



IJPPR

INTERNATIONAL JOURNAL OF PHARMACY & PHARMACEUTICAL RESEARCH
An official Publication of Human Journals

ISSN 2349-7203



Human Journals

Review Article

May 2020 Vol.:18, Issue:2

© All rights are reserved by Harjot S.Kathuria et al.

Artificial Intelligence in Healthcare



Harjot S.Kathuria*¹, Haridas A.Sangale², Swati
G.Talele³, Shweta S. Gedam⁴, Anil Jadhav⁵

¹Mpharm student, Sandip Institute of pharmaceutical
science, Nashik India

²Mpharm student, Sandip Institute of pharmaceutical
science, Nashik, India

³Professor, Sandip Institute of pharmaceutical science,
Nashik, India

⁴Professor, Sandip Institute of pharmaceutical science,
Nashik, India

⁵Principal, Sandip Institute of pharmaceutical science,
Nashik, India

Submission: 23 April 2020

Accepted: 01 May 2020

Published: 30 May 2020

Keywords: Artificial Intelligence, Machine learning(ML), Deep learning(DL), Natural Language Processing(NLP)

ABSTRACT

Artificial Intelligence is a rapidly evolving technology in the field of healthcare. This review article summarises the new innovations developing in the healthcare which will completely transform the role of the doctor and revolutionize the practice of medicine. It also explains the way in which it is utilized in healthcare by different computerized softwares and examples along with it. Such innovations have already been initiated in health sectors for the treatment and diagnosis of disease and therefore assisting the healthcare experts. It also explains different types of AI in which deep learning when merged with machine learning can be the promising one in the years to come followed by natural language processing, robotics automation, physical robots and rule based experts systems. The history of patents in AI till date are also discussed in this review. The most number of patent filings have been done by the leading organization in healthcare such as Siemens, Philips and GE healthcare. The success of AI can also be attributed to the recent developments in diagnostics and medical imaging applications. The global insights of artificial intelligence in healthcare are described in this review. The future scope and applications of AI to healthcare are also discussed.



www.ijppr.humanjournals.com

1.1 INTRODUCTION

Artificial intelligence (AI) and associated innovations are progressively persistent in business and society, and are emerging to be applied to medicinal care. These advances can bring numerous transformations to different aspects of patient care as well as administrative systems inside pharmaceutical organizations.^[1]

Globally, There is no acceptable meaning of AI. The term extensively refers to computational models that mimic processes related with human intellect, for example, thinking, learning and modification, knowledge, and affiliation. As of now, most utilizations of AI are restricted in that they are simply able to perform particular activity or resolve specified issues.^[2]

Artificial intelligence (AI)

Artificial intelligence (AI) is quickly changing the universe of medication, as the past decades have implied rise in the growth of medical AI. These reasoning machines are currently utilized in diagnostic, treatment, and medication advancement applications.^[3]

For AI technologies, healthcare has been considered as a promising field since long time. Artificial intelligence based applications can possibly improvise interaction in a clinical care-related environment, thus having an inevitable impact on the health effects and standard of living. AI systems have now been employed to assist health-care professionals in managing enormous amounts of patient data, provide guidance and decision support, and improve clinical workflow. Despite the recent developments, these systems are limited when it comes to the need of monitoring and updating by clinicians.^[4]

1.2 Objectives of AI in healthcare

- To spot the top medical companies and research institutes working in the AI domain.
- To identify the potential of AI-based technologies in assisting the medical personnel.
- To recognize the type of diseases that can be diagnosed, treated or predicted with the assistance of AI tools.
- To estimate the risks or challenges we need to consider while deploying AI systems for clinical purposes.
- To approximate further growth and future prospects of AI in the health-care industry.^[5]

1.3 Artificial intelligence in medicine

AI in medicine is the utilization of computerized reasoning innovation/mechanized procedures in the biopsy and treatment of patients who require care. While biopsy and treatment may appear like basic steps, there are numerous other backend processing that must occur all together for a patient to be properly looked after, for instance:

- Gathering of data through patient consultation and tests
- Processing and examining results
- Using various roots of information to go to a precise finding
- Determining a proper treatment strategy (frequently giving alternatives)
- Preparing and dispensing the selected treatment method
- Patient monitoring
- Aftercare, follow-up course of appointments and so on.

The dispute for greater utilization of AI in medication is that a considerable amount of the above could be robotized - robotization frequently implies activities are done even more quickly, and it liberates up a clinical expert's time when they could be performing additional responsibilities, ones that can't be mechanized, and hence are seen as a even more precious use of human resources.

The push, therefore, is not to excessive over-automation of the medical and health care fields, but to purposely and reasonably distinguish those zones where mechanization could save time and effort. The objective is a harmony between the efficient utilization of innovation and AI and the human qualities and judgment of skilled medical experts.

1.4 Artificial intelligence technologies

There is already an incredible amount of technology and automation in play in medicine, whether we realize it or not - medical records are digitized, appointments can be scheduled online, patients can check in to health centers or clinics using their phones or computers. Currently, there is a remarkable innovation and computerization which plays an important role in medicine, regardless of whether we realize it or not- clinical records are digitized,

arrangements can be booked online, patients can register to health centers utilizing their computers or mobile phones.

