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Research on the Responsibility Traceability Mechanism Based on AI and the Application Boundary of Algorithmic Ethics in Medical Decision Making

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Abstract: With the rapid advancement of medical artificial intelligence (AI) technology, particularly the widespread adoption of AI diagnostic systems, ethical challenges in medical decision-making have garnered increasing attention. This paper analyzes the limitations of algorithmic ethics in medical decision-making and explores accountability mechanisms, aiming to provide theoretical support for ethically informed medical practices. The study highlights how the opacity of AI algorithms complicates the definition of decision-making responsibility, undermines doctor-patient trust, and affects informed consent. By thoroughly investigating issues such as the algorithmic "black box" problem and data privacy protection, we develop accountability assessment models to address ethical concerns related to medical resource allocation. Furthermore, this research examines the effective implementation of AI diagnostic systems through case studies of both successful and unsuccessful applications, extracting lessons on accountability mechanisms and response strategies. Finally, we emphasize that establishing a transparent accountability framework is crucial for enhancing the ethical standards of medical AI systems and protecting patients' rights and interests.

Keywords: Algorithmic ethics; Medical decision-making; Liability tracing; Medical AI; Patient rights protection

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1. Introduction

1.1. Research background and significance

The rapid advancement of artificial intelligence (AI) technology in medicine has led to significant developments in areas such as medical image analysis, treatment planning, and algorithmic decision-making in clinical diagnosis. These technologies are now widely applied, offering powerful tools to support medical professionals. However, their widespread use has also raised increasing ethical concerns, particularly regarding the decision-making

process in clinical settings. As AI becomes more integrated into medical practice, ethical and moral considerations must be weighed alongside technical and professional criteria to ensure that patients' rights, autonomy, and dignity are fully respected and protected [1].

The medical decision-making process is basically a complicated ethical decision-making process. At present, the medical decision-making model in our country is still dominated by family medical decisions, especially in the treatment options for serious diseases such as cancer. This decision-making model has created a number of ethical issues [2]. In the context of the intervention of artificial intelligence algorithms in medical decision-making, how to balance algorithmic technology with the subjectivity of doctors, how to ensure that the basic rights of patients are respected, and how to regulate the development of technology for good have become key issues that need to be addressed urgently [3].

Medical ethics includes several important subjects such as human trials and patient rights, which are not only related to academic talks and research, but also deeply affect the development and application of medical and nursing practices. Ethical decision confidence refers to the degree of confidence that decision-makers have in their ethical judgments and moral judgments. In clinical practice, having a high level of ethical decision confidence is critical for medical staff to make good ethical decisions, which helps to better protect patients' rights and interests, provide high-quality care, and ensure that care practices comply with ethical principles [4].

The purpose of this study is to investigate the application boundaries of medical decision-making algorithm ethics. Constructing AI diagnostic system-based responsibility mechanism, and give theoretical support and practical direction. In the field of medicine, for the purpose of making ethical analyze the ethical conundrums of medical decision. In this study, we witnessed that the doctor's professional judgment is divided algorithmic advice in an AI-assisted decision-making environment and how to make sure the decision-making the procedure adheres to moral precepts and how to explain responsibility when things happen to them. This is significant to enhance the ethics of medical decision-making and protecting patients' rights and interests, further promoting the development and progress of medicine and nursing [5].

1.2. Research objectives and methods

By creating a traceable accountability procedure, the main goal of this research is to investigate the ethical limitations of algorithmic decision-making in medical AI systems and to accomplish efficient regulation and evaluation of medical AI systems. This research attempted to solve important problems, such as ambiguous responsibility definitions and algorithmic black boxes, by conducting a thorough examination of the decision-making process in medical AI systems [6]. To create a responsibility traceability assessment model, the research approach integrated empirical research with theoretical analysis.

The time component, risk coefficient, and corresponding weight coefficients were indicated by the following symbols, which stand for the decision factor and the time dimension. Through qualitative analysis, this study addressed the ethical problems faced by medical AI systems in actual applications, including the lack of algorithmic transparency and the problem of trust between doctors and patients. Combined with case study methods, typical medical AI events were studied, key influencing factors were removed, and an evaluation index system was built. In the process of data collection, the principle of multi-source validation was adopted to assure the reliability and universality of the research conclusions.

The purpose of this study was to build a methodological model for analyzing the choice of the AI system quantitatively, as well as by combined fieldwork, expert interviews, and field research in order to build an entire

system of responsibility. In addition to efficiently locating possible risks in the process of making decisions, this method also gives the foundation of a theory that is needed to construct a trustworthy medical artificial intelligence system [7].

