1. AI in Healthcare

Learning objectives

By the end of this lesson, you will have a detail understanding of:

1. The industry trend of AI applications in the Healthcare industry.
2. AI use cases within the healthcare Global .
3. AI companies niche in the healthcare industry.
4. Challenges of AI in healthcare.

Prerequisites

Readers should have knowledge of the following concepts before starting this read:

1. Types of algorithms in machine learning/ deep learning, data to classes, scores, and clusters.
2. Building ML models.
3. AIDR framework.

Today, the evolution of AI, deep learning, computer vision, and natural language processing systems have exemplified to a great extent that machines are much better than humans at analyzing large-scale data. Data is considered a new oil in today's world. So, most of the health companies around the globe are collecting patient data on a large scale. AI has played a great role in analyzing patient data more accurately than experienced medical staff for early diagnosis, prevention, and better treatment.

1. Industry trend on AI applications for Healthcare

A lot of predictions are related to the growth of AI in Healthcare. Frost & Sullivan, states that the market revenue earned by Artificial Intelligence & Cognitive Computing Systems in Healthcare will increase from $600 Million in 2014 to an estimated $6.6 Billion in 2021 at a compound annual growth rate of 40 percent. AI in HealthCare has the potential to improve outcomes by 30 to 40 percent while cutting treatment costs by as much as 50 percent. As the interest in AI in the healthcare industry continues to grow, numerous current AI applications have been developed throughout the globe in the healthcare sector.

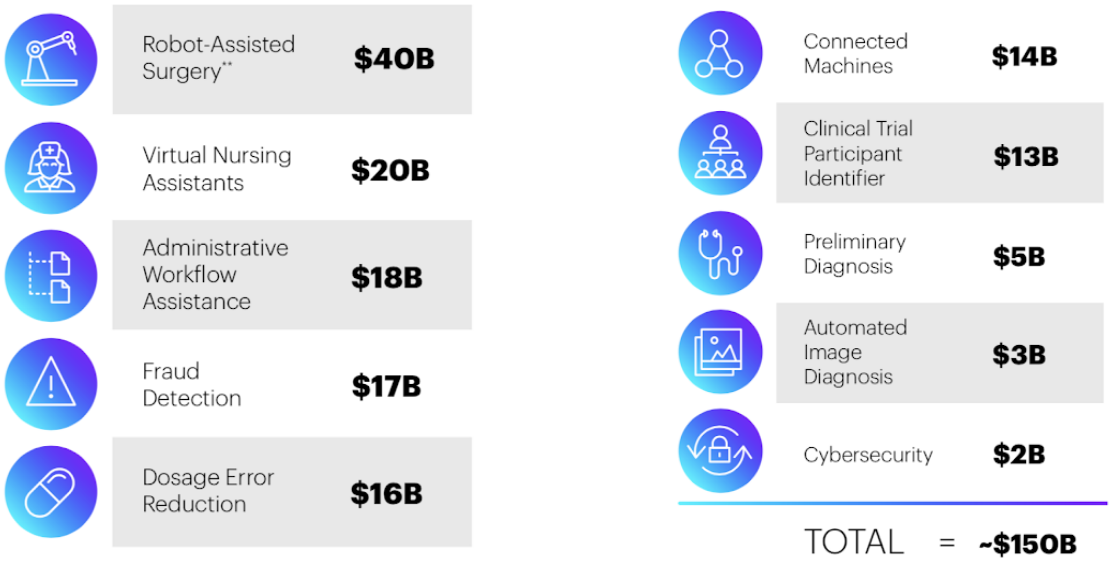


Figure: Estimated potential annual benefits for each application by 2026.

Accenture has analyzed 10 AI applications with the most prominent near-term impact on the healthcare industry. The evaluation is characterized by the effect of each application, probability of selection, and value to the health economy. Value (in Billion) is the estimated potential annual benefits for each application by 2026. The leading three applications with much more potential are robot-assisted surgery ($40 B), virtual nursing assistants ($20 B), and regulatory workflow assistance ($18 B). According to the analysis, AI and robotics will cause a 21 percent reduction in length of surgical stay, 17 percent and 51 percent reduction in work time for doctors and registered nurses respectively.