For example, **Futurism lists the following examples** of AI already being used in medicine today:

- Decision support systems-When a set of symptoms are given, **DXplain** comes up with a report of possible diagnosis.
- Laboratory information systems- **Germwatcher** is intended to recognize, follow and investigate syndromes in hospitalized patients.
- Robotic surgical systems - The **da Vinci robotic surgical system**, with robotic arms, precise movement and magnetized vision, allows doctors to precision surgery that wouldn't be possible with an entirely manual approach.
- Therapy - **AI Therapy** is an online course for people struggling with social anxiety.
- Reducing human error - **Babylon** is an online application where patients in the UK can book appointments and routine tests, plus consult with a doctor online, check for symptoms, get advice, monitor their health and order test kits.

The potential for increasing use of AI in medicine is not only causing reduction of manual responsibilities and releasing of doctor's time, enhancing effectiveness and efficiency- it additionally open door for us to move towards more 'accuracy medication'.^[4]

The primary aim of utilizing AI tools in the medical platform is to provide better diagnosis, cure and treatment of critical patient conditions. For such decision support, the intelligent systems must be integrated with algorithmic methods of automatic learning and approaches involving fuzzy set theory, Bayesian networks and artificial neural networks. These intelligent systems are implemented for diagnosis of early stages of cancer, suggesting efficient treatment plans, predicting future adverse conditions and providing risk assessment of surgical procedures and health record management.^[5]

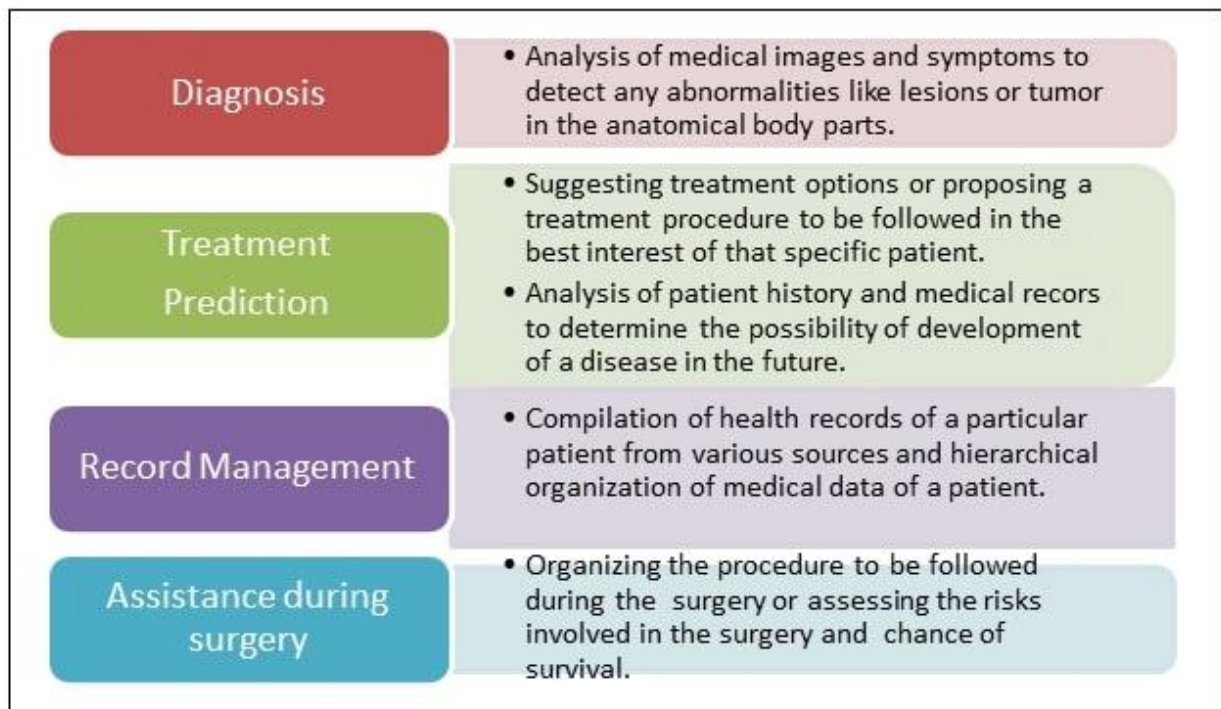


Fig 1. Different assistance offered by AI systems in healthcare^[5]

1.5 Types of AI of relevance in healthcare

Artificial intelligence is not a single technology, but somewhat combining several of them. A large portion of these innovations have direct importance in the field of healthcare, however the particular procedures and responsibilities may differ largely. Some specific AI innovations of high significance to medicinal services are described and depicted underneath.

1.5.1 Machine learning – Neural networks and Deep learning

Machine learning is a technique for fitting models to information statistically. Machine learning is amongst the most extensive types of AI. It is a broad technique at the center of numerous ways to deal with AI and there are numerous forms of it. The most well-known utilization of machine learning in healthcare is accuracy medication foreseeing what treatment conventions are probably going to prevail on a patient on the basis of different patient aspects and treatment condition.

Neural network-a more complex form of machine learning technology that has been accessible since 1960s has now been firmly established in field of medical research and has been utilized for determination of the probability of acquiring a particular disease by the patient.

