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REVIEW ARTICLE

Artificial intelligence in medical science: a review

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Abstract
Artificial intelligence (AI) is a technique to make intelligent machines, mainly by using smart computer programs. It is based on a statistical analysis of data or machine learning. Using machine learning, software algorithms are designed according to the desired application. These techniques are found to have the potential for advancement in the medical field by generating new and significant perceptions from the data generated using various types of healthcare tests. Artificial intelligence (AI) in medicine is of two types: virtual and physical. The virtual part decides the treatment using electronic health record systems using various sensors whereas the physical part assists robots to perform surgeries, implants, replacement of various organs, elderly care, etc. Using AI, a machine can examine various kinds of health care test reports in one go which could save the time, money, and increase the chances of the patient to be treated without any hassles. At present, artificial intelligence (AI) is used while deciding the treatment, and medications using various tools which could analyze X-rays, CT scans, MRIs, and any other data. During the COVID pandemic, there was a huge/massive demand for AI-supported technologies and many of those were created during that time. This study is focused on various applications of AI in healthcare.

Keywords Artificial intelligence (AI) · Computer vision · Clustered regularly interspaced short palindromic repeats (CRISPR) · Deep learning · Machine learning · MYCIN

Introduction

Innovations, their modifications, and using new technologies are very important to grow a manufacturing industry. Artificial intelligence (AI), along with its associated methodologies, is already widely recognized for its capability to attain sustainable manufacturing within the industry [1]. Mainly, artificial intelligence (AI) is based on a statistical analysis of data or machine learning. Machine learning can design software algorithms depending required on the application [2]. In the present day, nearly every sector is in the process of digital transformation, eventually leading to a reduction in the requirement on human labor and operational expenses [2]. In the aftermath of COVID-19 pandemic, devices and medical aid with minimal human touch are a must requirement. Healthcare industries are constantly making efforts to undergo digital transformations to fulfil these requirements [3, 4].

These techniques can generate new and significant insights from the data produced using various types of healthcare tests. The main purpose of using artificial intelligence (AI) in healthcare is to improve health outcomes and patient experiences [5]. With the advancement in computer science and informatics, artificial intelligence (AI) now becomes an essential part of modern healthcare. Medical professionals widely use artificial intelligence (AI) algorithms and other applications to treat patients [6].

In 1950, Alan Turing gave the concept of using computers for simulating the critical thinking and intelligent behavior like humans [7]. In his book Computers and Intelligence, Turing described a simple test, which was later referred to as the "Turing test," to determine whether computers were capable of human intelligence. Six years later, John McCarthy coined the term artificial intelligence (AI) as "the science and engineering of making intelligent machines" [8]. AI has advanced slowly and steadily from very simple to more complex algorithms that can perform like the human brain [9].

The first use of artificial intelligence (AI) in medicine can be traced back to the 1970s when researchers at Stanford University developed the MYCIN system for diagnosing infectious diseases [10]. The MYCIN was an early expert

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system that used a rule-based approach to diagnose bacterial infections and recommend treatments. It was designed in such a manner that it could imitate the decision-making process of an expert clinician, by using a knowledge base of medical information and a set of inference rules to arrive at a diagnosis and treatment plan. The system was tested on real patient cases and showed promising results, with an accuracy rate of over 90% for diagnosing infections [11, 12].

The development of the MYCIN system was a milestone in the history of AI in medicine, demonstrating the potential of AI to assist clinicians in making diagnoses and treatment decisions. Since then, AI has continued to advance and is now being used in a wide range of medical applications, from imaging analysis to drug discovery and personalized medicine [13, 14].

Artificial intelligence (AI) can be classified into three main subfields like machine learning (ML), deep learning (DL), and computer vision. Machine learning (ML) is the use of specific traits to identify patterns that can be used to analyze a particular situation [15].

The machine can then "learn" from and apply that information to future similar scenarios. This prediction tool can be applied dynamically to clinical decision-making to individualize patient care rather than follow a static algorithm [16]. Machine learning (ML) has advanced into what is now commonly known as deep learning (DL), which is a technique that is inspired by the structure and function of the human brain, particularly in its use of artificial neural networks (ANN) to process and analyze large datasets. Deep learning excels at automatically learning and extracting relevant information from raw data and make decisions on its own like the human brain [17, 18].

Computer vision enables the computers to extract meaningful information from various digital visual mediums like images and videos and then recommend solutions for a given problem [19]. It allows machines to go beyond merely "seeing" images and videos and enables them to process and understand the content within these visual mediums. This understanding involves tasks such as recognizing objects, detecting patterns, identifying shapes, and comprehending spatial relationships.

