforms that have changed the landscape. While by no means coordinated to any true extent, federal policy has pushed for a focus on shifting payment from volume to value and has incentivized healthcare

Exhibit 1. Market Pressures Driving Growth of AI in Healthcare



1 Prashant Gandhi, Somesh Khanna, and Sree Ramaswamy, "Which Industries Are the Most Digital (and Why)?," *Harvard Business Review,* April 1, 2016.
2 Heather Landi, "COVID-19 Has Accelerated the Adoption of AI. Executives from Google Cloud, Suki, and Olive Spell Out Why," *Fierce Healthcare,* August 13, 2020.
3 Paras Malik, et al., "Overview of Artificial Intelligence in Medicine," *Journal of Family Medicine and Primary Care,* July 2019.
4 Sumant Ugalmugle and Rupali Swain, *Artificial Intelligence in Healthcare Market Forecast Report 2021–2027,* Global Market Insights, October 2021; *Artificial Intelligence in Healthcare Market by Offering, by Technology, by End-Use, and Region Forecast to 2027,* Reports and Data, January 2021; *Artificial Intelligence in Healthcare Market Report, 2021–2028,* Grand View Research, May 2021.
5 Deidre McPhillips, "Aging in America, in 5 Charts," Best States, *U.S. News & World Report,* September 30, 2019.

providers to adopt health information technology (HIT) to improve data exchange. Experts would say that the former driver is a reaction to runaway healthcare costs, which have consistently increased at a rate of 3.5 to 6 percent a year—especially the costs of clinical services, healthcare administration, and prescription drugs.[6] The latter focus on HIT adoption has been an attempt to modernize U.S. healthcare infrastructure to reduce administrative costs and more recently, improve data sharing between providers, payers, and patients. To the extent that this HIT adoption has delivered on this promise is still up for debate.[7]

According to Forbes, 90 percent of all the world's data was generated in the last two years alone.

Running concurrently with these major trends is the consumerization and personalization of healthcare to resemble other consumer-focused economic sectors. In other words, patients are asserting more influence and control over their medical needs and wellness. Given the explosion of information available on the Internet, thanks to "Dr. Google,"[8] patients are in return more empowered to search for the services they deem necessary to address their concerns and maintain their well-being. In fact, recent research suggests that up to four in five patients will show up to their healthcare providers having conducted their own diagnosis research.[9]

In response, the market has produced thousands of patient-facing services from telehealth, to wellness management applications, to even personalized digital therapeutics and diagnostics, which are often powered by AI-based machine learning technology. However, the ubiquitous use of these solutions requires an environment supportive of high transmissibility of data between entities and that assumption is challenged by the patchwork of data privacy and security regulations in place.

Where Is AI Changing the Healthcare Paradigm?

The best way to understand the growth and impact of AI in healthcare is to understand where it is already disrupting or projected to have a disruptive effect on the provision of healthcare services. However, it is also important to note that AI use has accelerated substantially in the biotech industry to support drug discovery, clinical trial enhancement, and even post-approval market adoption activities. Moreover, while the overview below will focus solely on AI's impact directly on care delivery and healthcare organization decision making, it is important to recognize AI's acceleration throughout the entire sector.

Outlined below are the key AI-based technologies that have been developed or are being developed to meet the needs of healthcare provider organizations. Each use case includes an overview of the opportunity, the potential impact to care delivery, and what is needed for the promises to be fully achieved.

Population health management:

- **Opportunity:** Machine learning[10] algorithms may be deployed to facilitate real-time feedback on provider performance and insights on community health to manage patient populations. AI can also be deployed in the form of virtual assistants[11] to enhance patient engagement tools in support of patient self-management.
- **Impact:** Streamlined patient registration and intake, alignment with patient preferences (which are continuing to transition to virtual interactions versus traditional phone calls), triaging patients based on reported symptoms and needs, and finally more real-time care management for patients with complex diseases.
- **What's needed:** Healthcare providers need to more actively manage the data that is being provided by patients to inform future patient engagement strategies. This is also a very saturated market and organizations should diligently assess

Exhibit 2. AI Use Cases and Main Impacts

AI Use Cases	Main Impacts	Maturity Level
Population Health Management	• Insights on practice-level outcomes • Increased patient engagement	
Remote Patient Monitoring	• Potentially reduce adverse events • More effective use of biometric data	
Clinical Decision Support	• Real-time clinical decision support • Delivery of personalized patient care	
Extraction of Clinical Data	• Reduce clinician administrative burden • Better access to unstructured datasets	
Revenue Cycle Management	• Holistic and more efficient revenue cycle management and operations	
Imaging (neural networks)	• Pattern detection for patient diagnosis • Improve efficiency of radiology practice	