The most unpredictable types of machine learning include *deep learning*, or neural network models with numerous degrees of highlights predicting outcomes. Deep learning is increasingly applied in radiomics for the identification of possibly carcinogenic lesions in radiology images.^[12] Both radiomics as well as deep learning are most frequently employed in oncology-oriented image analysis where combination of both seems to assure better accuracy in diagnosis than the computer aided detection or CAD(robotized tools for picture examination).Additionally, Deep Learning is gradually utilized for recognition of speech and by itself is a form of natural language processing (NLP), depicted below.^[1]

1.5.2 Natural language processing (NLP)

Understanding human language has been an objective of AI experts since the 1950s. This field, NLP, incorporates applications like speech recognition, text analysis, translation and other objectives associated with language. There are two essential ways to deal with it: statistical and semantic NLP. Statistical NLP is connected to machine learning (deep learning neural networks in particular) and has done contribution to enhancement in more accurate speech recognition.

The principal applications of NLP in healthcare include creation, understanding and classification of medical records and published literature. Such systems can identify unstructured clinical notes on patients, get ready reports (such as on radiology examinations), interpret patient interactions and carry out conversational AI.^[1]

1.5.3 Rule-based expert systems

In healthcare, expert systems technology were broadly utilized for the purpose of clinical decision support in the past few decades which are still in wide use today.^[11] Nowadays Several Electronic health record (EHR) providers have given a set of norms with their systems. Expert systems require human specialists and expert system programmer to build a set of standards in a specific information area. They function quiet well up to particular point and simple to understand. But, when the rules are in large numbers (generally over few thousand) and the disputes begin to occur between them, they will in general collapse. In addition, if the information area changes, changing the standards can be troublesome and tedious. They are gradually being substituted in healthcare by more methods dependent on information and machine learning algorithms.^[1]

1.5.4 Physical robots

Physical robots are notable by this point, given that in excess of 200,000 mechanical robots are introduced every year around the globe. They carry out pre-defined functions like lifting, repositioning, welding or collecting objects in places like industrial sites and storehouses, and providing supplies in healthcare centers. Robots have become even more cooperative with humans and are trained with ease by moving them through a required task. Besides, they are becoming wiser due to incorporation of other AI capabilities in their mind. Regular surgery utilizing automated medical procedure include gynaecologic surgery, prostate surgery and head and neck surgery.^[1]

1.5.5 Robotic process automation

This innovation performs organized digital functions for managerial reasons, i.e. those including computer systems. When compared with other types of AI they are economical, simple in programming and straightforward in their operations. Robotic process automation (RPA) doesn't actually involve robots-just computer programs on servers. In healthcare, they are utilized for monotonous jobs like earlier authorization, updating patient information or invoicing. In combination with other technological innovations like image recognition, they can be utilized to remove information, for example, faxed images so as to enter it into value-based systems. We've depicted these innovations as individual ones, they are being combined and integrated; robots are getting AI-based minds, image recognition is being integrated with RPA.^[1]

