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# Use of AI in Early Disease Detection

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**Abstract:** Artificial Intelligence (AI) has emerged as a valuable technology in health care primarily for the early detection and prediction of diseases. AI leverages machine learning and deep learning systems to analyse complex and large healthcare datasets to identify disease related patterns and abnormalities that may not be easily detected using conventional methods. This review discusses the advancement and role of AI in early disease detection and its applications in various aspects of healthcare. This review further explores the methodology involved in developing AI-based detection systems focusing mainly on data collection, model training, optimisation, and model validation. Various applications and potential advantages of AI, including improved diagnostic accuracy, early identification of disease, along with their role in assisting clinical decision making is discussed. However, challenges such as data quality and availability, privacy concerns, regulatory issues may affect the implementation of AI in healthcare. Finally, regulatory and ethical considerations, following future directions including explainable AI, personalised medicine, wearable devices are explored in this review. Overall, AI shows considerable promise for early disease detection, but its successful integration requires reliable data, proper validation, responsible regulations, and human-AI collaboration.

**Keywords:** Artificial intelligence, early disease detection, multimodal AI, machine learning, deep learning, medical imaging, personalized medicine, wearable devices, electronic health records, precision medicine.

## 1. INTRODUCTION

The healthcare sector is experiencing a significant transformation, with AI becoming one of the leading forces behind this change.AI has the potential to detect diseases at an early stage. It also facilitates timely intervention and effective treatment. Some life-threatening diseases, such as cancer, cardiovascular diseases, neurological diseases, and rare diseases, become less difficult to treat if detected at an early phase. By utilizing AI, along with cognitive computing and machine learning systems, vast amounts of healthcare data, such as medical images, patient records, and genomic information, can be analysed rapidly and with greater accuracy. These technologies enable healthcare providers to identify hidden relationships within medical data, supporting better diagnosis and prediction of potential health risks. [1]

The Healthcare sector encounters several obstacles in the early detection of diseases due to rapid population growth, increasing diagnostic needs and the limited availability of skilled health care workers. Therefore, AI [Artificial Intelligence] plays an important role in overcoming these limitations by improving diagnostic performance, strengthening disease prediction, facilitating early detection, and enabling effective treatment management. AI also plays a crucial role in public health education and healthcare management by serving as a smart learning assistant, facilitating guidance and decision support, offering knowledge based on experience, and evaluating cognitive strategies. AI helps ensure the accuracy of medical records, supports healthcare professionals in decision-making and enhances patient safety.[2] AI can also help identify demographics and areas where diseases or high-risk health behaviour are more common. [3] AI can also improve some diagnostic tasks and make clinical work faster and more efficient. [6]

The rapid integration of artificial intelligence (AI) and medical imaging has contributed to the development of automated techniques for disease detection, anatomical segmentation, and image-based classification. Various medical imaging techniques, such as X-rays, MRI, computed technology, microscopy, and ultrasound, produce vast amounts of complex datasets. AI methods, such as Machine Learning (ML) and Deep Learning (DL), are widely used to predict and diagnose diseases, identify risk factors, discover medicines, and analyse medical images and signals. Support Vector Machine (SVM), an ML method, and Convolutional Neural Network (CNN), a DL method, are commonly used for disease diagnosis and detection. [3]

Healthcare systems are facing challenges due to aging populations, increasing diseases, and unequal access to healthcare. To address these issues, a paradigm shift toward "Virtual Medicine" has been introduced. Virtual Medicine refers to a digital healthcare system that uses advanced technologies, including AI, to improve disease prevention, diagnosis, and treatment. Over the years, AI has developed from a theoretical idea into a practical tool in healthcare. Improvements in ML and natural language processing have increased the use of AI in medical imaging, disease prediction, drug development, and clinical decision-making. [6] For rare and complex genetic disorders where diagnosis and prognosis are difficult, advanced methods are needed to analyse genomic data. Therefore, the use of AI, especially ML, has increased due to its capacity to understand complex genomic data. [4] Early detection and timely response to infectious diseases are essential for controlling their spread. Therefore, AI has become an important tool for improving disease monitoring and providing early warning of potential outbreaks. [5] AI systems help detect diseases at an early stage, identify high-risk patients, and support personalized treatment. [6]

