

Artificial Intelligence in Healthcare: Boon or Bane?**Seema Vishwanath Bhalerao¹, Samiksha Sanjay Shelar^{2*}, Bipin Sanjay Shelar³**¹Professor, Department of Pharmacology, Dr. D. Y. Patil Medical College, Hospital & Research Centre, Pune, Maharashtra, India 411018, Orcid Id- 0000-0003-4039-2005.^{2*}Assistant Professor, Department of Pharmacology, Bharati Vidyapeeth (DTU) Medical College, Pune, Maharashtra, India 411043, Orcid Id- 0000-0001-7833-4930³Under Graduate Student, Prakash Institute of Medical Sciences and Research, Urun-Islampur, Sangli, Maharashtra, India 415409, Orcid Id- 0009-0000-3326-027X***Corresponding Author:**

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ABSTRACT

Artificial Intelligence (AI) is a data driven technology that helps to generate intelligent and smart machines that are highly capable of performing different tasks by analysing data without human intervention. This technology is able to identify the patterns and deliver automated insights by using data and algorithms. Hence, it becomes useful in various applications in healthcare like Health monitoring, Management of medical records, Digital consultations, Treatment designing etc. In spite of evident benefits of AI in healthcare, its usefulness in patient care is debatable. The merits and demerits AI use in healthcare are compiled together to seek its potential impact on healthcare system and thereby explore its controversy.

From various studies it has been observed that, AI aids in improving patient's access and experience to healthcare services and enhancing healthcare outcomes. It can give rise to productive and efficacious delivery of healthcare. It allows the healthcare providers to dedicate more time in direct patient care by preventing their exhaustion as it can automate their administrative tasks thereby improving the experience of healthcare providers. AI is undoubtedly useful to healthcare system, but difficult to implement. It needs to be extensively trained in order to improve performance. Ethical concerns can produce difficulty in accessing the data which is necessary to facilitate AI learning. Considering rapid increase in use of AI, there is a challenge for the healthcare system to keep up with the pace of innovations with continued vigilance to avoid harm.

KEYWORDS: Artificial intelligence, healthcare system, benefits- disbenefits.

INTRODUCTION

Artificial Intelligence (AI) is a technology that helps create smart and intelligent machines that are capable of performing tasks without human intervention.^[1] The term AI was first coined by John McCarthy in 1955. During the period 1960s-1970s, “Dendral”, the first problem solving program was produced to assist in identification of bacteria and antibiotic recommendations. From 2010-2019, AI technology was used in electronic health record system, Natural language processing and computer vision, Genomic sequencing databases, Robot- assisted surgeries, etc. Since 2019, AI has been used for drug discovery and development, preclinical research and personalized healthcare setting.

This technology has the potential to transform various aspects of patient care and administrative processes within healthcare providers (HCPs), payers and pharmaceutical organisations.^[2] The rise in data and its complexity in the healthcare system leads to increasingly prevalent use of AI in this field. AI-based machines are programmed to learn and explore their surroundings with the help of data analysis. In the real world, various applications of AI help us to perform our day-to-day tasks easily and rapidly.^[1]

This is a narrative review of impact of AI applications in healthcare system. Number of research studies suggested that AI can perform healthcare tasks like diagnosing a disease, better than humans.^[2] Nowadays, AI methodologies are implemented for automation and to simulate human intelligence for either solving a problem or making a decision by providing the advantages of permanency, reliability and cost-effectiveness.^[3]

TYPES OF AI USED IN HEALTHCARE SYSTEM

AI comprises of diverse technologies such as machine learning, deep learning, neural networks, natural language processing, rule-based expert systems, physical robots, robotic process automation, etc. All these technologies are being combined and integrated in healthcare field to perform specific tasks. Highly significant subsets of AI technologies of healthcare are as follows:

1) Machine Learning –

- Geoffrey Hinton a cognitive psychologist and a computer scientist is known as the father of machine learning and neural network.
- It is a developing technology which enables the computers to learn automatically from past data and improve its performance without being explicitly programmed. It's the ability to get better with experience.
- Mathematical models are built on the grounds of many algorithms and predictions are made using data or information.
- Precision medicine is the most commonly used application of traditional machine learning in healthcare system which involves prediction of specific treatment protocols that are likely to succeed on a patient based on their characteristics and treatment context.^[2]

2) Deep Learning –

- It is complex form of machine learning which has the capability to learn from unstructured information.
- It is commonly used in radiology for recognition of potentially cancerous lesions in images.^[4]
- It is used in radiomics and oncology-oriented image analysis for the detection of clinically relevant features in imaging data that cannot be perceived by human eye.^[5]
- It promises greater accuracy in diagnosis.
- It is also used for speech recognition.

