Chapter

Artificial Intelligence in Healthcare: An Overview

Syed Shahwar Anwar, Usama Ahmad, Mohd Muazzam Khan, Md. Faheem Haider and Juber Akhtar

Abstract

The healthcare industry is advancing ahead swiftly. For many healthcare organizations, being able to forecast which treatment techniques are likely to be successful with patients based on their makeup and treatment framework is a big step forward. Artificial intelligence has the potential to help healthcare providers in a variety of ways, including patient care and administrative tasks. The technology aims to mimic human cognitive functions, as it offers numerous advantages over traditional analytics and other clinical decision-making tools. Data becomes more precise and accurate, allowing the healthcare industry to have more insights into the theranostic processes and patient outcomes. This chapter is an overview of the use of artificial intelligence in radiology, cardiology, ophthalmology, and drug discovery process.

Keywords: artificial intelligence, algorithms, healthcare, radiology, cardiology, drug discovery

1. Introduction

In the field of healthcare, Artificial Intelligence (AI) is the privilege to breathe. It's a maneuver of the algorithm for the purpose of diagnosis, prognosis, or treatment of certain diseases. AI is the convergence of human and machine learning. John McCarthy, one of the founding fathers of AI, defined it as "the science and engineering of making intelligent machines" [1]. In this current era, intelligent machines pertain in various domains like financial, automatic driving, smart home, etc. In healthcare, machine learning is widely used to build automated clinical decision systems and in the treatment of different diseases [2]. AI utilizes advanced algorithms to learn from healthcare data and assist healthcare professionals in clinical practice. It has self-correcting and learning capabilities to cope with its exactness based on analysis [3]. AI can detect the spread of endemics by tracking animals and plant diseases and by accessing global airline ticketing data that are when and where the infected residents are moving and detect when an endemic can become a pandemic. The advancement in AI and its caliber to imitate human intelligence is heading towards the passing of Turing test [4] and AI will have a major impact on the forthcoming industrial revolution [5].

1.1 History/evolution

AI is the ray of computer science that deals with counterfeit intelligent human behavior. Using an electric circuit, Dr. Warren Mculloch and Dr. Walter Pitts [6] described neuronal activity and their modeling and explained the notion of neural networks. AI was first coined at Dartmouth college conference in 1956 [7] and the primitive work of AI was recorded in the 1970s after 15 years of existence of AI. The dendral experiment was the early employment of AI in life science [8]. The interpretation of electrocardiogram (ECG) stepped from 1970 to 1990 is considered as a major development in the field of AI [9]. A clinical decision support system was developed during the 20th century [10, 11]. However, the eagerness about AI was at its peak during the 1980s, but the phenomena of "AI winter" occurred due to groundless forecasting by the observers led to a lack of funding and interest [12]. There was continuous progress in building artificial intelligence in mid-20s by improving the algorithm and feeding the huge data of healthcare and its intelligence makes it cognizance of assisting the clinical cases of patients with the support of healthcare professionals. The renaissance of AI happened in 2012 after the evolution of image classifiers [13] and incorporation of AI in patients treatment needs to be trained on the basis of large data of clinical case studies so that it can examine the patient condition on the basis of history and the data which it has and results in diagnosis and in treatment methodology. The devices which favors in the department of healthcare are trained through machine learning. Basically, machine learning makes computer learn by the provided data i.e. algorithm in great measure [14, 15]. Supervised and unsupervised machine learning are two paradigms of machine learning [16]. Supervised machine learning classified the large data result and separate it into different categories and also predicts the result i.e. regression. In unsupervised machine learning there is no result prediction and it conglomerates the results [17].

The proof of AI and its concept has been demonstrated since older times. The history has been recorded with such minds related to the AI and executed their intellections and till today there are a new development, researches, and inventions going on in the field of AI and its application in different branches of healthcare.

