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Application Progress of Artificial Intelligence in the Diagnosis and Treatment of Diabetes and Its Complications

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Abstract: ***Diabetes is a global chronic disease, and its diagnosis and treatment process faces many challenges such as precision, individualization and prevention and control of complications. Artificial intelligence (AI) technology has shown great transformative potential in the whole process of diabetes diagnosis and treatment with its ability to integrate multimodal data. This article discusses the application of AI in the early screening and diagnosis of diabetes, blood glucose management and treatment optimization, and complication prediction and management, and analyzes the challenges and future development direction, so as to provide a reference for research and clinical practice in the field of endocrinology.***

Keywords: Artificial intelligence, Diabetes mellitus, Complications, Diagnostic and therapeutic applications**.**

1. Introduction

With the rapid development of science and technology, artificial intelligence technology is gradually being integrated into the medical field, profoundly changing the traditional diagnosis and treatment mode. Diabetes mellitus, as a chronic metabolic disease that is widely prevalent in the world, the number of patients has continued to grow. It is predicted that the number of diabetes patients worldwide will surge to 1.3 billion [1] by 2050. This not only places a heavy burden on the health of individuals with diabetes, but also places a huge strain on the global healthcare system. Due to the complexity and diversity of diabetes, traditional diagnosis and treatment methods are difficult to meet the precise and personalized medical needs. In this context, the introduction of artificial intelligence technology has brought new opportunities for the diagnosis and treatment of diabetes and its complications.

With the help of deep learning and big data analysis, artificial intelligence technology plays an important role in the early screening, accurate diagnosis, personalized treatment plan formulation, and the prediction and management of complications of diabetes. Its unique algorithm model can process massive medical data and capture subtle changes that are difficult to detect by traditional methods, thereby improving the accuracy and efficiency of diagnosis and treatment. In addition, artificial intelligence can also simulate the thinking and diagnostic reasoning process of doctors, provide strong auxiliary decision support for clinicians, and help to formulate more scientific and reasonable treatment plans. In the diagnosis and treatment of diabetic complications, artificial intelligence has also shown significant application potential, which can realize the early prediction and effective management of retinopathy, renal disease, peripheral neuropathy and other complications, thereby reducing the disability rate and mortality of patients [2,3].

With the continuous progress of artificial intelligence technology and the continuous accumulation of medical data, its application prospect in the diagnosis and treatment of diabetes and its complications increasingly broad. This article reviews the latest research progress and application cases of artificial intelligence in the diagnosis and treatment of diabetes and its complications, and discusses its future development trends and challenges, in order to provide a useful reference for endocrine experts and researchers in related fields.

2. Application of AI in the Early Screening and Diagnosis of Diabetes Mellitus

2.1 Risk Prediction and Early Warning

2.1.1 Machine learning models help in disease risk prediction

In the early prevention and control of diabetes, accurate prediction of the risk of onset is very important. Traditional scoring tools have certain limitations in assessing the risk of developing diabetes. With the development of artificial intelligence technology, machine learning models based on electronic health records, genomics and lifestyle data have emerged. Models such as Random Forest [4] and XGBoost [5] can comprehensively analyze a large amount of complex data. Electronic health records contain rich information such as patient's past medical history, medical records, laboratory examination results and so on. Genomic data reveal the genetic characteristics of individuals, and some gene variants are closely related to the onset of diabetes. Lifestyle data include diet, exercise, smoking, alcohol consumption, and so on. Through deep mining and analysis of these multi-source data, machine learning models can find hidden rules and patterns behind the data, so as to predict the risk of diabetes more accurately. A large number of studies and practices have shown that these machine learning models are significantly better than traditional scoring tools in prediction accuracy, which provides strong support for the primary prevention of diabetes and helps doctors to take intervention measures in advance to delay or prevent the occurrence of diabetes.