2. An overview of algorithmic ethics

2.1. Definition and framework of algorithmic ethics

In the context of digital technology, algorithmic ethics are the bottom-line standards for guaranteeing the scientific and reasonable application of medical artificial intelligence systems. It would be possible to comprehend the two main components of this concept: functionality and normality. In terms of normative thinking, algorithmic ethics is the moral standards and value standards that must be adhered to in the design, development, and application of artificial intelligence systems. It attempts to guarantee the upkeep and promotion of human well-being in algorithmic decision-making processes, particularly to ensure that patients' rights are not violated in medical settings from a functional standpoint. In the context of digital technology, algorithmic ethics are the bottom-line standards for guaranteeing the scientific and reasonable application of medical artificial intelligence systems. It is possible to comprehend the two main components of this concept: functionality and normality. In terms of normative thinking, algorithmic ethics is the moral standards and value standards that must be adhered to in the design, development, and application of artificial intelligence systems. It attempts to guarantee the upkeep and promotion of human well-being in algorithmic decision-making processes, particularly to ensure that patients' rights are not violated in medical settings from a functional standpoint.

In the discipline of medical artificial intelligence, the core of algorithm the methodology was balanced in the relationship between technical progress and medical ethical values. This balance could be represented by the algorithmic ethics valuation function. In this case, the algorithm's ethical score was shown, which is the first ethical principle's weight, and the algorithm performs on that principle with the following performance score: the algorithm is in charge of the first. This mathematical model makes the abstract ethical concepts quantifiable by allowing us to measure the ethical evaluation of algorithms.

There are basically four basic pillars that make up the medical algorithm ethics model: responsibility; privacy protection; and transparency. In order to make the process of making an algorithm transparent and understandable; it is necessary to allow patients and staff of the medical system to be able to understand how the AI system approaches particular diagnostic judgments. Fairness places the idea of using algorithms to keep the system from being discriminated against particular populations, make sure that diagnosis outcomes are not affected by variables such as a patient's socioeconomic level; privacy protection concentrates on the security of patients' medical information during collection, storage, and use; liability tracing, however, attempts to identify the responsible party and the course of accountability when problems arise in algorithm-assisted decision-making.

One of the main tenets of artificial intelligence algorithms, with the use of algorithms to make decisions and the replacement of physician decision-making and option rights in medical practice, and the ability to present more automated decision-making features and is becoming increasingly weak. This characteristic is at odds with the fundamental characteristics of conventional medical practice, which gives rise to ethical concerns. According to some academics, the concept of Isaac Asimov ought to be incorporated into machine behavior mechanisms after being processed in a computer that is "computable" and should be incorporated in the process of behavior, and that the concept should be taken into account in order to direct machine behavior through moral principles and ethical

norms a computer [8].

2.2. Categories of ethical issues

Ethical issues in the area of medical artificial intelligence are various and might be classified into several main categories based on their scope and type of influence. Data privacy and security problems are the most important ethical problems in medical AI applications, involving the collection, storage, and use of patient sensitive information. The current legal system in China has not yet clearly defined the data rights that extend from patients' privacy. How to protect patients' privacy rights during the application of AI technology has become a big issue that needs to be immediately addressed in the ethical governance of the medical AI industry [9].

Second major ethical dilemma is the question of whether or not fairness and algorithmic transparency are important. Because of the complicated models and huge numbers of parameters of AI algorithms, it is frequently difficult to comprehend and analyze how to make decisions, which is referred to as an "algorithmic black box." This opacity also limited patients from having the right to informed consent and autonomy, which also weakens their confidence and acceptance of decisions. Artificial intelligence technology is directly related to patient rights and medical equity, which are two common ethical issues that arise from algorithmic discrimination, the rationality of algorithmic decision-making, and the problem of transparency.

Third, there is the third moral issue with the definition and allocation of responsibility. Currently, the relevant laws and rules of the law still lack specific guidance, which not only undermines the basis of social morality and legal responsibility, limits the ability to assign responsibility and control decisions, but also gives lawbreakers more opportunity, which further exacerbates public concerns about medical AI technology. Ethical risks such the opacity of the decision-making process, the effect on the role of doctors, and the possible erosion of patients' rights are also new problems because of the application of AI algorithms in healthcare, which has great potential in improving diagnosis and treatment efficiency and optimizing medical services.

The problem of public cognition and attitude is the fourth category of ethical challenge that cannot be ignored. As the end users of medical AI technology, the public's view and attitude directly affect the early development of the product and its practical application in the middle and later stages. The classification of these ethical difficulties helps us obtain a more systematic knowledge of the ethical problems of AI application in the medical field and lays the basis for developing an effective accountability mechanism.

