An Elsevier Indexed Journal ISSN-2230-7346

Journal of Global Trends in Pharmaceutical Sciences

ARTIFICIAL INTELLIGENCE IN HEALTHCARE SYSTEM- A REVIEW

Tamilselvan Natrajan[1*], Reshma V B[2], Habibur Rahman [3] Vinesha Ravi [1]

[1]Department of pharmaceutics, KMCH College of Pharmacy, Coimbatore, Tamil Nadu, India
[2]Department of Pharmaceutics, Westfort College of Pharmacy, Thrissur, Kerala
[3]Department of Pharmaceutics, UCSI University, Malaysia

*****Corresponding author E-mail: tselvan24@gmail.com

ARTICLE INFO

Key Words

Healthcare systems, Artificial intelligence, Artificial neural networks

ABSTRACT

Artificial Intelligence (AI) is the buzzword of the millennium. The development of 'thinking' computer systems is the basis of AI. It is a shoot arising from computer science that is referred to as the computational tools which are capable of substituting human intelligence to carry out certain tasks and to solve complex problems. The term AI was derived from a Czech word robota that means forced labor biosynthetic machines. The invention of robots is the starting of AI. The AI history was started in ancient times in which the artificial beings and mechanical men appeared in myths, stories, and rumors. John McCarthy first introduced the term artificial intelligence in 1955, and defined it as, "the science of developing intelligent machines" and in 1956, he discovered the artificial intelligence field at Dartmouth College conference on artificial intelligence. There are different subfields in AI. One of the major subfields of AI is Machine learning (ML), which uses statistical methods with the ability to study with or without being specially programmed. The subfield of ML called deep learning (DL) utilizes artificial neural networks (ANN) that adapt and learn from the vast amount of experimental data. AI methods and applications have recently gained attention in many areas such as fields of medicine, mathematics, neuroscience, economics, engineering, linguistics, gaming, and many others. AI is a fast-growing and promising technology that reached in our day-to-day life and becoming an essential part of research in the science community. Moreover, researchers estimate that AI will become better than human beings in the future.

INTRODUCTION

Artificial intelligence (AI) or machine intelligence in medicine is the application of AI techniques and processes (automated) for disease diagnosis and its treatment. Data obtained by patient examination and through interviews can be gathered, analyzed and give more reliable results. The worldwide applications of AI are vast and rapidly growing. It is a branch of engineering and it involves the implementation of new concepts and novel solutions for resolving complex challenges. In the field of medicine, Intuitive Surgical, which is an American company, developed a surgical system and named as Da Vinci as an appreciation of his great contribution. Food and Drug Administration approved this innovation in 2000 and it is used for prostatectomy and gynecologic surgical procedures. It is also useful in cardiac valve repair.[1] First medical applications of AI predominantly occurred in the 1960s and

1970s. Complex biomedical problems can be solved specifically or clarified by AI methods. Four distinct ways of employing AI in medical space are: (1) Assessment of risk of disease onset and in estimating treatment success prior to initiation; (2) To reduce complications; (3) Patient care assistance during the active treatment or procedure phase; and (4) To elucidate the pathology or mechanism and the ideal treatment for a disease.[2] AI in medicine is associated with two major streams namely virtual and physical. To enhance learning through experience, virtual branch of AI mainly comprises Machine Learning (ML) which includes mathematical algorithms. To deliver care and help during surgery, the physical branch of AI possesses medical devices and advanced, sophisticated robots.[3] Proniosomes are considered as a potential carrier for control delivery of drugs through different routes, comparatively AI can also be considered as a promising component in healthcare system due to its application in various streams.[4] AI techniques are not new to medicine. Visual diagnoses are the major aspects in the field of dermatology which are well suited for AI. Most expectedly visual recognition tasks performed by physicians in radiology would be replaced by AI. In oncology, AI can also support mammography screening in the future. Millions of morphological datasets are obtained from digital images that can be analyzed fast and non-invasively using AI in the ophthalmology field. Convolutional neural network (CNN) is designed to map a set of Electrocardiogram (ECG) samples arranged in a particular pattern which can be used to detect cardiac arrhythmias. To enhance the effectiveness of the cardiologist AI and ML are applied in cardiology.[5]