2.1.2 Early warning of complications can be achieved by fundus image analysis

Diabetic retinopathy (DR) is one of the common and serious complications of diabetes mellitus. Early detection and intervention are essential to prevent vision loss. A community screening model developed by a team [6] from Shanghai Jiaotong University has brought a new breakthrough in the early warning of DR. The model uses artificial intelligence technology to analyze the images of the fundus. The fundus is the only part of the body where blood vessels and nerves can be directly observed. Diabetes can cause a series of pathological changes in the fundus vessels. Through advanced image recognition and analysis algorithms, the model can detect small lesions in fundus images, such as microhemangiomas, bleeding spots, exudates, etc. These early lesions may be difficult to detect with the naked eye, but the AI model is able to detect them acutely. The sensitivity of the model is up to 94%, which means that it can accurately identify patients with DR In the vast majority of cases, realizing the early warning of DR. The application of the model at the community level can easily screen a large number of people, improve the early diagnosis rate of DR, and obtain timely treatment opportunities for patients.

2.2 Subtype Classification and Accurate Classification

2.2.1 Unsupervised clustering algorithm subdivides diabetes subtypes

Type 2 diabetes mellitus (T2DM) is highly heterogeneous, and different patients have great differences in pathogenesis, clinical manifestations and treatment response. Unsupervised clustering algorithms such as K-means play an important role in the subtype classification of diabetes. By analyzing the clinical characteristics, metabolic indicators, gene expression and other multi-omics data of patients, K-means algorithm can subdivide type 2 diabetes into different subtypes, such as insulin resistant type and β-cell defect type. Patients with insulin resistance are mainly characterized by decreased sensitivity to insulin. Even if the insulin level in the body is normal or increased, it can not effectively lower blood glucose. Patients with β-cell deficiency have insufficient insulin secretion due to impaired islet β cell function. This subtype classification helps doctors to understand the pathophysiological mechanism of patients, and then develop a more individualized treatment plan for patients. For example, patients with insulin resistance can be treated with drugs that improve insulin sensitivity; In patients with beta-cell deficiency, more aggressive insulin supplementation or the use of insulinotropic agents [7,8] may be required.

2.2.2 Deep learning combined with CT images assisted metabolic classification and risk judgment

In addition to subtype classification, metabolic classification of diabetes and risk assessment of complications are also of great significance for clinical treatment. Deep learning models combined with CT image analysis provide a new means for this field. CT images can clearly show the morphology and structure of human internal organs, especially the distribution of visceral fat. Visceral fat accumulation is closely associated with insulin resistance, metabolic disorders, is important in the development of diabetes risk factors. Deep learning models have powerful feature extraction and analysis capabilities, which can accurately identify and quantify the content and distribution characteristics of visceral fat from CT images. Through the analysis of these features, the model can assist doctors to determine the metabolic classification of diabetic patients, such as the presence of central obesity and abnormal [9-10] fat metabolism. At the same time, it can also assess the risk of complications such as cardiovascular disease and kidney disease in patients. Based on this information, doctors can make more accurate treatment and management plans for patients, including adjusting diet, increasing exercise, and rational use of drugs, so as to improve the patient's metabolic status and reduce the risk [11-12] of complications.

3. Ai-driven Blood Glucose Management and Treatment Optimization

3.1 Multimodal Data Fusion and Real-time Analysis

By integrating continuous glucose monitor (CGM) time series data, exercise volume collected by wearable devices, nutritional parameters from dietary records, and drug metabolism information from electronic medical records, the AI system can construct a multi-dimensional health portrait. The CGM-OGTT model developed by the Stanford University team can extract blood glucose curve characteristics through the 16-point glucose tolerance test, and combine with machine learning to identify metabolic subtypes such as insulin resistance and β-cell defect, with an area under the curve (AUC) of 88%-95% [13]. Fudan university RL - DITR system using reinforcement learning algorithm, real-time processing history blood sugar fluctuation, insulin sensitivity and so on more than 40 patients with physical characteristics, dynamic optimization dosing strategy [15].

