Chapter

Types of Artificial Intelligence and Future of Artificial Intelligence in Medical Sciences

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Abstract

Artificial intelligence (AI) is the machine-based approach for processing various communications and data in computers for defining their actions in future performances. Different types of machine learning are described in medical sciences for proceedings in medical education, medical research, and clinical trials and in treatment of the diseases after appropriate diagnosis. These require less time and efforts of medical professionals and bring a more efficient way to fulfill the standards of medicine. The clear understanding of the workforce accomplishments is required for the future doctors to perform well, alongside the AI. Awareness of AI in the field of medicine is needed for general population to give them an idea for utilization of all new technologies, thus enlightening the feasibility of machine learning at consumer level as well. In future, AI will enhance the efficiency and effectiveness of healthcare delivery in all sectors of medicine and surgery.

Keywords: artificial intelligence, future medical science, healthcare, medical education, medical research, robotic surgery

1. Introduction

Artificial intelligence, AI, is the process of developing perspicacious machines from already existing statistics and data. Past experiences of the different events are learned by these machines to perform human like activities including decision making on their own. This type of complicated technique can be used in almost every sector of the societies like transportation, healthcare, banking, and entertainment [1].

An English mathematician, computer scientist and theoretical biologist, Alan Turing, has been widely considered to be the father of Artificial intelligence. Term artificial intelligence was first coined in the Dartmouth college conference, in 1955. AI program MYCIN was the first use of AI in medicine, developed to identify the treatments of blood infections, in 1970s [2, 3].

Here authors describe various types of AI and role of this machine-based technology in medical sciences along with future perspective of AI for the budding doctors.

2. Methodology of the chapter

The wide range of classifications have been described in different researches [4–7]. We have classified AI based on the need in medical sciences. The aim of present classification is predominantly focused on the understanding of this evolving technology for the scholars of the medical field and the clinicians [8]. This method of categorization makes AI easy to understand to all the personnel concerned with their practices in every sector of the medicine.

To explore the future of AI in medical sciences various scholars in their study had focused individually on the criteria of medical education [9], innovations and researches [10], and disease diagnosis and treatments [11, 12]. Here, we have incorporated all the research details collectively and analyzed them for further use at multi-disciplinary level. Publications of AI on medical curriculum and research were few in comparison to the AI discussions on diagnostic methods and treatments of the diseases.

Here in this chapter, importance of AI in medical curriculum and innovative research are also stressed, along with the use of AI in delivery of medical services. Key word 'artificial intelligence' was used to search references on PubMed and on Google. Further literature was procured by exemplification of primary articles.

3. Types of artificial intelligence

Artificial intelligence in medical sciences is divided into two main categories [8]:

- Virtual
- Physical

3.1 The virtual component

Machine learning delineates the virtual part, which helps to control health management systems by electronic records of health and actively guides the physicians for decision making. It is a neural network-based system using deep learning of information for different approaches of the clinicians. This machine learning or deep learning has three types of mathematical algorithms (**Table 1**).

S.No	Type	Applications
1	Unsupervised learning	Previously undetected patterns are grouped in a logical way
2	Supervised learning	Previous existing patterns are used to compare the given samples
3	Reinforcement learning	Machine learns from its own experiences
		Model based- advanced control of the planning from the learning
		Value based- deep networks represent the functions
		Policy based- more complex neural networks exemplify the functions

Table 1.
Virtual component of artificial intelligence.

- Unsupervised learning (UL)
- Supervised learning (SL)
- Reinforcement learning (RL)

3.1.1 Unsupervised learning (UL)

Unsupervised learning identifies the patterns that are undetected previously. Machines classify them without any guidance from any source. It groups the information in a logical way after comparing and categorizing the unlabeled data, thus performs more complicated process compared to other forms of deep learning. UL is an auto-correction technique based on interpretation and identification to amend the issues of unpredictability. A more commodious AI aid can be developed by taking unsupervised learning principles to ameliorate the effectiveness and precision of health systems. Priority for the health in new generations causes a great number of clinicians to focus specifically on the use of UL to upgrade the efficiency of applications in medical sciences [4].