Despite the numerous benefits of artificial intelligence (AI) in medicine, there are also some concerns. One concern is the potential for AI to replace human healthcare professionals resulting in gradual decrease in the requirement of workforce, thereby resulting in loss of jobs. While AI can help healthcare professionals make more informed decisions, it cannot replace the human touch that is so important in healthcare especially in the field of psychiatry and mental health where the patients may feel intimidated interacting with a robot or machine. Another concern is the potential for AI to be biased. Artificial intelligence (AI) is completely dependent on data. If the data is not accurate or incomplete, it could lead to severe errors especially for diseases that are rare and have high degree of variability. Therefore, if artificial intelligence (AI) is trained on biased data, it may perpetuate that bias in its decision-making [20–22]. Despite all these limitations, artificial intelligence (AI) has a huge potential that can be tapped to revolutionize the field of medicine. In the current manuscript, an overview on the impact of artificial intelligence (AI) on health facilities and its limitations has been studied.

Major milestones in the development of artificial intelligence in medical sciences

Artificial intelligence (AI) started in 1950 with the statement of Alan Turing in which he mentioned that the computers could simulate intelligent behavior and could have critical thinking and introduced the term "Turing Test" which is a method used in artificial intelligence (AI) to inquire whether a computer is capable of thinking like a human being or not. In 1956, John McCarthy gave the term artificial intelligence (AI) as "the science and engineering of making intelligent machines" [23, 24]. The major advancement of AI in medical science is shown in Fig. 1.

George Devol invented the first industrial robot arm, Unimate, which was presented in the assembly line at General Motors in 1961. It was a hydraulic manipulator arm that was able to execute repetitive tasks [25]. In 1964, Joseph Weizenbaum introduced the first chatbot Eliza which was able to mimic conversation patterns using matching and substitution methodology. ELIZA used natural language processing (NLP) to simulate a conversation with a psychotherapist and was designed to help patients explore their feelings and emotions in a non-threatening environment [26]. Shakey "the first electronic person" was the first mobile robot developed in 1966 that could able to observe and reason about its surroundings [27].

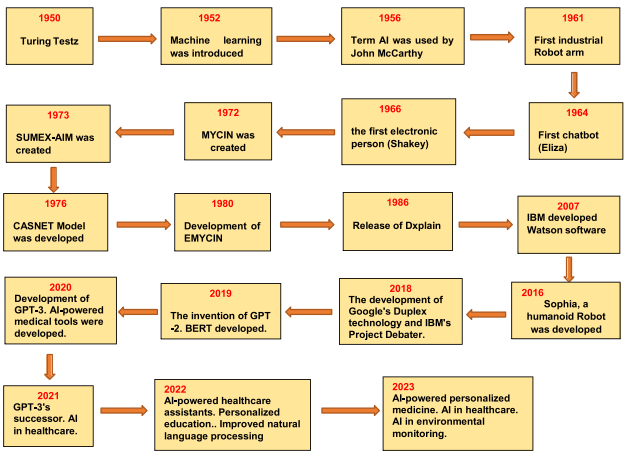

Fig. 1 Major milestones in the development of artificial intelligence in medical sciences

MYCIN, one of the earliest expert systems, was designed to assist doctors in diagnosing bacterial infections in 1972. Although MYCIN is no longer in use, it remains an important milestone in the development of AI in medical systems [28]. SUMEX-AIM was a time-sharing computer system that was developed in 1973 at Stanford University Medical School. It was one of the earliest computer systems dedicated to medical research and was used extensively by researchers in the field of artificial intelligence, as well as in other scientific areas such as molecular biology and genetics [29]. The CASNET model was developed in 1976. It is a type of artificial neural network used for image processing and recognition tasks. It stands for "Convolutional Auxiliary Supervision Network," and it incorporates auxiliary supervision modules to help improve the accuracy of image recognition. The CASNET model has been used for a variety of image recognition tasks, including object recognition, facial recognition, and scene recognition. The CASNET model can be used to analyze medical images, such as X-rays and MRIs, to assist doctors in diagnosing diseases and medical conditions with greater accuracy and speed than traditional methods [30].

The EMYCIN shell was built using the Lisp programming language in 1980. It used a rule-based approach to problem-solving, which involved breaking down complex medical problems into a series of smaller, more manageable sub-problems. Over the years, EMYCIN has been used in a variety of medical contexts, including diagnosis and treatment planning for cancer, infectious diseases, and other conditions [31]. Dxplain is a computer-based diagnostic decision support system developed in 1986 that helps healthcare professionals in making accurate diagnoses. It uses a knowledge base of thousands of medical conditions and their associated symptoms, as well as patient data entered by the healthcare professional, to generate a list of possible diagnoses and suggest appropriate tests and treatments [32].

