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Thinking and Methods

Intelligent Chinese Medicine: A New Direction Approach for Integrative Medicine in Diagnosis and Treatment of Cardiovascular Diseases*

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ABSTRACT High mortality rates from cardiovascular diseases (CVDs) persist worldwide. Older people are at a higher risk of developing these diseases. Given the current high treatment cost for CVDs, there is a need to prevent CVDs and or develop treatment alternatives. Western and Chinese medicines have been used to treat CVDs. However, several factors, such as inaccurate diagnoses, non-standard prescriptions, and poor adherence behavior, lower the benefits of the treatments by Chinese medicine (CM). Artificial intelligence (AI) is increasingly used in clinical diagnosis and treatment, especially in assessing efficacy of CM in clinical decision support systems, health management, new drug research and development, and drug efficacy evaluation. In this study, we explored the role of AI in CM in the diagnosis and treatment of CVDs, and discussed application of AI in assessing the effect of CM on CVDs.

KEYWORDS Chinese medicine, Western medicine, artificial intelligence, cardiovascular diseases, ischemic heart disease, heart failure

People's living standards have improved significantly, owing to the rapid economic development and the continuous improvement of health conditions. The spectrum of human diseases has also changed.[1] Chronic non-communicable diseases (CNCDs) are the leading cause of death and morbidity worldwide. According to the World Health Organization (WHO), CNCDs contribute to about 41 million deaths annually, with cardiovascular diseases (CVDs) accounting for 71% of all deaths worldwide. Moreover, CVDs are one of the leading causes of morbidity and mortality worldwide.[2] The etiology of CVDs is complex, involving several factors and mechanisms.

Chinese medicine (CM) has been used for long to prevent and treat CVDs. Clinical evidence suggests that CM potentially improves the prognosis of patients with CVDs,[3] significantly improves the quality of life of patients with CVDs by syndrome differentiation and treatment.[4] CM also has similar advantages as modern Western medicine (WM) in micro monitoring and precise treatment. In the big data era, artificial intelligence (AI) technologies are increasingly used in many industries and countries, including medicine. CM is mainly applied in auxiliary diagnosis, treatment and screening decision aids, expert systems, and health management. AI contributes to the modernization of CM. In this study, we summarized the role of AI in cardiovascular disease diagnosis, digital syndrome differentiation, health management, and data mining. In addition, we integrated AI into digital medica to effectively analyze how it could be used in CM and WM, particularly to improve the clinical diagnosis and treatment of CVDs, drug development, and improve the quality and cost of healthcare.

John McCarthy coined the term "AI" in 1955, defining it as "the science and engineering of making intelligent machines."[5] AI has been applied in robotics, language processing, natural language processing,

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and expert systems, for example, Stanford University developed the first expert system-based diagnosis and treatment system MYCIN in 1972.[6] In the 1970s, Chinese scholars tried to combine AI technology with CM. In 1978, they developed the first expert system of CM, GUAN You-bo's Liver Disease Diagnosis and Treatment Program, which pioneered the AI diagnosis system of CM.[7] In the 21st century, the internet and information technology have promoted the emergence and development of cloud computing, machine learning (ML), neural network, and deep learning (DL). Therefore, a vast amount of clinical experience in CM has been compiled into a databases, providing a solid foundation for the continued development of in the field of CM. Recently, with the continuous development of deep learning techniques, computers have been used to simulate human thinking for language recognition, image recognition, and natural language processing, among others. This has laid the foundation for the development of intelligent CM. The application of AI in modern WM also provides direction in CM.

Application of AI in WM and Traditional Medical Healthcare

AI technology used to develop algorithms that perform tasks related to human intellect. AI encompasses a wide range of learning practices, including but not limited to ML, representation learning, DL, and natural learning.[8] AI technologies can perform multiple functions, including disease diagnosis and therapy selection, risk prediction and disease stratification, reducing medical errors, and improving patient care.[9]