1.6 Artificial intelligence patents for healthcare

1.6.1 History of Artificial Intelligence

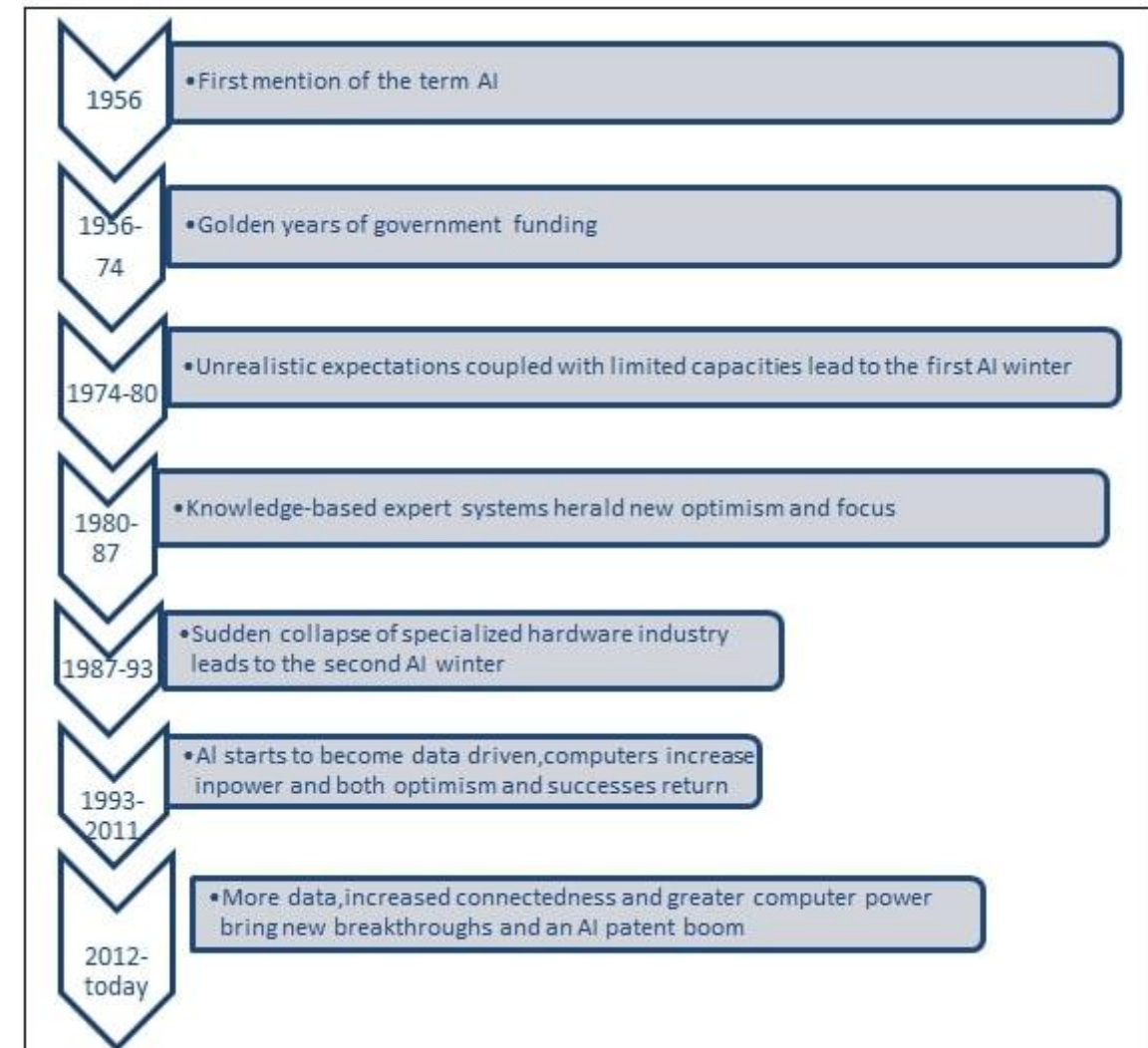


Fig 2. Timeline in Artificial Intelligence^[6]

1.6.2 Patent Filings Distributions

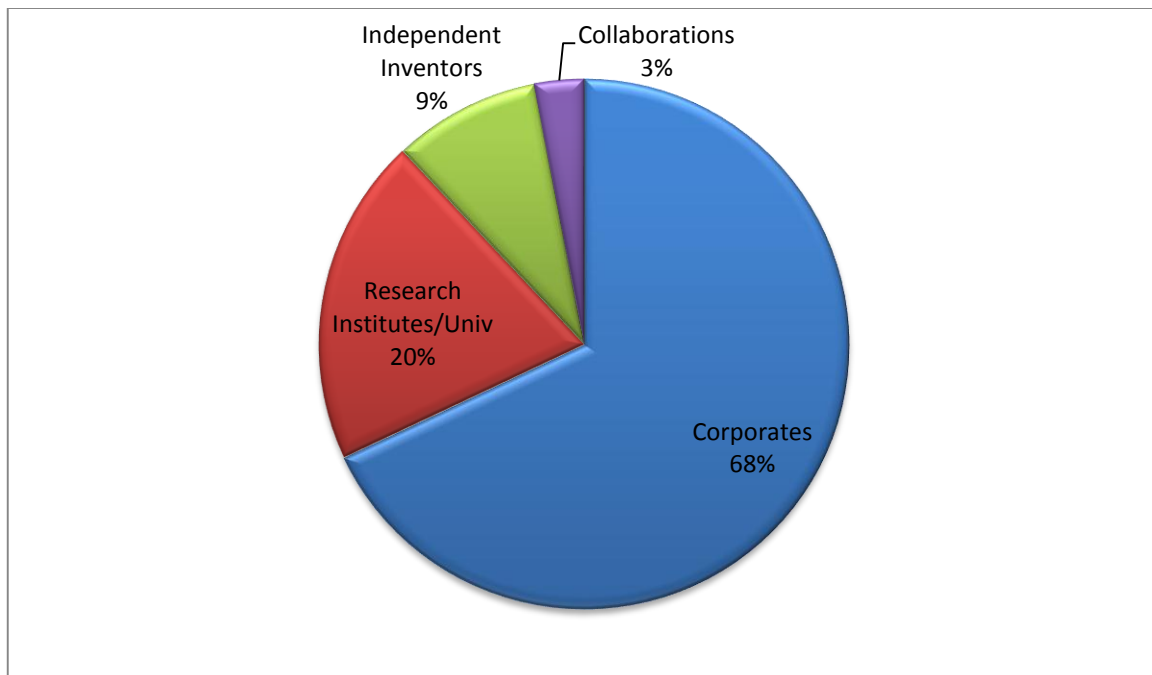


Fig 3. Patent Filings Distributions based on types of Assignees^[5]

Overall, corporates have accounted for the majority of filings at 68%. Interestingly, research institutes and universities have contributed 20% of the R&D that, by all means, can be considered as comparatively on the higher side. Other minor contributions of independent inventors and collaborations account for 9% and 3%, respectively.

Siemens, Philips and GE Healthcare are the leading health-care organizations in the AI domain in terms of patent filings. Siemens is at the forefront of inventing decision support systems for computerized detection and treatment of breast cancer. It has come up with automated methods for distinguishing benign and malignant lesions. The well-established health-care organization, Philips, developed clinical decision support systems for both diagnosing and treating cancer as well as neurological disorders (Alzheimer's disease).