Watson is a computer program developed in 2007 by IBM that uses artificial intelligence and natural language processing to understand and analyze vast amounts of data. In healthcare, Watson has been used to assist in the diagnosis and treatment of diseases, by analyzing patient data and medical literature to generate personalized treatment plans. It has also been used to improve patient outcomes by identifying potential drug interactions and adverse effects [33].

Sophia was developed by Dr. David Hanson in 2016. Sophia has since become a highly recognized and celebrated robot, known for her advanced capabilities and human-like interactions. She can make eye contact, recognize faces, and have conversations on a range of topics. These robots can be used as doctor's assistants to perform routine tasks such as taking vitals, monitoring patients, managing medication, and assists in surgeries with precision and accuracy. Additionally, Sophia robots can be used to conduct research and collect data on diseases and medical conditions. They can analyze large amounts of data quickly and accurately, helping researchers identify new treatments and cures [34].

One of the significant artificial intelligence (AI) inventions in 2018 was the development of Google's Duplex technology. Duplex is an artificial intelligence (AI) assistant that can make phone calls and appointments on behalf of its users. In the medical field, Duplex can be used to schedule appointments for patients, remind them of upcoming appointments, and confirm their attendance. It can call pharmacies to refill prescriptions, remind patients to take their medication, and even order medication for home delivery [35].

IBM's Project Debater was developed in 2018 which is an artificial intelligence (AI) system that can debate with humans on complex topics. It uses natural language processing and machine learning algorithms to understand arguments and generate counterpoints, making it a valuable tool for decision-making and critical thinking. One potential application of Project Debater in medicine is in medical ethics. Project Debater could also be used to analyze medical research and provide insights into the strengths and weaknesses of different studies. It could be used to analyze and debate different healthcare policies and their potential impact on patients and the healthcare system [36].

In 2019, one of the most significant artificial intelligence (AI) inventions was OpenAI's GPT-2 (Generative Pre-trained Transformer 2) language model. GPT-2 can be used to generate educational material, such as medical textbooks and online courses. It can be used to analyze medical research papers and extract insights from large datasets which can help medical professionals identify new treatments and cures for various diseases [37].

BERT (Bidirectional Encoder Representations from Transformers) is an AI-based language model developed in 2019 that can understand the context of words in a sentence. It is pre-trained on a large amount of text data and can be fine-tuned for specific tasks, such as sentiment analysis and entity recognition. BERT can be used to analyze electronic health records and medical imaging data to assist doctors in diagnosing diseases and can help medical researchers identify new treatments and cures for various diseases [38].

In 2020, AI played a critical role in the fight against the COVID-19 pandemic. Artificial intelligence (AI) algorithms were used to predict the spread of the virus, track infected individuals, and develop potential treatments. The year also saw a growing concern about AI's ethical and social implications, with many experts calling for increased regulation and oversight [4]. OpenAI's language model GPT-3 was developed in 2020 to generate human-like text and complete tasks such as translation and summarization [39]. AlphaFold, a DeepMind AI system, was established in 2020 which can predict the 3D structures of proteins, which could lead to breakthroughs in drug discovery and disease research. [40]. Artificial intelligence (AI) is being used to develop new medical tools, such as an AI-powered microscope that can detect cancer cells in real time.

Language model GPT-3's successor was developed in 2021 with more advanced capabilities. In this year, artificial intelligence (AI) is being used to improve healthcare in a variety of ways, such as analyzing medical images and predicting patient outcomes. Companies are developing robots that can perform a variety of tasks, such as cleaning, cooking, and even caring for the elderly [41].

In 2022, artificial intelligence (AI) was used to develop assistants that can monitor patients' health and alert healthcare professionals when necessary. Artificial intelligence (AI) algorithms were used to analyze large amounts of patient data, including medical images, lab results, and electronic health records, to assist doctors in diagnosing diseases and medical conditions with greater accuracy and speed than traditional methods. Artificial intelligence (AI) can also be used to analyze a patient's genetic makeup and medical history to develop personalized treatment plans that are tailored to their individual needs. AI-powered robots were able to perform surgical procedures with greater precision and accuracy than human hands, reducing the risk of complications and improving patient outcomes [42].

In 2023, artificial intelligence (AI) could be used to develop personalized treatment plans for patients based on their genetic makeup, medical history, and other factors. It could be used to monitor and analyze environmental data, such as air and water quality, to help prevent pollution and promote sustainable practices. These are the main developments of artificial intelligence (AI) inventions. In the future, it can open many new possibilities [43].