3) Neural Network –

- A technology and a means of machine learning in which computer learns to perform a specified task using training examples.
- It has been well established in healthcare research as a basic architecture since 1960s.^[6]
- It identifies the problems in terms of inputs, outputs and other variables associated with it and utilize this information for categorization applications like determining whether a patient will acquire a particular disease.^[2]

4) Natural Language Processing (NLP) –

- It is the capability of computer to process and understand human language.
- The two basic approaches to NLP are statistical and semantic.

- It is used in creation, understanding and classification of clinical documentation and published research and in applications like speech recognition, text analysis, translation, etc.
- Recently, Statistical NLP has increased the accuracy of recognition.

5) Rule Based Expert System –

- In healthcare, it is a most widely used dominant expert system for “clinical decision support” which is based on collections of ‘if-then’ rules.

6) Physical Robots –

- Currently, physical robots are mainly used for surgical purposes such as to perform minimal invasive, remote and unmanned surgeries.
- Surgical robots provide ‘superpowers’ to surgeons, improving their ability to see, create precise and minimally invasive incisions, stitch wounds and so forth.^[7]
- Common surgical procedures using robotic surgery include Gynaecology surgery, Prostate surgery, Head and Neck surgery and Hip Replacement.

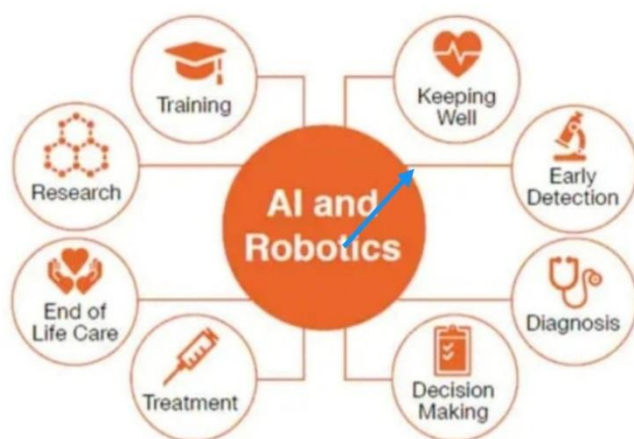
7) Robotic Process Automation (RPA) –

- This technology involves computer programs and not the robots to perform repetitive and structured digital tasks such as prior authorization, updating patient records, billing and various other administrative purposes.^[8]

All these technologies are combined and integrated to use in various applications, e.g. robots are acquiring AI-based “brains”, and image recognition is being integrated with Robotic Process Automation.

ROLE OF AI IN HEALTH

AI is no longer a science fiction but it is actually transforming the healthcare system.



- 1) **Keeping well** – Technology applications and wearable health trackers (e.g. FitBit, Apple, Garmin, etc) encourage healthier behaviour in individuals and monitor heart rate and level of physical activity and send alerts to the users to increase the exercise. It can share health information to the physicians and thereby makes proactive management of healthy lifestyle feasible. An AI fuelled Medical chatbot platform is used by HCPs to provide instant support to their patients, reduce their wait times and improve patient satisfaction.^[9]
- 2) **Early detection** –AI is being used to detect diseases like Cancer more accurately and in their early stages. According to American Cancer Society, a high proportion of mammograms yield false positive results (1 in 2 healthy women) faster with high accuracy and thus reduce the need for unnecessary biopsies e.g., Google’s DeepMind health helps in detecting and solving healthcare problems.^[10]
- 3) **Diagnosis** - Machine learning algorithms can process vast amount of information very rapidly and precisely than humans (IBM’s Watson for Health) and helps in detection of every minute detail in medical imaging. Most commonly used AI diagnostic systems are as follows
 - 1) ‘Profound’ developed by Zebra Medical Vision which can analyse all medical imaging reports that is able to recognize all signs of probable disorders like Breast Cancer, Osteoporosis, Aortic aneurysm, etc. with 90% accuracy rate.
 - 2) ‘IDX-DR’ is the first ever FDA approved AI diagnostic system that can autonomously diagnoses patient for diabetic retinopathy, macular oedema, etc. within 30 seconds without the oversight of the specialist.
 - 3) ‘Google DeepMind’ is developed for diagnosing eye diseases and quickly triaging patients.
 - 4) ‘Convolutional Neural Networks (CNNs)’is used for automatic classification of skin cancer.^[11]
- 4) **Decision making** –AI technology helps in analysis of robust health data and assists the clinicians in timely and accurate decision making, to take appropriate actions and to prioritize administrative tasks e.g., Digital consultations using ‘Health Tap’, Babylon App etc. based on patient’s medical history and common medical knowledge. These Apps use speech recognition for user’s reported symptoms, compare it against illness database and accordingly suggest various treatment options to the users for further care.