3.2 Dynamic Prediction and Personalized Intervention

The Transformer architecture based GluFormer model showed strong predictive ability. By analyzing 12.5 days of continuous blood glucose data, it not only generated blood glucose curves that were highly consistent with the real CGM (correlation coefficient > 0.9), but also generated blood glucose curves that were highly consistent with the real CGM (correlation coefficient > 0.9). Can also be four years ahead prediction glycosylated hemoglobin (HbA1c), blood lipid and other key indicators. When combined with dietary data, the model accurately simulated the effects of specific foods on individual blood glucose, with a 37% [15,16] reduction in error compared with traditional methods. Hong Kong scholars team found further, through 10 kinds of metabolic marker combination forecast accuracy can reach 86% of diabetes onset, reveals the depth of AI in metabonomics level mining potential [17]. Some studies have shown that the deep learning early warning module can predict the risk of hypoglycemia 20 minutes in advance by analyzing 12 parameters such as 72-hour blood glucose fluctuation trend and insulin sensitivity coefficient, with a sensitivity of 92%. In clinical trials, the module reduced the incidence of nocturnal hypoglycemia by 42% and the incidence of daytime hypoglycemia by 30%.

3.3 Decision Support for Drug Therapy

3.3.1 Prediction of SGLT2 inhibitor Response

Sodium-glucose cotransporter 2 (SGLT2) inhibitors have become an important class of drugs for the treatment of type 2 diabetes, of which canagliflozin is widely used as a representative drug. However, the response of different patients to canagliflozin is significantly different, which directly affects the treatment effect and prognosis of patients. The ML-Diabetes platform is a machine learning-based diabetes management and prediction system. It integrates a variety of biomarkers and clinical parameters, and provides patients with personalized treatment plans through advanced algorithm analysis. The platform predicted the difference in treatment effect of canagliflozin on 3P-MACE (major adverse cardiovascular events, including cardiovascular death, nonfatal myocardial infarction, and nonfatal stroke). Its prediction model in the area under the curve (AUC) in the high level reached 0.89, compared with the traditional method, the performance of the ML - Diabetes platform was increased by 31%, for clinical doctors to patient evaluation card Glenn net response provides a more reliable tool, help to develop more accurate treatment strategies [18,19,20].

3.3.2 Screening for GLP-1 receptor agonist adaptation

GLP-1 (glucagon-like peptide-1) receptor agonists are also important drugs in the treatment of diabetes. The researchers developed a multimodal model based on gut microbiota metabolites, such as butyrate levels, and liver fat content. This model takes into account the interaction between gut microbiota metabolites and liver fat content, as well as their influence on the efficacy of semaglutide. Using this model, the researchers were able to identify groups of patients who were particularly sensitive to semaglutide and who experienced significant improvements in weight loss. Experimental data showed an 18% improvement in weight loss after adaptation screening using this model, which has important implications [21,22] for improving weight management and diabetes control in patients.

4. Breakthroughs in AI in the Prediction and Management of Complications

4.1 Application of Diabetic Retinopathy

4.1.1 Improve screening efficiency and accessibility

The application of artificial intelligence technology in the medical field has been deepening, especially in the screening of diabetic retinopathy. Through the detailed analysis of fundus images by deep learning algorithms, artificial intelligence can complete the screening of diabetic retinopathy in a very short time. Relevant studies have shown that artificial intelligence systems have achieved comparable or even better sensitivity levels than manual grading, with sensitivities ranging from 85% to 95% [23]. The US Food and Drug Administration has approved the IDx-DR system for clinical deployment. The system greatly simplifies the screening process, patients without experience tedious mydriatic process for inspection, effectively relieve the strain on the resources of ophthalmology. Of southern California in a pilot project to fully display the advantage of artificial intelligence screening: compared with traditional methods, artificial intelligence screening follow-up rate of diabetes patients significantly increased, and the whole screening process the amount of time is only 1/104 of the traditional method, realized the optimization [24] of existing health resources.