The application of AI technology in the medical field has rapidly developed in recent years (Figure 1). Ma, et al[10] developed an intelligent medical diagnosis model based on integrated deep neural networks. Contrary to the traditional medical system, it compensates for the numerous drawbacks by combining medical big data, authoritative expert literature, and neural network algorithms. This model not only performed a systematic diagnostic analysis of various symptoms but also exhibited higher accuracy and efficiency compared with traditional medical diagnosis models. AI can also be applied to medical image acquisition thanks to the digitalization of this process. Wang, et al[11] used a semi-supervised learning and multi-task technique to train a DL model and found that these advanced strategies improved the performance of the DL model in detecting structural changes of glaucoma in optical coherence tomography two-dimensional (2D) B-scan images. Moreover, the use of AI can improve image quality, imaging efficiency, and diagnostic accuracy for patients and doctors.[12] Wu, et al[13] used pyramid scenario analysis networks and transfer learning to build a Cystoscopy Artificial Intelligence Diagnostic System (CAIDS) for bladder cancer diagnosis. CAIDS has several clinical benefits, including increased diagnostic accuracy for bladder cancer, even for commonly misdiagnosed cases such as flat cancerous tissue, and shortened cystoscopy operation time. Gros, et al[14] proposed an OptiC algorithm, which enables the automatic, rapid, and accurate segmentation of brain and spine regions in magnetic resonance imaging. Additionally, the algorithm facilitates the precise marking of the spinal cord centerline. The recognition rate of OptiC for the gold standard centerline is 98.77%, and the average error is 1.02 mm. The recognition accuracy of the brain region is 99%, and the distance error between the brain and spinal regions is 9.37 mm, making them ideal for spinal cord image analysis. AI has also achieved good results when applied in pathologic diagnosis. By training AI models using swarm learning, Saldanha, et al[15] demonstrated that colorectal carcinoma pathology slides stained with hematoxylin and eosin can be used to predict the BRAF mutational status and microsatellite instability.

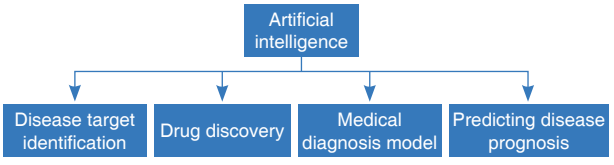

Figure 1. Application of AI in Medicine

Furthermore, AI has numerous advantages in predicting disease prognosis. Zou, et al[16] used four ML algorithms [gradient boosting machine, support vector machine, logistic regression, and random forest (RF)] to identify key clinical and pathological features to build a risk prediction model for end-stage renal disease (ESRD). The ML algorithms accurately predicted incident ESRD in patients with diabetic kidney disease. Among the four algorithms, the RF algorithm performed best in predicting the progression of ESRD. Similarly, network-based biology analysis algorithms and ML-based biology analysis play an important role in disease identification and drug discovery.[17] Selvaraj, et al[18] searched for therapeutic targets for lung adenocarcinoma in protein-protein

and protein-drug interaction networks and used neural networks to identify candidate drugs, in which threonine phosphate was predicted through molecular dynamics simulation, with mitogen-activated protein kinase 1, the hub node in the network, as the target. In conclusion, AI has thrived in various fields such as radiology,[19] oncology,[20] liver diseases,[21] CVDs,[22] psychiatry,[23] histopathology,[24] proteomics,[25] disease target identification,[26] and drug discovery.[27]

The main focus of CM's clinical practice is diagnosis and treatment. CM has a history of thousands of years of use and application. Modern studies have confirmed that CM has made great progress in the diagnosis and treatment of CVDs,[28] cancer,[29] ischemic stroke,[30] and other diseases. Recently, CM has shown unique advantages in the treatment of coronavirus disease 2019 (COVID-19) and gradually gained international recognition.[31,32] The combination of AI and CM is of great significance in promoting innovation of CM, creating modern diagnosis and treatment modes of CM, providing objective evidence for the scientific nature of CM, improving the clinical efficacy of CM and medical service ability of CM hospitals, and developing a health management model of CM preventive medicine.[33]

Firstly, digitalization of the four diagnostic methods of CM can improve the accuracy of CM diagnosis. Wu, et al[34] quantified four diagnostic methods of CM as input data of the model and used an adaptive neuro-fuzzy reasoning system to diagnose insomnia in CM. It was found that the accuracy rate of the model was 97.6%, which provided a reference for objective research on the diagnosis of insomnia. Li, et al[35] conducted a study involving 937 gastric cancer patients and 1,911 control participants (healthy individuals, superficial gastritis, and atrophic gastritis) across 10 centers in China. Using AI in-depth learning method, the authors established 3 diagnostic models utilizing tongue images. The findings indicate that tongue images can serve as a reliable diagnostic tool for gastric cancer, exhibiting significantly greater diagnostic value compared to the comprehensive analysis of 8 blood tumor markers. Furthermore, the fusion of tongue images and blood tumor indicators can improve the diagnostic value of individual tongue images.