Role of AI in medical science

AI-assisted medical diagnoses are an emerging field that has the potential to revolutionize healthcare. Artificial intelligence (AI) can help physicians and healthcare providers to make more accurate and faster diagnoses, which can lead to better patient outcomes. Here are some ways that AI can assist in medical diagnoses [44]:

1. Image analysis: Artificial intelligence (AI) can analyze medical images such as X-rays, magnetic resonance imaging (MRI), and computed tomography (CT) scans with high accuracy, helping to identify abnormalities and diagnose diseases
2. Medical history analysis: Artificial intelligence (AI) can analyze a patient's medical history, symptoms, and other relevant information to help healthcare providers make a more accurate diagnosis.
3. Treatment recommendations: Artificial intelligence (AI) can analyze vast amounts of medical data to recommend the best course of treatment for a patient based on their medical history, genetics, and other factors
4. Predictive modeling: Artificial intelligence (AI) can use predictive modeling to identify patients who are at risk of developing certain diseases, allowing for early intervention and treatment

Artificial intelligence (AI) can assist in robotic surgery by providing real-time guidance and feedback to surgeons, improving accuracy, and reducing the risk of complications. The surgical robot was manufactured about 30 years ago when the Westinghouse PUMA 2000 was used for a CT-guided brain biopsy in place of a needle. After that, surgeons start using robots alongside them. Using robotic surgery, surgeons can perform complex surgery which might be tough with other methods. It is usually performed with minimally invasive surgery using tiny incisions. In a clinical robotic surgical system, a camera arm and mechanical arms and surgical instruments are attached to the system. The surgeon controls the system with the help of a computer placed near the operating table which provides a high-definition, magnified, and 3D view of the surgical site. This helps the surgeon to lead other team members assisting him during the operation [45].

However, these robots are not capable to do surgery independently till date. The benefits of using robotic surgery are minimizing the complications such as surgical site infection, less pain and bleeding, spending fewer days in the hospital, fast recovery, and small and fewer scares.

AI-powered chatbots can assist patients with routine medical questions, helping to reduce the workload of healthcare providers as shown in Fig. 2 [45]. Artificial intelligence (AI) has the potential to improve healthcare outcomes by increasing efficiency, accuracy, and personalization.

Artificial intelligence (AI) can also be used as virtual nursing assistants. It can be used to shift the care of the patient in new ways by minimizing the human touch. It has already started in many smart organizations to revolutionize patient care.

Virtual nursing assistants are intelligent chatbots, driven by artificial intelligence (AI) and can focus completely to provide support for medical patients. These assistants can update information regarding patient's health daily using wireless straps and seamless monitoring, call patients to know whether they are on prescribed medications or not, and collect patient's queries and pass this information to the concerned doctor, so that any further appointment with the doctor (if required) can be scheduled without actually visiting the doctor. Apart from monitoring health status, virtual nursing assistants also have the power to identify any hidden problem in the body in accord to the symptoms. Patient care is not everything operating on the body. It is about collecting routine information, analyzing symptoms, mapping improvement, and more. This saves the precious time of the doctor or surgeon and they can focus on the key vulnerabilities of the patient [46].

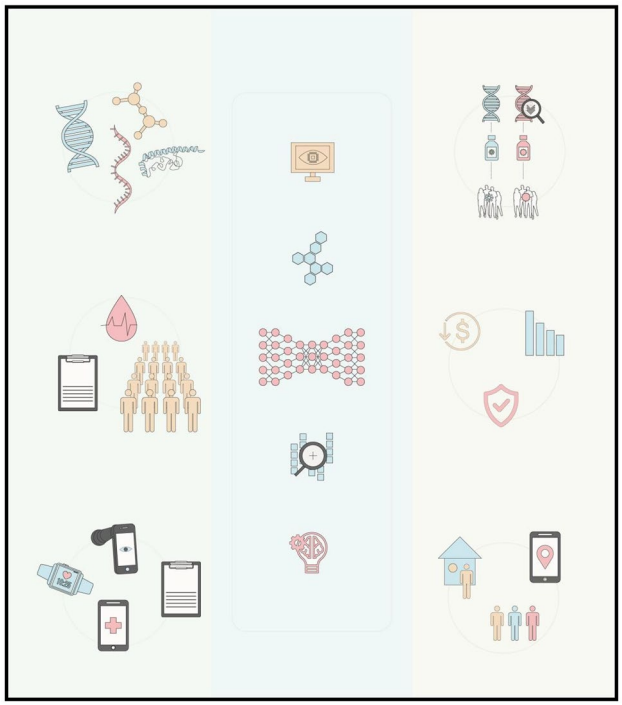

Fig. 2 Use cases of artificial intelligence in medical science; reproduced from ref. 46 under a Creative Commons Attribution 4.0

Artificial intelligence (AI) can be used to develop screening tests for diseases such as cancer, which can help to detect the disease in its early stages when it is most treatable. It can use predictive modeling to identify patients who are at risk of developing certain diseases, allowing for an early intervention and treatment. Artificial intelligence (AI) can be integrated into wearable devices such as smart watches to monitor vital signs and detect diseases such as heart disease and diabetes [47].