4.1.2 Accurate classification and early lesion identification

Artificial intelligence has also made remarkable achievements in the classification and early detection of diabetic retinopathy. Through the advanced image recognition technology, artificial intelligence can accurately identify the micro hemangioma, rigid seepage, new blood vessels, the hallmark of diabetic retinopathy. Based on multispectral imaging system of artificial intelligence, in the early lesion recognition show a high degree of accuracy, the kappa coefficient is 0.95, is better than that of low qualification ophthalmologist. Some advanced algorithms can also predict the risk of disease progression, such as assessing the probability of proliferative diabetic retinopathy by analyzing the area of non-perfusion area, which provides doctors with a more scientific basis [25,26,27] for decision-making.

4.1.3 Dynamic monitoring of therapeutic effect

Artificial intelligence also plays an important role in treatment follow-up and effect evaluation. Taking anti-VEGF therapy as an example, automatic analysis of OCT images after treatment by artificial intelligence can quantify the changes in retinal thickness, so as to accurately evaluate the efficacy of treatment. In the process of laser treatment, the artificial intelligent algorithm to optimize the photocoagulation parameter setting, reduce because of insufficient or excessive risk treatment. In addition, artificial intelligence can also accurately predict serious complications after treatment, such as vitreous hemorrhage. Relevant studies have shown that the prediction accuracy of artificial intelligence is more than 90%, which provides strong data support for doctors to adjust the treatment strategy, and helps to improve the treatment effect and quality [28] of life of patients.

4.2 Application in the Field of Diabetic Nephropathy

4.2.1 Renal image analysis and pathological diagnosis

Artificial intelligence can automatically analyze renal biopsy images through deep learning technology to identify typical pathological features of diabetic nephropathy such as glomerulosclerosis and basement membrane thickening. Literature shows that convolutional neural network-based models can achieve consistent diagnostic agreement with pathologists and reduce interobserver variability. In addition, artificial intelligence can also perform virtual staining optimization on hematoxylin-eosin (HE) and hexaminesilver (PASM) stained sections to assist the quantitative assessment of glomerular filtration rate and lesion severity [29].

4.2.2 Renal function assessment and risk prediction

Artificial intelligence algorithms can construct risk prediction models for diabetic kidney disease based on electronic health records (Ehrs) and laboratory data. By analyzing indicators such as blood glucose, urine protein, and blood pressure,

machine learning models (such as random forest and support vector machine) can predict the risk of progression to end-stage renal disease with a sensitivity of more than 85%. Some studies also integrate genetic factors (such as GLUT1 gene expression differences) to improve the prediction accuracy [30].

4.2.3 Personalized treatment decision support

The artificial intelligence system can combine the patient's pathological stage (such as the MEST-C score of IgA nephropathy) and clinical characteristics to recommend personalized treatment. According to the different stages of diabetic nephropathy (stage I-V), artificial intelligence can dynamically adjust protein intake, insulin dosage and antihypertensive drug selection to delay the deterioration [31] of renal function.

4.3 Application in the Field of Diabetic Cardiovascular Disease

4.3.1 Intelligent analysis of cardiovascular images

In cardiac echocardiography, artificial intelligence technology can automatically identify the left ventricle and assess the degree of myocardial scar and fibrosis. Studies have shown that the fully convolutional neural network (FCN) model can accurately identify the early structural abnormalities of diabetic cardiomyopathy, which is highly consistent with the results of manual analysis by experts. In addition, AI can also eliminate imaging artifacts and improve image quality [32].

4.3.2 Risk prediction of cardiovascular events

Machine learning models can predict the risk of myocardial infarction and stroke in diabetic patients based on multimodal data, such as electrocardiogram, blood lipids, and glycosylated hemoglobin. For example, random forest algorithm integrated variables such as age, blood pressure, microvascular complications and so on, and the AUC value of predicting cardiovascular death was 0.92, which was significantly better than that of traditional scoring systems. Some models also included continuous glucose monitoring data to improve the timeliness [33] of prediction.