Secondly, the integration of the CM theory of "prevention of disease" with modern prophylactic medicine and AI technology is of great significance in improving the efficiency of health management. Xia, et al[36] employed ML methods to establish a diagnostic model of metabolic syndrome using physicochemical and CM indicators. The findings revealed that waist circumference, body mass index, and fasting blood glucose are the most important indicators to predict metabolic syndrome. Additionally, CM indicators such as body fat, wiry pulse, chest tightness, spontaneous perspiration, greasy tongue coating, and snoring play an important role in metabolic syndrome prediction. Integrating CM indicators with physicochemical indicators enhances the specificity of metabolic syndrome diagnosis. This diagnostic model holds substantial importance for the early detection and treatment of metabolic syndrome, ultimately mitigating the incidence of cardiovascular and cerebrovascular diseases.

Third, new methods such as systems biology, bioinformatics, data mining, and network pharmacology provide a new direction for the development of CM.[37-40] A paradigm shift has been marked in CM by the integration of pharmacology and conventional medicine, especially after the birth of network pharmacology.[41] Compared with the holistic concept of CM, network pharmacology stands out for its emphasis on systematization and integrative analysis, offering a promising new approach for investigating complex CM systems. By elucidating the pharmacological basis and therapeutic CM targets for the treatment of diseases, and using AI technology to bridge the biological network of disease phenotypes and patient genotypes, a new targeted biological network therapy method combining CM and WM is established.[42] Molecular biological studies and/or network pharmacology prediction have demonstrated that CM may have therapeutic effects on COVID-19 by targeting angiotensin-converting enzyme 2,3C-like protease, and interleukin 6 (IL-6).[43] Through network pharmacological techniques, Pan, et al[44] showed that the "*Cinnamomum cassia*-*Paeonia lactiflora* Pall" herb pair could treat chronic pain with comorbid anxiety and depression through targets such as serine/threonine kinase 1, IL-6, tumor necrosis factor (TNF), prostaglandin-endoperoxide synthase 2, JUN, and advanced glycation end product (AGE)/AGE receptor (RAGE), IL-17, and TNF signaling pathways. In summary, the intellectualization of CM diagnosis and treatment and the modernization of CM theory will certainly make great progress with the continuous integration of AI into healthcare.

AI Is an Important Link Integrating CM and WM

AI has the potential to significantly advance CM phenomics, enabling more precise diagnosis and treatment in the field of CM. Drawing on the fundamental principles of CM, as well as advanced tools such as cellular molecular biology, genomics, and proteomics, CM phenomics offers a comprehensive and precise evaluation of the full spectrum of CM diseases and syndromes, tracking their progression and response to CM intervention at macro, meso, and micro levels.[45] Through this approach, modern scientific essence of CM can be fully revealed. AI can utilize ML or DL algorithms to identify and extract the phenotypes of the four diagnoses of CM. These phenotypes can then be quantified and standardized, and a database can be established. Next, the macroscopic phenotypic characteristics of CM and WM were integrated based on the microscopic information such as cellular and molecular information, and the overall information network of "disease-syndrome-treatment" was constructed. During diagnosis and treatment, data mining is performed to identify indicators for disease risk characterization and biomarkers for accurate diagnosis and treatment of diseases and syndromes. This improves the overall information network of "disease-syndrome-treatment", and promotes the development of CM phenoomics. The development of CM phenoomics provides a basis for exploring the internal mechanism of CM diseases and syndromes at micro level, there revealing the material basis for the occurrence and development of diseases. This also allows the establishment of a CM syndrome differentiation and treatment system that combines macro and micro information. Li, et al[46] developed the UNIQ System (Using Networking target for Intelligent and Quantitative analysis on drug actions) which facilitated the panoramic analysis of the relationship between phenotypic cell-molecule-Chinese and WM through a series of high-precision relationship inference algorithm and network target global analysis algorithm. The system can improve the interpretation of the scientific principles of CM from the perspective of information and system, and promotes accurate diagnosis, treatment, and research on CM.