Artificial intelligence (AI) is being increasingly used to enhance the precision and efficiency of gene editing. One way this is being done is by using machine learning algorithms to predict the outcomes of different gene editing techniques. It can be used to predict the effects of specific genetic mutations or changes and to identify the most effective gene editing tools and techniques to address them. Another potential application is in the analysis of gene expression data. Artificial intelligence (AI) algorithms can be trained to identify patterns in gene expression that are associated with specific diseases or conditions [48].

Applications of artificial intelligence (AI)

Today, AI has applications in almost all branches of Medicine, some of which are discussed below:

Radiology and pathology

Patient information to create personalized treatment plans based on individual characteristics and medical history. It can assist in quality assurance by flagging potential errors or inconsistencies in imaging data, helping to improve accuracy and reduce the likelihood of misdiagnosis. AI can further help in optimizing the paperwork in radiology departments by automating repetitive tasks, such as image analysis and report generation. This can free up radiologists' time and allow them to focus on more complex cases artificial intelligence (AI) has revolutionized the field of pathology with improved diagnostic accuracy and efficiency. It is being used for analyzing medical images and detecting patterns and anomalies in pathology slides. Artificial intelligence (AI) algorithms can quickly examine enormous amounts of data, providing pathologists with a more objective and accurate diagnosis. Artificial intelligence (AI) can also help pathologists identify rare or complex cases, reducing the likelihood of misdiagnosis or missed diagnosis and can help in identifying cases that require urgent medical intervention and thus it is a great assisting tool for the pathologists helping them in making accurate diagnoses. Repetitive tasks such as analyzing images and entering data can be very effectively automated using Artificial Intelligence (AI). This can save pathologists time and reduce the risk of human error. Artificial intelligence (AI) can also help prioritize cases and allocate resources more effectively [49].

Altogether, artificial Intelligence (AI) has the capability to transform pathology by improving accuracy, efficiency, and patient outcomes. It can be a great handy tool for the pathologist providing them with additional information and tools to make more informed decisions.

Artificial intelligence (AI) has also made significant advances in the field of radiology, with applications that have the potential to revolutionize the way diagnoses and treatment plans are made. Artificial intelligence (AI) is being used in automated image interpretation. Radiologists are heavily dependent on imaging for their diagnoses. Sometimes they need to study hundreds of images especially for cases like trauma patients before giving accurate diagnoses [50]. Artificial intelligence (AI) algorithms can be trained to analyze medical images and detect abnormalities in a matter of seconds, which can save radiologists valuable time and improve diagnostic accuracy. For example, AI has been shown to be highly effective in detecting breast cancer in mammograms, lung cancer in chest x-rays, and brain hemorrhages in computed tomography (CT) scans. AI can also be used to predict the likelihood of certain conditions developing in the future based on imaging data. For example, a machine learning algorithm can analyze a patient's medical history and imaging data to

predict their risk of developing heart disease or cancer. It is also used to provide personalized medicine by analyzing medical imaging data and others.

Oncology

The future use of artificial intelligence (AI) in oncology is very promising, with new applications and technologies being developed that have the potential to improve patient outcomes and revolutionize the way we diagnose and treat cancer. AI can significantly assist in the early detection and diagnosis. Algorithms can be used to analyze medical images, such as mammograms and computed tomography (CT) scans, to detect early signs of cancer. It has been shown to be highly effective in detecting breast cancer in mammograms and lung cancer in CT scans [51].

Artificial intelligence (AI) can help physicians determine the best treatment plan for individual patients based on their medical history, genetic information, and other factors. For example, it can be used to analyze genetic data from a patient's tumor to identify potential drug targets and predict which treatments are most likely to be effective. Artificial intelligence (AI) can also be used to monitor patients' response to treatment and predict their prognosis. For example, artificial intelligence (AI) can analyze medical images and other data to detect changes in tumor size and shape, which can help physicians, determine if a treatment is working or if additional interventions are needed. Further, artificial intelligence (AI) can be used to identify new drug targets and accelerate the development of new cancer therapies. For example, artificial intelligence (AI) can analyze large amounts of data from clinical trials to identify new drug combinations and predict which treatments are most likely to be effective [52].