Figure: Investments in using AI in healthcare

Owing to these promising benefits, investments in using AI in healthcare has increased as well. In the second quarter of 2020, the number of healthcare deals worldwide hit 1,272, up by 6% compared to the first quarter of 2020. Similarly, financing to healthcare startups has come to $18.1B — a quarterly record, surpassing the past record of $16.4B in the third quarter of 2018.

According to *CBINSIGHTS*, the big worldwide health industry deals in the quarter are:

- $1B Series B in April for Medical device startup *MGI Tech*.
- $481M Series A extension in June, Seattle-based *Sana Biotechnology*.
- $490M private equity round from The Carlyle Group in June, *Piramal Pharma*

2. AI use cases within the Healthcare Industry

The applications of AI in healthcare can be loosely divided into four subdomains: Individual Health, Healthcare system , Pharmaceuticals, and Population Health. We will discuss the problems with traditional systems existing in each of these subdomains and how AI has overcome these problems providing better service experience for patients, reducing their expenditure, improving healthcare efficiency and revolutionizing the entire industry.

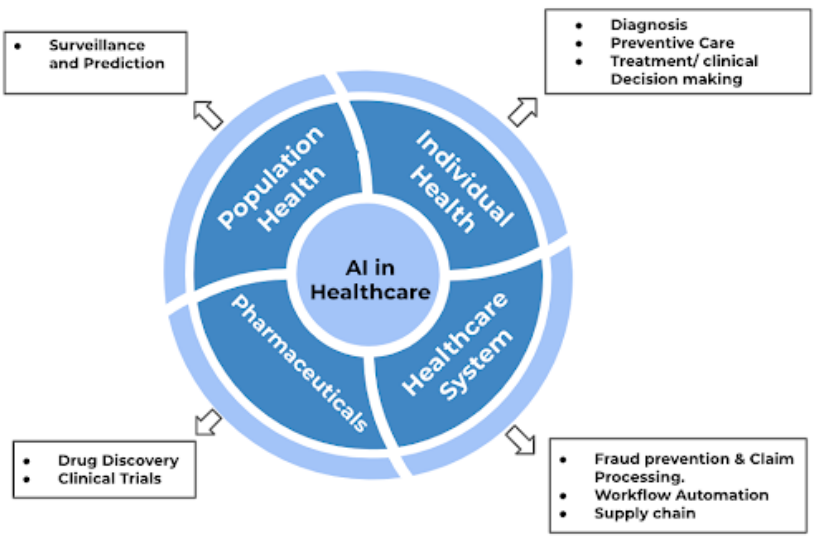


Figure: AI use cases within the Healthcare industry.

A. Individual Health

According to the Johns Hopkins study, more than 250,000 people in the U.S. die every year from medical errors. Other reports claim the numbers to be as high as 440,000. You can read the article about these reports *here*. In 2015, misdiagnosing and medical blunder accounted for 10% of all US deaths. Incomplete medical histories and huge caseloads can lead to dangerous human mistakes. Resistant to those factors, AI can predict and analyze illness faster than most medical experts. For illustration, an AI demonstrates using algorithms and deep learning analyzed *breast cancer at a better rate than 11 pathologists*.

Under Individual Health care sub-domains, AI have several use cases; let's explore them in details:

- **Medical Imaging and diagnosis**

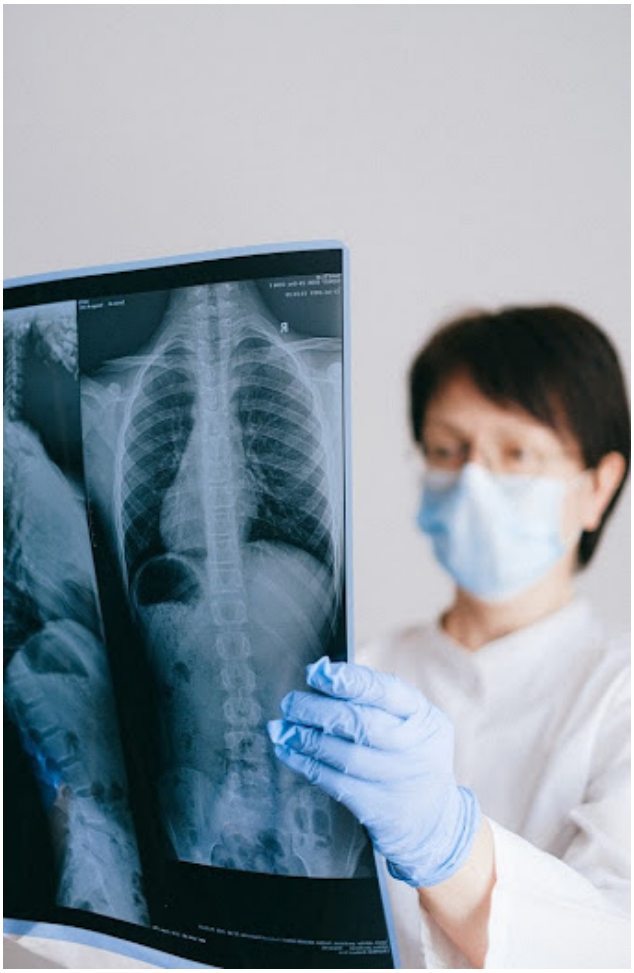


Image Source: *www.pexels.com*

AI systems are reading medical reports and imaging data like MRIs, X-rays, and CT scans to diagnose diseases. AI systems are robust in analyzing images and patient historical data if backed by an appropriate algorithm. Immune to large caseloads and complicated diagnosis decision-making, AI can accurately predict and diagnose disease faster than most medical professionals.

An AI model that used deep learning, diagnosed breast cancer at a higher rate than 11 pathologists. According to the paper published by Achim Heckler, the Convolutional Neural Network achieved a mean accuracy of 68% over 11 test runs. In comparison, the 11 pathologists achieved a mean accuracy of 59.2%.

Some of the AI-backed companies that work on disease diagnosis are:

1. Buoy: Buoy is an online symptom and cure checker that uses an intelligent algorithm backed by medical data to diagnose patients. A chatbot listens to a patient's symptoms and health concerns, either by text or speech. Natural Language Processing is used to understand patients' queries and then guide them to the correct care based on their diagnosis. Harvard Medical School uses it to help diagnose and provide medical service to the patient more quickly.
2. Enlitic: Enlitic uses a deep learning model to study and analyze disorganized medical data like patient medical history, blood test reports, radiology images, etc., to assist doctors in analyzing patient cases quickly and more accurately. Enlitic was named the *5th smartest* AI company worldwide, beating IBM, Microsoft, and Facebook by MIT. They promise that their system, which is still in the testing phase, beats human experts to detect lung cancer.

- **Preventive Care**

We all know that prevention is better than cure but people do not always care about early-stage symptoms. Hence, the problem escalates. Early alertness for the symptoms can save many people their health and their money. The patient frequently needs to visit the doctor for a reported diagnosis and medical advice, which may be stressful. Hospital charges on frequent visits and long waiting lists may also cause patient stress.AI can closely analyze patient data and actively alert them of any changes in their health condition without having to visit the doctors. AI collects individual patient data and uses that data to detect various underlying health conditions present in the patient and notify them. For example, AI powered wearable systems can provide insights to their current health condition and recommend personalized exercise and diet based on the risk profile of the patient and virtual assistants can provide preventive care information and reminders. Some companies and their products working on using AI for preventive care are:

1. Sugar.IQ:

Diabetes Assistant from Sugar IQ continually tracks and analyzes the factors that can affect a person's glucose level. It provides a detailed report on the effect of foods and activities on the patient's glucose level so that the patient can tweak their regimen accordingly. Furthermore, the AI-powered application provides the patients a daily summary of their glucose trends so that they know their current overall condition.