Second, evaluation of dominant diseases in CM and WM and selection of appropriate diagnosis and treatment methods can help achieve more personalized and accurate patient care. Through expert investigation, medical record review, and evidence-based evaluation methods, the use of CM treatment may yield better clinical outcomes than WM, or further improve the efficacy on the basis of WM treatment, or alleviate the adverse reactions caused by WM treatment. Moreover, CM is safer compared to WM treatment, and its less costly.[47] AI integrates existing evidence-based medical evidence and recommends the most appropriate CM and WM for the diagnosis and treatment of different patients based on available evidence, which results in enhanced efficacy, reduced adverse reactions, as well as less diagnosis and treatment costs. Cen, et al[48] developed a quantifiable CM syndrome differentiation and treatment platform based on the knowledge of dominant diseases, which automatically recommends treatments and prescriptions by obtaining patient symptoms and physique quantification codes for syndrome differentiation and classification, with good clinical results.

Thirdly, AI has the potential to optimize existing diagnosis and treatment plans and facilitate a coordinated approach to diagnosis and treatment, drawing from both CM and WM. At present, CM is rarely applied in the diagnosis and treatment of major and difficult diseases, mainly attributed to the differences in the theories of CM and WM. As a result, there are great differences in the understanding of diseases, diagnosis and treatment approaches, making it is difficult to integrate them in clinical practice. AI has the potential to change this situation. By integrating clinical detection indicators and biological information of CM and WM, a disease stage prediction model is established, which enables early prevention, diagnosis, and treatment of CM using modern microscopic index data. Next, using data mining, network pharmacology and other AI technologies, the application of new CM drugs can be investigated to identify new disease and syndrome intervention programs in line with the characteristics of CM syndrome differentiation. Finally, by predicting prognosis of disease, CM and WM intervention can be administered as early as possible to improve the prognosis of patients and the quality of life. Qiao, et al[49] developed a new CM drug Heihuang Chizhu Yin (黑黄赤株饮) on chronic heart failure based on targeted transcriptomes, expert experience and AI, to regulate multiple signaling pathways, easy availability of drugs, good safety and affordable price as a basis for further development of CM new drugs.

Opportunities of Intelligent CM in Diagnosis and Treatment of CVDs

CM Clinical Decision Support System

The CM Clinical Decision Support System

(CMCDSS) provides clinicians with knowledge and person-specific information to enhance diagnostic and therapeutic decision-making. Intelligent modern diagnosis can reduce misdiagnosis rates and improve efficiency and diagnostic accuracy. The four intelligent diagnostic methods of CM can also be helpful in disease diagnosis and the formation of CM disease names and syndromes. For example, Zhang, et al[50] developed an ML approach that can use 64 2D speckle tracking echocardiography (2D-STE) features and seven clinical features to predict coronary heart disease (CHD). Their method shows good diagnostic performance in identifying CHD patients. Moreover, the method is non-invasive and takes less time compared with coronary angiography and magnetic resonance imaging. Cui, et al[51] identified coronary artery lesions by acoustic waves of the radial artery. This method can effectively identify stable CHD patients. Zhou, et al[52] used weakly supervised DL for tooth-marked tongue identification. This method improves the clinical diagnosis of CM. The first two methods can assist in the diagnosis of CHD while the last method can assist CM in syndrome differentiation and treatment. Finally, CM and WM diagnosis is determined.

CMCDSS also provides the corresponding CM clinical treatment plan. Zhao, et al[53] developed a CM herbal prescription recommendation model based on a multi-graph convolutional network, which significantly improved the accuracy of CM herbal prescription recommendations. Zhang, et al[54] also developed a new system that is more suitable for modern CM clinical practice. They developed a transformer-based CM prescription recommendation model, which provides WM and CM prescription recommendations to clinicians by analyzing clinical health records that include medical history and current symptom and diagnostic information.