5) Treatment –

a) Treatment design –It functions by analysing the data after collecting information from patient's files, expert opinion from clinicians and research thus help to select the most accurate and customised treatment path as per individual requirement.

b) Precision medicine – Medicine has shifted towards prevention, personalization and precision as an alternative to developing treatments for population. The role of genetics and genomics is to spot mutations if any and link it to the disease from the DNA information. AI can help to spot the cancer and vascular diseases at early stage and anticipate the disorders beforehand, based on their genetic makeup. Genomics, biotechnology, AI are gradually leading the healthcare system to create vast amount of data using advanced technology and make the basis of precision medicine.^[12]

6) End of Life Care: Nowadays, most of the people are dying slowly due to conditions like dementia, Alzheimer's, heart failure, osteoporosis, etc. which are often aggravated by loneliness in life. AI avatar companion can offer medical tips to elderly people about their diet, exercise, medication and sleep to improve the health conditions, loneliness and social isolation e.g., a text-based "companion" i.e., 'Lena chatbot' developed by Alex Harb that uses AI to connect with senior citizens and checks in like a friendly neighbour and is also capable to instantly elevate a situation to a professional care team. AI has conversations and social interactions and conversations with elderly people to keep their aging minds sharp.

Medication Management: AI cure App developed by National Institute of Health (NIH) monitor the patient's medications. A Smartphone's webcam can independently confirm that the medications are taken and helps to manage their disease.

7) Research: Molecular Epidemiology; currently facing the greatest statistical computational challenge in identification and characterisation of genes that are responsible for multi-factorial diseases.

Traditional statistical methods cannot solve his problem due to multiple polymorphism and high dimensionality of the data. Various machine learning methods such as Neural Networks (NNs), Support Vector Machine (SVM) and Random Forests (RFs) helps in solving such problem by identifying the susceptibility genes in these multi-factorial diseases.

8) Training: Naturalistic simulation practice of trainee is provided by AI.

ADVANTAGES OF AI IN DIFFERENT SECTORS OF HEALTHCARE SYSTEM^[1,2,13]

- 1) **Healthcare providers and users**
- 2) **Pharmaceutical companies**
- 3) **Researchers.**

1) **Healthcare Providers and users:** AI provides a helpful hand and supports the medical staff in data analytics and administrative works and also resolves the greatest problem of healthcare industry, i.e. lack of time.

i. Improvement in efficiency:

- Accuracy and speeding up of diagnostic process and boosts patient engagement.
- AI analyses human cognition to find out the connection between the type of treatments and the subsequent medical outcomes.
- AI helps to predict and prevent diseases by considering the previous medical records from other patients.
- It can prevent misdiagnosis and increase the efficiency, as it considers large data rapidly at lower cost; e.g. finding hints of Diabetic Retinopathy on the basis of eye images.
- Many hospitals can detect onset of sepsis using AI.

ii. Enhancing customer service and satisfaction:

- Patients usually complain about large queues and never-ending referrals to other specialists.
- AI provides the new platform where the patients do not have to visit a doctor.
- Use of the apps can provide real time health monitoring to them.
- They can also communicate with the doctor.

AI provides personalised medical approaches and services to the patients by the cross transfer of referenced data of the patients bringing similar complaints. AI system compares conditions, treatments and the flow of courses. It results in a personalised medical approach and thus offers plenty of treatment options to the patients.

- 2) **Pharmaceutical companies:** AI holds huge potential for improving and speeding up the process of drug development by various ways such as-
- i. Reduce the cost of research
 - ii. Avoid human errors in calculations
 - iii. Identify significant areas of improvement and needed intervention
 - iv. Discovering candidates
 - v. Speeding up tests and results
 - vi. Classify biomarkers to identify the risk factors for the development of disease.
- AI holds huge potential for improving the R&D process, and many companies are already investing heavily.
 - Pharmaceutical companies and research institutions can use AI to examine the mechanism of disease and map out potential therapeutic targets.
 - It can also help identify patient subgroups that may benefit from certain therapies and support pricing commensurate with the level of benefit.
- 3) **Researchers:** AI associated with developing new tools is using NLP to speed up the clinical trials. AI is used in genome-based diagnostics such as genome sequencing and annotations where algorithm tries to recognize the common pattern to develop solutions.