3. Overview of AI diagnostic systems

3.1. Technological developments in AI diagnostic systems

3.1.1. Applications of AI technology in medical care

The medical industry is gradually adopting the use of artificial intelligence technology, especially as it is becoming more and more common in the field of medical imaging diagnosis. With the use of artificial intelligence to perform denoising, image segmentation, and quantitative analysis, AI systems have successfully increased the accuracy of disease diagnosis, efficacy assessment, and prediction of the prognosis [10]. AI technology has been widely used in particular application areas to the diagnosis of diseases such as lung cancer, gastric cancer, thyroid nodules, and diabetic retinopathy. Besides than detecting colonic polyps and adenomas, researchers have created computer-aided detection systems that can evaluate the quality of a colonoscopy. The medical industry is gradually adopting the use of artificial intelligence technology, especially as it is becoming more and more common in the field of medical imaging diagnosis. Using artificial intelligence to perform denoising, image segmentation,

and quantitative analysis, AI systems have successfully increased the accuracy of disease diagnosis, efficacy assessment, and prediction of the prognosis [11]. AI technology has been widely used in particular application areas to the diagnosis of diseases such as lung cancer, gastric cancer, thyroid nodules, and diabetic retinopathy. In addition to detecting colonic polyps and adenomas, researchers have created computer-aided detection systems that can evaluate the quality of a colonoscopy.

AI-assisted technologies have been used in the measurement of myocardial strain in the fields of cardiology. With the help of this technology, patients can receive more precise diagnoses and treatment regimens and can increase the accuracy of diagnosis by reducing the amount of labor they need [12] . Artificial intelligence is very likely to be used in the diagnosis of colorectal cancer by medical imaging as deep learning technology has advanced. AI algorithms can assist doctors in identifying possible lesions early by learning and analyzing vast volumes of imaging data.

Despite the advantages of AI technologies in the medical field, its use also has ethical and safety problems. The algorithms of medical AI are described by complicated models and a huge number of parameters, making their decision-making processes sometimes difficult to understand and interpret, creating what is termed a "black box" problem [13]. This opacity not only prevents patients from exercising their right to informed consent and autonomy, but may also undermine patients' trust and acceptance of AI's diagnostic judgments.

As physicians' main authority uses algorithms to improve their ability to make decisions and to uphold the fundamental rights of patients, more and more voices in the development of medical AI are advocating for a return to the subjective position with doctors as the primary body. The best course of action for medical AI applications in the future might be this human-machine collaboration model, which would give patients and the trust of their patients the advantages and dependability of medical decision-making, while also fully utilizing the benefits of AI technology.

3.1.2. Key technologies and their advantages

The creation of medical artificial intelligence diagnostic systems was based on the assistance and application of various important technologies, which were the basis of medical AI as a whole and give clinical diagnosis strong support. Medical artificial intelligence systems mostly use technologies like deep learning, natural language processing, computer vision, and other technologies in terms of their own advantages and are important to the medical field in terms of practical application.

Deep learning technologies have shown to have a substantial advantage in the medical imaging diagnosis. AI-assisted diagnostic systems are capable of denoising, lesion segmentation, and quantitative analysis on medical images, effectively increasing the accuracy of disease diagnosis, as well as the evaluation of prognosis. For instance, in the diagnosis of pulmonary nodules, multiple AI-assisted diagnosis has been used extensively throughout the nation with diagnostic accuracy equal to that of experienced medical [14]. The second Xiangya developed the "Rui Fu System" Hospital of Central University had done very well within the field of skin disease diagnosis. The system can assist in the process of identifying skin conditions including a topic and psoriasis militias with an accuracy rate of up to 95.80% [15].

The significant application of artificial intelligence (AI) in the treatment of patients is the clinical decision support system, or CDSS. these kinds of systems might help clinicians make decisions on a variety of clinical possibilities as well as more precise and efficient ones in the diagnosis, course of the patient, therapy, and so on of a patient [16]. Using AI (the National Clinical Research Center for Kidney Disease) to predict the long-term prognosis risk of IgA nephropathy and can provide decision support to nephrologists in a number of top-tier hospitals in the

nation. An additional study was designed to diagnose pediatric pneumonia using both natural language processing and deep learning techniques with an accuracy rate that was similar to that of experienced pediatricians, which was based on a large volume of pediatric patient referral data. An additional study was designed to diagnose pediatric pneumonia using both natural language processing and deep learning techniques with an accuracy rate that was similar to that of experienced pediatricians, which was based on a large volume of pediatric patient referral data. An additional study was designed to diagnose pediatric pneumonia using both natural language processing and deep learning techniques with an accuracy rate that was similar to that of experienced pediatricians, which was based on a large volume of pediatric patient referral data. An additional study was designed to diagnose pediatric pneumonia using both natural language processing and deep learning techniques with an accuracy rate that was similar to that of experienced pediatricians, which was based on a large volume of pediatric patient referral data. An additional study was designed to diagnose pediatric pneumonia using both natural language processing and deep learning techniques with an accuracy rate that was similar to that of experienced pediatricians, which was based on a large volume of pediatric patient referral data.