Disease Prediction and Drug Evaluation

Accurately evaluating the outcomes of both CM and interventions is crucial to determine effective treatment and intervention strategies moving forward. For example, Wang, et al[55] validated a predictive model based on 6 ML algorithms for major adverse cardiovascular events (MACE) within 6 months after coronary revascularization. Their study achieved acceptable performance in predicting MACE, and extreme gradient boosting was the best-performing ML algorithm. Zuo, et al[56] employed network pharmacological visualization to compare the target spectra of CM combination Danshen (*Salvia miltiorrhiza bunge*, DS)-Chuanxiong (*Ligusticum sinense*, CX) (DS-CX) and WM cardiovascular drugs. The objective was to predict common herbal drug targets and elucidate the molecular-level interactions between CM antithrombotic drugs and WM cardiovascular drugs. The results demonstrated that DS can directly react with WM cardiovascular drug targets related to the antithrombotic pathway (i.e., thrombin, coagulation factor Xa and cyclooxygenase-1), while CX does not. However, CX can still synergistically enhance the antithrombotic effect of DS at specific combination ratios. In addition, DS-CX may have a wide range of biological functions through a complex "neuro-immune-metabolism/endocrine" (NIM) mechanism, causing multiple direct and indirect interactions with WM cardiovascular drugs.[56] AI has the potential to guide the next steps of treatment by predicting the outcomes of both CM and WM interventions, ultimately leading to improved patient prognoses. Furthermore, by homogenizing data and identifying individualized diagnosis and treatment experiences, AI can evaluate the efficacy and safety of existing CM treatments. This process involves the construction of evaluation indices based on the unique characteristics of CM diagnosis and treatment, ultimately promoting further research and development of existing drugs.

Health Management

As aforementioned, intelligent CM health management is formed by integration of the CM theory of "prevention of disease" with modern health management and AI technology, which is of great significance in improving health management, reducing medical expenditure, and saving medical resources. Meanwhile, CM can be deeply involved in the whole process of disease management and improve overall effect of CM.[57] Intelligent CM constitution identification serves as a crucial approach in CM health management. Lai, et al[58] collected voice samples of 48 subjects and determined their physique classification through physique classification and measurement in CM. Subsequently, ResNet residual neural network model was established to classify subjects' physique, revealing an 81.5% classification accuracy for qi-deficiency and balanced constitutions. These findings highlight the substantial potential of the ResNet residual neural network model in promoting the automatic identification of CM constitution and health

management for patients with different constitutions.

In light of "Internet Plus", social media platforms have become important channels for the dissemination of health knowledge. Wang, et al[59] found that Zhejiang Provincial Chinese Traditional Medicine Hospital and Jiangxi Provincial Chinese Traditional Medicine Hospital used WeChat public accounts to spread CM health knowledge. Developing WeChat public accounts for hospitals may promote people's health and equity in accessing medical information and services, as well as boost internet-based healthcare services.

Disease Identification and Drug Discovery

The structure of CM components is complex and diverse, and the pharmacodynamic effects are multi-effective, extensive, and systematic; therefore, it is difficult to accurately identify the corresponding relationship between CM multi-components and multi-targets. By constructing a "drug ingredients-component target-disease genes" network, AI technology can predict the active ingredients, potential efficacy, clinical indications, and the mechanism of action of CM compounds, which helps provide the scientific basis for CM treatment of chronic diseases and the development of new drugs. Yang, et al[60] used network pharmacology and ML to explore the mechanism of CM prescription in the treatment of CHD with different CM syndromes. They found that the targets of all CM prescriptions were significantly correlated with genes related to CHD, and overlapped with those of 9 Food and Drug Administration-approved small molecule drugs for the treatment of CVD to a certain extent. Moreover, all prescriptions were involved in 7 pathways closely associated with CHD and may exhibit a combined effect in relieving angina pectoris. Thus, from a modern biological perspective, it may help to better understand the different types of CHD described in CM. Gao, et al[61] demonstrated that the anti-chronic heart failure mechanism of Fuzi Decoction (附子汤) may be associated with the regulation of the hypoxia-inducible factor 1 signaling pathway, pyruvate-lactate axis, and glycine, serine, and threonine metabolism by network pharmacology combined with metabolomics. Network pharmacology helps discover the medication pattern and scientific significance of CM prescription in the treatment of CVDs.