## 2. HISTORY

**Origin of AI:** AI was first outlined in 1950. However, various challenges in the initial frameworks prevented its wider acceptance, recognition, application, and integration into healthcare. Many of these challenges were overcome with the development of deep learning during the early 2000s. Nowadays, AI systems are capable of analysing complex algorithms and self-learning. A new era in medicine has emerged, where AI can be applied to clinical practice through risk evaluation systems, enhancing diagnostic accuracy and workflow optimization. The development of computer-based intelligent behaviour was first discussed by Alan Turing in 1950, and he proposed the Turing Test, which determines whether computers are capable of demonstrating human-like intelligence. In 1956, John McCarth coined the term "Artificial Intelligence" (AI), defining it as the "science and engineering of making intelligent machines." (7)

**AI Development in 1960s:** In the 1960s, the National Library of Medicine developed the 'Medical Literature Analysis and Retrieval System', which became a useful digital source for medical literature and later supported the development of PubMed. During this period, clinical informatics databases and electronic medical record systems began to emerge. In 1961, the 'first industrial robot arm', "Unimate", was introduced on the General Motors assembly line in the USA for automated die casting. In 1964, Joseph Weizenbaum introduced "ELIZA", a natural language processing program designed to mimic human conversation through pattern matching techniques. In 1966, the Stanford Research Institute developed the 'first mobile robot', named "Shakey", which was capable of interpreting complex instructions and performing appropriate actions. It is marked as an significant advancement in robotics and AI.[7]

**Evolution of AI in Medicine from the 1970s to the 2000s:** This period is considered the "AI winter," characterized by reduced funding and interest, resulting in fewer significant advancements. There were two major AI winters, with the first occurring in the late 1970s and the second beginning in the late 1980s and continuing into the early 1990s. In 1971, Saul Amarel developed the Research Resource on Computers in Biomedicine at Rutgers University. In 1973, the 'Stanford University Medical Experimental–Artificial Intelligence in Medicine' (SUMEX-AIM) system was established at Stanford University to support collaboration among clinical and biomedical researchers. In 1976, the 'CASNET' model was developed at Rutgers University as an early AI-based consultation system for glaucoma diagnosis and patient management. It supported the early application of AI in medicine. [7]

'MYCIN' was developed in the early 1970s to identify potential pathogens causing bacterial infections and suggest appropriate treatments. In 1971, the Internist-1 project was launched to apply AI to complex medical diagnosis and featured one of the largest medical knowledge bases of its time. [6] In 1978, "AI in Medicine" (AIM) gained considerable attention within the AI research community, and the journal Artificial Intelligence published a special issue focused on AIM research. In 1980, the 'American Association for Artificial Intelligence' (AAAI) was established, which led to the formation of a special subgroup, AAAI-M, to focus on AI applications in medicine. Later, 'Artificial Intelligence in Medicine Europe' (AIME) was established. [8] In 1983, Arthrobot enabled early robot-assisted surgery, marking a milestone in medical robotics. [6] In 1986, 'DXplain' was developed as a decision-support system that acts as an electronic medical textbook, offering information on diseases. When it was first developed, it contained information on only 500 diseases. It later grew to cover approximately 2,400 diseases. [7]

**Advancement of AI in medicine (2000-2020):** In 2006, Hinton introduced deep learning, enabling neural networks to automatically learn features and improve performance on complex tasks. [6] In 2007, IBM developed Watson, a question-answering system designed to compete with human participants. In 2017, Watson was used to identify new RNA-binding proteins associated with amyotrophic lateral sclerosis. As computer hardware and software improved, digital medicine became more accessible, which helped AI in Medicine (AIM) develop rapidly. Chatbots also became more advanced, moving from simple systems like ELIZA to virtual assistants such as Apple's Siri, developed in 2011, and Amazon's Alexa, introduced in 2014. In 2015, Pharmabot was introduced as a chatbot designed to support medication education among paediatric patients. In 2017, Mandy was developed to streamline the patient intake process in primary care settings. [7] In 2017, Arterys developed Cardio DL, a deep learning tool that was approved by the FDA for automated ventricular segmentation in cardiac MRI, representing a significant step toward the clinical adoption of AI [6].

