L.E.K.

Special Report

Artificial Intelligence and Hospitals: Separating Myth From Reality

Contents

Introduction

There's rarely a day that goes by when we aren't reading an article about the latest developments in artificial intelligence (AI) and its application in healthcare, or when our hospital clients aren't asking us exactly what AI is and whether they should be doing something with it.

AI is poised to disrupt healthcare, and we don't think the hype surrounding it is overblown. Technology leaders and influencers agree that AI is the new frontier and that healthcare in particular is poised for disruption due to AI advancements (see Figure 1). While we are not likely to see a robot doctor scanning your body for illnesses anytime soon, we are beginning to see both clinical and nonclinical advancements in AI technology that prove that healthcare is rapidly approaching an inflection point for substantial change.

However, with the excitement also comes a fair amount of confusion regarding what AI can do, as well as the fear that AI will replace clinical and nonclinical staff. While the hesitance regarding AI is understandable, we do believe AI will ultimately augment today's practices and bring us closer to a more accessible, efficient and functional healthcare system.

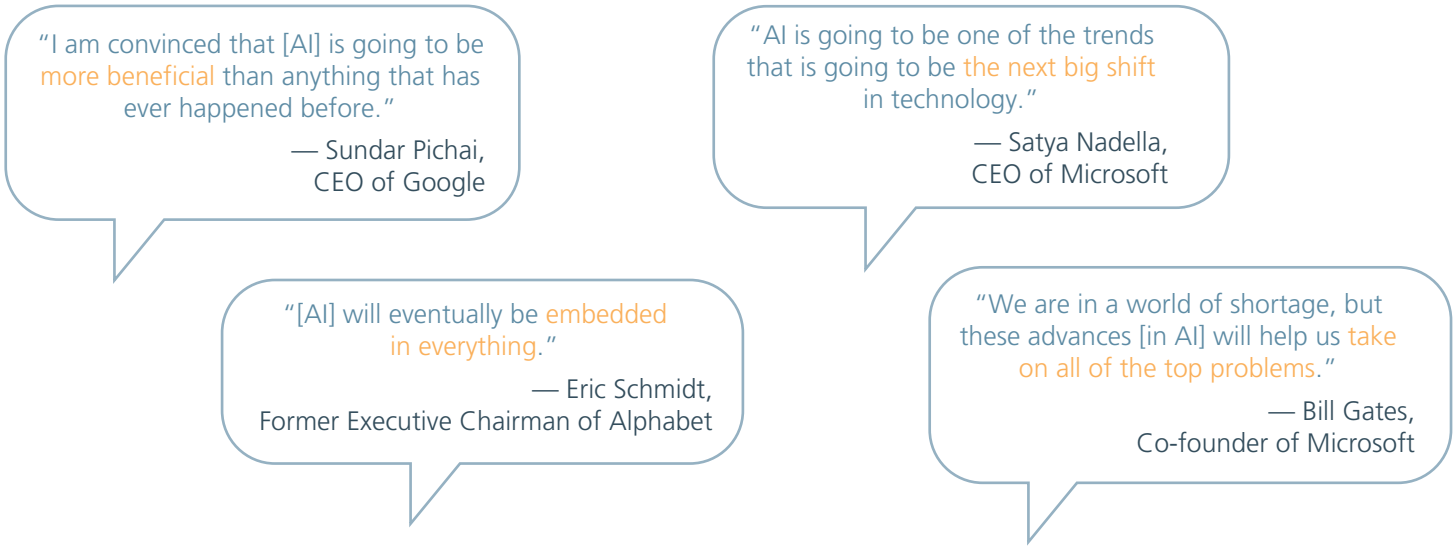
This paper aims to better inform readers on what AI is, how it is being utilized today and early implications for healthcare providers (integrated delivery networks, academic medical centers, etc.). The goal is to help us understand how AI can enhance healthcare and ultimately improve patient outcomes at a reduced cost.

Specifically, we answer the following questions:

1. What is AI, and how does it work?
2. What healthcare problems is AI attempting to solve, and what are the implications for hospitals?
3. What is the current level of maturity of AI solutions, and where can they eventually go?
4. Why is AI in healthcare harder to implement than AI in other industries?
5. How can healthcare providers prepare to embrace the full potential of AI in healthcare?