Meanwhile, data mining is a process of exploring hidden, unknown, and potentially valuable principles based on the database through statistics, ML, and other methods. Nowadays, data mining technology is widely used in the field of CM to promote the inheritance of famous doctors' experience, syndrome standardization research, compound research, etc. The integration of AI technology and data mining technology can improve the efficiency of data mining, provide a better understanding of the quantitative and qualitative analysis of CM data, and significantly assist in the discovery of the internal relationship between disease symptoms, syndromes, and prescriptions, thereby promoting the manifestation of CM tacit knowledge.

Zhou, et al[62] developed the FordNet system an intelligent formula recommendation system that integrates phenotypic and molecular information using DL. They have collected over 20,000 electronic health records from the experience of LI Ji-ren, an experienced CM doctor, and used them to train the models. They found that FordNet could effectively mine expert experience and provide accurate CM formula recommendations. In addition, Guo, et al[63] used data mining technology to analyze the drug use principle of CM in the treatment of heart failure with preserved ejection fraction. By searching the databases for literature, a database of CM prescriptions for heart failure was developed. After extensive research and experimentation, it was ultimately discovered that combination of *Astragali Radix* and *Salviae Miltiorrhizae Radix* Et Rhizoma served as the fundamental herbal blend for optimal results.[63] Identifying CM prescriptions through data mining technology may help to reveal the core drugs for the treatment of CVDs, which is of great significance for the research and development of new drugs (Figure 2).

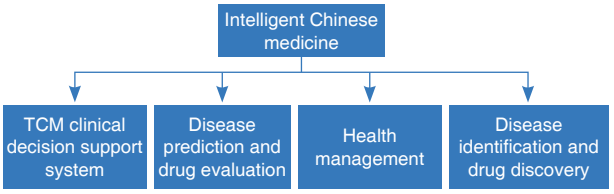

Figure 2. Intelligent Chinese Medicine in the Diagnosis and Treatment of Cardiovascular Diseases

Challenges of Intelligent CM

CM Thinking Is Difficult to Simulate

Simulation of CM thinking and techniques is crucial for the successful integration of AI in CM practices. The main thinking method of CM is image thinking, which emphasizes holistic thinking, open

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dynamic thinking, empirical thinking, and predictive reasoning. However, current studies on AI of CM tend to divide and refine the whole process of CM diagnosis and treatment, rather than explore CM diagnosis and treatment reasoning from a holistic perspective. Meanwhile, for the established CM intelligent diagnosis and treatment model, data such as CM medical records, ancient books, experiences of famous doctors, and information on four diagnoses should be digitized as a database. In this process, data cleaning, standardization, and normalization are unavoidable, and thus problems such as information loss and distortion are inevitable. The diagnosis and treatment model constructed in this way cannot fully reflect the actual CM clinical diagnosis and treatment thinking. Finally, CM syndrome differentiation and treatment under the influence of image thinking are fuzzy and subjective, and clinical data collected at the same time of data collection are also fuzzy, complex, and high-dimensional, complicating data analysis and reasoning.

Lack of Uniform Standards

The clinical information collected from the four CM diagnoses is mainly qualitatively analyzed, which is affected by the subjective consciousness and experience accumulation of physicians and has multiple defects, including defective data, noisy data, redundant information, and lack of organization. Besides, CM tacit knowledge is mostly inherited by masters and apprentices, which is greatly influenced by region and culture; therefore, it is difficult to establish a clear quantitative standard. Furthermore, clinical information collection schemes and objectification indexes adopted by various CM research institutes are different, and thus the collected data cannot be shared, and the final data output mode is also different. It is difficult to merge data in different systems; hence, it is naturally impossible to form big data for AI to learn. Moreover, the disease changes dynamically in clinical practice, and different pathogenesis requires physicians to make real-time adjustments to the treatment methods, prescriptions, and medications. Besides, due to complex contradictions between standardized CM syndrome standard and variable clinical diagnosis and treatment, it is difficult to establish a standard system with universal compatibility.