**AI Innovations in Recent Years (2020–2025):** In 2020, generative AI began gaining momentum. In 2020, AlphaFold 2, an AI system achieved a major advancement in determining protein structures, supporting the development of peptide drugs and advances in structural biology. In 2024, RETFound was developed to perform eye disease detection, diagnosis and prognosis using retinal imaging, while reducing the workload of healthcare professionals. In 2025, the MUSK model was introduced as a vision-language model for personalized cancer care. It is used to detect cancer, predict molecular biomarkers and assess clinical outcomes such as diagnosis, prognosis, recurrence, and response to immunotherapy, therefore improving the effectiveness of cancer treatment [6].

## 3. METHODOLOGY OF AI-BASED EARLY DISEASE DETECTION

The exact methodology of AI-based early disease detection may differ based on the disease, data type, and AI technique. However, AI early disease detection generally follows a series of stages involving data collection and preprocessing, feature extraction and selection, model training and optimization, and validation and evaluation irrespective of the disease. [9]

### 3.1 Data Collection and Preprocessing:

The first step of AI disease detection starts with data collection and preprocessing of the patient data.

**3.1.1 Data collection:** A massive amount of patient data must be collected by the AI model at their earliest stages from clinical, biological, and daily lifestyle sources. These sources are typically divided into different categories:

**Electronic Health Records –** Electronic Health Records serves as a backbone of patient clinical history. It provides a comprehensive, long-term record of a patient's health across different health care settings over the years. EHR includes structured data and unstructured data. Structured data contains patient demographics, laboratory results, vital signs, medication prescriptions, and standardized medical codes. Unstructured data contains free-form clinical notes written by physicians and nurses, which contains detailed prescriptions about the patient's history, physical tests, and treatment plans.

**Medical imaging –** Medical imaging is visual data that represents detailed images of the human body. These images are often large, high-resolution, and structurally complex datasets.

They help healthcare professionals identify abnormalities, diseases, and clinical conditions.

AI models analyse medical images to extract important information and support diagnosis.

Major modalities include X-rays, CT, MRI, ultrasound, nuclear medicine, retinal, and thermoscopic images. Digital pathology also provides high-resolution whole-slide images that help AI detect diseases.

**Physiological signals and wearables –** Physiological signals are the continuous data that capture a patient's physical and biological rhythms in real-time. This continuous data tracking can be implemented inside the clinic and also in daily life for monitoring of patients' signals over time. Common bio-signals include electrocardiograms (ECGs) for cardiac activity, electroencephalograms (EEGs) for brain waves, electromyograms (EMGs) for muscle contractions, and nuclear medicine imaging (PET/SPECT). Wearable sensors also generate continuous signals, such as PPG for heart and oxygen saturation, and accelerometry for physical moments. These signals generate a long-time dataset for disease detection or disease monitoring [9][10].

**Genomic and multi-omics data –** AI processes massive biological data to identify complex genetic patterns linked to diseases. Genomic data helps assess genetic risk factors before clinical symptoms appear. High-throughput data includes DNA sequencing, proteomics, transcriptomics, and gut microbiome profiles. Omics data supports biomarker discovery and prediction of treatment responses. These insights enable personalized medicine and more precise healthcare decisions. [10]

**Multi-modal data –** Multimodal data is the combination of patient data that facilitates the diagnosis and treatment decisions. In clinical practice, it is rare to rely on a single data source, so the physicians combine data from patient history, physical examination, laboratory tests, medical imaging, pathology reports. By integrating these different patient data, multimodal data can capture the data that can be missed by individual modalities and potentially improve the efficiency of diagnosis or detection of a disease [9][10].

**3.1.2 Preprocessing:** Raw healthcare data are often heterogenous and prone to artifacts. The preprocessing cleans, standardizes into a common format and structure, and secures the data so that AI models can analyse it accurately.

**Data cleaning and Scaling -** Preprocessing resolves the missing data using mathematical imputation methods. Standardizes the different measurement errors and corrects the obvious typographical errors to prevent model degradation.