GE Healthcare has shown notable progress by developing computer-aided image processing systems for diagnosis, particularly, in the branch of oncology.

Intriguingly, Samsung Electronics has come forward with computer intelligent systems to assist in diagnosis. Arch Development Corporation and Hologic Corporation have precisely developed apparatus for computer-aided detection of breast cancer, while IBM Corporation has

designed decision support systems for assistance in diagnosis and treatment of cancer and neurological disorders.

The University of Chicago, the University of South Florida and the University of Michigan are the noteworthy research universities that have contributed by deploying automated methods for early detection of lung and breast cancer. [5]

Also, in order to fight against the new emerging disease like corona virus, Siemens and Aucma has recently developed an intelligent disinfection robot from design to sample production in just one week to help fight the virus. [7]

Computer based intelligence is already being applied in several areas of healthcare including in radiology and imaging and in bioinformatics. AI shows great hopes in improvements to information assortment, handling and modeling in areas like gene sequencing, nucleic acid hybridization, protein structure prediction, pharmacology and receptor modelling. [8]

1.6.3 Recent Developments in AI in Medicine, Diagnostics and Bioinformatics

In 2015, IBM started **Watson Health**, an organization whose goal is collaborate with clinical experts to establish new technologies in healthcare. Recently, Google introduced its new division **DeepMind Health** which has a comparative model of collaborating with clinical experts and healthcare professionals. Similarly, there are several instances of small scale artificial intelligence organizations which are involved in development of healthcare technological innovations in the fields of customized health and customized medicine, medical imaging and diagnostics.

Enlitic is a little Silicon Valley based startup that utilizes deep learning to examine radiographs as well as other imaging information, for example, CT and MRI.

TwoXAR utilizes their DUMA Drug Discovery platform to assess huge public and exclusive datasets to distinguish and rank high probability drug-disease matches.

Atomwise utilizes their AtomNet deep learning innovation to identify large number of molecules that may act as drug candidates as well as indicate their fitness for blocking the pathogen mechanism.

Canadian Start-up **DeepGenomics** is utilizing deep learning innovation to huge information collections of hereditary data as well as clinical records to distinguish linkages between hereditary mutation and illness.

Verb Surgical, a joint project among Alphabet as well as Johnson & Johnson are working on an AI equipped medical robot that they assure will be a significant development over existing careful robots, for example, the da Vinci system. ^{[8] [9]}

1.7 Market growth analysis

The development of artificial intelligence in the area of drug discovery, medical imaging, precised medication and genomics combined with rapidly growing customized treatments according to particular patient's requirement will drive the worldwide market. The demand for artificial intelligence technology is increasing to carry out data mining quicken the speed of delivery of healthcare services, rise of novel and promising applications for illness diagnosis and monitoring will additionally increase the market development in the years ahead.

Development in data analytical process in the healthcare artificial intelligence will increase the market growth during the analysis time frame. Enormous amount of information is produced each year in industrial healthcare and ever-expanding volume of large information has produced the need to incorporate artificial intelligence technology for managing information more effectively. Artificial intelligence has transformed the healthcare field by planning treatment strategies, supporting in monotonous jobs, proper management of medications, and drug discovery. It can also be adequately utilized for managing healthcare information by collection, storage and normalization of data. Lately, the research division of the Google artificial intelligence, introduced its Google Deepmind Health plan, for data analysis of medical records to give quicker and better medical care. Growth of innovatively upgradation of information programming and solutions will promote the industrial growth. Yet, high capital demand might create affordability concerns and hamper the industrial growth.

In 2018, drug discovery section accounted for USD 345.0 million and is expected to have substantial growth during the predicted time period. Drug discovery is one of the most recent applications of artificial intelligence that has changed drug discovery process and can be utilized to cut the expense of production for new drug development. Recently, Astra Zeneca has collaborated with Berg, a specialist in artificial intelligence for drug discovery in Boston.

Such continuous efforts from industrial players will undoubtedly have positive effect on industry development.

In 2018, hospital workflow section accounts significant revenue share and is anticipated to reveal 40.6% CAGR during the forecasted time period . Rising adoption of artificial intelligence for collecting patient data to encouraging decision making in hospital workflow has fundamentally improved results, diminished waiting times and costs that will improve segmental growth in the years to come.

Few other sections that have considerable share include medical imaging and diagnostics,therapy planning and virtual assistance.^[10]

1.7.1 Market dynamics

Keeping a harmony between health workforce and patients is a challenge developed and developing nations, including the US, UK, Germany and India. AI and cognitive mobility are providing medical experts the platforms to perform their responsibilities with ease and also with minimal human interference.The deep learning innovation in medical imaging helps in different pathology tests, for example, blood test, X-ray analysis, and detection of cancerous cell.

AI systems help in medicine administration with the assistance of NLP and setting mindful preparing innovation.Hence, with the decline in doctor-patient ratio,AI gets new solutions to bridge the gap healthcare workforce and patients.

.AI in healthcare market estimated to be valued at USD 2.09 billion in 2018 and further expected to reach USD 36.15 billion by 2025, at a compound annual growth rate(CAGR) of 50.2% during forecast period.