Artificial intelligence (AI) can analyze large amounts of data from clinical trials to identify new drug combinations and predict which treatments are most likely to be effective [52].

In general, the future use of artificial intelligence (AI) in oncology holds great promise for improving patient outcomes and advancing our understanding of cancer. As artificial intelligence (AI) technologies continue to evolve, we can expect to see new applications and approaches that will transform the field of oncology.

Surgeries

Artificial intelligence (AI) is increasingly being used in surgeries to improve patient outcomes, reduce the risk of complications, and enhance surgical precision. Here are some of the key areas where artificial intelligence (AI) is being used in surgeries.

(a) Preoperative planning

Artificial intelligence (AI) can be used to generate 3D models of a patient's anatomy, allowing surgeons to plan the surgical procedure with greater accuracy and precision. This can help reduce the risk of complications and improve patient outcomes.

(b) Navigation

Artificial intelligence (AI) can assist surgeons in navigating complex anatomy during surgery, using real-time imaging, and tracking to guide surgical instruments. This can help reduce the risk of errors and improve surgical precision [53].

(c) Robotics

AI-powered robots can be used to perform surgeries with greater accuracy and precision. For example, robots can be used to place implants, perform minimally invasive procedures, and perform complex surgeries with greater accuracy and consistency.

(d) Predictive analytics

Artificial intelligence (AI) algorithms can analyze patient data, such as medical history and imaging, to predict patient outcomes and recommend the most effective surgical approach. This can help improve patient outcomes and reduce the risk of complications.

(e) Postoperative monitoring

Artificial intelligence (AI) can be used to monitor patients after surgery, using data from wearable devices and other sensors to detect signs of complications and recommend appropriate interventions [54].

Gene therapy

Artificial intelligence (AI) has the potential to significantly accelerate the development and delivery of gene therapies, which are a promising approach to treating a wide range of genetic diseases. Here are some of the key advances that artificial intelligence (AI) is making in the field of gene therapy:

(a) Precision medicine

Artificial intelligence (AI) can be used to analyze genetic data from patients to identify potential gene therapy targets and develop personalized treatment plans based on an individual's unique genetic profile. This can improve the efficacy of gene therapy and reduce the risk of side effects [55].

(b) Gene editing

Artificial intelligence (AI) can be used to optimize gene editing techniques, such as CRISPR-Cas9, to improve their efficiency and reduce the risk of off-target effects.

Artificial intelligence (AI) can also be used to design new gene editing tools that are more precise and effective.

Artificial intelligence (AI) algorithms could be used to design new enzymes or proteins that are better suited for gene editing and to optimize their performance in different cell types and environments.

Artificial intelligence (AI) can help researchers to identify potential risks associated with specific gene editing techniques and to develop strategies to mitigate them. One important application is in the design of guide RNAs (gRNAs), which are used to target specific genes for editing.

Artificial intelligence (AI) can be used to predict the efficiency and specificity of different gRNA sequences, allowing researchers to choose the best ones for their experiments [56].

(c) Drug discovery

Artificial intelligence (AI) can be used to identify new gene therapy targets and accelerate the development of new gene therapies. For example, artificial intelligence (AI) can analyze large amounts of genomic data to identify disease-associated genes and develop targeted therapies to treat them.

(d) Gene delivery

Artificial intelligence (AI) can be used to optimize gene delivery methods, such as viral vectors, to improve their safety and efficacy. Artificial intelligence (AI) can also be used to design new delivery methods that are more target oriented and efficient. This can reduce the costs and time involved dramatically and produces more accurate results compared to trial-and-error approaches. AI-equipped light microscope could be used to facilitate the imaging of intracellular organelles and cellular contents with high precision. The gene delivery vehicle movement during intracellular trafficking could be tracked using artificial intelligence (AI) hence decreasing the off-target effects of CRISPR/Cas technologies [50].

Dentistry

Artificial intelligence (AI) is also being used in dentistry to improve patient care, streamline workflows, and enhance the accuracy of diagnoses and treatment plans. Here are some of the key areas where AI is being used in dentistry [57]:

(a) Image analysis

Artificial intelligence (AI) algorithms can analyze dental images, such as X-rays and CT scans, to detect dental caries, bone loss, and other abnormalities. This can help dentists diagnose dental problems earlier and with greater accuracy.

(b) Treatment planning

Artificial intelligence (AI) can assist dentists in creating customized treatment plans for individual patients based on their medical history, genetic information, and other factors. For example, artificial intelligence (AI) can analyze a patient's dental images and provide recommendations for orthodontic treatment.

(c) Robotics

AI-powered robots can be used to perform dental procedures with greater precision and accuracy. For example, robots can be used to place dental implants and perform complex surgeries with greater accuracy and efficiency.