2. Apple Watch:

Apple watch and the powerful apps present in it make it a very useful device for a healthy life. The newly added ECG app and notifications provides the patients with important information concerning their heart health. It notifies the patients of their unusual and irregular heart rate. This could help the patients to identify situations which may require further evaluation. For instance, if a heart patient is developing a quick pulse after certain minutes of walking, at that point, the apple watch would make a forecast and alarm the patient to avoid surpassing the suggested minutes of walking.

- **Treatments and Clinical Decision-making**

AI can assist in treatments and clinical decision-making. AI based surgical robots such as Da-Vinci have become popular to provide higher precision robotic surgeries. AI systems can also find errors on prescriptions and check prescribed medicines against the disease symptoms. When a new prescription deviates from the spectrum of typical treatment patterns, it can be flagged as a potential error and prompt the physician to double check. AI can also tailor a personalized dosage of medicines for each patient.

Intendu is a digital health company that delivers science-based cognitive treatment to the people with brain dysfunction. It assists neural training through adaptive video games, targeting the training for cognitive problems like motor dysfunction, memory issues, dementia, stroke, etc. Intendu's neuro-cognitive algorithm continually screens a player's movement as they interact in video games through body motions. Based on the player's performance and bio-feedback, games' challenges dynamically adjust to optimize the patient's brain simulation.

B. Healthcare System

In a recent Market Insight report, the American Hospital Association said when a patient visits a hospital five years from now, the application of AI technologies will markedly change how work gets done inside and outside of the hospital. In addition, research by HIMSS Media shows that 59% of healthcare organizations are or will be using AI specifically for resolving operational inefficiencies, and 48% for optimizing administrative and clinical workflows. 40% of tasks carried out by healthcare support staff and 33% of healthcare practitioners' tasks have the potential to be automated, estimated by the Brookings Institution.

The use case of AI in healthcare may be more promptly acknowledged when it helps free up professionals from the scheduled administrative task to spend direct time with patients. Potential applications of AI for improving healthcare operations includes scheduling, hospital admissions and discharge, capacity management, fraud prevention, claim to process, optimizing processes in the operating room and the emergency department, as well as moving patients between diagnostics and the ward. Such applications can essentially influence patients by lessening waiting times and expanding straightforwardness on process, times, and outcomes.
Here are some of the applications of AI that are already prevalent in healthcare.

- **Automating office administration:**

Qventus is an AI-based software platform that solves operational challenges that occur in the hospital. Combining an AI-based innovation platform with expertise services, Qventus gives a comprehensive closed-loop administration system that delivers and supports operational enhancements.

With Qventus, organizations can distinguish operational issues before they occur. The platform can help staff complete all the pre-surgery prerequisites, e.g., reminding the physician to complete consent forms or issuing updates for missing diagnostics. Ward medical caretakers have the advantage of having reliable start times and estimates for the length of surgery, which helps them way better plan daily work and prioritize which patients need to be prepared. Throughout North America, health systems have deployed Qventus technology, including Fairview Health Services, the Mercy health system, New York-Presbyterian Hospital, and SCL Health. According to Qventus, its operating room solution has helped clients reduce same-day cancellations by 25 percent and peri-acute care unit exchange delays by 23 percent, whereas seeing a 20 percent increase in patient satisfaction score.
Furthermore, other operations in healthcare like transcription of a doctor's voice and handwritten notes can be automated using NLP to make overall note taking faster. Similarly, automatic form filling for prescriptions can save time for doctors and nurses.

- **Fraud Detection and Claim Processing:**

Claims processing is costlier and time-consuming. Billing and insurance-specific expenses make up 13% of physician-care spending and 8.5% of hospital-care expenditure, estimated by *The Center for American Progress*. Denied claims are also expensive, with some estimates showing a *price tag of $118 per claim*. The volume of claims makes it hard for insurance agents to review all items carefully. AI systems can be used to identify anomalies in insurance claims. Other data streams like prescriptions, medical records can also be mined for possible fraud. Claim processing can be automated to a degree that it can reduce errors.