Figure 1: Applications of AI in healthcare system

Ophthalmology: AI methods employed in the retinal disease analysis are diverse. The applicability, interpretability, and reliability of these methods are different. Screening of diabetic retinopathy (DR) can be done by fully automated and approved systems based on AI. Identification, localization, and quantification of pathological features of many retinal diseases are done by methods based on Machine Learning (ML) and Deep Learning (DL) Potential benefits of AI are personalized health care and large-scale management of ocular diseases based on prognostic conclusions and prediction. Machine learning classifies, segments, and predicts retinal images. The CNN classification model was trained for the classification of retinal images based on DL. For the successful implementation of AI in ophthalmology, it is very important to understand how it works in addition to its potential advantages and disadvantages. With a large patient image dataset, AI provides a unique way to analyze them and transform this information into a useful tool to make a clinical decision. Teleophthalmology was developed to detect retinopathy of prematurity (ROP), diabetic retinopathy screening and glaucoma screening.[6]

Radiology: Radiology is a medical specialty that uses medical imaging to diagnose and treat diseases within the human body. In the case of radiology, AI is useful for the diagnosis of stroke, white matter abnormality, and malignancies. One of the important applications of AI is in chest X-rays, which is used for the screening and diagnosis of many lung diseases. A collection of chest X-rays is stored in the picture archiving and communication systems of hospitals and read by the deep learning paradigm which involves recognizing and locating the common disease patterns. Better diagnostic accuracy can be obtained using this technology. Also, a large number of data can be processed within a short time.[7]

Cancer: Cancer may be a group of diseases characterized by abnormal growth of the cells with thepotential to invade or spread to other parts of the body. Cancer, infectious diseases and metabolic disorders are major causes of deaths worldwide. The aspects that make an individual liable to cancer are genetic

composition, environmental factors, lifestyle and ageing

Radiation Oncology [8]: AI applications in radiation oncology include:

- Segmentation of images,
- Optimization of radiotherapy dose,
- To support clinical decision,
- To predict outcomes,
- Cross checking

Esophageal Cancer: Esophageal cancer is the sixth most common reason for cancer-related death and it is the eighth most common cancer worldwide.[9] The prognosis of esophageal cancer is relatively poor and the early detection is very important. Through a CNN, deep learning was developed for the detection of esophageal cancer. CNN is an AI-based system used for the diagnosis of esophageal cancer which was trained using a huge number of Esophagogastroduodenoscopy (EGD) images. This CNN system can analyze previously stored endoscopic images with high sensitivity in a short time. The diagnostic accuracy increases with further training. This system can be used for the early detection of esophageal cancer leading to a better prognosis.[10]

Breast Cancer: The advances in AI algorithms have reduced the gap between human experts and computers in breast cancer detection by Digital mammograms (DM). Breast cancer detection and accuracy can be improved by implementing AI systems in digital mammography.[11] An analogical reasoning called Case-based reasoning (CBR) in which the solution for a new query case is obtained by utilizing a database of previously known cases with their solutions. CBR is being applied to many domains, including medicine. Cases are retrieved from the database which is similar to the query, and then their solutions are adapted to the query. To diagnose a particular disorder or a small number of close disorders, a medical CBR system can be used by the physicians. This method can also be applied to the management of breast cancer.[12]

Head and Neck Cancer: AI algorithms were initially applied for non-medical areas such as credit card fraud detection and product labeling. At present, these novel techniques are applied to solve problems involved in the head and neck cancer treatment planning like Intensity-modulated radiotherapy (IMRT) dose prediction, clinical decision support, automated treatment planning, outcome modeling and auto segmentation for patients.[13] IMRT treatment planning for head and neck cancer is a lengthy procedure and it requires a group of highly trained clinical experts. The three main types of volumetric dose determination techniques include: Atlas-based, CNN, Fully connected neural networks.

