

# The Future of Artificial Intelligence in Healthcare

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**ABSTRACT** In this article, we describe the potential future impact of AI-augmented healthcare systems, present new developments in harnessing AI's power in healthcare, and outline a roadmap for building safe and reliable AI systems that are likely to succeed. AI stands for artificial intelligence, and it is the simulation of human cognitive processes by a computer or machine. This revolution is being driven by the increasing availability of healthcare data and improvements in analytical methods. AI's entry into the healthcare sector has opened a new era and radically transformed the sector as never before. This work explores the deep impacts that AI is having on healthcare systems and what the future will look like. AI is changing patient care, increasing operational effectiveness, and encouraging creative solutions, ranging from tailored treatment plans to sophisticated diagnostics. From personalised treatment plans to advanced diagnostics, AI is transforming patient care, improving operational efficiency, and driving innovation. This study offers a holistic view of the new shape-shifter AI and the future of medicine through the prism of our understanding of technology and human well-being.

**Keywords.** Artificial Intelligence; Healthcare Medicine; Healthcare Systems; Medical Practice; Advanced Diagnostics

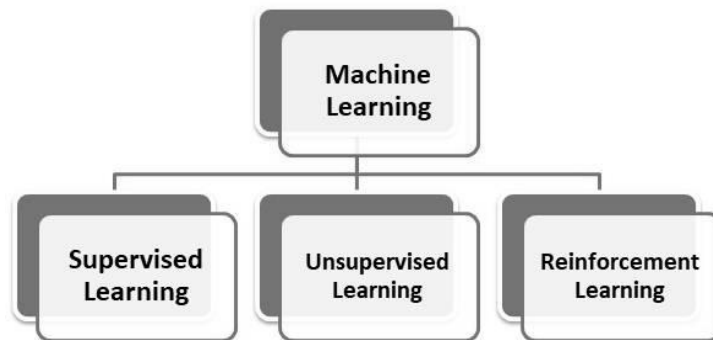
## 1. INTRODUCTION

Traditional medical diagnosis relies on human expertise, clinical observation, and established medical knowledge to identify and treat illnesses. While this approach has been effective for centuries, it is highly dependent on the experience, judgment, and availability of healthcare professionals [1-6]. A medical healthcare professional takes the history of the patient by asking about symptoms, medical history, family history, and lifestyle habits. This step is crucial in forming an initial impression; sometimes, a patient is not in good mental health, and they may have missed some important information regarding the illness or related to the illness. This can lead to misdiagnosis [7],[8],[9]. Diagnosis heavily relies on the physician's knowledge and ability to interpret symptoms and biochemical and physical examination of the patient accurately, and to make a decision regarding the diagnosis is often guided by clinical guidelines, but subjective judgment plays a significant role [10],[11],[12]. In cases where the diagnosis is unclear, doctors may adopt a trial-and-error approach, prescribing treatments or ordering additional tests to narrow down possibilities, for complex or rare conditions, patients may be referred to specialists with advanced knowledge in specific medical fields, this process takes multiple visits to the doctor and healthcare providers for the biochemical investigations which results in the delay in treatment and decision making of treating doctors also challenging to diagnose early-stage diseases or conditions with ambiguous symptoms [13],[14],[15]. A branch of computer science called artificial intelligence (AI), which refers to the attempt to reproduce human intelligence in machines to "perceive, reason, learn and act" like humans [16],[17],[18]. It had focused on developing systems that are able to perform tasks that usually need humans to perform, namely to learn, to reason, to solve problems and make decisions [19],[20],[21]. There are a number of different ways the AI mimic the human brain processes. ML, which means Machine learning, is the main way in AI that programs analyse the data to find patterns in data and make predictions without having to be explicitly programmed [22],[23],[24]. Inside the ML, it is a study field that uses multi-layered neural networks to find complex patterns in large data, thus deep learning works very well in areas like image recognition and natural language processing [25],[26],[27]. AI technologies that use NLP and computer vision have gained increasing capabilities that allow computers to understand and generate human language and images/pictures, respectively [28],[29],[30]. Another important approach is Reinforcement Learning, which allows systems to identify the best action to take through trial and error based on interactions with their environments. [31],[32],[33]. AI is used to analyse images used for diagnosing diseases in medicine, which shows equal accuracy as a radiologist can help early detect disease. [34],[35],[37]. Natural Language Processing (NLP) revolutionised how people interact, allowing virtual assistant