- Machine learning innovation anticipated to hold major market share of AI in healthcare in 2018. Among machine learning,deep learning expected to hold largest size of AI healthcare market.
- Accessibility of large information and demand for decreasing healthcare cost led to development of AI in healthcare market.^[11]

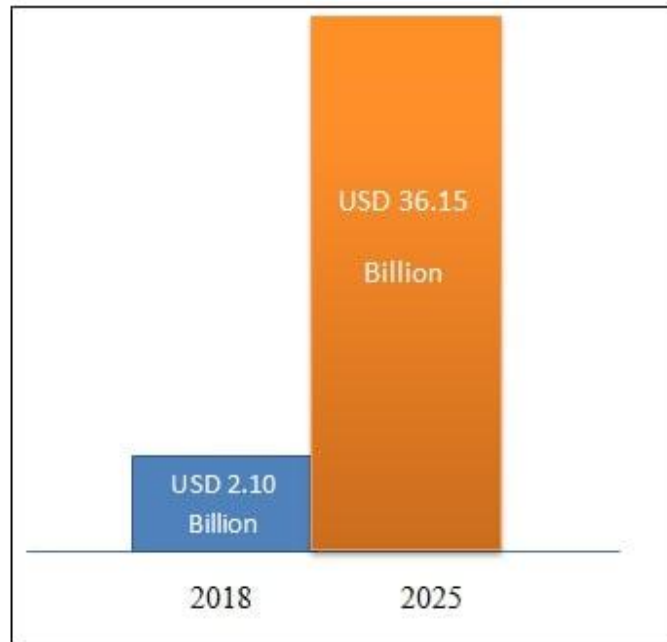


Fig 4. Attractive Opportunities in the Artificial Intelligence in healthcare Market^[11]

1.8 Applications of Artificial Intelligence in healthcare

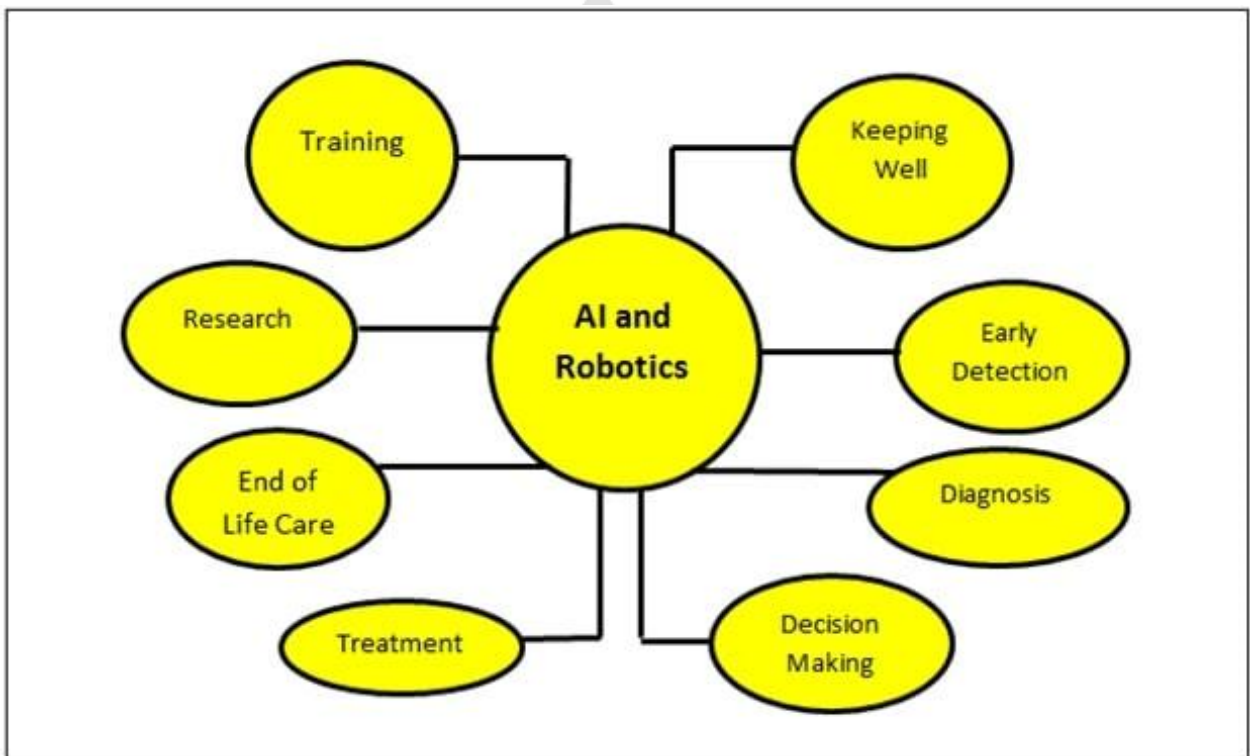


Fig 5. Various applications of AI in healthcare^[12]

1. Keeping Well

One of AI's greatest potential advantages is to assist individuals staying fit so as to ensure that they don't require a doctor or at least very rarely. The utilization of AI and the Internet of Medical Things (IoMT) in customer wellbeing applications is providing assistance to individuals. Furthermore, AI enhances the potential for healthcare experts for greater understanding of daily activities as well as caring of the needs of the individuals and with that understanding they can give better response, advice and assistance for staying fit.^[12]