FRISS is an AI-backed application to detect fraud, mitigate risks, and support the digital transformation process of claim processing. FRISS combines various technologies, including AI features such as network analysis, text mining, database search, anomaly detection, and machine learning, to estimate the potential risks associated with a claim. It identifies insurance fraud before claims are paid out which reduces loss ratios by increasing the chances of fraud detection and minimizing false positives.

C. Pharmaceuticals

Artificial Intelligence has streamlined and affected the pharmaceutical industry in numerous ways, extending from making new and superior drugs to combatting fast-growing diseases. Let's discuss some peculiar applications of AI in the Pharmaceutical industry.

- Drug Discovery:

Reportlinker.com announces the drug discovery services market is projected to reach USD 21.4 billion by 2025 from USD 11.1 billion in 2020, at a CAGR of 14.0%. It costs $2.6 billion to develop one drug from scratch and takes an average of 14 years.

The approval rate for drugs entering clinical development is less than 12% which makes the drug discovery industry highly expensive and risky.
Finding the right molecular combination is the key to discovering the right drug. Certain molecules or their composition cure certain diseases. But molecules are dynamic structures, they consist of multiple chemicals. The drug database publicly available consists of around 72 million molecules. The search space for molecular arrangement or composition grows so huge that humans are nearly incapable of finding the right combination in such a huge space. Or it may take a lot of time for humans to solve such puzzles. AI systems can help discover molecules, compounds, proteins by exhaustively searching through their large number of combinations at a faster pace than humans. They can test and recreate thousands of bio-medical circumstances to determine which combination of chemicals and substances produces the desired effect. AI systems can also help in analyzing changes on drugs that can yield better results

Here are some companies that are using AI for drug discovery:

1. Benevolent AI is the London based AI company actively assisting in Drug discovery. It uses exponential growth and availability of biomedical data to fuse science and technology and re-engineer drug discovery and development. Responding to the global health crisis caused by COVID-19, Benevolent AI is researching to identify existing drugs that could be used to treat the novel coronavirus.

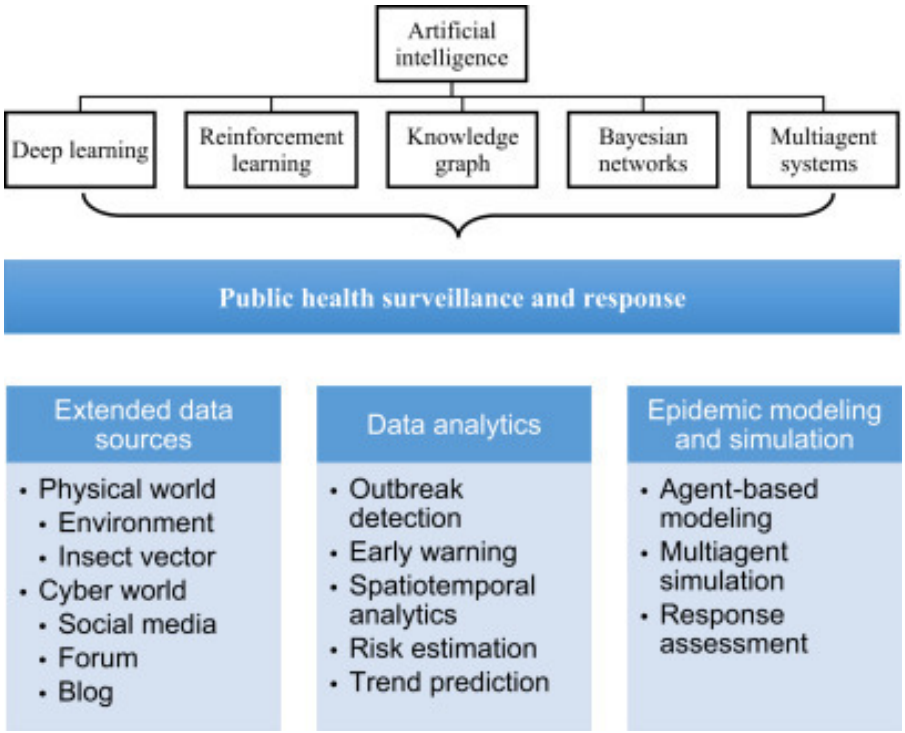
2. San Francisco-based Blackthorn Therapeutics is backed by Google Ventures and Polaris Partners. Through a circuit-based approach to understanding neurobehavioral health, Blackthorn Therapeutics is integrating State-of-the-Art Data Science into drug discovery and Clinical Development to transform drug discovery for neurobehavioral health.