Alexa and chatbots to have interaction without difficulty [39],[40],[41]. This shows the rising importance of AI in finding solutions to many complex issues and improves the efficiency of several industries [42],[43],[44]. However, there is also debate whether it is right for AI to manage ethical concerns, data privacy and system biases while advancing. However there are many discussion on whether AI will take over the jobs of doctors and physicians in the next few years, based on our current knowledge, this is very unlikely, however, AI will assist the physician in clinical decision making and some decision making aspect that usually need human interaction like Radiology can be taken over [45],[46],[47] The reasons why AI technology can be adapted well in healthcare industry is due to the availability of healthcare data, and rapid growth of big data analytics [48],[49],[50]. Advanced AI algorithms can improve healthcare decision-making, focusing on pertinent clinical questions and uncovering key information hidden in huge data [51],[52],[53]. This chapter provides an overview of the rapid development of AI technology and its application in the healthcare industry [54],[55],[56]. This chapter lays the foundation for why this study is relevant and how the AI technology will impact the healthcare services, patient outcomes and dynamics within the industry [57],[58],[59].

## 2. LITERATURE REVIEW

One of the dominant paradigm-shifting technologies is Machine Learning (ML). ML involves techniques of analysing large amounts of data in order to discover patterns, predict outcomes and aid decisions, especially within the clinical setting, and it is one of the major areas of artificial intelligence [60],[61],[62]. Some applications of ML include diagnostics, prediction of future health outcomes, personal healthcare, drug development and patient monitoring [63],[64],[65]. There are many categories of ML approaches, some of which are illustrated within Figure .1



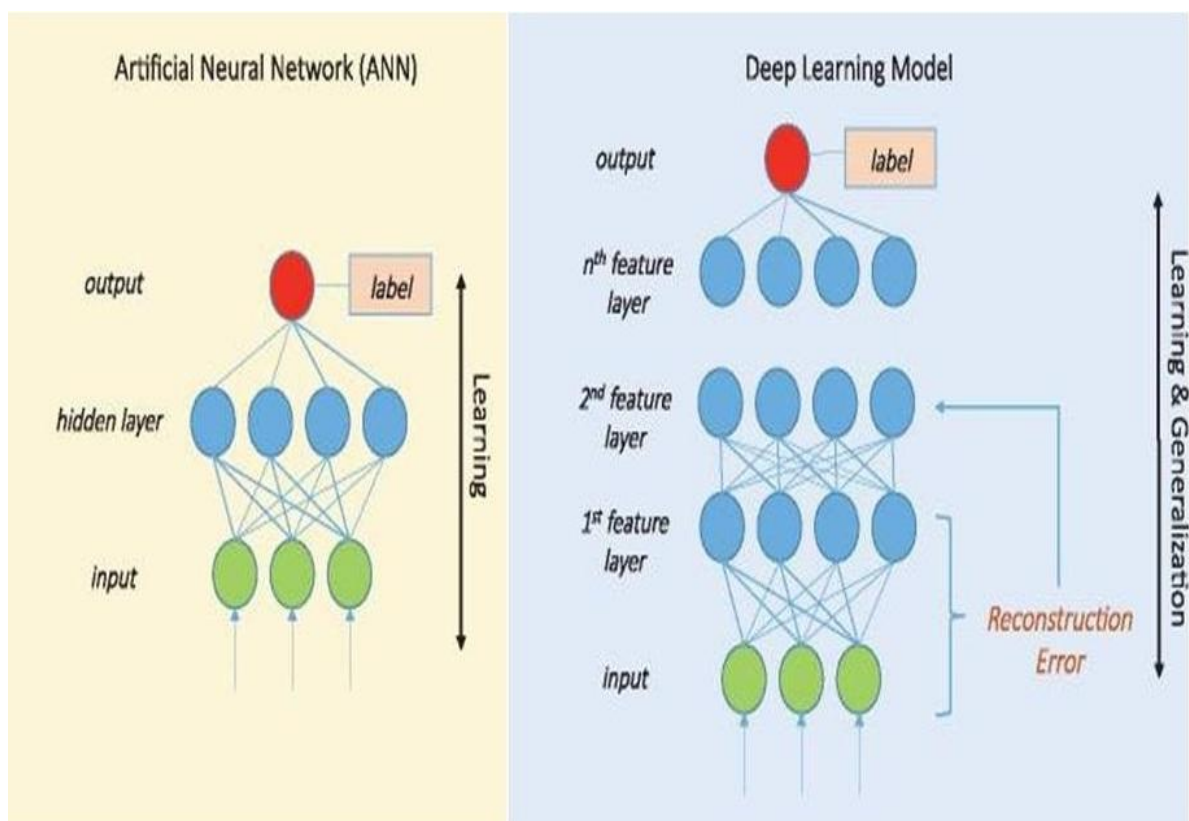
**Figure 1** Types of Machine Learning Algorithms