3.1.2 Supervised learning (SL)

Supervised learning uses the already existing labeled data to generate the correct conclusions from the samples given. Machines becomes more accurate to give conclusions as number of the samples increases. Machines in SL have already been trained by the previously labeled correct and appropriate input data. This data input helps the machine to further plan a correct output when new unsolved tasks are subsequently given to it. Various algorithms and computational methods are used in SL techniques. Some frequently used learning methods in SL are Neural Networks, Naïve Bayes, Linear Regression, Logistic Regression, Support Vector machine, K-nearest neighbor, and Random Forest for accurate data predictions [5].

3.1.3 Reinforcement learning (RL)

Reinforcement learning is the science of creating verdict, which is akin to the process that appeared previously to focus in animal behavioral psychology. In this deep learning method, positive and negative reinforcement plays a key role to give reward for machine learning. Unlike supervised learning, in RL, machine is always bound to learn from its own experiences and does not use already labeled correct data for any favorable outcome (**Figure 1A**). RL gives output based on its own exploration of data with a balance between scrutiny of a given data and exploitation of the basic knowledge of machine for that data [6].

Three main approaches are there to apply in Reinforcement Learning [6]: policy based, value based and model based (**Figure 1B**).

3.1.3.1 Policy based

Policy is the core element of RL. Policy of RL has been made when an agent's behavior at a particular time mapped by the machine and perceived by the environment.