(d) Personalized care

Artificial intelligence (AI) can be used to develop personalized treatment plans based on a patient's unique needs and preferences. For example, AI can analyze a patient's dental history and recommend preventive measures to reduce their risk of developing dental problems in the future.

Overall, AI has the potential to transform the field of dentistry by improving diagnostic accuracy, enhancing treatment planning, and improving patient outcomes. As AI technologies continue to evolve, we can expect to see new applications and approaches that will transform the field of dentistry in the years to come [58].

Ophthalmology

Artificial intelligence (AI) has made significant advances in the field of ophthalmology. It is being used in early detection of eye diseases and personalized treatment planning. Here are some of the notable advances of AI in ophthalmology [59]:

Early detection of eye diseases: AI algorithms can analyze medical images, such as fundus photographs and optical coherence tomography (OCT) scans, to detect early signs of eye diseases like age-related macular degeneration, diabetic retinopathy, and glaucoma. This can lead to earlier treatment and better outcomes for patients. AI algorithms can analyze medical images to determine the best dosage and timing of anti-VEGF injections for patients with wet age-related macular degeneration and thus assist in providing personalized treatment plans for patients.

Predicting disease progression: Artificial intelligence (AI) algorithms can analyze medical images over time to predict the likelihood of disease progression in patients with eye diseases. This can help ophthalmologists make more informed decisions about treatment and follow-up care.

Improving surgical outcomes: Artificial intelligence (AI) can assist ophthalmologists during surgery by providing real-time feedback and assisting with precise incisions. This can improve surgical outcomes and reduce the risk of complications.

Hence, artificial intelligence (AI) has the potential to revolutionize the field of ophthalmology by improving early detection, diagnosis, treatment planning, and surgical outcomes. However, it is important to note that artificial intelligence (AI) should not replace the role of the ophthalmologist but rather complement it, providing additional information and tools to improve patient care [60].

Psychiatry

In the early 1970s, a computer program called ELIZA was developed by MIT computer scientist Joseph Weizenbaum. ELIZA used natural language processing (NLP) to simulate a conversation with a psychotherapist and was designed to help patients explore their feelings and emotions in a non-threatening environment [61].

Although ELIZA was not specifically designed for the diagnosis or treatment of mental health conditions, it was a significant milestone in the development of AI in psychiatry.

Since then, the use of artificial intelligence (AI) in psychiatry has grown significantly, with the development of new algorithms and technologies that are specifically designed for mental health applications. Today, artificial intelligence (AI) is being used in a variety of ways in psychiatry, from diagnosis and treatment to monitoring and suicide prevention.

After the deadly attack of coronavirus in 2019, the world is struggling with mental health disorders more than ever. There is vast requirement of skilled doctors who can manage the increased number of mental health cases. Artificial intelligence (AI) seems to be very efficient in dealing with the mental health issues. Computer algorithms tend to identify the patients with schizophrenia with relatively high accuracy and are also able to predict and identify the patients with suicidal tendencies with great accuracy [62].

AI algorithms are being developed to assist in the diagnosis of mental health conditions, using a range of data such as genetic information, imaging, and patient behavior. This can lead to earlier and more accurate diagnoses, as well as personalized treatment plans.

It is being used to develop new treatments for mental health conditions, such as virtual reality therapy and chatbots that can provide cognitive behavioral therapy (CBT) to patients. It can be used to monitor patients with mental health conditions, both in the clinic and remotely. This can include monitoring of behavior, physiological data, and speech patterns and can provide clinicians with valuable insights into how patients are progressing. Artificial intelligence (AI) algorithms are being developed to help identify individuals at risk of suicide based on factors such as social media activity and speech patterns. This can help to intervene before a suicide attempt occurs. It is being used to assist in the development of new drugs for mental health conditions, by predicting drug efficacy and side effects based on genetic and other patient data. Overall, artificial intelligence (AI) has the potential to revolutionize the field of psychiatry by improving diagnosis, treatment, and monitoring of mental health conditions. However, it is important to ensure that these technologies are developed and implemented ethically and with the input of mental health professionals [63].

Endoscopy

Artificial intelligence (AI) is a growing field in this specialty and shows promising future. It is being used for early detection and examination of stomach cancers. It has a very high percentage of detecting lesions and polyps and is found to be 82% faster than endoscopists. Artificial intelligence (AI) will be very useful in timely detection of stomach and esophageal cancers. It is capable of quickly and accurately identifying the polyps at an early stage and reduces the dependence on biopsies and other lengthy pathological examinations. This will help doctors in performing the surgical removal of polyps (polypectomy) at an early stage, thus improving the chances of early and full recovery significantly [64].