- The supervised learning approach is employed when there is a known data type, as in labels versus object output; this can be utilised for the purpose of predicting diseases, for example. An example of this method includes SVM or decision trees [66],[67],[68].
- Unsupervised learning refers to the method of finding hidden structures within data that doesn't contain any pre-defined labels; two examples are K-Means clustering and Principal Component Analysis [69],[70],[71].
- Reinforcement learning is another type of ML that helps to optimise sequential decision processes and has applications such as robotic surgery and treatment planning [72],[73],[74].
- There are advantages and disadvantages of ML; however, improved diagnostics and personalised treatments are seen to benefit healthcare, but the confidentiality of data and bias in algorithms are major concerns [75],[76],[77].

## 3. METHODOLOGY

Deep Learning (DL) is a subfield of Machine Learning, utilising artificial networks to assess complicated data; this has a particularly strong impact on the healthcare area. It allows processing large quantities of both structured and unstructured data, such as images, genomic data, medical records and so on, in different healthcare domains and has become highly valuable [78],[79],[80]. The representation learning in deep learning represents a rather

different paradigm from the classical machine learning approach, which attempts to learn a representation from the raw data. DL utilize a class of computational models, typically layered artificial networks, where the computation is performed as a cascade of non-linear processing stages at increasingly abstract levels. In contrast with the typical neural networks used in ML, Deep Learning networks have a greater number of layers, complex interconnectivities and allow the extraction of complex features [81],[82],[83]. Traditional ANNs are normally confined to 3 layers and trained to supervised representations best-suited for a given task (Figure 8.2), lacking in most cases generality. Each layer in a deep network produces a representation of the features it observed based on the features observed by the previous layer below [84],[85],[86]. This is achieved through the optimisation of local, unsupervised criteria. A major point of deep learning is that feature representation is learned from data using a general-purpose learning algorithm rather than being hand-engineered. A sketch of this is provided by Fig. 2; through the use of multiple hidden layers, a deep neural net can non-linearly understand the input data and thus allows the subsequent hidden layers' nodes to learn robust "deep structure" and representations that can then be pre-trained [87],[88],[89].



**Figure 2:** Structure of ANN and Deep Learning [15]

#### 4. RESULTS AND DISCUSSION

Natural Language Processing (NLP) refers to the AI technology that is concerned with how machines can interpret language in a human-readable manner - basically like how we communicate with one another [90],[91],[92]. NLP analyses natural language information from a variety of sources (text and audio recordings, images, etc.) through algorithms and techniques, including machine learning, deep learning and text analytics [93],[94],[95]. NLP technologies can be used in many computer science domains, such as named entity identification, text categorisation, automatic summarisation, question answering, and sentiment analysis. A comparison of different AI algorithms is represented in Table 8.1. the structure and meaning [96],[97],[98]. With this capacity, firms may better access client input and make more accurate and well-informed decisions. Due to health systems' recognition of NLP's capacity to search, analyse, and interpret large volumes of patient data, its use in the healthcare industry is growing, as given in Table 1[99],[100],[101].