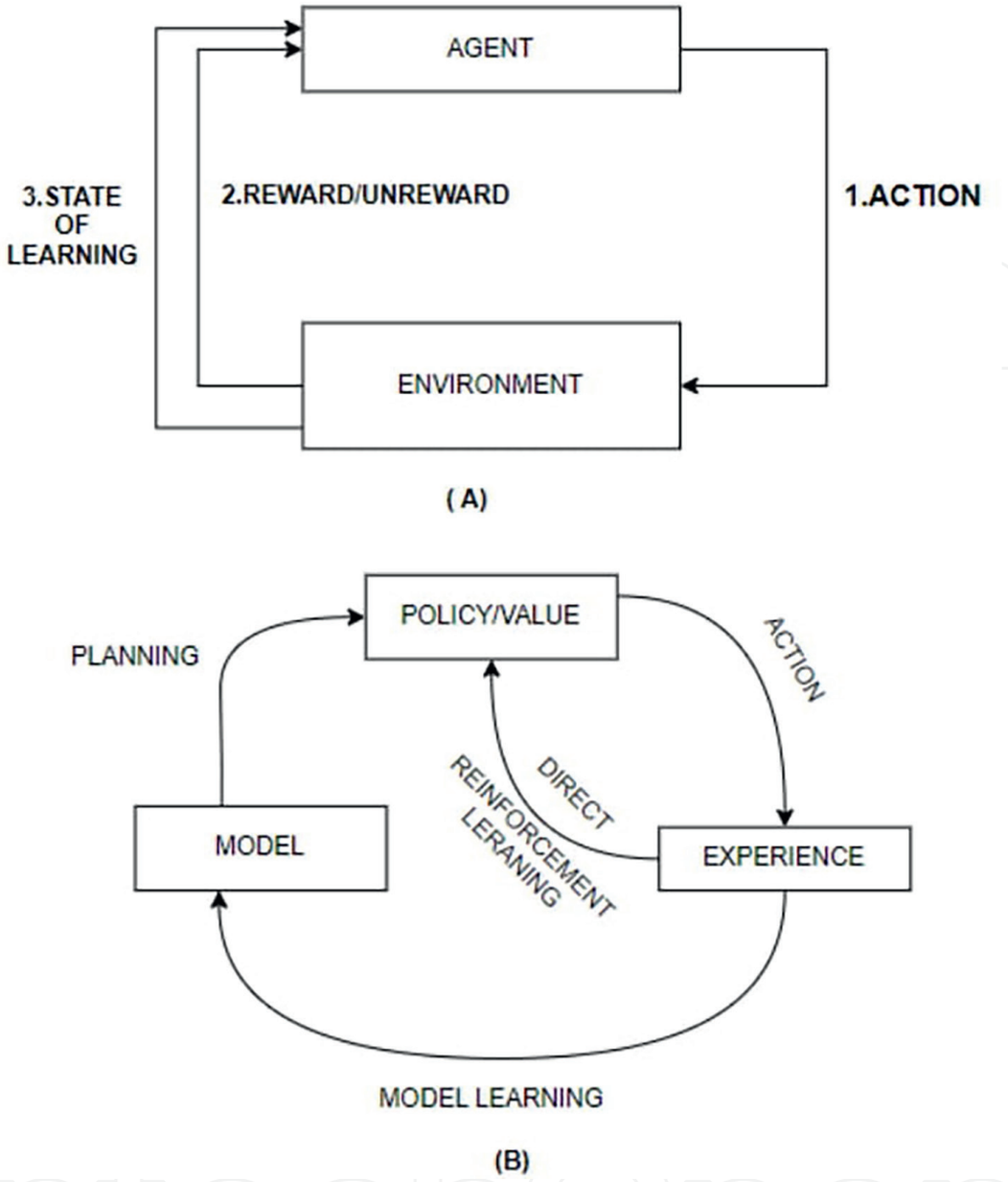

Figure 1.
Reinfiorcement learning. (A) Steps of reinfiorcement learning. (B) Model based, value based, and policy based reinfiorcement learning.

3.1.3.2 Value based

Value based approach gives an idea about the favorable and unfavorable situations to reward or un-reward the agent and depends on the signals for all good and bad steps. It predicts value of a behavior when measured by reward, whereas it counts no value when behavior has been finalized without any reward by the machine.

3.1.3.3 Model based

Model based approach is especially useful for further planning of the ways to take the set of tactics in consideration with all the future circumstances. It acts to make machines in learning process with a goal of having forward thinking in deep learning.

Complex objective after many steps can be attained by these neural network-based learning [6].

3.2 The physical component

Robots, nanorobots, physical objects, medical equipment and many futuristic robots meant to deliver proper care to the patients, come under physical components of AI (**Table 2**). They assist to perform surgeries and help handicapped and aging population to deal with day-to-day challenges in their life [2].

Diagnosis of a disease is frequent and time draining process due to applications of various diagnostic procedures and their interpretation by a limited number of expert doctors. It brings the medical fraternity under a lot of stress for saving the patient's life within limited initial golden hours of the treatment. Digitalized automatic diagnosis of diseases by complex algorithms of machine learning makes a cost effective and time saving measure for doctors as well as for patients. Standard algorithms for diagnoses can benefit consistently with the main quality of their universality in the form of assessment with same team of top experts globally on a low price and within seconds. AI also provides treatment alternatives for the specific diseases, which have been diagnosed by the machines [13].

Earliest detection of impending autism in children can be detected by the eye tracking technology in psychiatry [13]. Robotic characteristics of communication and teaching have created the most impressive example of AI utility in autistic children in future [14–16]. Facial emotion recognition (FER) is a separate area in AI to analyze patient's emotions by comparing images with the available database in the system. This systematic database has already been fed with the patient's data, who had undergone with the same disorders and treatments [13].

Robotic systems which can be used in surgeries are robotic surgery, computer assisted surgery and robotically assisted surgery. Open surgeries have now been improved in the form of minimally invasive surgeries when they are assisted by robots. Tele manipulator devices provide the possibility of distant surgeries in the areas where no surgeons are available. A remote control, governed by the doctor, potentiates the real surgeries on patients without the presence of specialist surgeon on the site of operation [13].

S.No	Type	Applications
1	Digital devices	Early detection of some diseases (autism, stroke, lung cancers, neurological malignancy)
		Digital diagnosis
		Care of elderly people
		Treatment of autism
2	Robots, nano robots, remote control devices	Robotic surgeries
		Computer assisted surgeries
		Remote surgeries
		Robotic solo performance

Table 2.
Physical component of artificial intelligence.

Da Vinci surgical system and AXSIS robot of the Cambridge advisors are well acquainted robots in surgery [13]. Da Vinci surgical system is commonly used for gynecologic surgeries and for prostate surgeries. Cardiac valve repair is the newer and propitious development by this machinery system. Most recent forms of robotic devices are highly evolved to give solo performance in advanced surgeries [14–16].

Benign and malignant tumors of the central nervous system and lung cancer detection by low dose computer tomography (LDCT) for high-risk individuals are some other applications of AI in medicine. Support vector machine (SVM) and convolutional neural network (CNN) are expert machinery system for identification and classification of stroke even before the episode of stroke. Direct analysis of stroke can be notified to the hospital team with in minutes. It helps the clinicians for early detection and treatment of such a medical emergency causing brain damage of the patient if there is any delay in the treatment [13]. Robots also has become promising to take care of elderly individuals and are becoming most emerging medical devices to help aging population on their own [14–16].