**Signal and image enhancement -** Visual data (medical images) is cleaned of artifacts and undergoes denoising to improve diagnostic clarity. Signal quality is directly evaluated, and noise filtering is applied to handle motion artifacts and displacements.

**Text standardization –** Narrative text is processed using Natural Language Processing (NLP) to handle clinical shorthand, speculation, and context-dependent abbreviations.

**Patient privacy and de-identification –** To comply with the rigorous data privacy regulations like HIPAA and GDPR, all sensitive patient data are secured through anonymization, consent, and privacy-preserving data sharing pipelines [9][10][11].

### 3.2 Feature Extraction and Selection:

Feature extraction and selection are the common second stage of AI-based disease detection. Feature extraction focuses on identifying predictive factors from raw clinical data that are associated with disease onset. Clinical data and laboratory data are examined to extract useful variables, such as biomarkers and vital signs, while CNNs are used to automatically extract meaningful features from imaging data. Feature selection narrows these factors by retaining the most relevant features and removing noisy, irrelevant, or repetitive inputs. PCA and RFE can be applied to reduce redundancy and data complexity. Cross validation is then used to assess the consistency and importance of the selected features. Together these steps help the AI model focus on the variables associated with early signs of disease, improving its efficiency and predictive performance [9].

### 3.3 Model Training and Optimization:

AI models used in early disease detection:

**Machine learning (ML) –** ML algorithms detect patterns from healthcare data and can be used to predict disease risk and promote early diagnosis.

**Deep learning (DL) –** DL uses multilayered neural networks to identify complex patterns in massive datasets. It is commonly applied in medical imaging to detect abnormalities associated with diseases such as cancer and neurological disorders.

**Natural Language Processing (NLP) –** NLP analyses and interprets the clinical language. It extracts disease information from clinical notes, medical records, and medical literature. which supports early disease detection.

**Computer vision –** Computer vision analyses medical images like X-rays, CT scans, and MRI scans and helps identify abnormalities that may indicate disease at an early stage [13].

During the model training, machine learning (ML), deep learning (DL), and other AI techniques are used to identify the patterns in healthcare data and predict a disease. Models such as logistic regression, decision trees, random forests, CNNs, and RNNs are trained and optimized through hyperparameter tuning to determine the most suitable configuration for disease prediction. Grid search or random search are used to adjust the parameters, which can significantly affect the model performance. Transfer learning can be used when labelled data are limited. It reduces the training time and improves the performance, particularly for medical imaging. SMOTE creates synthetic samples of the minority class if some diseases have fewer datasets. This helps the AI model to recognize rare disease indicators and also improve sensitivity [9].

### 3.4 Validation and Evaluation:

Validation and evaluation are the last stages of AI-based disease detection. Validation and evaluation determine the reliability of an AI model in detecting a disease and assess whether it can perform effectively as a real-world clinical tool. AI models are assessed through internal and external validation, followed by prospective clinical validation. Their performance is measured using statistical metrics. Therefore, validation and evaluation acts as the ultimate gatekeeper that translates the experimental model into a safe, real-world clinical tool [10][11].

**Validation –** Validation usually progresses from internal validation using cross-validation or held-out test sets to external validation, where the model's reliability and generalizability are assessed. Prospective studies or clinical studies provide stronger evidence of clinical validity by assessing the AI's performance in real clinical practice.

**Statistical performance metrics –** Model's performance is evaluated using metrics such as accuracy, precision, recall (sensitivity), specificity, F1 score, and AUC-ROC. This provides a clear picture of how effectively each model could detect disease across different classes.

**Clinical evaluation and interpretability -** Clinical evaluation goes beyond statistical performance by assessing algorithmic bias, health disparities, and explainability. Models should be evaluated to improve performance and interpretability. Explainable AI (XAI) techniques such as SHAP, LIME, and Grad-CAM are used to determine whether predictions are based on clinically relevant features rather than spurious patterns. Sensitivity analysis can also assess model stability under different parameter settings [9].
Overall, this methodology combines careful preprocessing, feature selection, model validation, and interpretability techniques to develop reliable and trustworthy AI-based approaches for early disease detection.