Although many challenges exist in this field, there is a bright future for artificial intelligence in IMRT treatment planning.[14]

Urinary Tract Infection (UTI): It mainly affects the urinary system. It occurs in bladder, kidneys, urethra, etc. The urinary tract inflammation is a cause of UTI. The routine examination procedures are not sufficient to diagnose UTI. The infection is caused by bacteria *E.coli* that reaches the bladder from the urinary tract.[15] The AI methods are of four, namely Decision Tree (DT), Support Vector Machine (SVM), Random Forest (RF) and Artificial Neural Network (ANN). These methods are applied widely for diagnosing diseases. Among these, highly accurate results were given by ANN in diagnosis of UTI. An information processing system called ANN inspired by biological neural networks. ANN has some performance characteristics similar to biological neural networks.[16]

Ulcerative Colitis (UC): Ulcerative colitis is an inflammation (irritation and swelling) of large intestine or colon and the forms ranges from mild to severe. Patients with UC are at higher risk of developing colon cancer. Identification of UC is very difficult by using conventional endoscopy. Here, computer-aided diagnosis systems were introduced. Quality of gastrointestinal endoscopy improves by implementing CAD systems. Neural networks give very sensitive readings and will be more accurate.[17]

Cardiology: AIand machine learning tools enhance the capability of the cardiologist. The patient care decisions made by the cardiologists are having more important compared to many other specialties and the availability of rich quantitative data is necessary. The best way of making decisions is based on the data which is obtained by the application of techniques drawn from AI. The cardiologists can add AI and ML into the clinic for the interpretation of more data with high accuracy.[18] Extremely large datasets in cardiology are difficult to analyze manually and is time consuming and can be done by big data analytics. In heterogeneous syndromes like heart failure, cardiomyopathy, hypertension (HTN) and coronary artery disease, the new genotypes or phenotypes are detected that leads to targeted and personalized therapy.[19]

Chest radiograph interpretation: A is also applied for interpreting chest radiographs in various clinical conditions. AI can be applied in two important areas, such as Tuberculosis (TB) and pneumonia. Machine learning is a technique applied to diagnose pneumonia. Lung parenchyma is automatically separated or segmented into different regions which is necessary for analyzing chest radiographs by using AI. Images can be recognized with the help of convolutional neural networks (CNN). Several algorithms were designed to identify pathology and also to localize abnormalities on chest radiographs. TB screening is done by chest radiograph interpretation both in patients with symptoms of respiratory infection and in patients without any symptoms but have positive purified protein derivative (PPD) tests.[20]

Infectious diseases: The data sets that are very complex and extensive are difficult to analyze by traditional data processing methods. The rodent reservoir of future zoonotic diseases can be identified by AI methods. The prediction of Extended-spectrum b-lactamase (ESBL) producing organisms can be done by these methods. It also helps to control the outbreaks of TB and gonorrhea disease. AI methods can be developed for infectious diseases that help predict the spread of diseases with high accuracy. Appropriate response measures can be taken by the authorities timely against infectious diseases. The extensive infectious disease and surveillance data can be analyzed more efficiently by reliable data management using AI methods. This can help to prevent diseases and to treat patients in the future.[21]

Dentistry: As in all the other fields, AI also plays a key role in dentistry. From locating for implants, to endodontics, surgical precision, determining the bone type and thickness of cortical can be successfully applied.[22] As the other parts of dentistry like the operating chairs, surgical tools have seen enormous advancement, while AI can make works simpler by assisting in acquiring patient's data, imposing a promising treatment protocol, and efficient diagnosis. Apart from treatment and diagnosis, AI also aids in forensic odontology for identifying the age by dental age determination. Fusion of AI with designing software can help the dentist in designing perfect prostheses. The recent CADCAM Technology produces two-dimensional and three-dimensional models that can potentially replace conventional casting and be a time saving, less laborious process.[23]Along with digitalization, AI has also enabled effective learning among students and creating awareness about oral health and maxillofacial diseases.[24]