- **Clinical Trials:**

Clinical trials are a sort of research that considers new tests and medicines and evaluates their impacts on human wellbeing. People volunteer to take part in clinical trials to test medical inventions including drugs, cells, and other biological products, surgical procedures, devices, behavioral treatments, and preventive care. Clinical trials are conducted in multiple phases. Despite the time and capital invested in trials, only 1 in 10 drugs that enter Phase-I of a clinical trial will be approved by the FDA. Incapable to locate enough participants, the drop outs, side effects, and poor data collection may cause the failure of clinical trials. Trials that fail later prove to be more costly for both the company conducting the trial and the patients. AI systems can automatically search through patients' histories to recommend suitable patients for a clinical trial, thus, reducing cost and providing better access for terminal patients willing to be on trials.

D. Population Health

Public health surveillance traditionally depended on statistical techniques. Artificial intelligence is hugely applied for infectious disease outbreak detection, early warning, and trend prediction. Public health surveillance is intrinsically data-driven. The main objective of public health surveillance has always been to identify early, accurate, and reliable signals of health anomalies and disease outbreaks from a heterogeneous collection of data sources. AI provides a range of methods to achieve these objectives. Some popular AI techniques and algorithms used in public health surveillance are shown below:



Artificial Intelligence tracks and foresees epidemic outbreaks utilizing all the most recent data extending from satellite pictures to social media information. Whether it could be a cholera or HIV/AIDS outbreak, utilizing an AI-based program can essentially alert specialists and possibly avoid the chance of an epidemic infection. Outbreak detection and early warning may also offer assistance to pharma companies to create conceivable arrangements before any epidemic/pandemic.

3. Challenges of integrating AI inHealthcare

We discussed several use cases where AI has numerous applications in the healthcare industry, and it continues to grow with the advancements in the technology. However, we will discuss some of the challenges hampering the implementation of AI in the healthcare industry.

i. Privacy

According to a recent *survey from KPMG*, 75% believe it could threaten the security and privacy of patient data. AI frameworks must comply with the patient information and maintain privacy. For example, sharing information among different companies is not permitted, unless the patient demands for it. For instance, in 2016, there had been a controversy regarding the sharing of patient data with Google DeepMind, violating the UK information protection law.

ii. Black Box Model

AI models are complicated to use and understand, and if used as a black box, it makes it difficult to understand how the model works and the reasoning for the model's outcomes. Healthcare workers need to understand how and why AI comes up with specific results to act accordingly. The lack of reasoning raises reliability issues for both healthcare compa nies and patients.

iii. Not All Embrace AI

All health-associated companies do not understand AI's capabilities in human aid, saving lives, minimizing cost. Lots of companies are still working on traditional manual intensive ways. This may be a lack of AI education. Only 47 percent of healthcare insiders responded that their organization offers AI training courses to employees. While only 67 percent said their employees support AI adoption, the lowest ranking of any industry.

iv. Lack of AI Talent

Companies across all industries have been struggling to secure top AI talent from a pool that's not growing fast enough. Educational platforms like Coursera, Udacity, Fuse.ai, etc, are contributing a lot in producing Industrial and research AI talents. The lack of AI talents in developing countries has been a major issue.

We have reached the end of this read on AI in Healthcare. The use of AI in healthcare is ever growing and so are its applications. However there are some challenges that must be faced and solved to implement AI in healthcare and reap its promising benefits.

Do tackle the quiz and assignment of breast cancer detection!!!