4. Future of artificial intelligence in medical sciences

Medical science enfolds various courses which describe the anatomy and functions of human body. Basic biology like anatomy, physiology, and biochemistry with many other graduate subjects in medicine come under medical sciences. Today, AI technology and machine learning (ML) have developed ahead of biological sciences to apply on a vast majority of medical specialties such as radiology, screening, psychiatry, primary medical care, diagnosis of the disease and telemedicine [17, 18].

Future of AI in medical sciences can be discussed in three forms (**Table 3**).

- Medical education
- Medical research and innovations
- Diagnosis and treatment of diseases

4.1 AI in medical education

Curriculum of medical education now emphasize more on e-learning methods which are yet to adopt in many countries. AI helps to see the bridge between the availability of digital resources and utilization of the resources by medical students and teachers. Integration of many technologies akin to neural networks, expertise, deep learning, machine learning, speech, image, and language recognition simulate insightful behavior of humans. Lately, AI has gained vast application in medical education. Many research has been conducted to observe the cause of underutilization of e-content by the students and teachers to reach the conclusion for possible solutions of those problems [9].

Presumably, AI will help teachers to promote the students for self-directed learning and will help to give healthy discussions on case-based studies. The major hurdle is to face multiple distractions while finding knowledge about simple and small topics by the students through e-learning platforms. In near future, as the technology advances, there might be a possibility of level wise distribution of digital

S.No	Category	Methods	Future expectations
1	Medical education	Availability of standard and best quality digital resources	Consumer friendly E learning platforms
			E content utilization by medical students and teachers
			Promotion of self-directed learning of medical students
			Level wise distribution of digital content for graduate, postgraduate and researcher scholars
			Digital synchronization of topic understanding between medical student and faculty
		Monitoring the use of digital content	Quality based efficiency of the electronic data for students and teachers can be measured
		Digital assessment program	Self-assessment methods to shape the right direction of student's learning
2	Medical research and innovations	Research exploration through machine learning	Time saving and cost-effective clinical trials
			Fair and ethical innovations by the diverse teams making universally acceptable data
3	Diagnosis and treatments	image analysis	Interpretation of radiological and pathological images
		Wide spread clinical practices	Digital clinical notes by speech recognition and text identification of the patient
			Integration of medical professionals with newer technology
		Prediction of high-risk situations	Stroke, sepsis, and heart failure
		Digital recording of genetic outlines in different tumors	Early detection and treatment of cancers
		Message alert and provocative action devices for the patient	Personalized and contextualized care of the patient
		Documentation of health records and claims processing	Administration, health insurers and other stakeholders time will be saved

Table 3.
Future of artificial intelligence in medical sciences.

content based on the understanding of graduate and post graduate students, as well as researcher and scientists. This distribution of content in digital library will be time saving for the teachers, students as well as for researchers [19].

Moreover, standard and quality along with the accessibility of the content will be considered the double edge sword for any digital content to make it available for

the students. Digital files will be more consumer friendly whether for teachers or for medical students, filling the gap between physical and digital resources. AI can be used to monitor the efficiency of e-resources to be used by the consumer on frequent basis and enhances the scope of improvement in medical education system globally in the universal form. It can make a synchronized understanding of the subjects between students and the medical faculty [20].

As the teaching is always followed by the assessment of students for different subjects, development of various digital platforms will make the assessment methods more convenient and user friendly. These platforms will save much time for the assessment as compared to the conventional methods. It will make formative evaluation easier for the teachers. Students can also evaluate themselves on different steps of learning by the newly developed assessment methods, giving them more confidence for development in the correct direction during their stay in medical schools. A digital self-assessment program can be developed for the students to judge themselves as to where they stand overall throughout the medical studies. These types of assessments will be helpful and time saving for the challenging newly applied competency based medical education curriculum, which is promising for creating competent physicians and surgeons to embark in health care system globally [21, 22].

4.2 AI in medical research and innovations

Implementation of machine learning (ML) to expedite clinical exploration are sporadically discussed on intellectual ground. Medical research is an extensive field, with investigations and observational evaluation, guiding traditional trials with realistic elements which in turn encourage clinical registries and additional implementation work. Clinical research is invaluable to improve the health care and outcomes. It has been proved as complicated, demanding in terms of labor, expensive and vulnerable to unexpected errors. ML has the possibility to help and improve the accomplishments, universality, patient focusing and effectivity of clinical trials, preventing the loss of years as well as dollars of expenditure as have been done in many conventional settings of analysis [10, 23].