Figure 1

Technology leaders and influencers believe that AI is the new frontier and that healthcare in particular is poised for growth



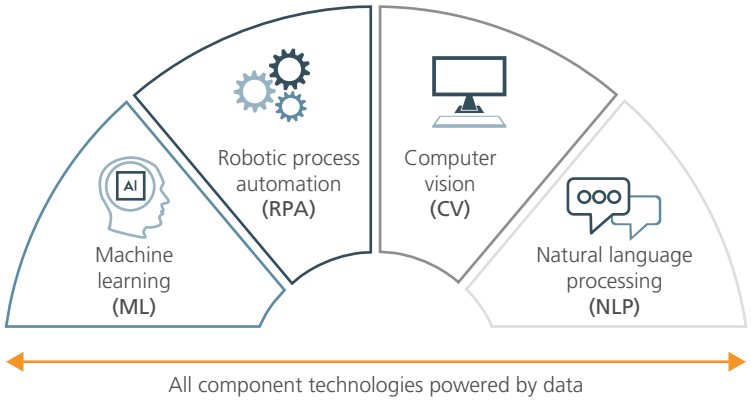
Source: Forbes; AI Business; The Telegraph; Gadgets; Futurism; L.E.K. Consulting research and analysis

What is AI, and how does it work?

AI encompasses the study and development of computer systems that can perform tasks that usually require human intelligence. AI-enabled processes can "learn" from experience (i.e., by ingesting and applying data to algorithmic models and using the results to improve those models), thereby improving with each iteration.

Today, AI typically makes use of several constituent technologies, including but not limited to machine learning (ML), robotic process automation (RPA), computer vision (CV) and natural language processing (NLP) (see Figure 2). However, these technologies are not truly disruptive in isolation and drive the greatest impact when combined (see Figure 3). Given the rapid pace of progress and development in the field, these solution components are likely to be significantly enhanced soon. They may even be supplanted by newer technologies currently being studied.

Figure 2
AI solutions typically make use of a number of constituent technologies



Source: CIO; Olive; SAS; L.E.K. research and analysis

Figure 3
These technologies are not truly disruptive in isolation but will drive the greatest impact when combined

Combination example #1 — Automation	
RPA	Automatically search a patient's health records for keywords
RPA + NLP	Interpret the meaning of those keywords in context, and generate relevant patient clinical history insights for the clinician
RPA + NLP + ML	While improving the performance of the algorithm with each iteration

While the primary benefit is efficiency/time savings, automation can also improve task outcomes and deliver other benefits throughout the organization.

Combination example #2 — Improvement	
ML	Predict the optimal medication for a patient given his/her clinical profile
ML + RPA + CV	Cross-reference the patient's health records and insurance documentation to determine coverage
ML + RPA + CV	And generate the appropriate prescription for clinician signoff

Similarly, while the primary benefit is outcome consistency and improvement, efficiency can also be positively impacted.

Source: L.E.K. research and analysis

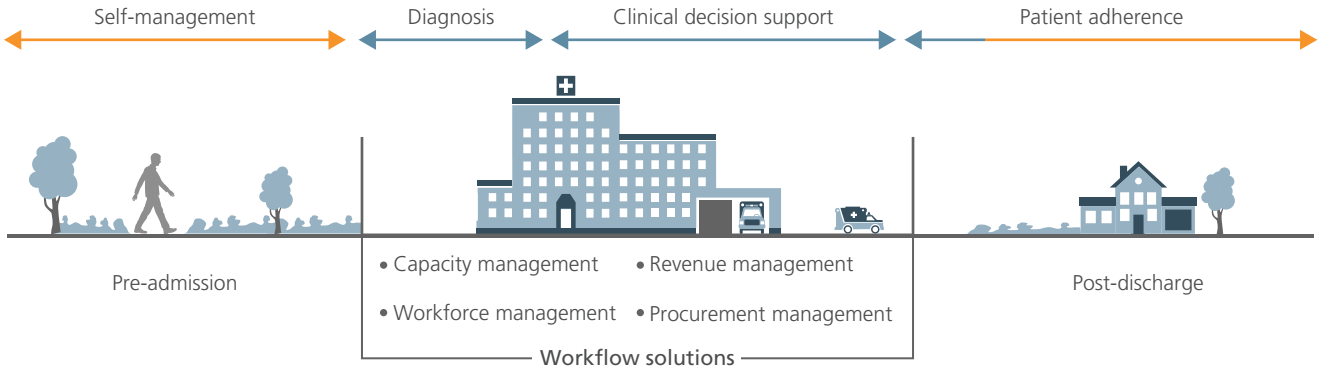
What healthcare problems is AI attempting to solve, and what are the implications for hospitals?