BENEFITS OF AI IN HEALTH-CARE INDUSTRY

- 1) **Increased diagnostic efficiency-** AI algorithms can identify and diagnose the diseases quicker than the physicians with least possible errors due to robust data quality e.g., PathAI can diagnose breast cancer at a higher rate than pathologist and thus provide accurate diagnosis and efficient treatment.
- 2) **Cost saving-** AI technology can analyse large number of images for diagnosis of disease and thus makes the diagnostic process inexpensive. Hence, it reduces the waiting time so the patient can be treated faster and more effectively reducing admissions and thereby reduces need for beds.
Continuous development of AI technology will make it more cost effective in robot assisted surgery, virtual nursing assistance, administrative workflow assistance, fraud detection and dosage error reduction.

- 3) **Safer surgeries-** AI robotics provide proficient support in surgery with its high level of dexterity and precision to operate in small spaces or around delicate tissues or small blood vessels. They lessen the risk of haemorrhage, infection and post-surgical discomfort as they require small incisions resulting in shorter recovery time and less scarring thus helps in alleviating surgeon's stress.
- 4) **Enhanced patient care:** Health-care facilities are typically overcrowded which leads to poor communication with patients. After reviewing the entire data and generating reports, AI guides the patient accordingly and thus avoids patient's confusion.
Further biggest advantage is its round-the-clock availability for the patient e.g. Babylon app (Interactive symptom checker)
- 5) **Easy information sharing-** e.g., Free style Libre glucose monitoring system allows the diabetic patient to track their glucose levels in real-time, to access the reports and to manage and review their progress with their doctors or support teams. It can be an indicator of the disease probability. E.g., wearable devices. AI can collect, store and analyse the medical data, it would create a treasure chest of revolutionary information for health care.
- 6) **Improved preventive care:** AI facilitates the prevention and control of infectious diseases with the help of following measures:
 - Blue Dot (Outbreak Intelligence Platform) detects the path of infectious diseases and helps in effective isolation of patients and quarantine procedures during outbreaks. It also helps the researchers to review the virus genomes for quick development of vaccines and prevention of disease e.g., during the outbreak of COVID-19 it analysed the airline tickets and flight paths to predict the path of COVID-19 from Wuhan to Seoul, Bangkok and Taipei.
 - AI powered wearables: Modern wearable technology e.g., smart watches and fitness trackers such as Fitbit charge, Bluetooth and VR headsets, smart jewellery, web enabled glasses etc. can detect and analyse user's heartbeat and speech patterns, monitor moods and warns about health signals.
 - Many hospitals are using AI to detect the onset of sepsis as early detection of sepsis is important in saving lives.

- Hospitals are using algorithms to target interventions to particular patients and that can reduce the risk of mortality and re-admission.

7) Improved accessibility:

According to WHO, due to limited or zero accessibility to standard healthcare facilities for the inhabitants of developing countries, the life expectancy is reduced (18.1 years gap) as compared to developed countries. This is due to the struggling of developing countries to keep up with the fast-paced global technological advancement in AI.

DISBENEFITS OF AI

- 1) Requires human surveillance** - AI works logically rather than empathically. Assistance of health practitioners is needed to identify or avoid medical issues e.g. Surgery Robots. For the efficient use of AI, human input and assessment is required [subject matter experts]
- 2) Lack of personal involvement** – Interaction between a doctor and a patient is crucial in establishing trust and providing therapy AI (e.g. Surgery Robots) are not programmed to have any feeling for the patients.
- 3) May overlook social and economic variables** – AI system can direct a patient to a specific treatment centre based on the diagnosis but, without the consideration of patient's financial condition and personal preferences. So, it is likely to be influenced by social, economic and historical variables.
- 4) Incorrect diagnosis** – The precise diagnosis of disease is based on information gathered from millions of patients with comparable symptoms by AI database. If there is paucity of data about a patient from a particular disease, AI may make an incorrect diagnosis and cause medical errors leading to deaths.
- 5) Unemployment** – AI has been applied (chatbots and robots) across the entire healthcare system on a larger scale. Many activities that were previously undertaken by healthcare providers can now be performed by machines. As a result, many people may lose their jobs and therefore, it is critical to address the social implications of its use.
- 6) Possibility of inaccuracies** – In case of scarcity of data on specific diseases and demographic details, environmental factors and treatment options available to medical AI who is primarily reliant on this data for the diagnosis and prescribing medication then due to data shortfalls it can cause misdiagnosis.