**Table1.** AI Algorithms Used in Healthcare

AI Algorithm	Description	Advantages	Disadvantages
<b>Machine Learning (ML)</b>	Algorithms that, without explicit programming, generate predictions or judgments by identifying patterns in data. Comprises reinforcement learning, supervised learning, and unsupervised learning.	Makes it possible to use predictive analytics to identify diseases. Enhances diagnostic precision. Encourages individualised treatment regimens.	Needs a lot of information. Data biases are likely to produce erroneous forecasts. Black-box models lack transparency.
<b>Natural Language Processing (NLP)</b>	Methods for clinical texts, audio, and unstructured data that give computers the ability to comprehend and interpret human language.	Enhances the ability to extract data from unstructured clinical notes.  Chatbots and virtual aides improve patient relationships. Decision-making is aided by real-time data analysis.	Contextual and unclear language can be difficult for them. Sensitive to differences in terminology, including medical jargon
<b>Support Vector Machines (SVM)</b>	An algorithm for supervised learning that is applied to regression and classification applications, such as cancer diagnosis.	Effective for small- to medium-sized datasets.  High accuracy in binary classification tasks (e.g., disease detection).	Not suitable for large datasets.  Sensitive to noise and requires careful parameter tuning.
<b>Decision Trees</b>	A decision-making tree structure is produced by a supervised learning algorithm that divides data into subsets according to feature values.	Easy to understand and interpret.  Can handle both numerical and categorical data. Efficient for simple classification tasks.	Prone to overfitting, especially with small datasets.  Performance can degrade with noisy data.
<b>K-Means Clustering</b>	An unsupervised technique, frequently used in patient segmentation, separates data into 'K' different groups according to similarity.	Simple and fast for clustering tasks. Efficient in segmenting large datasets.  Helps in identifying patterns in patient data.	Requires a predefined number of clusters. Sensitive to the initial choice of 'K'.  Can struggle with non-linear data.
<b>Generative Models</b>	Models that generate new data points similar to training data are used in drug discovery and virtual screening.	Can simulate new drug molecules and predict their effectiveness.  Helps in optimising molecular design for drug discovery.	Computationally expensive. Often requires a large amount of data to produce accurate results.

#### 4.2. The AI in Healthcare

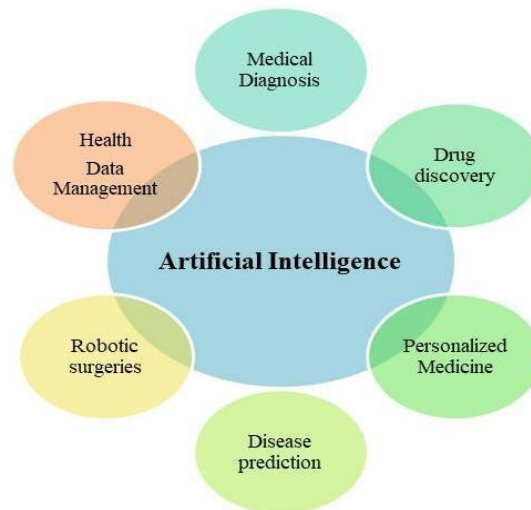
Be the type of telemedicine technology supplier that a clinician will trust and admire [102],[103],[104]. Briefly speaking, AI means developing computer systems to perform tasks requiring human intelligence, such as learning from experience, reasoning, making decisions, and using natural language. Because of the fast progress of machine learning, deep learning, neural networks, and AI, problem-solving strategies of all fields [105],[106],[107] are changing. Healthcare is one of the areas where you find some applications for AI, giving new ways for improving patient risk reduction, operational efficiency, and access improvement. The most prevalent uses of AI in healthcare are diagnostics. AI-driven solutions are capable of analysing medical images (X-rays, MRIs and CT scans) to such an accuracy that it even exceeds and equals that of human radiologists in identifying abnormalities. For example, algorithms are deployed to detect the earliest indicators of disease, including cardiac and neurological conditions as well as cancers [108],[109],[110]. Winning Diagnostics, Accelerating Interventions, Better Health for patients; Furthermore, AI-based tools can also read a wide range of EMR data to pinpoint certain connections and patterns that human health care professionals might overlook, enabling the whole body view for a patient [111],[112],[113]. One public health use case of AI is for forecasting and monitoring diseases. AI can analyse information from a range of sources, from social media to news articles to medical records, searching for patterns that might indicate the outbreak of a disease and where it may spread. This allows rapid identification and prevention of diseases along with proper allocation of resources.