Healthcare AI solutions fall into three categories when viewed from a hospital's perspective: provider- or clinician focused, patient focused and operations focused (see Figure 4). These AI solutions impact different parts of the patient journey, both pre-admission and post discharge.

Provider-focused

- **Diagnosis:** Multiple AI tools are being developed to assist in the diagnosis of disease, often for conditions that are underreported or underdiagnosed (e.g., diabetes, stroke, cancer), as well as in primary care (e.g., Babylon Health). These tools harness historical diagnostic data to develop algorithms that can predict the onset of particular conditions in new patients. On the one hand, these solutions can increase the number of patients identified for medical intervention. On the other hand, by catching the patients earlier in the disease life cycle, the tools can prevent higher-cost medical interventions that might otherwise have been required later. Most of these tools are being developed by health technology companies in partnership with hospitals and other healthcare companies that have access to historical diagnostic data.
    - **AI diagnostics tool:** DreaMed claims to use adaptive learning algorithms and fuzzy logic to evaluate data from insulin pumps, continuous glucose monitors, blood glucose meters and patient-reported lifestyle choices to identify patterns from each insulin dosing event. Through the identified patterns and learnings, DreaMed says it can provide recommended treatment (e.g., adjusting insulin dosing) to the physician to approve and send to the patient, without an appointment.
- **Clinical decision support:** As hospitals continue to standardize and digitize their clinical processes, a new opportunity is being created to embed AI systems in these processes to assist physicians and other healthcare staff in making decisions related to a patient's care. For example, these solutions aim to assist physicians with making choices about which tests they should run, as well as which drugs or treatment pathways are most suitable for that patient. Such solutions, in combination with AI-enabled diagnostic solutions, hold the promise of enabling patient-focused precision medicine.
    - **Clinical decision support AI tool:** Qlarity Imaging improves patient care by extracting clinical insights from existing medical images. Its initial product is the first computer-aided diagnosis software for radiology cleared by the U.S. Food and Drug Administration. It integrates

Figure 4
AI across the health system business continuum



Provider-focused
- A Diagnosis
- B Clinical decision support
- C Disease prevention, monitoring and treatment

Patient-focused
- D Patient adherence
- E Self-management solutions

Operations-focused
- F Workflow solutions

Source: Kansal & Company

images from multiple modalities to assist radiologists in the assessment and characterization of breast abnormalities.

- **Disease prevention, monitoring and treatment:** Many hospitals are investing in building digital capabilities for population health management. In this context, they are also experimenting with healthcare AI solutions to assist healthcare providers in preventing the spread of disease, as well as in monitoring, maintaining or improving the health of their patients. Hospitals that are vertically integrating to offer insurance, for example, can leverage AI to assist with customizing and adjusting health insurance premiums based on a patient's health history and potential for future diseases.
    - **Disease prevention, monitoring and treatment AI tool:** Biofourmis is an "FDA-cleared Biovitals™ Analytics engine that is part of a highly sophisticated AI-powered health analytics ecosystem that predicts clinical exacerbation in advance of a critical event. It can help hospitals prevent disease, manage complex chronic populations and minimize unnecessary readmissions and ER visits."

Patient-focused

- **Patient adherence:** AI solutions are also being developed to assist healthcare providers in improving patients' post-discharge compliance with their treatment (e.g., taking medications, attending follow-up visits). These solutions are typically embedded in digital therapeutics or smart devices that passively track patient compliance, create a communication link with providers, and apply behavioral science to predict and prevent nonadherence.
    - **Patient adherence AI tool:** AiCure's intelligent medical assistant (IMA) uses visual recognition to monitor patient adherence, the company says, and has been used in clinical research trials and by providers. AiCure says its app can recognize whether the patient has taken his or her medication, without the involvement of a physician. If the IMA raises flags about adherence, medical professionals can reach out to the patient in real time via the app.
- **Patient self-management:** A broad category of healthcare AI solutions that aim to empower patients to manage their health are also under development. They encompass fitness and wellness devices (e.g., personalized health trackers) and personal health assistants (e.g., knowledge tools, consumer health information). Hospitals have an opportunity to integrate data from such personal devices into their patient databases to enhance the patient experience.