4.3.3 Hypoglycemia and arrhythmia monitoring

Artificial intelligence is outstanding in identifying diabetes-related cardiovascular complications. For example, using continuous glucose monitoring (CGM) and wearable data, a deep-learning model can warn of asymptomatic hypoglycemic events in real time with more than 90% accuracy. Meanwhile, the AI electrocardiogram analysis system can automatically detect arrhythmias such as atrial fibrillation and premature ventricular contractions with a sensitivity of 95% [34].

5. Challenges and Future Directions of Artificial Intelligence in the Diagnosis and Treatment of Diabetes and Its Complications

5.1 Challenges of Artificial Intelligence in the Diagnosis and Treatment of Diabetes and Its Complications

5.1.1 Data privacy and security issues

Medical data contains a large amount of sensitive information of patients, such as health status and genetic data. In the process of applying artificial intelligence to diabetes diagnosis and treatment, these data need to be collected, stored and transmitted. Once the data is leaked, it will not only damage the rights and interests of patients, but also cause a crisis of confidence in the medical industry. For example, if a patient's diabetes-related privacy data is illegally obtained and disclosed, it may have a serious negative impact on the life, work and psychology of patients. At the same time, data may also face the risk of being tampered with in the process of transmission, affecting the accuracy [35] of diagnosis and treatment decisions.

5.1.2 Problem of algorithm interpretability

Many artificial intelligence algorithms, especially deep learning algorithms, make decisions that resemble black-box operations. In the diagnosis and treatment of diabetes and its complications, doctors need to understand the rationale and logic behind diagnosis or treatment recommendations in order to make reasonable judgments and decisions. However, some advanced AI algorithms have difficulty in explaining the causes of the results, which limits their wide application in clinical practice. When using AI to diagnose diabetic retinopathy, doctors may not know how the algorithm draws the conclusion of the lesion based on the fundus image, which makes doctors have concerns when referring to the diagnosis results and also raises concerns about the determination of medical liability.

5.1.3 Imperfect medical supervision

The application of artificial intelligence in the field of diabetes diagnosis and treatment is an emerging field, and the existing medical regulatory framework is difficult to fully meet its development needs. Regulatory authorities need to determine how to approve and certify medical AI products, how to regulate their clinical use, and how to monitor their performance and safety. At present may lack the unified standards to evaluate the accuracy, reliability and safety, which may lead to unqualified products into the market, bring potential risk [36] to the patient.

5.1.4 Insufficient technical reliability and stability

Medical scenarios require high reliability and stability of technology. Artificial intelligence (AI) systems may be affected by various factors such as data quality, algorithm bias, system failure and so on, leading to wrong diagnosis or treatment recommendations. There exist deviations in training data, for example, could lead to a diabetes diagnosis model for certain people appear deviation, influencing medical fairness and accuracy; Failure of the system during operation may lead to failure to provide timely diagnosis and treatment services for patients or incorrect results.

5.1.5 Difficulties in clinical verification and application transformation

Although many achievements have been made in the research of artificial intelligence in the diagnosis and treatment of diabetes and its complications, the transformation process from laboratory research to clinical practice faces many difficulties. On the one hand, the effectiveness and applicability of the research results in different clinical Settings and patient populations need to be further verified. Clinical doctors, on the other hand, the acceptance of new technology and using habit may also affect its application promotion. For example, some AI-based diabetes complication screening models perform well in a specific research environment, but in clinical practice, due to individual patient differences, device differences and other factors, their performance may be greatly compromised, making it difficult to be widely accepted in clinical practice.