2. Applications in healthcare industry

AI has proliferated its roots in the noble profession of healthcare. There is a boom in the use of AI, from detection of pulse rate to cancer detection and therapy consultation, from complete medical history to health monitoring to maintain and analyze the healthcare system. It is a helping hand in drug discovery and drug creation database and all this is implemented by the use of the algorithm and deep neural network.

Currently, AI is being used in various healthcare departments like radiology, cardiology, hematology, ophthalmology, and also in the management of various diseases.

2.1 AI in cardiology

AI in cardiology assists healthcare professionals in detecting the changes in normal heart functioning and helping in making a clinical decision. ECG is also a contribution of AI. There are various devices that are used in the monitoring of heart rate, blood pressure, tachycardia, bradycardia, stroke, and atrial fibrillation which works on the algorithm and deep neural network. These devices are

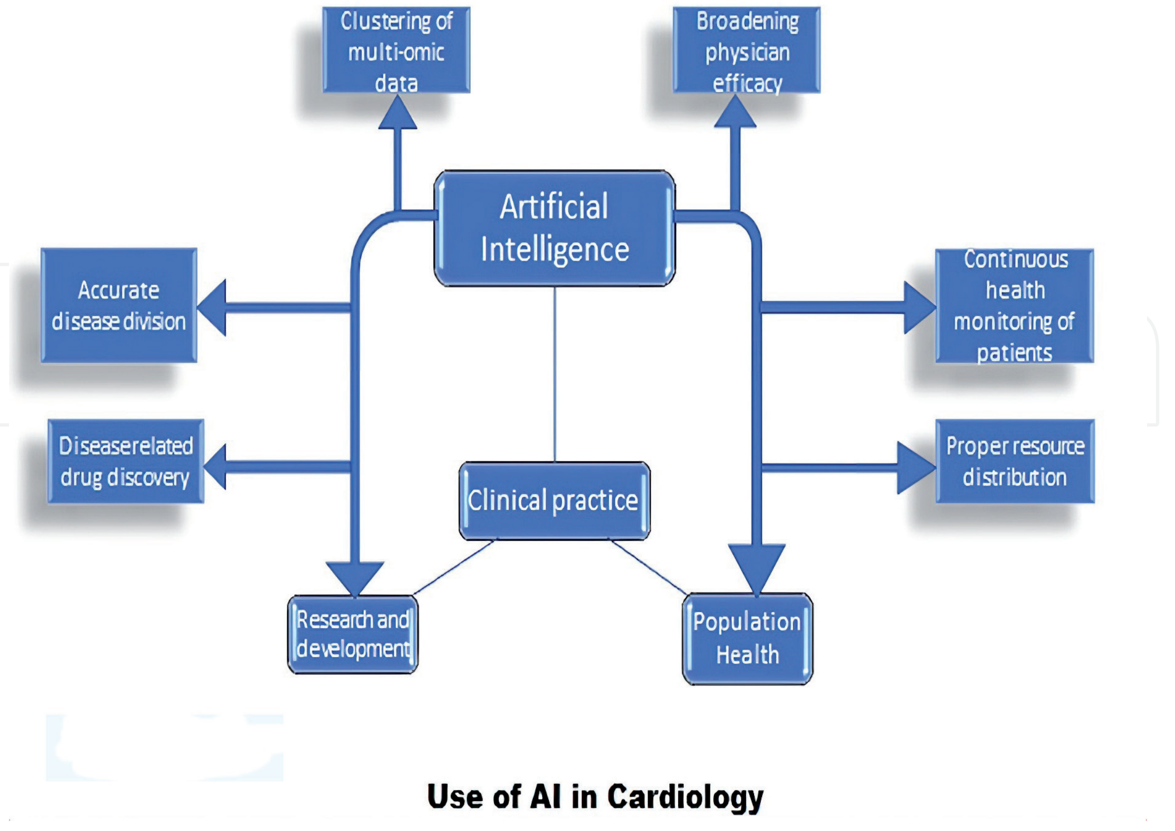

Figure 1.
Use of artificial intelligence in cardiology.

user-friendly and alarm the individual who is using them. Wearables that detect biological activity also work on the same principle [18]. A schematic representation of the use of AI in cardiology is given in **Figure 1**.