Functional and metaphysical barriers in ML can do well in clinical research in future after précised focus on them. The prospective applications of ML to medical research recently overtake its existing use, because few potential studies are available about the reasonable effectiveness of ML in contrast to the conventional approaches. Conversion of traditional methodology to ML needs time, enthusiasm, and collaboration for effective adoption. Communication and cooperation are crucial for application of this favorable technology for the future application in medical research and innovations [24].

The future goal for application of ML in research is to create fair and ethical innovations that will be universally acceptable. Vigorous and integrative collaborations can reduce chances of bias in clinical research with ML. More diverse teams may offer innovative insights for de-biasing ML models [2].

4.3 AI in diagnosis and treatment of diseases

For healthcare delivery of the future AI has a very important role. At the beginning, efforts to provide diagnosis and treatment are challenging but expectations to pick up in this area is anticipated in the future (**Table 2**). In radiology and pathology

most images will be analyzed and examined by the machines at some point. Usage of already working speech recognition and text identification for communication with the patients and getting clinical notes will increase [11]. A widespread challenge for the use of AI in health domain is the ensured adoption in clinical practices rather than proven capability of technology itself. This provocation can overcome by integration with the system, approval by the regulators, sufficient standardization, awareness to the clinicians and getting updated (both medical professionals and consumers) over time-to-time basis. Overcoming the challenges will take longer time compared to the time taken by technologies to mature [12].

There will be more use of technologies in next 10 years but not within 5 years due to this time constraints in adoption of something new in medical field. On a substantial scale, it is very clear that AI methods will not supersede the human physicians, but rather will boost their endeavors for patient's care. Human physicians gradually may proceed towards the job motif that makes them capable on unique soft skills like empathy, and the integration with unique understanding on the big scale. Conceivably, the healthcare personnel who deny to work next to the artificial intelligence will no longer have a job in near future [12].

It is important to consider the development of our health care systems in terms of AI. These technologies potentially transform various aspects of patient care better than humans, most importantly the diagnosis of disease. But replacing humans by computer's AI for a vast medical domain will take many years due to multiple barriers [25]. To achieve the human level performance in terms of cognition, intelligent behavior of a computer has been used since year 2016, a well-known time to show highest investments in AI for healthcare applications [26].

As we already are familiar with "virtual" and "physical" subtypes of AI [8]. The physical part deals with the performance of robots in various surgeries, care of handicapped individuals and elderly people. The virtual part deals with a range of information data from digital records of the patient's health to the guided neural network in treatment decisions of the patients. It describes the diagnosis of the patients via two wide techniques: Flowchart based and Database [2].

The flowchart-based method translates the sequence of questions of a physician for taking history to reach a most likely diagnosis after amalgamation of complex presented symptoms. A large amount of data, containing multidirectional clinical features of diseases, is the main requirement into cloud-based machinery networks. A major challenge in ML is inability to gather patient's cues which can only be observed directly by a doctor during consultation. This results in a belief that AI can assist the physicians in future but cannot replace the human physicians in health care [2].

The database uses recognition of different images of a specific group to apply for answering the questions related to a particular diagnosis. A decade ago, google project "artificial brain" was designed on the principle of deep learning by database approach. This approach was used to match and mismatch various images in radiology and pathology for diagnosis of distinct sets of diseases [2].

MYCIN, Watson and some free open source such as Tensor Flow on Google are systems developed to incorporate in healthcare system. The strict rule oriented clinical opinion making machinery systems are not easy to maintain on medical ground due to constant change in medical knowledge. A big amount of data handling too is a big challenge for the healthcare system in ML. Statistically based ML framework leading the way in a period of evidence-based medicine, which is reflecting a positive change in broad term, but has many challenges such as ethical issues of the patients. Google now a days collaborates with health delivery channels to make prediction

designs from big data to alert the physicians for high-risk situations, like sepsis and heart failure [12].

Various firms are also there to focus more on investigation and treatment protocols of different cancers based on their genetic outlines. Foundation medicine and Flatiron health are specialized firms for complex understanding of all the genetic variants of cancers and their response to new treatment protocols. These rules-based, algorithmic diagnosis and treatment methods are many times challenging to get embedded in clinical fields. Majority of AI techniques address only one aspect of medical care thus standalone in nature. Such incorporation issues have possibly been a substantial barrier to broaden the application of AI than accuracy and effectiveness of the technique itself [27].