5.2 The Future Development Direction of Artificial Intelligence in the Diagnosis and Treatment of Diabetes and Complications

5.2.1 Strengthening data protection and management strategies

In order to ensure the privacy and security of medical data, it is necessary to comprehensively use advanced encryption technology, strict data access control and anonymization. At the same time, a complete data sharing mechanism should be constructed to promote the circulation and rational use of medical data under the framework of following laws and regulations, so as to provide sufficient data resources for the development of artificial intelligence. For example, blockchain technology can be used to realize the secure storage and sharing of data to ensure the integrity and traceability of data. Federated learning and other technologies are used to train the model without disclosing the privacy data of patients, so as to effectively improve the efficiency of data utilization.

5.2.2 Research and practice on improving the interpretability of algorithms

Increase investment in the research of interpretable artificial intelligence algorithms, and strive to develop models and tools that can clearly explain the decision-making process. Visualization technology is used to present the internal mechanism of the algorithm in an intuitive way, so that doctors and patients can intuitively understand the process of the algorithm making diagnosis and treatment recommendations based on patient data. For example, the graphical interface shows the key steps and decision nodes when the algorithm processes patient data, which helps doctors to understand the algorithm logic.

In addition, the development of artificial intelligence system based on rules, is also an effective way to enhance decision-making interpretability and transparency. Such systems make decisions based on clear rules and logic, and each step of decision-making has a clear basis, which is easy for doctors and patients to understand and supervise, so as to enhance the credibility of the application of artificial intelligence in the medical field.

5.2.3 Improve the medical supervision system

Regulators should strengthen the close cooperation with research institutions and enterprises, and formulated specifically for medical artificial intelligence regulations and standards. The approval process, certification standards, clinical use specifications and quality control requirements of medical artificial intelligence products should be clarified to effectively ensure the safety, effectiveness and reliability of products.

The establishment of strict clinical trial standards is one of the key measures. Artificial intelligence products are required to undergo sufficient clinical trials to comprehensively evaluate their performance in different clinical scenarios and patient populations before they are marketed. At the same time, strengthen the market regulation, on a regular basis to evaluate product performance and security, once found the problem timely take measures to ensure the health of the patients' rights and interests.

5.2.4 Enhance technical reliability and stability

Continuously optimize artificial intelligence algorithms to improve their anti-interference ability and stability. With the help of big data augmented learning, multimodal data fusion and other technologies, the generalization ability and robustness of the model are improved to ensure its accurate operation in the complex and changing medical environment. A real-time monitoring and feedback mechanism is established to find and correct errors and deviations in the process of system operation in time.

Taking diabetes blood glucose monitoring and early warning system as an example, by integrating a variety of sensor data, such as blood glucose, heart rate, exercise, etc., it can more comprehensively capture the physiological information of patients and improve the accuracy and stability of blood glucose change prediction. At the same time, the real-time performance of the artificial intelligence system is monitored, and in case of abnormal situations, such as excessive deviation of diagnostic results and too long response time of the system, timely adjustment and repair are performed to ensure that the system is always in the best operating state.

5.2.5 Deepen the development of clinical application and integration

Strengthen the close collaboration between clinicians and technology development teams to ensure that the developed algorithms and models closely fit the actual clinical needs and have high practicability. Large-scale, multi-center clinical studies should be carried out to further verify the effectiveness and safety of artificial intelligence in the diagnosis and treatment of diabetes and its complications, and promote the translation of research results from laboratory to clinical practice.

For example, clinicians and technicians jointly develop intelligent diagnosis and treatment systems for different diabetes complications, and carry out joint clinical trials in multiple hospitals. In the process of trials, the performance of the system was optimized according to clinical feedback to make it more in line with the needs of clinical diagnosis and treatment. At the same time, the clinical practice of artificial

intelligence-assisted diabetes management should be actively carried out to explore its long-term effects in improving blood glucose control and reducing complications, so as to provide a solid clinical basis for the wide application of artificial intelligence in the field of diabetes diagnosis and treatment.

5.2.6 Promoting personalized diagnosis and treatment and health management

Using artificial intelligence technology to fully consider the individual differences of patients, such as genetic data, living habits, disease history, etc., to provide patients with more personalized diabetes diagnosis and treatment plans and health management plans. Through the analysis of the genetic information of patients, and predict the response to different treatments, realize accurate medication, in improving therapeutic effects and reduce adverse drug reactions.