2. Early Detection

AI is now being utilized to identify illnesses, for example, cancer, more precisely and in their initial phases. As per American Cancer Society, a significant proportion of mammograms yield wrong outcomes, as a result 1 out of 2 women being told that they have cancer. The utilization of AI is empowering survey and interpretation of mammograms multiple times quicker with 99% precision, eliminating the requirement for useless medical examinations.^[12]

3. Diagnosis

IBM's Watson for Health is assisting medical institutions in utilization of advanced innovation with unlocking huge masses of health information and forced biopsies. Watson can survey and keep lot more health data- each health journal, indication, and empirical study of treatment and reaction around the globe – exponentially quicker than any human.

Google's Deep Mind Health is working in association with clinicians, analysts and patients in solving healthcare issues globally. The innovation is responsible for merging machine learning with neuroscience systems to develop broadly useful learning algorithms into neural systems that mimic the human intellect.^[12]

4. Decision Making

Improvement in care ask for the aligning of large health information with proper and favourable decisions, and prediction analysis can promote clinical decision making process and activities and moreover prioritization of managerial responsibilities. By virtue of pattern recognition, the identification of patients who are at risk of development of infection or seeing it worsening because of way of living ,environment-friendly, genetic, or other influences is another aspect where AI is emerging to take charge in healthcare.^[12]

5. Treatment

Besides analyzing medical records to assist healthcare professionals in identification of frequently ill people who might be at risk of an adverse incident, AI can be helpful to healthcare professionals by adopting a more extensive strategy for management of disease condition, better facilitate care plans and encourage patients to handle better and abide by their treatment plan in the long run.

Robots have been utilized in medication for over 30 years. They vary from basic research laboratory robots to surgical robots of higher complexity that can either assist human surgeon or carry out operations by themselves. Apart from surgery, they're utilized in labs as well as hospitals for performing monotonous jobs, in restoration, physical treatment and assistance of those with long duration conditions.^[12]

6. End of Life Care

We are living much longer than past ages, and as we approach the finish of life, we are passing on in an alternative and slower manner, from diseases like dementia, cardiac arrest and osteoporosis. It is likewise a period of life that is frequently troubled by isolation. Robots can possibly change end of life care, helping individuals to stay independent for long time decreasing the requirement for hospitalization and care homes. AI coupled with development in humanoid model are empowering robots to go considerably further and have 'discussions' and other social interactions with individuals for keeping aging minds intelligent.^[12]

7. Research

The journey from research laboratory to patient is too longer and expensive. As per the California Biomedical Research Association, it takes approximately 12 years for a medicine to travel from the testing laboratory to the patient. Just five of every 5,000 of the medicines that start preclinical trial passed on further for clinical trials and merely few of these five is permitted for human utilization. Moreover, on an average, it will cost an organization US \$359 million to build up another medication from the research laboratory to the patient.

Medicine research and discovery is one of relatively new applications of AI in healthcare. By directing the most recent development in AI to facilitate the drug research as well as drug repurposing operations there is one possibility to essentially reduce both the time to trade for new drugs and their costs.^[12]

8. Training

Artificial intelligence permits those to go through realistic models such that ordinary computer driven algorithms cannot. The emergence of natural language and the learning ability of an AI system to draw promptly on a huge database of situations, , implies the reaction to questions, decisions or recommendation from a learner can challenge in such a way that a human cannot. Furthermore, the preparation program can gain from past reactions from the student, implying that the difficulties can be persistently changed in accordance to fulfill their learning needs.

Also training can be accomplished everywhere; By means of AI installed on a cell phone, quickly catching up of lost sessions, complicated case in a healthcare center or while travelling, will be possible.^[12]

1.9 Future scope of AI in healthcare

We think that AI has a major part in contribution to healthcare in the future. The principal potential behind the progress of accuracy medication by means of machine learning is a much needed development in healthcare. In spite of the fact that efforts taken early at providing analysis and treatment suggestions have proved to be difficult, we assume that AI will eventually overcome that area too. Due to the fast advancement in AI for imaging investigation, it appears to be likely that most radiology and pathology pictures will be inspected sooner or later by a machine. Speech as well as text recognition are currently in use so far for functions like patient communication and their utilization will increase. The ultimate challenge to AI in these healthcare areas is not whether the innovations will be fully capable to be effective, but instead ensuring their adoption in day to day clinical practice. For large scale adoption to occur, AI systems require the approval from controllers, integrated with electronic health record (EHR) devices^[18], standardized to an adequate degree that comparable items work in the similar manner, educated to clinicians, paid for by open or private payer associations and upgraded from time to time in the field. These challenges will eventually be overcome however they will take lot of time to do so. The AI frameworks shall not substitute physicians widely, but on the contrary will enhance their efforts in caring of patients. Probably, the only medical professionals who will lose their position after some time might be the individuals who refuse to work with artificial intelligence. ^[1]

1.10 SUMMARY

The Artificial Intelligence marks the beginning of a trend that will be able to ease the load on overburdened healthcare system. There is an immense shortage of doctors, which is why AI can definitely prove to be essential and fruitful. The main aim of introducing AI into the healthcare system is to scale hospitals and doctors infinitely, and increase efficiency of doctors by 3-4 times in the near future so that they can see more patients. To make this possible, it is only technology that can help remove barriers of distance and time. Anyone with a smartphone can connect to a doctor if AI is introduced into the healthcare system.