Orthopaedics: It is obvious that AI is involved in orthopedic surgeries. This could lend a hand in carrying out surgeries with high precision. Computer Assisted Orthopaedic Surgery (CAOS) is one such modern tool of AI. With additional facilities like mature technology and robotic support, it has results in more accurate and better outcomes. It is successfully being applied in spinal surgeries, arthroplasty and oncology.[25]Accurate analysis of the skeletal radiographs, Treatment and co-ordination, surgical training, better performing of robot-assistedorthopaedics surgery remain valuable advantages.[26]

Psychiatric disorders: Severe brain researches are being carried out around the globe to implement AI in psychiatric disorders. The complexity of the disorder lies within its etiology which remains undiscovered completely. Incorporating AI

algorithms in diagnostic techniques like Support vector machines, Bayesian model are being highly appreciated.[27]

Neurocritical care: Neurocritical care revolves around handling critical diseases and disorders. The most critical drawback in treatment is the threat of brain damage. Two methods of AI are being incorporated in neurological treatments. This includes model-based method and data driven method. They enable one to study a wide range of patient data and alter the prospective of physician's judgement, minimize expenses and errors.[28]

Plastic surgery: AI has a major advantage of minimum human involvement due to which it is being employed in plastic surgeries. AI can provide better surgical care, craniofacial surgery, burn treatments, wound care, microsurgeries, diagnosis, etc. Machine Learning is supporting vital requirements like data collection, patient assessment, surgical planning and outcome assessment.[29]

CONCLUSION

The clinical diagnosis of a disease and treatment decision can be done by computer techniques in the field of medicine. In a dataset, AI is also useful in the detection of meaningful relationships and has been applied for diagnosis, treatment, result prediction and, many other clinical problems. The higher we unify and digitize medical data, the higher we can apply AI to obtain beneficial information. The advances in AI systems and researches in health care may have the ability for transforming the disease diagnosis and its treatment. AI systems can help the physician to provide appropriate treatment to the patient at correct time. AI techniques are not only used in medical field, but also in many other areas.

Acknowledgment: Authors would like to thank KMCH College of Pharmacy, Tamil Nadu, India and The Tamil Nadu Dr.M.G.R Medical University for providing the science direct access to carry out this review.

Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Hamet P, Tremblay J. Artificial intelligence in medicine. Metabolism. 2017;69.
2. Becker A. Artificial intelligence in medicine: What is it doing for us today?. Health Policy and Technology.2019; 8(2): 198–205.
3. Londhe VY, Bhasin B. Artificial intelligence and its potential in oncology. Drug Discovery Today.2019; 24(1): 228–32.
4. Maryam Khatoon, Shah KU, Din FU, Shah SU, Rehman AU, Dilawar N, Khan AN.Proniosomes Derived Niosomes:Recent Advancements In Drug Delivery And Targeting. Drug Delivery. 2017; 24: 56-69
5. Schmidt-Erfurth U, Sadeghipour A, Gerendas BS, Waldstein SM, Bogunovic H. Artificial intelligence in retina. Progretin eye res. 2018; 67: 1–29.
6. Kapoor R, Walters SP, Al-Aswad LA. The current state of artificial intelligence in ophthalmology. Survey of Ophthalmology.2019: 64(2): 233–40,.
7. Jalal S, Nicolaou S, Parker W. Artificial Intelligence, Radiology, and the Way Forward. Can AssocRadiol J.2019; 70(1): 10–12.
8. Thompson RF, Valdes G, Fuller CD, et al. Artificial intelligence in radiation oncology: A specialty-wide disruptive transformation? Radiotherapy and Oncology. 2018; 129(3): 421–26.
9. Liang, He. Epidemiology, etiology, and prevention of esophageal squamous cell carcinoma in China. Cancer biology & medicine. 2017;14(1): 33-41.
10. Horie Y, Yoshio T, Aoyama K, *et al.* Diagnostic outcomes of esophageal cancer by artificial intelligence using convolutional neural networks. Gastrointestinal Endoscopy. 2019; 89(1): 25–32.
11. Rodriguez-Ruiz A, Lang K, Gubern-Merida A. Stand-Alone Artificial Intelligence for Breast Cancer Detection in Mammography: Comparison with 101 Radiologists.