Operations-focused

- **Workflow solutions:** Digitization of nonclinical operations such as workforce management, capacity management, revenue management and procurement management also presents opportunities to harness AI to drive accuracy, efficiency and cost savings.
    - **Workflow solutions AI tool:** LeanTaas has multiple products aimed at improving hospital efficiency. iQueue for Operating Rooms "uses predictive analytics, mobile technologies, and cloud-based tools to free up capacity in operating rooms and create a much more transparent and surgeon-centric process for measuring OR utilization." iQueue for Infusion Centers "uses predictive analytics, level-loading principles, optimization algorithms, and discrete event simulation to build optimized schedules for each infusion center."

While most AI-enabled healthcare solutions are still in their infancy, analysts are predicting rapid growth in the market over the next three years. We anticipate that within the hospital setting, AI solutions focused on diagnostics, clinical decision support and workflow improvement will see faster adoption than other categories of offerings.

What is the current level of maturity of AI solutions, and where can they eventually go?

Now that we have a better sense of the types of healthcare AI solutions, it's crucial to understand how mature/advanced these solutions are today. The reality is that most AI solutions in healthcare are in the early stages of development and require significant human intervention, and they are often unproven.

The six levels of autonomous driving, as defined by SAE International's standard J3016, provide an excellent analog to understand the level of maturity of AI in healthcare (see Figure 5). Our perspective is that today's (publicized) AI solutions in healthcare at best qualify as performing at Level 1. They are mostly experimental and selectively being used to assist clinical and nonclinical workflows in hospitals.

However, as noted, the technology is improving rapidly, and we expect to see significant advancements into the next levels soon.

Figure 5
SAE J3016™ levels of driving automation

	SAE LEVEL 0	SAE LEVEL 1	SAE LEVEL 2	SAE LEVEL 3	SAE LEVEL 4	SAE LEVEL 5
What does the human in the driver's seat have to do?	You are driving whenever these driver support features are engaged — even if your feet are off the pedals and you are not steering			You are not driving when these automated driving features are engaged — even if you are seated in "the driver's seat"		
	You must constantly supervise these support features; you must steer, brake or accelerate as needed to maintain safety			When the feature requests, you must drive	These automated driving features will not require you to take over driving	
	These are driver support features			These are automated driving features		
What do these features do?	These features are limited to providing warning and momentary assistance	These features provide steering or brake/acceleration support to the driver	These features provide steering and brake/ acceleration support to the driver	These features can drive the vehicle under limited conditions and will not operate unless all required conditions are met		This feature can drive the vehicle under all conditions
Example features	• Automatic emergency braking • Blind spot warning • Lane departure warning	• Lane centering or • Adaptive cruise control	• Lane centering and • Adaptive cruise control at the same time	• Traffic jam chauffeur	• Local driverless taxi • Pedals/steering wheel may or may not be installed	• Same as Level 4, but feature can drive everywhere in all conditions

Source: SAE International, SAE J3016™ Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles (2018-06-05), https://www.sae.org/standards/content/j3016_201806/

Analog: six levels of autonomous driving

The six levels of autonomous driving, as defined by SAE International's standard J3016, delineate driving operations that require human supervision versus those that don't — with Level 0 representing no automation and Level 5 representing complete automation.

For example, in vehicles today, features such as blind-spot monitoring, lane departure warning, adaptive cruise control or alerting drivers when they are about to fall asleep would classify as AI assistants to the driver. However, as the driver must continuously steer, brake or accelerate the vehicle as needed, according to J3016, these vehicles would belong to Level 0, 1 or 2 based on the number and sophistication of the embedded assistive technologies. While most current vehicles with these features would be classified as Level 1, a Tesla, with all the integrated AI features, can be classified as Level 2, given the extent of its integrated assistive technologies.

Honda is working on a car that would be Level 3 — it would drive itself, but the driver would have to be ready to take back control anytime the automated system cannot complete the task at hand. Companies like Waymo are developing cars that would qualify for Level 4, cars that can drive themselves in a controlled environment without human intervention, and Level 5, cars that can drive themselves in any conditions without human intervention. Level 4 and Level 5 vehicles are still in experimental phases.

Today, AI solutions in healthcare — whether provider-, patient- or operations-focused — are at best analogous to Level 1 cars as defined by the J3016 framework (see Figure 5). Just as drivers need to be in full control while the automation features support their driving, healthcare providers need to be in complete control of these AI solutions while they assist providers in decision-making.