Medical theories and medical technologies show great potential; however, there are ethical difficulties with the ability of the decision-making process; the effect of algorithming; the harm of physicians; and the deterioration of patient rights as well. The emergence of medical artificial intelligence will need to maintain a people-oriented value orientation in order to keep that decision, which will guarantee that algorithmic decisions always satisfy the requirements of human health, to keep the technological layer from becoming more and more complicated, and to continuously improve the situation of changing medical situations.

4. Future direction

With the continuous development of artificial intelligence technology, the application prospects of AI diagnostic systems in the medical field are getting more and more broad. Medical AI systems are moving towards higher precision, greater interpretability and a wider variety of application situations. These developments will bring new changes to medical practice, along with new ethical difficulties.

The technical development of artificial intelligence diagnostic systems will focus more on algorithmic transparency and explainability. "The black box" nature of the current AI decision-making process makes it difficult for doctors and patients to understand the reasons for their recommendations, which not only affects trust between doctors and patients, but also weakens patients' compliance with medical treatment plans [17]. Future artificial intelligence systems will make the medical decision-making process clearer by increasing technological transparency and explainability, helping patients exercise their right to informed consent and autonomy, and increasing trust in AI-assisted decision-making. This tendency is not only a requirement for technological advancement, but also an unavoidable choice to address ethical problems.

Medical AI systems will pay more attention to value orientation and ethical standards. In the face of the possible threat of AI algorithm decision-making to patients' basic rights, future developments will adhere to a people-oriented value orientation, improve the knowledge boundaries and value benchmarks of AI algorithms, and further define patients' rights such as data autonomy, privacy, right to know, and right to use. By clarifying the scope of patient rights, the "domestication" of algorithmic technology will enable medical AI algorithms to be morally just, therefore increasing diagnosis and treatment efficiency and optimizing medical services while effectively avoiding ethical risks.

Interdisciplinary integration will be a major trend in the development of medical AI. Future medical AI technologies will be more closely integrated with medicine ethics, law, sociology and other disciplines to create a fuller ethical governance structure. This integration is not only shown in the technical part, but also in institutional design, responsibility distribution and the construction of social consensus. Through interdisciplinary collaboration to jointly address ethical problems that arise in the application of medical AI, such as algorithmic puzzles, data security issues, accountability problems, and social equity issues, it provides a good foundation for the sustainable development of AI technology in the medical field.

4.1. The current status of artificial intelligence diagnostic system applications

4.1.1. Data privacy and security issues

The use of medical artificial intelligence systems has becoming more common as a means of gathering, storing, and processing data because they are unable to perform without the need for large amounts of medical data and the security protection of patient privacy data. Patients' medical records, genetic information, diagnosis results and so on, are the examples of sensitive information that is included in clinical data. When AI is diagnosed, these data might be at danger of being made public or not accessible.

Medical data protection mainly depends on three levels. In the data collection process, patients' small information may be leaked if they are not controlled by medical staff or intentionally leaked by insiders. Technical issues such as system weakness and hacking might result in the theft of database data during the data storage phase. When processing data in the training of artificial intelligence models in the data application phase, there may be privacy leakage [18].

In order to deal with these security issues, a reliable data protection system must be developed. Clinical data should be desensitized and the informed consent of patients should always be strictly enforced when collecting data. To guarantee data security, strict encryption approaches and access control procedures should be used during data transmission and storage. Privacy computing techniques are useful tools for using data to secure patients' privacy in the training of AI models.

4.1.2. Ethical compliance assessment

The process of guaranteeing that medical AI is applied rationally is known as ethics compliance evaluation, which is an important first step in the process of making sure the system is used reasonably. Ethical governance in the field of medical AI focuses on factors such as fairness, algorithm openness, and the protection of patient privacy. The four guiding principles of medical ethics should be the foundation of the ethical compliance assessment system; this is why the AI should be expanded to create an assessment matrix that can be used to express the weights of each dimension as follows

In this section, the total number of evaluation dimensions, which stand for the weight of the ethical dimension, and the score of that dimension are shown.

Algorithmic black box problems are particularly significant throughout the evaluation process. The decision-making procedure of medical AI systems is generally difficult to understand and interpret, which not only limits patients from exercising their right to informed consent and autonomy, but also undermines patients' trust and acceptability of decisions. Therefore, developing explainable AI algorithms that increase their legitimacy and enable healthcare practitioners to grasp and accept their results has become one of the key indicators in ethical compliance assessment [19].

Another important component of evaluation is patient data protection. A lot of patient data is being used in the process of creating and validating AI models, which increases the possibility of losing patient privacy by raising the sensitivity and specificity of the models, all of which are highly sought after by the enormous amount of patient data. Ethical disputes have also increased as medical institutions use patient data on a large scale for AI model training without getting patient informed permission [20].