JNCI: J Natl Cancer Inst. 2019; 111(9): 222.
12. Lamy J-B, Sekar B, Guezennec G, Bouaud J, Seroussi B. Explainable artificial intelligence for breast cancer: A visual case-based reasoning approach. Artifintell med. 2019; 94: 42–53.
13. Wang, Chunhao.Artificial Intelligence in Radiotherapy Treatment Planning: Present and Future. Technology in cancer research & treatment. 2019; 18.
14. Kearney V, Chan JW, Valdes G, Solberg TD, Yom SS. The application of artificial intelligence in the IMRT planning process for head and neck cancer. Oral Oncology. 2018;87: 111–6.
15. Flores-Mireles, Ana L. Urinary tract infections: epidemiology, mechanisms of infection and treatment options.Nature reviews. Microbiology. 2015; 13(5): 269-84.
16. Ozkan IA, Koklu M, Sert IU. Diagnosis of urinary tract infection based on artificial intelligence methods. Computer Methods and Programs in Biomedicine.2018; 166: 51–9.
17. Maeda Y, Kudo S-E, Mori Y. Fully automated diagnostic system with artificial intelligence using endocytoscopy to identify the presence of histologic inflammation associated with ulcerative colitis (with video), Gastrointestinal Endoscopy.2019; 89(2): 408–15.
18. Johnson KW, Soto JT, Glicksberg BS. Artificial Intelligence in Cardiology. J Am CollCardiol, 2018; 71(23): 2668–79.
19. Krittanawong C, Zhang H, Wang Z, Aydar M, Kitai T. Artificial Intelligence in Precision Cardiovascular Medicine. J Am CollCardiol, 2017; 69(21): 2657–64.
20. Kallianos K, Mongan J, Antani S. How far have we come? Artificial intelligence for chest radiograph interpretation. Clinical Radiology. 2019; 74(5): 338–45.
21. Wong ZS, Zhou J, Zhang Q. Artificial Intelligence for infectious disease. Big Data Analytics, Infection, Disease & Health. 2019; 24(1), 44–8.
22. Deshmukh SV. Artificial intelligence in dentistry.J Int Clin Dent Res Organ. 2018; 10:47-8.
23. TejaswiKatne. Artificial intelligence: demystifying dentistry – the future and beyond. International Journal of Contemporary Medicine Surgery and Radiology. 2019; 4(4):D6-D9.
24. Sunali S Khanna, Prita A Dhaimade. Artificial Intelligence: Transforming Dentistry Today. Indian Journal of Basic and Applied Medical Research. 2017;6(3): 161-167.
25. F. Picard, A.H. Deakin and P.E. Riches.Computer assisted orthopaedic surgery: Past, present and future. Medical Engineering and Physics. 2019; 72:55–65.
26. Haleem A. Artificial Intelligence (AI) applications in orthopaedics: An innovative technology to embrace. Journalof Clinical Orthopaedics and Trauma. 2019
27. G.-D. Liu, Y. C. Li, W. Zhang et al. A Brief Review of Artificial Intelligence Applications and Algorithms for Psychiatric Disorders.Engineering. 2019
28. Fawaz Al-Muftia. Artificial intelligence in neurocritical care. Journal of the Neurological Sciences.2019; 404: 1–4.
29. Joseph M Firriolo. Artificial Intelligence in Plastic andReconstructive Surgery: A Systematic Review. J Am Coll Surg.2019; 229. 4(1):S219–S220.