## 4. APPLICATIONS OF AI IN EARLY DISEASE DETECTION

AI is widely used to facilitate the diagnosis of medical conditions accurately at the early stages. AI algorithms can detect the diseases with high accuracy and are often detected at earlier stages than traditional methods. These early interventions can improve the quality of life [12].

**Cardiovascular Disease:** AI algorithms use patient health data (BP, cholesterol, family history, and life style) to predict the risk of heart diseases, heart attacks, and strokes. The AI models can identify even subtle patterns in the data, like detecting the abnormalities and changes in heart function, which facilitate early treatment to prevent severe cardiovascular problems. Wearable devices in AI (smartwatches) are also used to monitor and track the changes in heart function, which facilitates early treatment and prevent severe cardiovascular problems.

**Diabetes:** AI systems use risk prediction models to analyse the factors like age, BMI, lab results, and family history of an individual in order to assess the risk of developing diabetes in high-risk individuals at an early stage. It can also use continuous glucose monitors (CGMs), which provide real-time data on blood sugar levels. This enables personalized diabetes management, and reduce risk of complications associated with diabetes.

**Cancer:** AI helps in the detection of cancer at early stages by analysing medical images (mammograms, CT scans, MRIs), genetic information, and blood samples. AI can identify microcalcifications or masses of cancer. By identifying the individuals at risk and supporting less invasive testing, suggesting the preventive measures, and using AI to make early diagnosis and treatment of cancer easier.

**Neurodegenerative disease:** AI algorithms detect the neurodegenerative diseases like Alzheimer's and Parkinson's by analysing cognitive changes, brain images, and brain scans. Analysing early cognitive decline detection, imaging, and biomarkers helps in identifying individuals at risk before symptoms become noticeable and enables the early interventions that decrease disease progression.

**Hypertension:** AI can detect hypertension at early stages by analysing data from blood pressure monitors to detect abnormal fluctuations in blood pressure, which may indicate hypertension or prehypertension. By analysing factors such as age, family history, lifestyle, and health conditions, it can predict risk and support preventive steps like healthier habits, diet changes, or medication [13].

AI systems and wearable monitoring devices can analyse the patient data using AI algorithms. These AI systems not only predict these diseases but also other relevant diseases like chronic kidney disease, obesity, and metabolic syndrome. Thus, AI plays a crucial role in predicting the risks of diseases at the early stages and provides the information about the disease progression and prevention with the help of healthcare professionals.

## 5. ADVANTAGES OF AI-BASED EARLY DISEASE DETECTION

AI-based early disease detection systems facilitate a wide range of benefits for both patients and healthcare professionals by completely transforming disease management and prevention [12].

- AI can enhance the accuracy of disease diagnosis by identifying subtle patterns from a vast amount of patient data that human clinicians may miss. This results in more accurate diagnoses and decreases in the likelihood of false results.
- AI systems can detect diseases in their earliest stages, even before symptoms appear. This early disease detection provides scope for intervention and improves health outcomes.
- Proactive or early identification of disease by AI in individuals at risk enables the healthcare providers to intervene before the disease progression. This proactive approach creates scope for preventive measures that can delay or even prevent the onset of chronic diseases.
- By early detection of disease, AI prevents the complications that are associated with the disease by appropriate treatment that can reduce the disease progression.
- AI analyses individual patient data and creates personalized treatment plans. This can help clinicians select the most effective treatments, minimize side effects, and improve overall treatment outcomes.
- AI simplifies routine healthcare tasks like data analysis, image interpretation, and risk prediction, which increases the efficiency and reduces the clinician's workload. Early disease detection by AI systems leads to timely interventions and preventive care that helps decrease the long-term financial burden on both patients and healthcare systems.
- AI systems can help reduce human errors by providing clinicians with data-driven insights. This eliminates guesswork involved in diagnosis and treatment, which in turn reduces the chances of incorrect or delayed diagnosis and the risks associated with the disease.
- AI systems provide consistent and objective analysis that improves the reliability of diagnoses and decisions, particularly in complex or high-stakes medical situations. This helps clinicians make decisions without any cognitive bias.
  In research and development, AI-based detection systems can quickly analyse large datasets of patient data to understand disease patterns, risk factors, and treatment outcomes. By analysing the data, AI systems can also identify new drug candidates for disease in clinical trials. This helps researchers develop effective and personalized medicines. [13]