Besides that, an assessment on ethics compliance should also focus on the issue of identification of responsibility. In case of the AI intervention there are some medical controversies about using artificial intelligence which is the need to deal with the problem of medical injury traceability and liability division by the new legislation and regulations, so that the responsibilities of each party can be clearly seen in the medical decision-making process, the evaluation system should include the assessment of the effectiveness of accountability mechanism in this regard, so as to ensure that the roles of every party can be seen clearly in the process of medical decision-making.

4.1.3. Collaboration between healthcare personnel and AI

Healthcare workers and the use of artificial intelligence systems are changing the way they work together. The widespread use of AI in the healthcare industry means that medical practitioners must modify their approaches to fit the needs of human-machine cooperation and consider the use of these technologies to be an effective means of auxiliary assistance. Physicians may more precisely identify lesions by using AI-assisted image analysis, such as CT and MRI, which occasionally goes beyond the diagnostic capabilities of human specialists [21].

Although there has been improvement in medicine efficiency due to the introduction of artificial intelligence, there are also new needs for medical practitioners. Professionals in medicine are not only required by law to be able to collaborate with AI systems but also to know how to work with them. One of the biggest problems for primary care workers is the absence of expertise and abilities to run complicated artificial intelligence systems; this is because they need ongoing training and support for education [22]. The primary cause of the diagnosis and treatment outcome is the degree of collaboration between physicians and artificial intelligence.

The best equilibrium, where E is the outcome, H is the expert judgment of the human physician, M is the auxiliary decision-making of the AI model, and α and β are its weight coefficients, respectively.

Physicians' subjective responses are having difficulty, which is being made worse by the extensive application of artificial intelligence [23]. The conventional "medical staff decision-making" model is progressively changing to the "AI decision-making-doctor verification review" model with the advent of autonomous AI. When there is medical harm, this change complicates the definition of medical liability and makes the responsible party a complex issue, a balance in which technological advancements are made and ethical standards are broken in order to build efficient human-machine collaboration [24]. Medical AI systems ought to always give patients the top priority and adhere to the principle of no harm.

It makes reference to an intelligent organization with the ability to make judgments and make decisions in the most autonomous way possible, which has a certain degree of autonomous decision-making ability.

5. The requirement of procurance connection

5.1. The idea and significance of liability retroactive

5.1.1. Legal liability and the ecological obligation

Legal and ethical liability in the decision-making process of medical AI algorithms constitutes a dual dimension

of the liability traceability mechanism. Legal liability emphasizes responsibility in accordance with the law and is mandatory and obvious. Ethical responsibility, on the other hand, focuses on moral appraisal, which is reflected in the value orientation and humanistic care of medical services. These two duties interweave with each other in the AI diagnostic system and together create a complete responsibility traceability system.

At the level of legal liability, medical artificial intelligence algorithm decision-making includes many parties, including algorithm developers, medical institutions and individual doctors. When an AI system makes a diagnostic error, the determination of liability needs to take into account aspects such as the transparency of the algorithm the extent of the doctor's intervention, and patient information consent. To defend the patient's rights in various circumstances, the legal system must clearly define the limits of responsibility for each party. In order to protect the patient's right, the FDA's Action Plan on AI/Machine Learning-based Medical Device Software, published in 2021, places a strong emphasis on regulation and an assessment of the whole life cycle of medical AI software, increases product transparency, and offers a significant reference for assessing legal liability.

Medical artificial intelligence algorithmic decision-making in the field of ethical responsibility needs to adhere to the five AI ethical principles of "accountability, fairness, traceability, reliability, and controllability". Patients' autonomy and the ability to know and exercise autonomy are hampered by algorithmic black box issues, which also jeopardize patient trust in decision-making. Positive value-oriented human intervention is required in the process of algorithmic programming in order to address this problem, and a "top-down" governance paradigm is created to direct and control machine behavior through universal medical ethics guidelines.

Reimbursing the subjective position to the doctors as the main body and algorithmic technology as an auxiliary, strengthening the decision-making capacity of doctors and respecting the basic rights of patients; Encouraging algorithmic optimization and discipline technology for good; the coordinated construction of legal and ethical responsibilities is necessary. The creation of this dual responsibility framework will guarantee the robust development of medical AI systems. Reimbursing the subjective position to the doctors as the main body and algorithmic technology as an auxiliary, strengthening the decision-making capacity of doctors and respecting the basic rights of patients; Encouraging algorithmic optimization and discipline technology for good; the coordinated construction of legal and ethical responsibilities is necessary. The creation of this dual responsibility framework will guarantee the robust development of medical AI systems.

5.1.2. Influencing factors of accountability traceability

The accountability of medical AI algorithmic decisions is determined by many things, which together constitute a complicated network of accountability determination. In the medical situation, the degree of responsibility for algorithmic judgments can be described as the following relationship.