Ethical Challenges

At present, AI is widely applied in the management of chronic disease and CM therapy. In the clinical process, CM doctors should not only pay attention to the pathological effects of diseases on patients but also the psychological and emotional effects, and adjust diagnostic and treatment strategies based on these changes, which is of great significance to ensure the diagnosis and treatment effect, which is the "human feeling" in the diagnosis and treatment of CM. However, the intelligent diagnosis and treatment system used a mechanized data-driven process that focuses solely on obtaining medical indicators. This can result in a lack of human touch, which ultimately hinders efforts to build and maintain a positive doctor-patient relationship and could potentially reduce the clinical efficacy of treatment. Meanwhile, the identification of the responsible body of intelligent diagnosis and treatment also has risks. If a model's algorithmic error results in misdiagnosis and incorrect medication, which in turn leads to a poor prognosis for patients. Generally, because patients have limited knowledge about emerging medical technologies, they tend to follow their doctors' decisions. Therefore, informal or perceived patient persuasion or coercion to choose CM intelligent diagnosis and treatment by some doctors or medical institutions remains an important ethical challenge. Finally, intelligent CM diagnosis and treatment are also faced with data security problems.

Countermeasures and Prospects

First, the establishment of uniform standards is the foundation. The CM intelligent diagnosis and treatment system requires a large amount of standardized and high-quality data. Thus, it is very important to establish a unified standard for the collection and processing of CM data. The classification and codes of diseases and patterns of CM and the clinical terminology of CM diagnosis and treatment—released by the National Administration of CM and the National Health Commission in 2020—provide a new version of the national standards for contemporary clinical, teaching, scientific research, management, and academic exchanges of CM. The new version of the standard is in line with contemporary CM information management standardization and international requirements. Given the different information collection schemes and objectification indicators adopted by different research institutions, multi-institutional exchanges and cooperation should be carried out, and the effectiveness of the existing CM intelligent diagnostic and treatment models should be compared and tested. The advantages and disadvantages of different schemes should be summarized to form industrial standards for national

promotion and implementation.

Second, following the theories of CM is the key to building an intelligent model that is in line with CM thinking. Decomposing the CM diagnostic process into measurable variables separates the independent CM concept system in the diagnostic and treatment process, identifies the correlation based on independence, and establishes a standardized intelligent CM diagnostic and treatment analysis system and CM database. In addition to the intelligent and digital CM knowledge map, the value of the collected information for CM syndrome differentiation and the curative effect evaluation are assessed to fit CM diagnostic and treatment reasoning to the greatest extent. Finally, intelligent CM diagnosis and treatment also need a perfect artificial control mechanism. In the event of missing data and model algorithm errors in the AI system, manual error correction by clinicians and software engineers plays an important role in implementing reasonable clinical decisions, thereby ensuring patients' life, health, and safety.

Third, it is an important means to promote multidisciplinary communication and integration and personnel training. Colleges and universities establish relevant teaching courses and activities so that students can develop an interest and learn relevant basic knowledge in theory and practice. Meanwhile, the establishment of a communication platform between colleges and universities of science and technology and enterprises, and the cooperation between production, university, and research are conducive to the research and development of intelligent diagnostic and treatment models and the cultivation of interdisciplinary talents. Furthermore, medical colleges and research institutions ought to encourage research into the integration of computer and AI technologies by clinical doctors and other groups. This will help identify areas of concern and promote evidence-based practice. Finally, active international cooperation is warranted to tap the potential of AI solutions and promote the intelligent development of CM to address global challenges.

Conclusions

The application of intelligent diagnosis and treatment for CVD using CM is of utmost importance to the development a diagnostic and treatment model for chronic illnesses that reflects CM's unique characteristics. It provides high-quality, evidence-based medical knowledge that enhances the clinical efficacy and medical service capabilities of CM while also improving the health management of patients. The difficulties encountered in the development of intelligent diagnosis and treatment need to be discussed and addressed.

Conflict of Interest

The authors declare that there is no conflict of interest.

Author Contributions

Wang ZY wrote the manuscript; Wang ZY and Guo ZH collected the information; Guo ZH critically revised the manuscript. All authors read and approved the final version of the manuscript.

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