In the coming years, with more innovative developments in AI it will serve as a major advantage for healthcare industry and also help to make the administration and applications of medical dosage more precise to control the unanticipated deaths and increase the reliability of patients in this technology.

1.11 REFERENCES

1. Thomas D, Ravi K, The potential for Artificial Intelligence in healthcare, Future Healthcare Journal, 2019 Vol 6, No 2: 94-8.
2. Nuffield Council on Bioethics, Bioethics briefing note: Artificial Intelligence (AI) in healthcare and research, 2018:1.
3. Susan Y. Tull, Paula E. Miller, Patenting Artificial Intelligence: Issues of Obviousness, Inventorship, and Patent Eligibility, The Journal of Robotics, Artificial Intelligence & Law, 2018 Vol 1, No. 5: 313.
4. Artificial Intelligence in medicine, Mendeley, 2018.
5. R. Sri Sai Shilpa, P. Amruth Sagar, Artificial Intelligence in Medicine: The Innovation Landscape, SciTech Patent Art Services, whitepapers
6. WIPO Technology Trends, Artificial Intelligence, 2019
7. <https://new.siemens.com/global/en/company/stories/industry/intelligentrobotics-siemens-aucma.html>
8. <https://www.gestalt.law/insights/artificial-intelligence-patents-for-healthcare>
9. S. Brayne, S. McKellar & K. Tzafestas, Artificial Intelligence in the life sciences & patent analytics: Market developments and intellectual property landscape, 2018; 1-101
10. Global market insights, Healthcare Artificial intelligence market share growth report 2019-2020; 1-120
11. Marketsandmarkets, Artificial intelligence in healthcare market, 2018; SE 5225
12. <https://www.pwc.com/gx/en/industries/healthcare/publications/ai-robotics-new-health/transforming-healthcare.html>
13. NITI Aayog, National strategy for Artificial Intelligence, GS SCORE-An institute for civil services; 4.
14. Sordo, Introduction to Neural Networks in Healthcare, OpenClinical 2002; 2:9
15. A. Vial, D. Stirling, M. Field, M. Ros, C. Ritz, M. Carolan, L. Holloway & A. A. Miller, The role of deep learning and radiomic feature extraction in cancer-specific predictive modeling: A review, Translational Cancer Research, vol. 7, (3), 2018; 803-816
16. A. Hussain, A. Malik, M. U. Halim, A. M. Ali, The use of robotics in surgery: a review, The international journal of clinical practice; 68; 1376-1382
17. Effective Altruism Foundation, Artificial Intelligence: Opportunities and Risks, Foundational Research Institute, 2015; 1-11
18. Tutorials point, Artificial Intelligence, Intelligent systems; 6-10

19. <https://plato.stanford.edu/entries/artificial-intelligence/>
20. <https://hbr.org/2018/12/using-ai-to-improve-electronic-health-records>
21. Keith Loria, Putting the AI in radiology, Radiology today, Vol.19 No.1 P.10; <https://hbr.org/2018/12/using-ai-to-improve-electronic-health-records>.
22. Erwin Loh Medicine and the rise of the robots: a qualitative review of recent advances of artificial intelligence in health, Faculty of medical leadership & management; 2018, 59-63.
23. Artificial Intelligence in Healthcare, eHealth initiative center, 2018; 1-7
24. Artificial Intelligence in healthcare, Mindfields: grow for tomorrow, 2018; 1-52
25. Ahmet İlker Tekkeşin, Artificial Intelligence in Healthcare: Past, Present and Future, Anatol J Cardiol 2019; 22: 8-9
26. Jiang F, et al. Artificial intelligence in healthcare: past, present and future, Stroke and Vascular Neurology, 2017; 230-243
27. Varun H. Buch, Irfan Ahmed, Mahiben Maruthappu, Artificial intelligence in medicine: current trends and future possibilities, British Journal of General Practice, 2018, Vol.68(668); 143-144

<i>Image Author -1</i>	<i>Author Name – Harjot S.Kathuria*</i> <i>Author Affiliation: Mpharm student Sandip Institute of pharmaceutical science, Nashik</i>
<i>Image Author -2</i>	<i>Author Name-Haridas A.Sangale</i> <i>Author Affiliation: Mpharm student Sandip Institute of pharmaceutical science, Nashik</i>
<i>Image Author -3</i>	<i>Author Name-Swati G.Talele</i> <i>Author Affiliation: Assistant professor Sandip Institute of pharmaceutical science, Nashik</i>
<i>Image Author -4</i>	<i>Author Name-Shweta S.Gedam</i> <i>Author Affiliation: Assistant professor Sandip Institute of pharmaceutical science, Nashik</i>
<i>Image Author -5</i>	<i>Author Name-Anil G.Jadhav</i> <i>Author Affiliation: Professor and Principal Sandip Institute of pharmaceutical science, Nashik</i>