**THE SURGE OF ARTIFICIAL INTELLIGENCE IN HEALTHCARE SECTOR**

**INTRODUCTION**

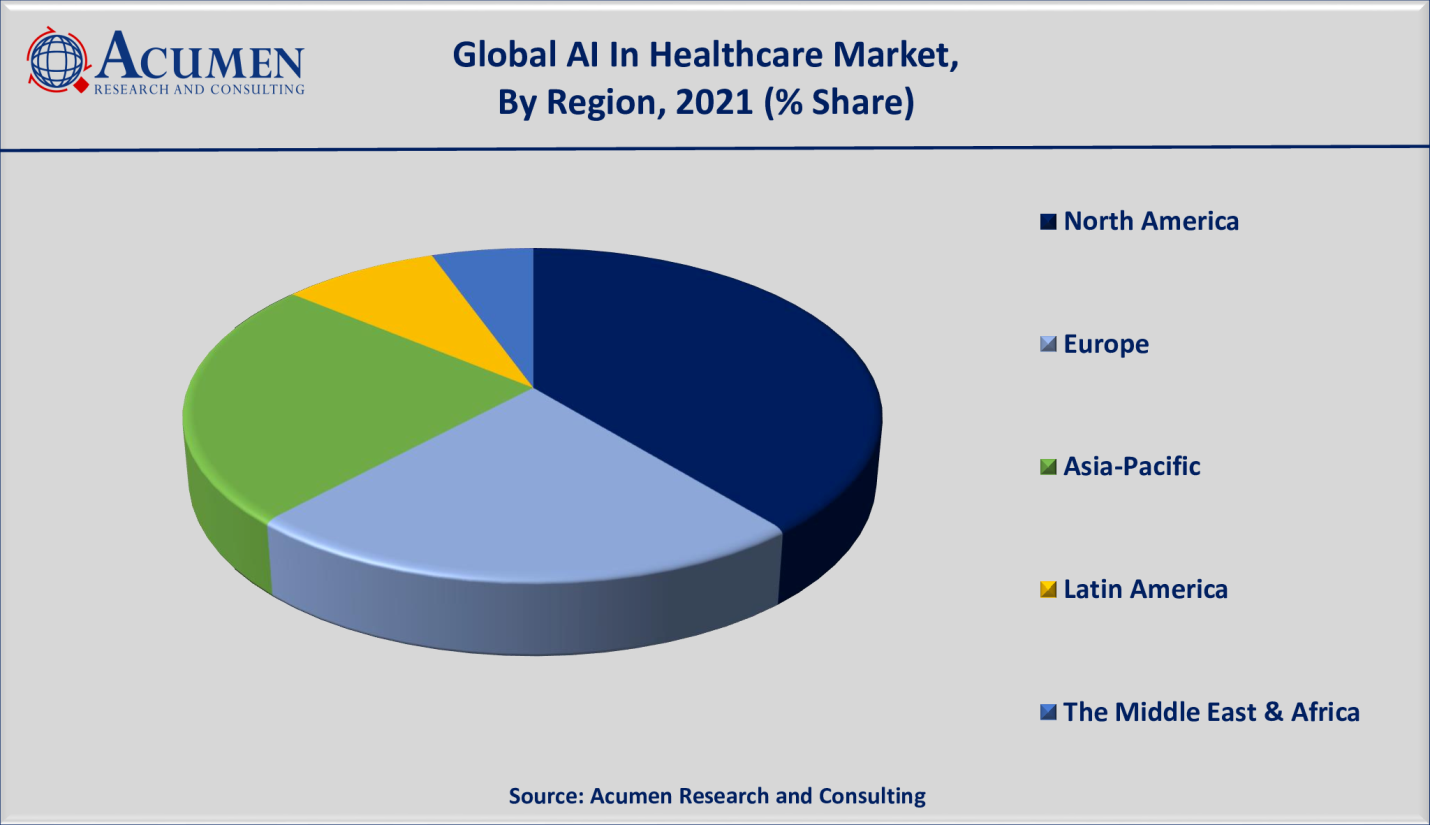
Artificial intelligence is the technique of making intelligent machines to solve the problems and tasks by combining various subfields like machine learning and deep learning. years. Artificial intelligence is an interdisciplinary approach that utilizes tools and principles from various fields, such as computation, mathematics, logics, and biology. It is a computer science branch where the systems are able to perform tasks such as decision-making visual perception, speech recognition that normally require human intelligence. AI solves the problem of understanding, replicating intelligence and cognitive processes.  There have been already reported published multiple cases giving the evidence how AI can be used to improve the access, safety and efficiency of healthcare services. Artificial intelligence has many applications in various domains such as Robotics , recognition of images and voices and expert systems. As per Literature, the first time in the 1950s the application of AI has been in medicine that had improve the diagnoses using computer-aided programs (1, 2). MYCIN was devised for establishing the diagnosis of blood borne bacterial infections (3) and a computer based algorithm was used to identify the cause of acute abdominal pain in 1970s (4). The use of Artificial intelligence in the healthcare sector is increasing substantially in the past few years (5). But despite of many years of focus on use of this technology in healthcare, it is still in the initial developmental stages but increasing at a fast pace (6-9).