Where is the data quality factor; is the algorithm transparency is the degree of human intervention; and is the weight coefficients of each factor, which is the compliance level, the level of human interaction and represents the degree of human interference. The efficacy of accountability is directly impacted by algorithmic decisions that are transparent and interpretable. To guarantee the transparency of information, including the algorithm model's structure, training data, input or output and more, medical institutions must be able to assess the algorithm's applicability and dependability [25].

The level of information protection and data security are two things that must be fully realized in the storage and application of medical data, which is a key factor influencing accountability. In the process of medical institutions to prevent the theft of data and to abuse it, they must use dependable data encryption, which is

necessary to prevent security and access control systems from being used. Another prerequisite that must be taken into account in the digital age of policy-making and enforcement is the variety of features that are considered, such as "digital bureaucracy", and "digital discretion", which have an impact on the process of being responsible [26].

A physician-patient trust relationship can also be developed with the help of the construction of accountability processes, which are also important. By providing doctors with the right training, which will raise patients' awareness of the diagnosis results as well as their understanding of technology and the degree of patient awareness regarding the results of the diagnostic process, it may be possible to increase the acceptance and trust of medical artificial intelligence. Meanwhile, in order to guarantee that AI technology is being used fairly and in accordance with compliance, ethical rules and monitoring systems established by relevant organizations and enterprises are also required [27].

5.1.3. Accountability and trust building

The building and development of accountability mechanisms are of great significance for maintaining the doctor-patient trust relationship. In the application cases of medical artificial intelligence, the doctor-patient relationship has changed from the traditional two-party relationship to a complicated relationship among doctors, patients and artificial intelligence [28]. Accountability strategies have been developed to positively increase patients' trust in health care services, and to further promote the healthy development of medical AI.

In medicine practice, the establishment of accountability systems might increase the openness and legitimacy of doctor-patient communication. Medical AI applications might help increase patients' trust in doctors by influencing doctor-patient contact, knowledge reserves, and environmental circumstances. Appropriate training of doctors to increase their understanding of the technology and patients' awareness of the diagnosis results might increase the acceptance and trust of medical AI by both doctors and patients.

It's worthwhile to keep in mind that using Artificial Intelligence could enhance the likelihood of a proficiency decrease. To avoid this the duty of the responsibility system to defend drugs, a staff members need to be more flexible and think critically to be the main in the processes. At the same time, it is necessary to adjust the application of technology in connection. To humanistic treatment as well as the requirement to avoid using artificial in intelligence and the interpersonal relationship so fpat and Pat patients who neglect the exchange of information and communication. When it comes to developing patient trust, medical services are essential comfort because they use different kinds of resources and materials, such as humanistic treatment and sympathy, which constitute the basis of both ecology-based and humanistic treatment of medical staff members.

Through the standardized building of accountability procedures, the application of medical artificial intelligence will better reflect the people-oriented concept of medical services, improve the quality of medical service sand, and thereby improve and promote patients' confidentiality with doctors. The construction of such a mechanism requires multi-party collaboration, including joint efforts in improving relevant laws and policies, formulating ethical guidelines and norms and strengthening quality monitoring and use evaluation.

5.2. Design and implementation of the traceability mechanism

5.2.1. Key elements of the traceability mechanism

Medical artificial intelligence algorithms are based on the idea of "meaningful human control" as part of the retroactive mechanism for making decisions about medical artificial intelligence; each subject in the system has a different set of moral standards that are clearly defined. The retroactive method is concerned with the division

of moral thresholds among many levels of accountable entities, including legislators, programmers, and system designers, in addition to direct operators [29].

Medical artificial intelligence systems must use three main components to track the process of traceability: data rights, accountability allocation, and algorithmic transparency. Because of the complicated models and a lot of parameters that not only have an impact on the reasonableness of patient assessment decisions, the decision-making process of the system is frequently difficult to understand and interpret when it comes to algorithmic but also limits patientives of their right to autonomy and consenting a certain way. In order to deal with this issue, in order to protect the algorithm's main technologies as it runs and to build an explanatory decision-making mechanism while making an accountable decision route recording system, the traceability mechanism must be established. The doctors, the AI systems and hospitals need to clarify the allocation of responsibility so that doctors always use the main authority in medical practice; and the AI technology is positioned as a tool for auxiliary decision-making; so as to ensure that doctors always use the primary authority in medical practice.

Data rights protection is a significant aspect of the retrospective process, involving several aspects such as patients' privacy rights, data autonomy, and the right to know. Under the current legal system, data rights that extend from patient privacy have not been clearly defined, making data protection an urgent problem to be addressed in the field of medical AI. The traceability mechanism needs to build a full chain of data usage records to ensure that every link in the data flow can be tracked and audited, whereas establishing a sound data security protection mechanism to prevent privacy leakage and data abuse. Data rights protection is a significant aspect of the retrospective process, involving several aspects such as patients' privacy rights, data autonomy, and the right to know. Under the current legal system, data rights that extend from patient privacy have not been clearly defined, making data protection an urgent problem to be addressed in the field of medical AI. The traceability mechanism needs to build a full chain of data usage records to ensure that every link in the data flow can be tracked and audited, whereas establishing a sound data security protection mechanism to prevent privacy leakage and data abuse.