One trend driving AI advancement is the ramping up of the FDA fast-tracking approvals of AI algorithms. A study produced by Eric Topol, director and founder of the Scripps Research Translational Institute, found that the FDA issued between one and two AI approvals per month in 2018, compared with a total of just two FDA AI approvals in 2017. Now, there are nearly 30 algorithms (with more coming) that the FDA has approved across various medical specialties.

That said, we believe that the overall adoption and eventual implementation of AI solutions in healthcare is likely to be slow, given the sensitivity around the possibility of negatively affecting human health. The debate as to who is liable when a patient's life is lost because of AI-enabled clinical procedures has just started. Until we have a better legal and regulatory framework within which to operate, we anticipate adoption will be slow.

Why is AI in healthcare harder to implement than AI in other industries?

Apart from the challenging and still unclear legal guidelines regulating AI in healthcare, several other factors are contributing to the slow adoption and implementation of AI:

- **Limited access to large amounts of high-quality data**
  Access to both clinical and nonclinical data to train and test AI algorithms is also substantially tricky and can often hamper the accuracy and consistency of AI solutions. This limitation is evident amid the COVID-19 pandemic we find ourselves in today. With no history of such disease, AI tools have limited value in diagnosis, clinical decision support and patient monitoring. Similarly, AI is at best an analytical tool; meanwhile, the industry is conducting vaccine research and development and evaluating treatment options. However, with the infrastructure in place to capture the data we will generate in fighting the current crisis, AI could potentially help us predict or better prepare for such events in the future.

And in fact, we are seeing examples of this occurring already — from Google DeepMind using deep learning to predict the structure of proteins associated with the virus that causes COVID-19 to Johns Hopkins University creating an interactive dashboard to track real-time data on confirmed cases, recoveries and deaths.

- **Constraints triggered by patient data privacy laws**
  The use of the Health Insurance Portability and Accountability Act of 1996 in the U.S., the General Data Protection Regulation in Europe and similar regulations in other countries pose a significant challenge for all healthcare AI ecosystem participants trying to bring solutions to the market.

- **Difficulty of integration with existing hospital information technology (IT)**
  The integration of AI solutions with the existing healthcare IT infrastructure is likely to be difficult, which will make the implementation process very taxing for all stakeholders. Further, with increasing mergers and hospital consolidation, the challenge of streamlining IT systems and implementing uniform clinical and nonclinical operations will continue to cause difficulties in the adoption of AI, especially in mature markets such as the U.S.

- **Limited staff buy-in**
  Convincing healthcare providers that AI solutions are not meant to replace them but to add value can be difficult. The absence of appropriate change management strategies will prevent these solutions from achieving their full intended clinical and operational impact.

However, as time progresses, several factors, in no particular order, will fuel the maturity and adoption of AI solutions:

- **Continued investment in AI**
  Medical technology companies, incumbents and startups alike, are investing heavily in embedding AI capabilities — AI assistants — in everything from stethoscopes to CT scanners and MRI machines. Over time, as new machines replace the old, the widespread availability of AI capabilities will drive the use of these technologies.

- **Increasing digitization**
  As digitization continues to pervade healthcare, we will see the adoption of AI solutions at a more rapid pace. Already, we see health systems becoming more sophisticated in tracking patient biometric and longitudinal data. Patients are also increasingly seeking to engage with data on their health. As data pools and data lakes of pertinent patient information mature, embedded AI solutions will be the logical next step.

- **Cost pressures**
  The Patient Protection and Affordable Care Act and macroeconomic conditions continue to exert cost pressure on health systems. As a result, they continue to invest in automation to reduce costs, streamline decision-making and standardize operations. These investments are creating the digital foundation required for both the development and the deployment of AI-enabled solutions across the healthcare continuum.

- **The continued shift toward value-based care**
  The pay-for-performance model (including such models used in accountable care organizations) incentivizes the use of IT to increase efficiency. It creates a higher demand for real-time clinical and financial data to drive optimal decisions. AI has the potential to play a critical role in automating clinical and nonclinical decision-making.

- **The shift toward ambulatory care**
  Advances in medical and communication technology are enabling new models of care delivery. Hospitals are increasingly

using ambulatory care settings as a lower-cost alternative to provide care. In fact, in July 2019, the Mt. Sinai Health System in New York submitted a $600 million plan to redesign Beth Israel Medical Center. The plan envisions a hospital where the number of beds is reduced from the 683 present today to only 70, plus an emergency room. The focus is on "increasing services available at outpatient offices and ambulatory settings as opposed to the less cost-efficient hospital setting."[1] With the shift in point of care, it is foreseeable that AI-based solutions will be needed to monitor and care for patients who are not physically present at the hospital.