**AI has two main branches: virtual and physical.**

The virtual branch includes approaches regarding informatics ranging from management of deep learning information to the control of health management systems. Thus ,enabling the maintenance of electronic health records as well as actively guiding the physicians in their decisions making about the treatment.

The physical branch is best represented by robots which may be used to assist the attending surgeon or the elderly patient or and targeted unique new drug delivery system named nanorobots.

**According to the Acumen Research report, the Artificial intelligence market in the healthcare industry is estimated to increase to US$8 billion till the year 2026 globally.**



North America (includes US, Canada and Mexico) is the AI market global leader due to the high expenditure on healthcare and a well-developed healthcare sector. The government support for the research and presence of leading players provide the necessary support for the growth of the artificial intelligence market in this region. The AI market is also growing at a fast pace in Asia Pacific region especially in developing economies like China and India owing to increased Government support and increasing awareness about healthcare.

Well known Healthcare companies like Microsoft, Johnson & Johnson Services, IBM, Philips N.V, Siemens, GE Healthcare, Google,Intel, CareSkore, Amazon CloudMedx Inc., Clarify Health Solutions, , Qventus Inc., Anju Software Inc. (Zephyr Health),Zebra Medical Vision Ltd are playing a major role in expanding the artificial intelligence global Market.

AI applications in health care include various fields like medical diagnosis, medical management(prevention and treatment), surgical management, rehabilitation and predictive medicine. It can also improve healthcare access and patient experience. AI is also playing a crucial role in new drug discoveries and managing medical data and records and improving the accuracy of health care analysis.

**Common applications of AI in Healthcare**

1. **Medical data and record management**

Maintaing patient medical record and data management by using AI is an emerging branch of research(10). Robots are being used to collect and store the data to provide more accurate and consistent access. AI helps to connect the significant data even from the past records and therefore fastens the process of forming a diagnosis and developing the new medicines and drugs.

AI can generate patient records and summarize the health issues for the physician. Rather than manually going through patient data, AI helps to search through required information much faster and highlight useful points.(11)

[Tempus](http://www.tempus.com/) located in Chicago, Illinois uses AI to examine thoroughly the world’s largest collection of clinical and molecular data to personalize healthcare treatments. The company develops AI tools that give physicians insights into treatments and cures.

[ICarbonX](http://icarbonx.com/en/) located in Shenzen, China looks closely at human life features with its Digital Life Platform by using AI. By analyzing the health and actions of human beings in a “carbon cloud,” the company hopes its big data will help manage various aspects of health. ICarbonX hopes that its technology can collect data to classify symptoms and develop better treatment options.

Another significant role of Artificial Intelligence and its tools in healthcare is that it automates less important but time-consuming tasks. This allows the administrators to spare more time to work on other important tasks. Olive, an AI-based platform integrates with the hospital software easily and automates the processes like medical claims and sends the required data to the concerned professionals and therefore saves lot of time.