5.2.2. Application of technical means in traceability

In order for medical AI algorithms to be accountable for the decisions, multiple technical means are needed to ensure that the results are transparent and traceable throughout the process. The use of technology is very important for protecting the rights of patients and the trustworthiness of medical decisions, especially in the context of the increasing algorithmic black box phenomenon.

Through the distributed ledger characteristic of medical decision-making and can guarantee that the data is both immutable and intact. The use of smart contracts, which also provide a clear path for the tracing of responsibility, enables the automatic definition of all parties' sentences and obligations in medical decision-making, which is also a means of achieving the goal of the tracing process of responsibility. The combination of these technologies supports the development of reliable medical AI systems [30].

In the use of liability traceability technology, there are four basic process which are the data acquisition, storage verification, analytic and processing, result output, and so on. The technology makes use of different encryption techniques so as to check the security of data by monitoring the real-time operation status of artificial intelligence algorithm, keeping the key data nodes in the decision process, and using several encryption techniques. At the same time, the technology has developed a robust log auditing system which can easily identify and solve the problems that may occur, which will ensure the reliability and traceability of medical decisions, and the system

has developed a good log auditing mechanism with the ability to quickly identify and address the problems which may occur.

5.2.3. Clear responsibilities in doctor-patient communication

In doctor-patient communication, the definition of rights and responsibilities among the AI diagnostic system, where the doctors and patients can ease the explanation of roles in it is a part of the process. Because the "black box" nature of AI diagnostic systems makes their decision-making process difficult to comprehend and explain, which presents a new obstacle for doctor-patient communication. When the diagnostic recommendations of AI systems are different from those of doctors, there is a difference in the clinical experience of these systems, so it is necessary to have clear accountability mechanisms to control how to explain and communicate to patients and who is ultimately responsible for decision-making.

By constructing a three-tier attribution model in practice, clear responsibility might be realized. Create the attribution function, in which the person in charge of medical judgments is represented, and assign responsibility as follows.

The quantifiable indicators of different kinds of responsibility are represented by the variables in this category, which also show the weights of various kinds of accountability. The limits of liability for each party at the legal and ethical levels are made easier by this quantification technique. To control the interpretation process of AI diagnostic reports and guarantee that patients fully comprehend the shortcomings of the AI system and its supporting function throughout the diagnosis and treatment process, medical institutions must create comprehensive communication rules.

During the process of making informed consent, physicians ought to give a clear explanation of the AI system's application and possible dangers, as well as to document the patient-led consent process. In the case of a medical dispute, these records will be a key source of liability trending. Conflicts between doctors and patients as a result of information asymmetry can be successfully decreased by creating uniform communication processes and documentation systems [31]. This system of accountability not only safeguards the rights and interests of physicians and patients, but also offers critical feedback for the AI diagnostic system to be continuously optimized.

6. Case analysis

6.1. Cases of AI diagnostic systems domestically and abroad

6.1.1. Analysis of successful cases

It has been very helpful to use clinical practice with the use of medical AI diagnostic equipment. When it comes to protecting patient safety by putting a strong system of responsibility, medical institutions have been able to combine AI technology with medical practice with an efficient combination of the latter. these success reports show the ability of AI to improve medical efficiency; although they guarantee ethical safety [32].

In the study of accountability procedures, some healthcare institutions have created explainable AI algorithms that increase the credibility of AI diagnostic results, enabling healthcare personnel to understand and accept their judgments. This approach effectively decreases the barriers of trust between doctors and patients and develops a good doctor-patient relationship. By building a sense of community between doctors and patients, doctors and people have reached a new consensus of trust in AI-assisted diagnosis and treatment. This approach not only protects patients' rights, but also lays the basis for the continual development of medical AI.

In terms of data protection and privacy protection, successful cases have generally adopted strict hierarchical

authorization mechanisms and data desensitization approaches. The application of these technologies has helped medical institutions to effectively use medical data to optimize AI models while completely protecting patients' privacy. At the same time, by establishing a good risk feedback mechanism and response measures, medical institutions can quickly find and solve possible problems in the application of AI, ensuring the security and reliability of medical AI algorithms.

6.1.2. Lessons from failure cases

The diagnostic system used by the artist system has had several medical problems, and there are many of them in the medical field, which gives us helpful information. Patients find it difficult to decide whether or not they are reasonable because many of the major problems with an artificial intelligence system are the absence of algorithms and the difficulty of describing the decision-making process. At the same time, because of this lack of opacity, patients are less likely to be granted permission and autonomy as a way to obtain informed consent. As a result, the latter also weakens their acceptance of AI diagnostic tools and their degree of trust.