Patient's cooperation is the final need for making any method to give good or bad outcomes. Better outcome has been observed as the participation of patients increases when they become more active to owe well-being and good health. For the better health outcomes, AI will be developed in such a way which personalize and contextualize the care. This can be supplemented by message alerts and provocative actions for the concerned patients [12].

Administration uses the AI less potentially, but it provides substantial efficiency in management of revenue cycle, clinical notes, claims processing and medical records documentation. False insurance claims can be identified easily and help the health insurers and governments to save time, finance, and lot of efforts of stakeholders [12].

To the best of all outcomes by using AI, it is believed that no jobs will be eliminated in health care working in parallel with the AI. Jobs pertaining to the direct patient interaction will have less impact to fade itself. In AI systems, radiology and pathology perform a single task such as specific nodule detection in chest computed tomography and specific specimen findings in a biopsy result. Only a few of pathology and radiology findings have been identified by AI till date, thus showing the role of human pathologist and radiologist to be there for a longer time before technology fully replace all the possible tasks done by the medical specialists. It is likely to create more jobs for the individuals having knowledge to work with AI which can further develop the effective use of AI in future [11].

In public health area, AI has a well-established role, which causes reduction in time of the doctors given on diseases already observed and treated many times, augmenting their work on more complicated and rare cases. Reshaping of various aspects of medical services are possible by these developing technologies and many patients can take advantages of taking alternative medications and follow-up care without much efforts. AI is expanding to have a significant impact on every angle of primary health care, reducing physician's labor and increasing their efficiency, precision, and effectivity. But AI cannot replace medical experts completely in the tactful branch of mankind [2].

5. Limitations of artificial intelligence in medical sciences

Data availability for construction of well executed artificially intelligent models consult the large quantities of high-quality data. Patient's confidentiality and public right to privacy issues restrict the data availability [14–16, 24], making compromised framework with limited potential (**Table 4**). This fragmented data limits the predictability of a model for successful application of AI within and between the organization. Biased data processing with or without biased data collection in terms of population specificity for distinct race, age, and gender result in the distorted

S.No	Limitations	Causes of the limitations
1	Data availability	Ethical issues
		Biased data collection
		Biased data processing
2	Complex mathematical algorithm	Burdensome for the medical users
		Obstinate to adapt the constant change in medical sciences
3	Human social skills	Not possible by machines and robots
		Medical professional assistance needed

Table 4.
Limitations of artificial intelligence in medical sciences.

collection of data, fabricating defective algorithm. Thus, it is invariably difficult to find elite algorithm matched for upcoming task to accomplish. Basic information is constantly needed to understand, for the building of AI prototypes, by a user. These details help them to interpret the correct or incorrect output and execution of preferable use of the output. But, despite having some latest studies in this direction, complex black boxes of mathematical algorithms are burdensome to approach and decipher precisely by the medical users [24].

Machines can be able to construe human behavior, but many human characteristics such as rational thinking, interactive and social skills, emotional understanding, and ingenuity cannot be acuminated by the machines and robots. The qualities for humanity present in the doctors cannot be replaced absolutely by AI. It is required for the medical neophyte to learn the notions and relevance of AI and how to ramify well organized work along with machines for greater advantages alongside plowing soft skills in them [8]. A wide range of skills are needed in future physicians to accommodate the constant changing technology-based healthcare delivery. An adequate understanding of technical concepts, basics of AI, data management and treatment oriented ethical issues are some newer expertise to incorporate in upcoming medical generations apart from the mastering medicine. These abilities will equip the doctors to identify the accuracy of machines, reducing the chances of error. Thus, a supervisor of AI tools will always be needed even with a well-established source of treatment modality and robots [28, 29].

6. Conclusion

Artificial Intelligence is an expanding science. The types of AI come under two categories, including virtual and physical components. Virtual components have many subdivisions in the applications of AI. The combinations of these Machine-based learning can be utilized in medical sciences including medical education, medical research and innovations along with the diagnosis and treatment of diseases. Some freely openable sources have already been developed in the field of health care, but need many modifications to define the uniqueness of AI for incorporation in the medical field effectively. Various research signals that AI is an intrinsically developing trade in the area of medicine. It can be safely concluded, there will be massive benefit to the healthcare care system by the application of AI under the supervision of medical professionals.

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Conflict of interest

"The authors declare no conflict of interest."

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