1. **Automated Image diagnosis**

In the recent years, AI has made an extraordinary progress in the field of medical imaging. The AI systems uses deep learning techniques and are equipped with algorithms that offer a faster reading of complex images, including those from CT scans and MRIs. The automated image diagnosis system relieves the workload, offers improved performance of doctors and providing better diagnoses of diseases. Analyzing tests, X-Rays, tests, CT scans and data entry can be done quickly and with more precision by robots. In cardiology and radiology, the data to be analyzed can be huge and therefore time consuming. AI can be used as a preliminary tool to screen images, potentially even partially completing reports for physicians to then approve (12). Optellum(13) is one such tool that automatically scans the lung X-rays taken in hospitals and highlights those of concern. This would help the Cardiologists and radiologists to look only at the most complicated cases where human intervention and supervision is required. Therefore, AI can even help to combat the shortage of radiologists, cardiologists and other health professionals in the hospitals.

[Enlitic](https://enlitic.com/) located in Fort Collins, Colorado develops [deep learning](https://builtin.com/machine-learning/what-is-deep-learning) medical tools to streamline radiology diagnoses. The company’s deep learning platform analyzes unstructured medical data — radiology images, blood tests, EKGs, genomics, patient medical history — to give doctors better insight into a patient’s real-time needs.

Arterys located in  San Francisco, California creates products for precision medicine. Its medical imaging AI platform can be used for detecting breast cancer, analyzing cardiac MRI images, reading emergency department X-rays, tracking lung nodules, diagnosing brain tumors and detecting strokes.

1. **Predictive Medicine**

Another relevant topic is AI applications for disease prediction and diagnosis treatment, outcome prediction and prognosis evaluation (14,15). Because AI can identify meaningful relationships in raw data, it can support diagnostic, treatment and prediction outcomes in many medical situations (16) predictions are possible for identifying risk factors and drivers for each patient to help target healthcare interventions for better outcomes (17).

1. **Improved Healthcare Access and patient experience**

The COVID19 period has led to increased remote patient diagnostics through telemedicine that enables remote observation of patients and provides physicians and nurses with support tools (18,19,20).

AI system can provide health professionals with constant real-time medical information updates from various sources such as journals, clinical practices and textbooks (21). These contribution by these applications has become even more crucial during the COVID-19 period, during which information exchange was continually needed to properly manage the pandemic worldwide (22).

AI applications allow, for example, hospitals and all health services to work more efficiently for the following reasons:

* Clinicians can access data immediately when they need it.
* Nurses can ensure better patient safety while administering medication.

Patients can stay informed and engaged in their care by communicating with their medical teams during hospital stays.

AI applications can also support the training of personnel working in health services. This evidence can help in bridging the gap between urban and rural health services (23).

AI has helped to develop medical softwares that offer customized and interactive services like fixing the appointment with doctors. Doctors visit is recommended only if required, otherwise the patient is suggested the medication for minor ailments. UK’s National Health uses Machine Learning based Babylon chatbots (24) to give medical consultations. The chatbots can establish a medical diagnosis through a series of questions, taking personal medical history. The patients report their symptoms into the app that uses the speech recognition to compare the database of illnesses and guides the patients for next healthcare action to be taken. This allows the better access to the hospitals and reduces the workload on doctors and nurses.

[Johns Hopkins Hospital](http://www.hopkinsmedicine.org/) has partnered with GE Healthcare and uses predictive AI techniques to improve management of patient flow. It helps the hospital to prioritize the various hospital activities for the enhanced benefit of the patients. Since implementing the program, the hospital has [admitted the patients to the emergency department beds at a much faster](http://hopkinsmedicine.org/news/articles/capacity-command-center-celebrates-5-years-of-improving-patient-safety-access) pace.

[Subtle Medical](https://subtlemedical.com/) uses AI to enhance images in radiology. The SubtleMR and SubtlePET products work with the machines an institute already uses to speed up MRI and PET scans by reducing image noise. This helps to scan more patients and therefore helps to reduce the waiting time for the patients.

Many smartphone AI applications give patients tailored health advice without visiting a hospital. These applications can diagnose symptoms or advice whether further help is needed or not (25). Virtual health assistants and virtual nurses tasks include responding to the queries of routine patients via emails and phone calls, managing medical records of the patients and hiding sensitive data, scheduling doctor appointments, sending clinical appointment and follow up reminders to the patients etc.

The startup [Sense.ly has developed Molly](http://sensely.com/), a virtual nurse to help people monitor patient’s condition and follow up of treatments between the doctor visits. The program is specialized in chronic illnesses and supports the patients by using machine learning.