2.2 AI in radiology

AI and radiology together have brought a drastic change in the field of healthcare. The dawn of the application of AI in radiology was since 1960s [19]. Medical imaging in the detection and diagnosis of diseases is the widest use of machine learning in the field of healthcare [20]. CT scans, MRI, tomography, X-Ray are used algorithms in radiodiagnosis. The machines detect and pinpoint the changes on the basis of large data by which the neural network has been trained. The AI in radiology is applied for the detection of breast cancer at an early stage by mammography scans [21, 22] and tumors, tuberculosis, or diseases related to lungs with chest radiography [23–27]. A schematic representation of clinical radiology workflow is given in **Figure 2**.

2.3 AI in ophthalmology

In ophthalmology AI is tremendously used in detection and monitoring of diabetic retinopathy [28–33], glaucoma [29, 34, 35], age-related macular degeneration (AMD) [29, 36, 37], retinopathy of prematurity (ROP) [38] with the help of retinal cameras of fundus photography [16]. The diagnosis of ocular diseases is based on the deep learning system that is trained on the numerous images of each disease. A study of the population with diabetes from US, Australia, Europe, and Asia in the years between 1980 to 2008 shows the frequency of diabetic retinopathy of 34.6% and 7% vision-threatening diabetic retinopathy [39]. Thus, continuous monitoring along

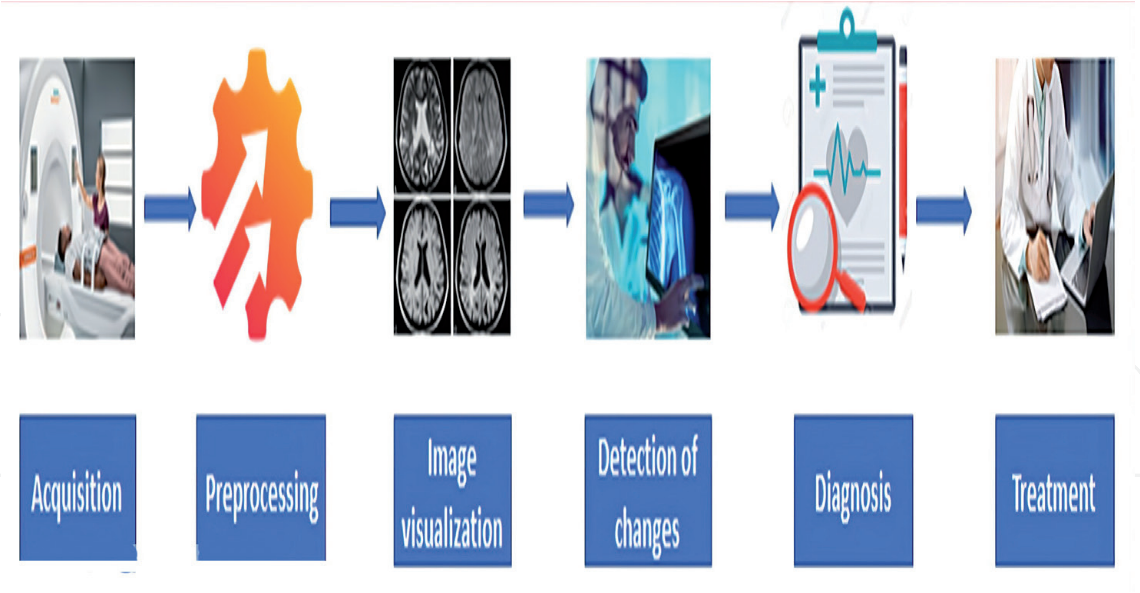

Figure 2.
Clinical radiology workflow.