AI and the COVID-19 Pandemic. The COVID-19 pandemic relied heavily on the use of AI from predicting infections to determining the allocation of vaccines [114],[115],[116]. Another substantial use of AI in healthcare lies within administrative procedures. By automating basic processes such as appointments, coding and billing, the use of AI can remove the tedious administrative load faced by healthcare professionals and allow them to devote more time and attention to the care of patients. Artificial analytics may also enable optimal usage of resources within hospitals, including bed usage, staff rotas and devices, and enhance effectiveness [117],[118],[119]. Despite its many uses in healthcare, there are many issues that may arise with the use of AI systems in the industry. There is concern surrounding data privacy and ethics, the establishment of appropriate laws and regulations, to prevent potential abuse of AI technologies [120],[121],[122]. While many news articles will promote the use of AI in the healthcare industry, they do not address additional issues that arise when considering the integration of AI in current healthcare settings, which will involve high costs on both the development of infrastructure and on staff training [123],[124],[125].

#### 4.3. Artificial Intelligence Applications in Healthcare

Industry leader, health care is quick to integrate technological development and innovation into its practices [126],[127],[128]. In recent years, the advancements in Artificial Intelligence (AI) have been tremendous; all the pharmaceutical and biotech firms, MedTech companies and start-ups have rushed to the developing stage for the latest new AI tools for each of the fields. There are patient monitoring, drug discovery, preclinical trials, clinical trials, genomics, and early diagnosis and detection tools. Other newly developed field of AI for health care includes surgical assistance, cyber security, patient management and fraud detection [129],[130],[131]. For example, during the last COVID-19 pandemic, the rapid deployment of AI-based tools was also observed in healthcare; this trend is expected to continue in the future [132],[133],[134].

For 20% energy efficiency and carbon reduction by 2020. The Information Communication Technologies (ICT) sector was asked for more green and low-carbon strategy plans, which have been done using modern designs and technologies [135],[136],[137]. The ICT industry is involved in the 2020 target in 3 ways. Directly, it is asked to decrease energy consumption of its devices (green networks, green IT), indirectly it is asked to decrease Carbon footprint (carbon displacement), and systematically the ICT tools cooperate with other economic sectors to obtain energy efficiency (smart grids, smart buildings, intelligent transportation systems, etc.) ICT has a significant contribution to carbon emissions, and its electrical demands take a large portion of the operational costs (OPEX) of companies. In this paper, sources of Carbon emissions and related issues for the sector should be addressed in order to decrease electricity costs and carbon emissions (Figure 8.3. Illustrates application field for AI in healthcare) as per Figure 3 [138],[139],[140].