Some Solutions At-Scale | Mostly Point Solutions | Mostly Pilot-Phase Solutions

6 Apoorva Rama, "Policy Research Perspectives: National Health Expenditures, 2019: Steady Spending Growth Despite Increases in Personal Health Care Expenditures in Advance of the Pandemic," American Medical Association, May 2021.
7 Robert Rudin and Paul Shekelle, "What Have We Learned About Leveraging Health Information Technology to Improve Health System Performance?," RAND Corporation.
8 Riza Conroy, "What Your Doctor Wants You to Know About 'Dr. Google,'" The Ohio State University, Wexner Medical Center, February 15, 2019.
9 *The Consumerization of Healthcare*, Econsultancy and Adobe, February 2019.
10 Sara Brown, "Machine Learning, Explained," MIT Sloan School of Management, April 21, 2021.
11 Adam Miner, Arnold Milstein, and Jefferey Hancock, "Talking to Machines About Personal Mental Health Problems," *JAMA,* October 3, 2017.

Barriers to Development of AI

The main barriers to significant development of AI in the recent past have included:

- Healthcare lacking proliferation of environment-awareness technologies (e.g., sensors)
- The right volume of *digital* data necessary to require complex analytics that AI supports
- Lack of business models mature enough to use AI effectively
- A lack of true demand for broad and deep data insights to drive decision making
- A general dearth in sufficient computer processing power to support AI implementation

However, the market pressures shared in this article have pushed the industry far enough along that most of these barriers have been overcome and there is now sufficient momentum to support a burgeoning AI market in healthcare.

options that best meet the needs of the patient populations under their care.

Remote patient monitoring:

- **Opportunity:** AI can substantially increase the value of implementing remote patient monitoring (RPM). For instance, machine learning algorithms can be developed and deployed, built upon analysis of large data sets, to better identify patient populations who would best respond to RPM. Further, RPM on its own generates real-time biometric data at a staggeringly higher volume and frequency that can improve learning algorithms to better guide care teams with treatment decision making.
- **Impact:** Ultimately, this technology enhanced by AI is promising to improve patient outcomes by reducing avoidable events, thereby offsetting healthcare costs associated with complications, avoidable admissions, and additional ED utilization.
- **What's needed:** If RPM is to deliver on these promises, AI technology will be required to integrate newly generated data into clinical workflows, accurate predictions, and effective patient identification. This means that the right EHRs and clinical data systems capable of interfacing with AI technologies will need to be in place before seamless integration and subsequently improved care can be achieved.

Today, algorithms are already outperforming radiologists at spotting malignant tumors, and guiding researchers in how to construct cohorts for costly clinical trials.

Clinical decision support:

- **Opportunity:** AI in the form of predictive analytics may be deployed to leverage contextual information on patients to provide more personalized, patient-centric care that considers data on external factors previously inaccessible to provider systems (e.g., social determinants of health and consumer data).
- **Impact:** This would enable providers to leverage the powerful insights generated from AI-based models to not only implement best practices but iteratively improve on process.
- **What's needed:** For clinical decision support to truly be enhanced in various disease areas, underlying clinical data that is often siloed or not readily available to support advanced analytics will need to be transformed or generated if non-existent. This will require complementary technologies like RPM, wearable devices, and specific types of AI like natural language processing to function in unison, which will necessitate the appropriate computing power to support.

Extraction of clinical data (natural language processing):

- **Opportunity:** Natural language processing (NLP)[12] may be used to translate unstructured clinical notes or even voice recordings of patient consultations into relevant, structured data that can easily be embedded in EHRs.
- **Impact:** As a result, NLP may reduce administrative burden in the form of clinical documentation, which is often cited as a reason for clinician burnout. In addition, it may increase the utility of clinical data to support real-world clinical insight generation for research and process improvement.
- **What's needed:** Training datasets that are as unbiased and balanced as possible to support maximum model validity and reduce bias risks will be needed. That will require advanced data analytics capabilities to enable iterative evaluation and post-hoc improvements to established models to better fit model performance to diverse patient communities.

Revenue cycle management (RCM):

- **Opportunity:** Existing use cases of AI in RCM are mostly focused on patient payment estimation modeling and eligibility and benefits verification. In the near term, AI is maturing to support prior authorization and payment amount and timing estimation.
- **Impact:** Once many of these solutions mature (which is projected to happen quickly), they will transition from point solutions solving just one problem to end-to-end support of RCM. In that state, hospitals will benefit from being able to better manage RCM holistically.
- **What's needed:** Simply stated, these solutions are not mature enough yet. Most of the offerings on the market support one single solution and do not articulate a clear ROI making their up-front investment costs questionable.