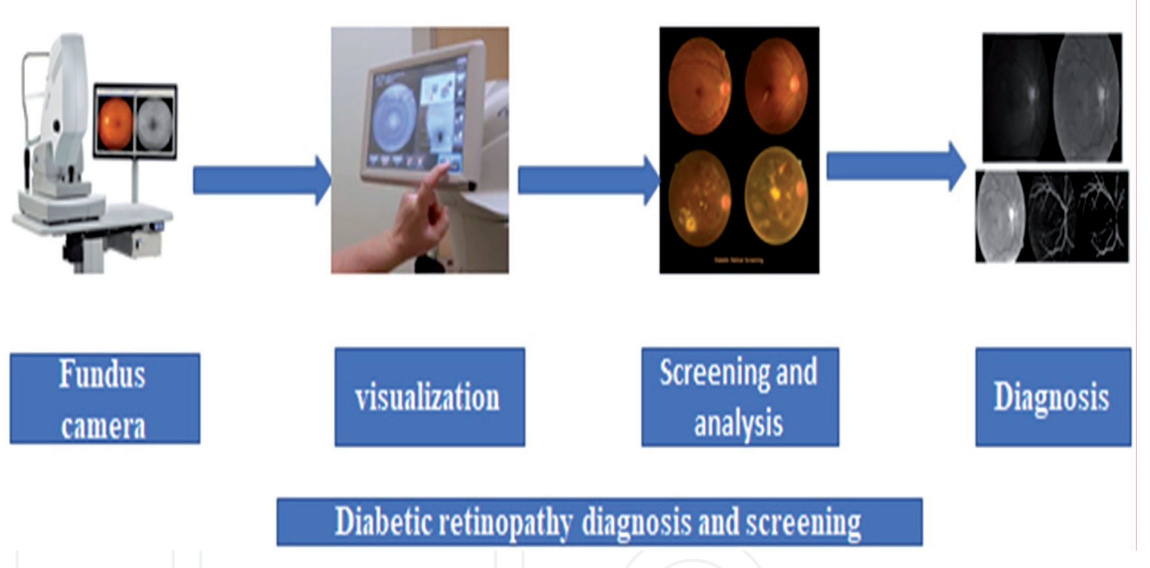

Figure 3.
Use of AI in diabetic retinopathy diagnosis and treatment.

with the treatment can prevent vision loss. A schematic representation of the use of AI in ophthalmology is depicted in **Figure 3** [40].

Machine learning models such as visual fields, optical coherence tomography (OCT), and optic disc characters are used for the diagnosis of glaucoma [41]. Glaucoma is a medical condition in which the intraocular pressure inside the eye rises up. Age-related macular degeneration (AMD) is a condition in which there is degeneration in the center of the retina and is responsible for vision loss. Spectral OCT is used in the diagnosis of AMD [42]. Retinopathy of Prematurity (ROP) is a disease that occurs in premature born babies and the leading cause of childhood blindness due to abnormal growth of blood vessels towards the edge of retina. Wide-angle retinal images with machine learning [43] and i-ROP DL system which works on the basis of convolutional neural network (CNN) was trained on the images more than 5000 in number with a single standard reference diagnosis (RSD) [44] for the diagnosis of ROP.