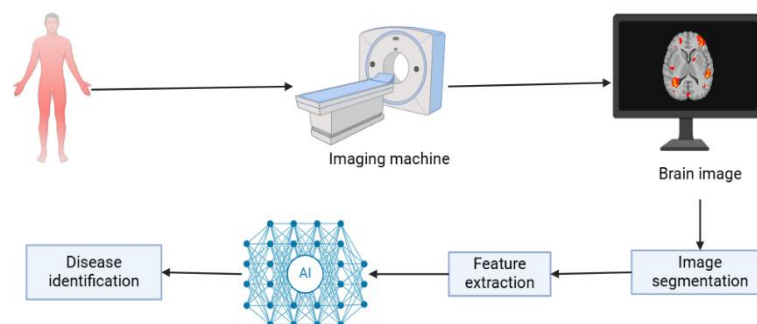


**Figure 3:** Artificial Intelligence Applications in Healthcare

#### 4.4 DISCUSSION

##### 4.5 Medical Diagnosis

Medical diagnostics is defined as the process of identification of the patient's state from examination of their symptoms, history, as well as data from tests such as examinations and laboratory analysis [141],[142],[143]. It plays a critical role in identifying underlying health problems and guiding effective treatment [23]. Diagnostic tests include various procedures, such as imaging studies (e.g., X-rays, CT scans, and MRIs), lab testing, and biopsy procedures that then inform the treatment regimen of patients by providers [144],[145]. The applications of medical diagnostics include disease diagnosis, assessment of treatment effectiveness in tracking disease progression, and prognostication of diseases to limit progression to an advanced stage [24]. AI's role in revolutionising medical diagnostics and improving patient care is predicted to be enormous [24]. The speed, accuracy, and efficiency of medical diagnoses in many specialities can be improved by AI. For example, AI algorithms are already assisting physicians by accurately identifying various medical conditions from medical imaging scans such as X-rays, CT scans, MRIs, ultrasounds, and DXAs [146]. Besides from identifying diseases, AI can examine large sets of patient information such as, 2D & 3D scans, bio-signals (EGG, EMG, EHR and ECG), vital signs (pulse, temperature, breathing and blood pressure), data of demography, clinical history and lab test results to improve both clinical decisions making, patient outcome prediction, to provide informed choices to clinicians [147]. It has brought an end to the need of identifying a condition that has started at the early stage of medical diagnosis so that advanced machine learning algorithms analyse medical scans such as X-rays, MRIs, and CT scans of patients, for abnormality indicators of tumours, fractures or organ failure, the role of the machine learning tool is also extended to aid physicians to detect rare conditions and further analyse its symptoms using vast medical databases [148] as shown below in figure 4.



**Figure 4:** Shows the AI Disease Diagnosis

#### 4.6 Drug Discovery

The research and development of drugs is a business area where high competition is, but many steps, financial resources, and time must be invested. The initial steps for the discovery of new drugs are fundamental research, such as assay preparation and structural determination. Further preclinical studies are performed on animals, where 5 out of 250 molecules get approved for clinical study phase (Figure .5) . People can barely access the clinical studies, and this lack of access to the medicine creates a financial burden on investment, which is caused by insufficient data at this stage. Although information is available for the phase IV study, uncertainty in clinical medicine development stages creates many barriers between consumers and medicine, hence interest tends to fall every day [149].

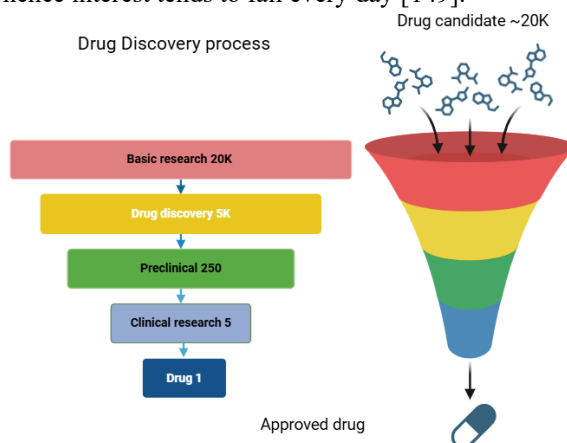


Figure 5: Pictorial representation of the drug discovery process during pharmaceutical research for a new molecule