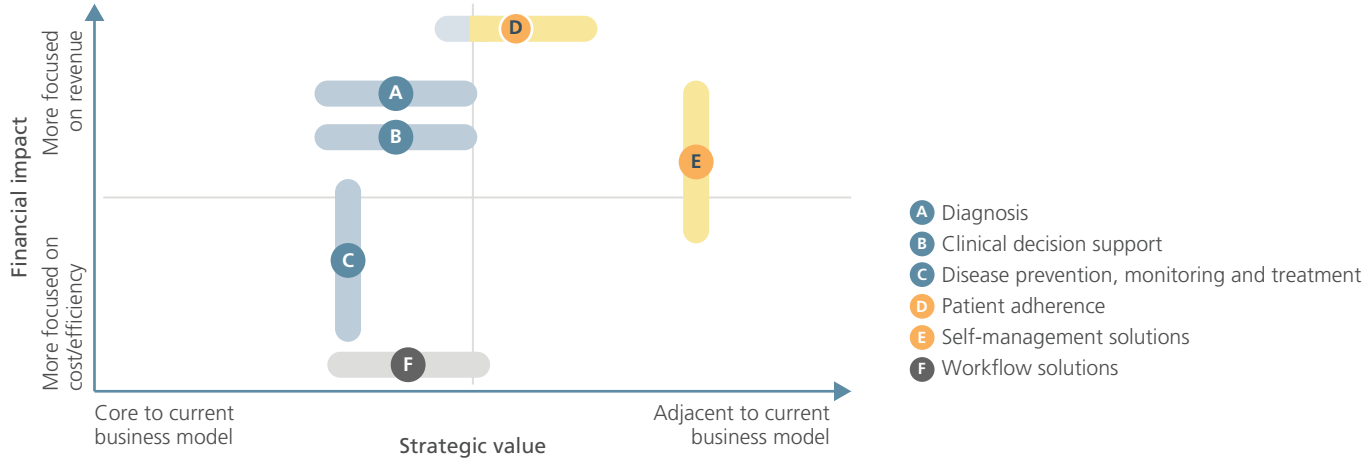
- Rise of consumerism
  On the one hand, the ongoing shift of healthcare costs to consumers has led to the development of self-help and self-monitoring tools such as the electrocardiogram (ECG) function in the Apple Watch. On the other hand, the millennials and Gen Zers are growing up in a digital world and expect their healthcare experience to be digital as well. We will continue to see proliferation of AI-powered wearable technology that predicts and helps prevent various health conditions. If locally integrated with the digital infrastructure of hospitals, these technologies can accelerate the disintermediation of the current business model of health systems and create distributed, always-on models of care.[2]
- Shortage of providers
  In the U.S., the number of physicians available per 1,000 patients is 2.6. In Germany, the number is 4.2, and in Sweden, 5.4. However, as we shift our focus to Asia, in two of the world's most populous countries — China and India — the ratios fall to 1.8 and 0.8 per 1,000, respectively.[3] As these countries face significant provider shortages while the appetite for quality healthcare continues to rise, they are investing heavily in AI-enabled healthcare models. In India we see the rise of companies such as Sigtuple, LiveHealth and Onlidoc. And one has only to look at Ping An and Tencent in China to see how AI can enable care delivery at scale using digital platforms.
- The emergence of "digital first" healthcare models
  Ping An's Good Doctor in China is the world's leading example of a digital-first, platform-based healthcare ecosystem. It provides one-stop access to a network of physical hospitals, doctors, diagnostic centers and pharmacy outlets. Besides, it has a team of doctors powered by AI who provide remote consultations. With more than 193 million registered users (by comparison, Amazon has 100 million Prime members), it is already using the data on patients enrolled in its platform to offer customized insurance plans.[4] One can only imagine how it could use AI to harness the insights from this extensive data set to create a new, personalized system of healthcare.
- Increasing number of scientific studies and real-world evidence
  As doctors and other care providers are given more evidence of the real-world benefits of AI, there will likely be a significant increase in comfort with the technology. For example, in Germany, where digital apps can be prescribed, companies are required to give evidence of their impact after one year of funding. Across the world, we're seeing a lot of investment into making deep learning algorithms more transparent about how they arrived at the solution they did.