Combined with patients' living habits and exercise data, personalized diet and exercise programs can be developed to help patients better control their blood glucose levels and improve the effect of diabetes management. In addition, with the help of smart devices and mobile health platforms, real-time health monitoring and remote management of patients can be realized, so that patients can obtain health guidance anytime and anywhere, improve their self-management ability, and improve the accessibility of medical services.

5.2.7 Expand the depth and breadth of multidisciplinary integration

Promote deep cross-disciplinary integration of artificial intelligence and medicine, biology, mathematics, statistics and other disciplines. Combined with biological knowledge, the pathogenesis of diabetes and its complications should be deeply explored, so as to provide richer biological characteristics and theoretical support for artificial intelligence models. For example, the study of genes and proteins related to the pathogenesis of diabetes can provide new biomarkers for artificial intelligence diagnostic models and improve the accuracy of diagnosis.

Mathematical and statistical methods are used to optimize algorithmic models and improve their performance and reliability. At the same time, we should strengthen cooperation with materials science, engineering and other disciplines to develop more advanced medical devices and sensors, provide better hardware for the application of artificial intelligence in diabetes diagnosis and treatment, develop new wearable blood glucose monitoring devices, achieve more accurate and convenient blood glucose monitoring, and provide more reliable data [37] for artificial intelligence analysis.

6. Conclusions

In the process of diagnosis and treatment of diabetes and its complications, artificial intelligence has played a positive and important role in many key links with its powerful data processing and analysis capabilities. From early risk prediction of disease, mining potential risk factors with a large number of clinical data and advanced algorithms, to accurate screening of complications, using image recognition, data analysis and other technologies to quickly and accurately detect lesions, to auxiliary decision-making of blood glucose management and treatment plans, providing doctors with data-based scientific recommendations. Artificial intelligence helps the early detection, early diagnosis and early treatment of diseases in an all-round way. This not only improves the efficiency and accuracy of diagnosis and treatment, but also to a certain extent makes up for the lack of data processing and analysis ability of traditional diagnosis and treatment methods, bringing a lot of convenience to patients and doctors.

However, the current practical application of artificial intelligence still faces a series of serious challenges. The issue of data privacy and security needs to be solved urgently. Medical data contains a large amount of sensitive information of patients, which will have a serious impact on patients once leaked, so effective measures must be taken to protect it. Explicable problems limiting its algorithm is widely used in clinical, doctors need to clearly understand the decision basis in clinical decision making, in order to ensure the rationality of the diagnosis and treatment, and the part of the "black box" of the algorithm features hindered the implementation of this requirement; The medical regulatory system is not perfect, which is difficult to keep up with the rapid development of artificial intelligence technology, and cannot effectively ensure patient safety and product quality. The reliability and stability of technology also need to be further improved. The complexity and particularity of medical scenarios require that artificial intelligence systems must operate accurately in various situations, otherwise it may lead to serious consequences. There are many difficulties in the process of clinical validation and application translation. Research results need to overcome many obstacles from laboratory to clinical practice, including adaptability to different clinical environments and doctors' acceptance.

Looking forward to the future, with the continuous progress of technology and the deep integration of multiple disciplines, the application of artificial intelligence in the diagnosis and treatment of diabetes and its complications is expected to make greater breakthroughs. Can be interpreted through strengthening the protection of data and improve the algorithm, improve the regulatory system, improve the technical performance and a series of measures such as deepening the clinical application of artificial intelligence will better service in the field of diabetes diagnosis and treatment, in order to improve the patients' health, reduce the medical burden of social and family play a bigger role. Doctors and collaboration of artificial intelligence will also become an important developing direction of the future medical model, the two complement each other, promote each other, jointly promote the diagnosis and treatment of diabetes and its complications towards a new height.

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