- 7) **Social prejudices** – AI algorithm may recommend an expensive care facility to low-income patient without taking into account of patient's social and financial circumstances. The reason is that AI based robots are unable to fully comprehend human's social and financial state.
- 8) **Vulnerable security** – Unregulated AI systems may lead to cyber security threats or cyber bullying as it depends on data networks. Cyber-attacks may outsmart the security defence and will become difficult to control.

KEY CHALLENGES TO SUCCESSFUL AI IMPLEMENTATION

Recently, application of AI in healthcare gathered too much attention but the implementation of AI posed wide range of unaddressed issues which include health system, social as well as financial implications of positioning of AI in healthcare settings. The paucity of labelled important training data understandable to machine and its black-box nature of AI model (e.g ANN) leads to the lack of transparency of results. So, training of deep learning algorithms to HCPs become difficult. Therefore, while incorporating AI into healthcare workflows, the medical professionals face the following critical challenges:

1. Legal and ethical concerns in high quality data exchange.
2. Training healthcare practitioners and patients to handle intricate AI models.
3. Management of strategic change to implement advanced AI system into actual practice.
4. Lack of high-quality data sets.
5. Clinically inapplicable and non-standardised AI model's performance matrix in terms of safety and efficacy.
6. Confounding factors and omitted variables.
7. Transparency and explainability ("Ghosts of AI") issues.
8. Regulation and data ownership issues.

FUTURE OUTLOOK OF AI IN HEALTHCARE

- ❖ Artificial Intelligence, as rightly called, is an art of restoration of human intelligence and behaviour in the computers and train them to make human- like decisions. In future, AI will attract significant attention from healthcare sector, pharmaceutical industries, academic organisations and government.
- ❖ AI has just started to play a vital role in the field of healthcare and now emerging as a game changer in variety of dimensions in healthcare system e.g., discovering drugs for dreadful diseases, early cancer detection in radiology, improving medication adherence and self-treatment of disease in patients using digital consultations, detecting high-risk viral infection rate & its prognosis and to develop real-time solutions for its control.
- ❖ Future prospectus of this revolutionary AI technology is the development of hybrid models to help the healthcare experts in making diagnosis, identification of risk factors and treatment planning with high efficiency and measurable progress in patient's results.
- ❖ It can also reduce the preventable human errors by recognising anomalies; assist the surgeons by understanding the 'grammar' of surgery and predict the readmissions by developing algorithms that identifies the probability that a patient will return.
- ❖ AI will become capable of extending medical facilities to backward and remote areas.
- ❖ It would also help in making the training of medical students more interesting and easier, through naturalistic simulations.
- ❖ In spite of bringing innovative solutions in healthcare, AI technology still has too much to achieve to produce a meaningful impact globally on the healthcare system, though it had already been proven to be highly efficient and effective in the delivery of patient care.
- ❖ AI is growing rapidly with increased technological development being made every day and is valued to be a billion-dollar industry today.
- ❖ Hence, it is expected that AI industry will continue to flourish and help the healthcare industry in upcoming years.

CONCLUSION

- ❖ AI appears to be the future of healthcare system. It can completely revolutionize the medicine and drug development with high efficiency in critical fields such as diagnosis and detection of disease, assessment of health risk, new drug development, administration and communication.
- ❖ Thus, it can make incremental progress in the areas of research and patient care. If the talent of researchers and healthcare providers can be combined with the predictive analysis and calculation skills of AI, living in a life-threatening disease-free world will not be a dream anymore. It is a fact that has been expected for ages and has now finally come into the view of mankind.
- ❖ It is also true that in the view of attracting patients and increasing the sale, Hospitals, Tech companies, etc are making aggressive use of AI which is leading to back-of-the-house improvements and neglecting the care giving attribute. Moreover, with rise in significant improvements comes a possibility of equal rise in wastage of money.
- ❖ In order to overcome this situation, the slow and cautious adoption of AI technology, for the right purpose and in a right way can be beneficial in right sense in healthcare.
- ❖ Lastly, AI system is a machine and prone to the fallacies and it is created by humans so it can never replace humans entirely because human's brain is the biggest mystery itself and nothing is comparable to its multidimensional thinking and learning potential.

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CONFLICT OF INTEREST: NONE

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