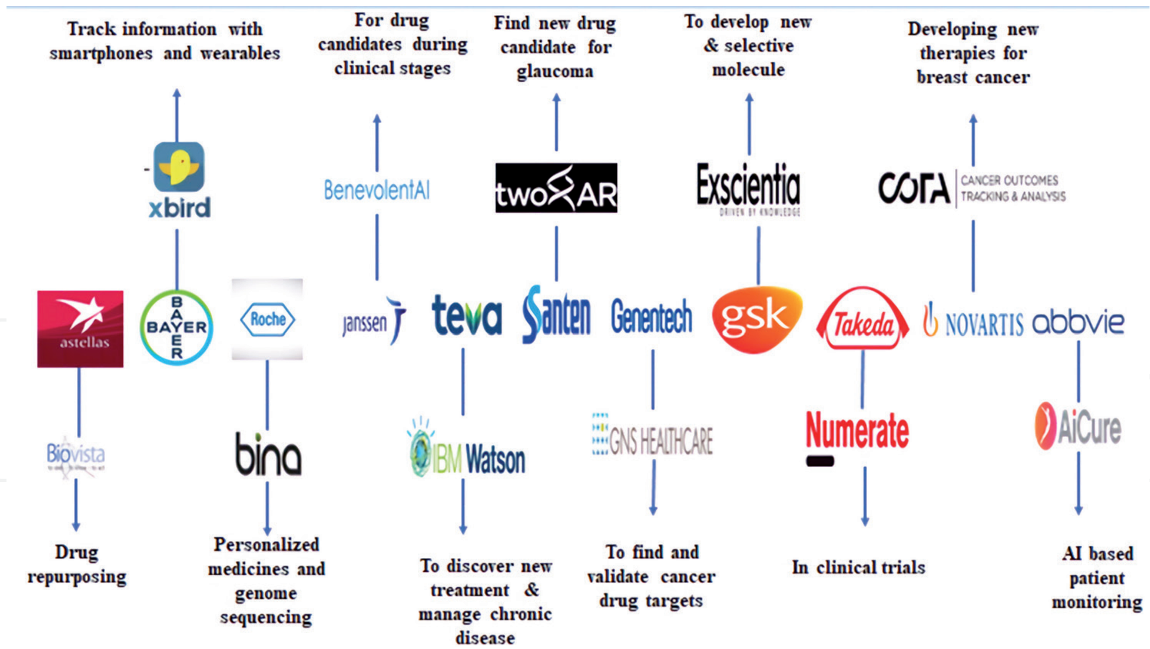

Figure 4.
Biopharmaceutical companies using AI technology in drug discovery.

2.4 AI in drug discovery

In this modern era, AI is used for drug discovery and drug design on the basis of artificial neural network (ANN), algorithm, and deep learning. In drug discovery, inaugural employment of ANN was in 1970 to detect whether the 1,3-dioxane is physiologically active or not [45]. The application of ANN in Quantity Structure Activity Relationship (QSAR) is the next stage in the field of drug discovery [46]. QSAR studies were involved in drug design since 1960 by involving the simple structures to know the activity of the combination of compounds [47] Currently the biological and physicochemical activity i.e. ADMET (Absorption, distribution, metabolism, excretion, and toxicity), binding constants according to their binding sites are also vaticinated using ANN which is trained on various sets of compounds in the field of drug discovery [48] The application of AI is at every step of the drug discovery process, from identification of drug targets to new drug molecule research following its volunteer election for clinical trials [49–51] also its pharmacological property [52], its binding effect with protein, potency and synergistic effect with other drugs [53, 54]. Docking software which is used to find the perfect binding molecule for the particular receptor and its activity also works on the algorithm. AI has simplified the process of drug discovery by saving time and money expenditure of US$2.5 billion on R&D [55]. Thus, AI has routed the drug discovery process into simpler, quicker, and cost-effective, an example of drug discovery is by BenevolentBio which has its own AI platform and was asked to suggest the treatment of amyotrophic lateral sclerosis (ALS) also called as motor neuron diseases (MND) and has displayed nearly 100 of drugs, five drugs were selected out of which four of them were effective and one was showing delayed neurological symptoms on mice [56]. The top multinational biopharmaceutical companies have started using AI technology in their drug discovery (**Figure 4**) [57].

3. Conclusion

Artificial intelligence is an important and valuable technology that offers promising solutions to healthcare industry needs. It opens up gateways to individualized treatment approaches tailored to the needs of individual patients. It offers multiple advantages over traditional analytics and other clinical decision-making tools. Data becomes more precise and accurate allowing the healthcare industry to have more insights into the diagnosis and treatment processes thereby improving patient outcomes.

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