How can healthcare providers prepare to embrace the full potential of AI in healthcare?

Will AI in healthcare be an oft-discussed myth, or will it shape our new reality? It is clear that while today, AI-enabled healthcare solutions are discrete, experimental and not widely adopted, the trend line for their maturity and growth is positive. It is also clear that if utilized appropriately, these solutions have the potential to improve patient care, increase provider engagement and optimize the cost of care. In our view, it is therefore imperative that hospitals and other healthcare providers embrace AI within their organizations and across their business continuums.

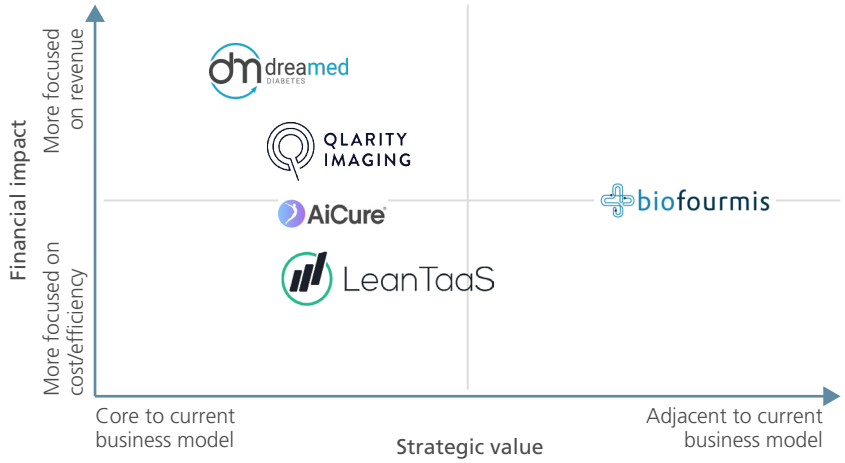
However, the decision about which types of AI solutions to invest in should be treated in the same manner as any other investment decision — namely, by evaluating the strategic value, the financial impact and the company's readiness to implement the solution.

Figure 6
Investment decision framework



Source: Kansal & Company

Figure 7
Select AI companies on the investment decision framework



Source: Kansal & Company

Hospital executives will find the proposed two-by-two framework (see Figure 6) useful in identifying the strategic value and financial impact of a specific solution in the context of their strategy.

Separately, readiness to implement can be determined based on the willingness of affiliated providers to embrace new technologies as well as on the sophistication of the hospital's technology team. Overall, solutions that are core to day-to-day hospital operations and that require incremental effort are likely a bit easier to implement than those that are new and necessitate transformative change.

Generally, each type of AI solution will be more focused either on increasing revenue or on improving costs/efficiency. However, solutions may also have indirect benefits for both revenue and cost (see Figure 7). Most of the companies we profiled above, in fact, are able to impact both areas.

Conclusion

In summary, AI in healthcare is here to stay. It has applications — clinical and nonclinical — across the business continuum of health systems. It holds the promise of improving the quality of care, optimizing costs, enhancing the patient experience and increasing provider engagement. However, in the near term (10-20 years), we see it as augmentative versus disruptive. We need to see further maturity in the digitization of current processes or the emergence of new digital processes before AI can be truly embedded in the health system workflow.

However, given AI's disruptive potential, we recommend that hospital executives do the following:

- Stay up to date on the technical, regulatory, legal and business model evolution of the field. Pay special attention to what is happening in Asia — where digital-first models of healthcare are being created.
- Proactively identify and analyze potential areas for adopting AI across your business continuum as part of your corporate and functional strategic planning processes.
- In the near term, make investment decisions about AI based on strategic potential rather than on calculated return on investment, and scale when appropriate.
- Partner with companies building AI solutions across identified areas to test the technology, train your staff and learn from experience.
- Invest in building human capital — both medical and technical — that is AI savvy and will champion the adoption of the technology as appropriate across your health system.

For further information on this Special Report and its findings, please contact lifesciences@lek.com.

Endnotes

[1] https://www.modernhealthcare.com/providers/mount-sinai-files-plans-600m-redesign-beth-israel

[2] https://vimeo.com/375654096

[3] https://data.worldbank.org/indicator/SH.MED.PHYS.ZS

[4] https://www.whartonhealthcare.org/growing_market_position_through_strategic_partnerships_in_healthcare

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