Limitations and challenges of artificial intelligence (AI)

Artificial intelligence (AI) offers several advantages; however, it also raises concerns regarding several issues such as legal liability, ethics, and data privacy [9]. Given below are some of the major challenges that need to be addressed before large scale and complete implementation of artificial intelligence (AI) in healthcare systems:

1. Data privacy: The artificial intelligence (AI) depends heavily on the algorithm for its diagnoses which in turn depends on the data that is used to create it. If the data is not extensive and exhaustive, then the accuracy of the artificial intelligence (AI) system would also not be good. This could lead to inaccurate diagnoses or treatment plan. Since artificial intelligence (AI) systems collect and analyze large amounts of health data that can be sensitive, the risk of data and information breaches

cannot be ignored. While sharing the data patients may also be concerned about the ways in which their personal health information would be used and shared

2. Cost: Adopting an artificial intelligence (AI) system requires a significant financial investment, making the process expensive. This can limit its accessibility and utilization across the entire healthcare sector. Smaller healthcare facilities, underfunded institutions, or those in economically disadvantaged regions may find it difficult to embrace AI due to budget constraints. Consequently, this creates a disparity in healthcare, where not all patients and healthcare providers have equal access to the benefits that AI systems can offer. This economic divide has the potential to worsen existing disparities in healthcare, as patients who can afford AI-based medical solutions may receive more advanced and efficient care, while those without the financial means might have to make do with traditional healthcare practices. Thus, the affordability of artificial intelligence (AI) technology can inadvertently widen the gap between those who can harness its advantages and those who cannot, which calls for careful consideration and policy measures to ensure equitable access to these innovations
3. Lack of human interaction: Lack of human touch is another important aspect. Although artificial intelligence (AI) can quickly collect and analyze a large amount of data required for the preparation of a treatment plan, it certainly cannot replace the human touch that is very essential for the patient care. Many patients feel connected to their doctors and are comfortable sharing their information with them. They might feel uncomfortable and intimidated doing the same with a machine, which could lead to undesired effects on their overall health outcomes
4. Legal liabilities: The hospitals require a robust and unambiguous legal system to deal with the cases of any disputes in the event of incorrect diagnoses or errors. It should be clear whether the hospital or the company that has installed the system would be held responsible for the misdiagnoses. This clarification is essential to define accountability and safeguard the interests of patients, healthcare providers, and the organizations involved, providing a basis for fair and just resolution in cases of adverse events

Future scope

One of the biggest challenges that artificial intelligence (AI) needs to overcome before its wide-scale use in all medical setups is interoperability of data. This refers to the ability of different systems and devices to exchange and use data in a standardized and seamless manner. To overcome this challenge, hospitals need to adopt open standards and protocols that enable data interoperability [65]. This includes adopting common data formats and interfaces, as well as implementing secure data-sharing mechanisms that protect patient privacy. Additionally, hospitals should prioritize the integration of artificial intelligence (AI) algorithms and tools into existing clinical workflows, so that healthcare providers can easily access and use these tools to improve patient care [66].

But hospitals would also need Robust data security and privacy protections to ensure patient data are protected from unauthorized access or use. There would be requirement of adequate training and education for healthcare providers to ensure they can effectively use and interpret AI-generated insights. The entire healthcare system would need to work towards developing a culture of complete trust and transparency and ensuring that patients and healthcare providers are comfortable with the use of these technologies [67].

Conclusion

Artificial intelligence (AI) in medicine has revolutionized the way healthcare is delivered and managed around the world. AI technology is playing a significant role in various medical fields and has major applications in diagnosis, treatment planning, drug development, and patient monitoring. Having the ability to analyze large amounts of data quickly and accurately, artificial intelligence (AI) has the potential to improve patient outcomes, minimize medical errors, and increase efficiency in healthcare delivery.

While there are many benefits to incorporating artificial intelligence (AI) in medicine, there are also potential drawbacks and challenges that must be addressed. These include concerns over data privacy and security, the need for transparent and ethical AI algorithms, and the cost of artificial intelligence (AI) enabled infrastructure.

Overall, artificial intelligence (AI) is the future of medicine and will continue to play a significant role in improving healthcare outcomes and advancing medical research. As artificial intelligence (AI) technology continues to evolve, it will be important for healthcare professionals, policymakers, and the public to work together to ensure that artificial intelligence (AI) is used ethically and responsibly to improve the health and well-being of patients.

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Declarations

Ethics approval Ethical approval was not sought for this analysis because it used secondary data available online.

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We certify that the submission is original work and is not under review at any other publication.