## 6. CHALLENGES AND LIMITATIONS

Despite the vast advantages of AI in early disease detection, there are also challenges and limitations that must be considered. Few of them are:

**Data privacy and security** – Maintaining security and privacy of the data is a big concern while using AI, as it requires vast amounts of data, including sensitive information of the patient, medical history, genetic information, which can lead to cyberattacks, data leakage, and unauthorized data access [13].

**Data quality and quantity availability** – AI uses medical data for disease identification. Medical data is complex and diverse, encompassing different information like laboratory results and medical images. Thus, incomplete or inaccurate data can affect the system's ability to do accurate predictions [14].

**Algorithms and data bias** – Bias in data and algorithms is one of the major challenges of using AL in disease detection. Bias may occur due to overfitting, incorrect labelling or unequal sampling of the data. Consequently, AI can produce inaccurate predictions or perform differently across patient populations, which potentially contributes to the unequal healthcare outcomes [14].

**Black Box models** – Many AI models, especially deep learning models, do the predictions without explaining how the decisions were made. These models are called black boxes since they lack transparency. In health care the lack of explanation could be problematic because knowing the reason behind a diagnosis is important for patient safety and for the clinician to trust the prediction made [13].

### Use of AI in healthcare raises regulatory and ethical issues.

Patient privacy, data security, and responsibility for AI decisions must be addressed before implementation. AI systems should be transparent, explainable, and free from avoidable bias in clinical decision-making. Proper regulatory oversight and human supervision are essential to ensure safe and lawful AI use. Healthcare professionals must remain accountable for decisions supported by AI systems [14].

**Cost and Accessibility** – Developing AI-driven early detections requires large amounts of money initially, while data collecting and model training, and then ongoing maintenance and operational expenses are required, which makes it difficult to adopt these systems. If AI systems are accessible only to well-funded hospitals or populations, low-resourced populations may not access the benefits of AI-driven systems. Therefore, the goal is to make the AI systems accessible to everyone regardless of where they live and their financial conditions, which is also a major challenge [13].

## 7. REGULATORY AND ETHICAL CONSIDERATIONS

AI-based diagnostic technologies and medical devices are developing rapidly. Understanding the liquid-like flow changes of AI, FDA is also adapting and changing its regulatory approach. AI-driven medical device manufacturers should stay updated with the new FDA's guidelines. The FDA continuously monitors the medical devices that are integrated with AI/ML software. FDA also maintains a list of about 500 medical devices using AI/ML technologies that have gotten the approval. Depending on the characteristics of the device, manufacturers may use different regulatory pathways, including 510(k) clearance, de novo submissions, and premarket approval (PMA). In both Unites States and the European Union, the regulatory framework enabling AI/ML-enabled medical devices is being developed.

AI-based diagnostic systems also need careful attention regarding the patient data because a large amount of sensitive patient data is used by the system to make the diagnosis. Appropriate measures must be taken to maintain the confidentiality and security of the data and comply with applicable requirements like the General Data Protection Regulation (GDPR) in the European Union and the Health Insurance Portability and Accountability Act (HIPPA) in the United States. To lower the risk of data breaching and unauthorized access, technical requirements like data encryption and access control must be implemented [15].

Usage of AI in healthcare raises many ethical concerns, because implementation is not only concerned with data accuracy but also with patient safety and privacy. The ethical issues that we should consider are patient rights, informed consent, responsibility to AI decisions, fairness, transparency, and doctor-patient relationship. Excessive dependence on AI can reduce the human element in healthcare while increasing accountability and evaluation concerns. AI software developed using highly resourced settings may not work the same way on every population and can cause inequalities in healthcare. Patients have the right to know whether AI has been used in their care; however, the regulations regarding such remain limited [11].