#### 4.7 Personalised Medicine

Personalised medicine (also known as precision medicine) is an evolving concept that emphasises tailoring medical treatment to an individual's unique characteristics [150]. Medicine is moving from the "one size fits all" paradigm toward tailored treatment and preventative strategies based on the genetic, lifestyle, and environmental factors that define each patient. Personalised medicine "is a revolutionary concept in healthcare that modifies the treatment of medicine to each specific patient, taking into account his/her characteristics, such as the environment, lifestyle, among many other factors. The move toward a tailored approach "has enormous potential to improve treatment efficacy, decrease side effects, and improve patient outcomes." This advancement in the area of personalised diagnosis and treatment has become a reality thanks to the latest developments in genomics, proteomics, and data analysis, which have assisted in the discovery of various biomarkers and therapeutic targets. Nonetheless, privacy of data, legal issues, and the fair distribution of technology remain major hurdles that prevent wider acceptance of personalised medicine. This approach of treatment development hopes to "foster healthcare in a totally different perspective, thus looking at the potential it possesses in different eras." It endeavours to "achieve proper markers, changes of the technology, clinical uses, obstacles and chances and thus is termed as the ability to achieve formulation of targeted medicine"[151]. While aiming for targeted treatments, it is crucial to identify diseases at the cellular level and improve overall treatment response. This concept may significantly boost quality of life while improving life expectancy, while simultaneously reducing both time and medical costs. Furthermore, it has great potential to identify genetic predispositions to disease in individuals. In medical anthropology, this has implications in identifying different conditions within individuals, to list a few of its multiple applications [152]. Large amounts of data can be analysed with AI to determine the response of a specific patient to a certain medication or treatment. This allows for targeted treatment to be administered, which is most effective and tailored to that specific patient's needs. For example, AI systems are currently used in oncology to optimise cancer treatment plans and make it easier to determine a treatment protocol to minimise the effects, maximise the success rate, and prolong the life of the patients [153]. AI is also used in the discovery of new drugs; with machine learning, scientists are able to identify which molecule structures have the potential to become future drugs. This methodology shortens the drug development timeline and its cost. Artificial intelligence (AI) plays a huge part in bringing about the shift that personalised medicine is introducing to the medical world. It allows processing and analysing vast and complex medical data, which will result in improvement of disease diagnosis, treatment discovery and patient outcomes [154],[155],[156]. By finding minuscule patterns within environmental,

genetic, and lifestyle data, AI is able to identify novel biomarkers and treatment targets, resulting in more successful and effective treatment methods (Figure 6) [157].

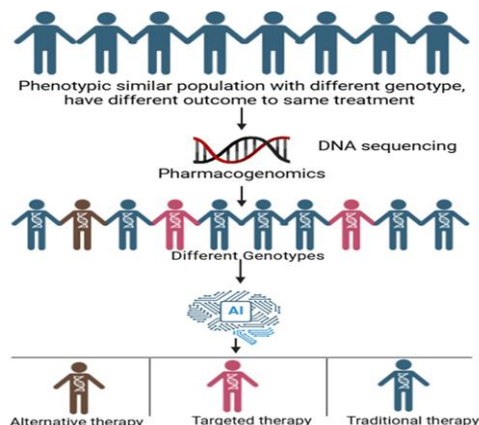


Figure 6: Role of AI in the era of personalised medicines for targeted treatment

## 5. CONCLUSION

AI is transforming the health care industry with machines performing tasks requiring general intelligence, such as learning, reasoning and decision making. The two main techniques involved are Machine Learning and Deep learning. These algorithms process large amounts of medical data to predict potential trends and outcomes for patients. Medical diagnosis is being greatly revolutionised by the advanced analysis of medical images, i.e. X-rays, CT scans, MRIs, etc. It has been noted that in certain circumstances, it can even outperform humans at detecting specific diseases at an early stage. AI is also contributing towards personalised medicine with treatment methods based on genetic information and the lifestyle of the patient, so that the best possible outcomes can be achieved. AI has been crucial to reducing both time and cost in finding drug candidates and, ultimately, the drug discovery process. It can also predict the patients' response to treatments, making the practice of medicine more preventive and personalised. The practice of robotic surgery can be made even more efficient with robotic assistance, reducing recovery times and improving the final outcome for the patients. Tasks such as planning and assigning medical staff and resources within hospitals are automated and streamlined. Medical diagnostic tools and management of health data are becoming increasingly sophisticated, with new techniques like machine learning, deep learning and natural language processing being able to create predictions based on the data, so that better care can be provided. Despite many advantages in AI integration in the health care field, there exist some difficulties that arise, including the issues of data privacy and algorithmic appropriation, along with the implementation of appropriate regulation frameworks. Despite this, technological advancement in AI in the field of health care is said to be ever-increasing in scale of operations.

## CONFLICT OF INTEREST

The authors declare no conflicts of interest regarding the publication of this research.

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