Imaging (neural networks):

- **Opportunity:** Neural networks, which mimic the way neurons in the brain signal to one another, support deep learning[13] that can recognize patterns in imaging data. AI deployment in support of radiology can take shape in two forms: 1) a machine learning algorithm that follows predefined criteria supported in clinical guidance documents to assist a radiologist's decision making more readily, and 2) using either supervised or unsupervised deep learning on large volumes of imaging data to extract patterns and insights likely to be missed by a human expert alone.
- **Impact:** These algorithms may detect and identify rapidly declining disease

12 "What Is Medical or Clinical NLP?" Lexigram.
13 "Deep Learning vs. Machine Learning," Western Governors University, February 5, 2020.

states, quantify lesions on previous and current scans, and predict morbidity and mortality from a series of images.
- **What's needed:** Currently, AI-supported imaging technology is expensive, and the ROI is not generated quickly given the learning curve required of radiologists. In addition, many available technologies in this area suffer from "black box syndrome" in that some deep learning platforms may not provide sufficient transparency to clinical experts to trust the insights generated.

Challenges and Risks with AI Use

After reading the overview above, anyone would likely assume that AI may be a silver bullet to the various challenges faced by healthcare providers. However, as with any burgeoning technology, there are challenges as well as risks with adoption. For AI technology specifically, here are some of the major associated challenges and risks to consider.

AI Use Risks

"Garbage in, garbage out" is a critical issue in AI technology associated with the quality of the underlying training data for model development and improvement. Readily available, fit-for-purpose data is still hard to come by given that many datasets are generated in siloes and there is still poor adherence to data standards. Bad data could influence your AI platform and provide you with inaccurate insights, poorly impacting your organization's decision making.

Also, without a diverse and representative sample in the data used to develop algorithms irrespective of AI modality, there is a high risk of perpetuating bias and inequities that are already present in the healthcare system today. This is quite relevant when AI models are applied to different populations, they will need to be modified to better fit the nuances of each respective patient community.

AI Use Challenges

For more advanced use cases, consider the need for appropriate computer processing power (e.g., imaging), reliable broadband connections (e.g., remote patient monitoring), and technical literacy and familiarity by both providers and patients. In some settings, these resource requirements will prove to be major access barriers to AI adoption. Oftentimes, some of the most challenging patients are least likely to meet the minimum requirements for technology adoption. Disparities in data and technological infrastructure will reflect unequal access to innovation.

The black box problem is also often an adoption barrier for even some of the most well-developed AI tools. If providers are unable to understand the process undertaken by an AI tool to generate insights or if the insights are not translated appropriately to achieve maximum interpretability, then the tools will not live up to their purpose or promise.

The Board's Role

No matter what type of AI is being considered, what's important is for hospital boards and executives to ensure the ultimate goals of efficient, more cost-effective, patient-centered care guide decision making. AI in healthcare is coming no matter what, so hospital leaders should get ahead of the curve by preparing for its arrival, if they have not done so already. A few things to consider include:
- Forward-thinking patients (especially those with chronic conditions) now expect to have access to convenient AI-assisted virtual care options. Hospitals and health systems that haven't yet adapted long-term to this shift in preferences are likely to see major financial impacts.
- Data security will become increasingly important as siloes are broken down and data is more freely exchanged between business units. Securing the systems from hackers and malware and making sure that their self-maintenance functions are reliable will be critical.

It's also important to note that not all AI is created the same. Hospital leaders should have a fundamental understanding of AI use cases and value propositions and keep track of maturing technologies, for example:
- Engage vendors early in the exploration process and ask questions regarding how they use AI in their products, what data will need to be in a ready state for the models to function properly, what efficiencies should be expected as a result of implementation, and so on.
- Also, consider not just what rules and logic an offering's AI is based on but how service providers improve upon the logic by incorporating new components or rules; avoid signing up for a black box service.

The board and management need to be strategic with investments in AI. It can get expensive fast, so hospital executives should ensure they can accurately track and measure the ROI in an AI product, as with any technology:
- Conduct a top-down assessment of existing technological capacity and data needs of the organization before investing in any one technology.
- Assess resource needs to find and retain the staff needed to support these systems, amid a general shortage of data scientists.
- When engaging with vendors, determine an opportunity to conduct a pilot phase to be able to evaluate the potential impacts to the organization and its constituents, especially.

AI is certainly a very promising technology that is purported to bring much-needed efficiencies and improvements to the U.S. healthcare system. However, it is important to recognize that our understanding of the short- and long-term impacts of AI in healthcare are still highly dependent on how market pressures evolve and the timeline of maturity for many of the use cases. For hospital leaders specifically, now is the time to become familiar with AI use cases and properly assess what resources and skills will be necessary to deploy available technologies. Ultimately, just like any major investment, a strategic approach with a clear assessment of benefits and risks will increase the value-add of AI solutions and minimize any potential negative impacts.

The Governance Institute thanks Angel F. Valladares, M.P.H., Real World Evidence Strategy Consultant at IQVIA, for contributing this article. He can be reached at angel.valladares@iqvia.com.