[Boston Children’s Hospital has developed an app for Amazon Alexa](https://www.eurekalert.org/pub_releases/2016-04/bch-bch041116.php) that gives basic health information and advice to parents of sick children. The app answers the questions asked about medications and whether the presenting symptoms require a visit to the doctor. It significantly reduces the frequency of hospital visits and both patients and healthcare experts are at an advantage.

AI can help in medical management and health monitoring of patients also. The[AiCure app](https://www.aicure.com/) helps to monitor the use of medication by the patient. A smartphone’s webcam using AI autonomously confirms whether patients are taking their prescriptions and helps them to manage their medical condition. Wearable health trackers and smartwatches – like those from FitBit, Apple, Garmin and others – monitors heart rate and activity levels and can even assist in managing chronic diseases like diabetes or asthma and helps to prevent hospital admission(26). They can send alerts to the person, share this information to doctors as well as with AI systems and provides additional data points about the needs of patients.

1. **Drug discoveries**

AI techniques help to design and formulate new drugs, monitor patients and design patient treatment plans (27). Developing new drugs through clinical trials consumes lot of money and time. AI helps to make this process cheaper and faster. Artificial Intelligence technology allows the healthcare professionals to scan pre-existing medicines and use them to redesign medication in a way that allows them to fight against specific diseases. During the recent Ebola virus scare, AI powered program was used to scan already existing drugs that could be redesigned to fight this disease.

The program could find two drugs that may reduce Ebola infectivity in a day while analysis of this type could otherwise takes months to years.

[BioXcel Therapeutics](http://www.bioxceltherapeutics.com/) develops new medicines in the fields of immuno-oncology and neuroscience using AI. Also,the company employs AI to find new applications to scan existing drugs and to identify new patients.

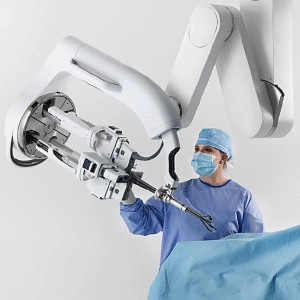
[Atomwise](http://www.atomwise.com/), San Francisco uses AI to tackle serious diseases such as Multiple Sclerosis and Ebola. AtomNet, helps to predict bioactivity and identifies patients for clinical trials. Atomwise’s AI technology can screens 10 to 20 million genetic compounds per day and can deliver the results much faster than traditional pharmaceutical companies.

ReveireLabs, Cambridge Massachuttes employs Machine learning tools to discover and design new cancer medicines.

1. **Robot Assisted surgeries and rehabilitation therapy**

AI techniques are making a difference in rehabilitation therapy as well as surgeries. Several robots have been designed all over the world to support and manage these tasks. Robot-assisted surgery has become quite popular in the recent times. Health Professional and hospitals are using robotics that assist them in performing tasks that need flexibility, precision and control. It is used in tasks such as open-heart surgeries with more accuracy than humans. These surgeries lead to lesser complications, comparatively lesser pain and quick recoveries of the patients.

Robots equipped with cameras, mechanical arms and appropriate surgical instruments enhance the skills, knowledge and experience of the doctors resulting in more precise and efficient surgery. The surgeon sits at the console of a computer and controls the robot’s mechanical arms. The robot gives an enlarged, 3-D view of the surgical site that is otherwise not possible to look at with their own naked eyes.

Rehabilitation robots physically support and guide the patient’s limb during motor therapy (28). For surgery, AI has a vast opportunity to transform surgical robotics through devices that can perform semi-automated surgical tasks with increasing efficiency. The aim of this technology is to automate the procedures to reduce human error and maintain a high level of accuracy and precision (29). The Robotics Institute at [Carnegie Mellon University](http://cmu.edu/) Pennysylvania has developed [HeartLander](https://www.cs.cmu.edu/~heartlander/index.html" \t "_blank), a miniature mobile robot designed to facilitate therapy on the heart. Under a physician’s supervision, the robot enters the chest through a small incision, navigates to certain locations of the heart by itself, attaches to the surface of the heart and delivers the required therapy.