## 8. FUTURE DIRECTIONS

The continuous advancement in AI shows significant potential for AI-driven systems for early detection of chronic diseases. The below are the few areas that are likely to shape the AI systems-based disease detection.

**Data integration and multimodal AI –** Future AI systems are expected to increasingly integrate and standardize data from different healthcare sources. Different sources of data include Electronic Health Records (EHRs), genetic information, medical imaging, and wearable devices. Standardizing large amounts of patient data from different sources can help improve data compatibility and support AI systems to work more effectively in real time. In addition, multimodal AI can combine different data like clinical notes, laboratory results, sensory data, and medical images, which may provide a comprehensive understanding of an individual patient's health. By incorporating this integrated approach, the detection of disease may become a lot more accurate.

**Advancements in AI algorithms and explainable AI –** Future research in healthcare using AI is expected to focus on transparency and interpretability of AI models. Explainable AI (XAI) helps clinicians to understand how an AI model has arrived at this prediction. This helps to increase trust and confidence in using AI-driven system predictions. In addition, techniques like transfer learning and few-shot learning may overcome the availability of low disease-related training data. These techniques can help the AI systems to use knowledge from related databases or learn from a small number of examples, which may improve the performance when the data related to a disease is limited [13].

**Personalized medicine –** Use of AI in health care has the potential to support personalized medicine. With patient-specific information, healthcare professionals using AI can detect the patient's risk of developing diseases and can also identify suitable treatment options. AI can assist in monitoring how a patient is responding to the treatment over time. This helps healthcare professionals to make decisions regarding individual patient care [14].

**Wearable technologies and real-time monitoring –** Wearable devices can become very important in AI-driven system monitoring, so future research may mainly focus on the accuracy of wearable devices. These wearable sensors can be used in monitoring blood glucose level, heart rate, oxygen saturation, and more. Continuous monitoring through these devices can help in recognizing the symptoms at an early stage before they become severe. Internet of Things (IoT)-enabled devices can be integrated with AI so that the collection and transmission of real-time patient data occur continuously. Further, these AI systems analyse the data and provide personalized monitoring, and real-time alerts will be sent to patients and the healthcare professionals. As AI algorithms continue to improve, they enable earlier identification of abnormalities and enhance disease detection using data collected from wearable devices [13].

**Clinical Validation and Real-World evaluation -** Prospective validation of AI systems is important for future clinical research. Researchers should conduct randomized controlled trials (RCT) to understand whether AI systems can improve the patient outcomes, be cost-effective and make healthcare more effective. Most of the AI systems have been working using the data that has been collected, whereas only a few systems work within actual clinical environments. Prospective validation helps us to determine whether, good-performing AI systems can produce benefits to patients [11].

**Human-AI Collaboration and Training –** The implementation of AI also depends on the readiness of healthcare professionals and the ability of the healthcare organizations to use AI effectively. Healthcare professionals should be able to evaluate the outputs of the data. Training is needed for healthcare professionals with a basic understanding of AI, the ability to access the results, and knowledge of how to work effectively with AI and ethical issues related to AI. Healthcare organizations and hospitals also need systems to manage AI. After AI systems are introduced, it should be continuously evaluated to ensure it fits into normal clinical work. Proper training and institutional preparation can help us introduce AI from research to everyday clinical use [11].

## 9. CONCLUSION

Artificial Intelligence (AI) is becoming an important technology in healthcare, especially for disease prediction, diagnosis, and prevention. AI can analyse different types of healthcare data, such as electronic health records, medical images, physiological signals, and genomic data, to identify disease-related patterns at an early stage. This can help healthcare professionals make better and faster clinical decisions. However, the effectiveness of AI depends on the quality of data, proper model training, and clinical validation. AI can improve diagnostic accuracy, support early intervention, reduce workload, and contribute to personalized healthcare. At the same time, challenges such as data privacy, security, bias, data quality, and lack of interpretability need to be addressed. In the future, combining multimodal data, wearable technologies, real-time monitoring, and personalized medicine may further improve AI applications in healthcare. Overall, collaboration between AI technologies and healthcare professionals is essential for safe, reliable, and effective use of AI in disease detection and patient care.

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