1. **Medical diagnosis and treatment**

Deep learning has proved to be valuable in detecting various medical conditions like diabetic retinopathy,tuberculosis ,breast cancer and irregular heart rhythms.(30-33) AI could work as an initial screening tool to interpret the scans, prioritizing those of concern so that the doctor’s attention can be brought to crucial situations earlier. This will also save lot of time and resources.(12,13) . A Deep Learning model CADx classifies breast tumors as benign or malignant and shows higher diagnostic accuracy and sensitivity than previous algorithms and humans(34). AI is also being used to manage stroke specifically the tissue plasminogen activator treatment and to predict the chances of intracranial haemorrhage(16).

AI can help in accurate cancer diagnosis. Body scans can detect cancer and vascular diseases at an early stage and predict the health issues person may face based on their genetics. Using the technologies like AI and Deep Learning, BenevolentAI has become capable of providing the right treatment to the patients at the right time. The company is also focusing on getting its drugs licensed and creating medicines for rare diseases.

AI techniques prove to be of immense help in early diagnosis of fatal diseases like parkinsonism. BERG is one such platform that works on mapping diseases to speed up the creation of advanced medicines and vaccines. BERG is also active for the treatment of Parkinsonism. BERG uses Artificial Intelligence to find the links between human body chemicals not known earlier.

PathAI uses Machine Learning tools in healthcare that allows Pathologists to make correct diagnosis especially the cancer patients.Due to more accuracy in the diagnosis, many of such patients can be cured at an early stage before turning fatal and therefore saving many lives. PathAI reduces errors during the process of cancer diagnosis and offers a range of new techniques for individual medical treatment. With increased accuracy in the diagnosis of cancer patients, most of them can be looked after or be cured at a stage where it does not turn fatal, saving numerous lives.

Artificial Intelligence provides help in diagnosing possibly fatal blood-related diseases at an early stage. With the help of AI-empowered microscopes, health professionals are able to scan the dangerous bacteria and substances in samples of blood, such as E. coli and Staphylococcus etc. at a much faster rate as compared to manual scanning. 25,000 blood sample images were used by the Scientists so that the machines could learn to find the harmful bacteria. AI enabled the machines to learn to identify the bacteria in the blood and detect their presence in the new samples with an accuracy of 95 percent thereby decreasing the fatality over a large margin.

1. **Clinical trial Participation**

For clinical trials to be conducted, a large amount of data needs to be collected and arranged in order to get the right theory for a particular clinical disorder and its management. With the help of AI applications, it becomes easier for hospitals to form a result-driven approach for the clinical trials. AI tools have helped the researchers to search the appropriate candidates to test the drugs for various diseases. AI have largely attributed to decrease the investment and increase the speed for conduct of clinical trials and therefore healthcare industry have seen an exponential rise in the number as well success of the clinical trials. Zippel et al. analyzed the application of Machine Learning in clinical research (35), Dong et al. and Liu et al. described the current status of registered trials for AI in cancer diagnosis (36), critical care, and emergencies(37).

**CONCLUSION**

**Artificial intelligence in healthcare has several benefits but has some drawbacks too.**The most frequent applications of AI is Clinical prediction, diagnosis and treatment. AI in general, has assisted medical professionals in various domains of health information systems; like in recent years, Machine-learning has become the most operational &amp; successful type of AI technique that is concerned with image recognition in imaging.

 Another use of AI is to collect data and information, in cancer treatment cases. It has, also emerged as a powerful technology for faster, cheaper, and more effective anti-cancer drug designs recently. In the developing countries such as China and India, AI is increasingly utilized in research in medical field.

Applications of AI has enormous capacity to deal with a mass of big medical data and unlock clinically relevant hidden information. AI provides healthcare professionals possibly with real-time and constant updates on medical information from various sources, including journals and clinical practices. This application was found to be critical in the COVID-19 pandemic times for the continuous exchange of new information.

AI has reduced care costs potentially and repetitive surgeries by focusing the medical professionals on creativity and critical thinking in clinical practice. In the future, focus will be on machine learning based on data obtained from the latest diagnostic modalities.

Although there are several benefits of AI technologies in the field of healthcare, it has some drawbacks also.

The use of AI faces sometimes ethical issues, potential to make errors in decision making, difficulty in adapting to new technologies, human supervision, problems in learning Artificial Intelligence, implementation challenges and so on.

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