In actuality, some medical facilities overly depend on the diagnostic performance of AI systems, controlling the dominant position and professional judgment of doctors. This practice goes against the basic tenet of "doctors as the main body and algorithmic technology as the wings", resulting to a rift in the doctor-patient relationship. While data is generally de-identified in medical AI projects, there is still a risk of re-identifying persons through cross-reference of data, and this privacy breach seriously damages the rights of patients [33].

To solve these problems, some medical institutions have begun to use the practices of companies like Google and build tight ethical frameworks when developing medical AI systems. These frameworks require that the training data and decision results of the algorithms must meet principles such as fairness, and the performance of the systems is evaluated by particular algorithmic ethics testing platforms. This approach assists to increase the interpretability and legitimacy of AI systems, permitting medical practitioners to better understand and accept their results [19].

6.1.3. Legal and ethical reflections

Medical AI was concerned with the legal and ethical aspects of a number of issues and calls for a well-developed legal and moral framework to deal with them. An examination of the current cases shown in actual practice, medical AI systems deal with important problems such as inadequate algorithmic transparency and data privacy protection as well as the division of decision-making duties. Under these circumstances, the establishment of an efficient ethical review system is especially crucial because it involves the participation of specialists from all relevant fields, which is necessary to guarantee the protection of the legitimate rights and interests of both the medical practitioner and the patients [34].

Several challenges may arise in addressing algorithmic transparency and ethical issues in medical AI. These include the difficulty of explaining black-box algorithmic decisions, the need to develop explainable AI systems, concerns over data privacy and the responsible use of patient data, the establishment of clear accountability and auditing processes, and insufficient interdisciplinary cooperation in ethical assessments. To effectively address these challenges, both legal and ethical frameworks must be strengthened simultaneously. Legally, patients' rights to reputation and data privacy should be clearly defined, with robust auditing and tracking mechanisms implemented to prevent data misuse. Ethically, the role of doctors should be reinforced, positioning AI systems as auxiliary decision-making tools that respect patients' rights to informed consent and autonomy.

In the long term, the healthy development of medical AI required the building of a complete regulatory structure that includes legal requirements, ethical guidelines and their enforcement procedures. This system should focus on encouraging trust between doctors and patients, and encourage the good development of AI technology in the medical field through algorithm optimization and risk control. Relevant institutions also need to conduct routine ethical effect evaluations to guarantee that AI applications always meet ethical and moral requirements and give better medical services to patients [35].

6.2. Practice of accountability mechanisms

6.2.1. Examples of the application of the mechanism

The responsibility mechanism of AI diagnostic systems has produced positive results in actual operation, which is why research on the use of these systems in our nation's major medical institutions has been done.

The use of medical artificial intelligence has been well known for being a physician, and they have also been supported by algorithms. The main body of this concept, which puts doctors as the main body and algorithmic technology as the wings, has been effectively used to guard against ethical hazards emerging from the use of algorithmic decision-making in the field of medical artificial intelligence.

Google's healthcare artificial intelligence system is based on the ethical framework practice, which gives us a key reference. In order to satisfy criteria including fairness, the system created a transparent ethical framework that calls for the training of the algorithm as well as the results of decisions. The system is able to produce simulated data for various social situations through a dedicated algorithm ethics testing platform, which also evaluates the ethical compliance of algorithmic judgments and gives suggestions for optimization based on the evaluation results [36].

In terms of algorithm transparentness and explainability, healthcare practitioners can evaluate the reliability and applicability of AI algorithms by making public information such as the model structure, training data, input/output, and performance evaluation of AI algorithms.

At the same time, to preserve patient privacy, healthcare institutions use security measures such as data encryption and access control to avoid data loss and leakage. these precautions not only assure the quality of medical services, but also lay the basis for establishing a doctor-patient trust relationship.

6.2.2. The impact of mechanisms on medical decisions

Significantly altering the application model of medical artificial intelligence, the accountability mechanism has a significant effect on the medical decision-making process. Physicians are the primary authority in the traditional medical decision-making system to diagnose and treat patients, but the use of artificial intelligence has complicated the process. Medical institutions can rationally assign the decision-making weights of doctors and AI systems while safeguarding the rights and interests of patients by establishing a reliable traceability mechanism.

Intelligent technology is being made more transparent thanks to the application of accountability methods. When making judgments, medical AI systems must give the reasoning and decision-making process a clear foundation, which aids physicians in comprehending and assessing the rationale of AI suggestions. At the same time, patients can have a greater understanding of the exercise and diagnosis process to be aware of and independent. The trusting relationship between physicians and patients is effectively strengthened by this increase in transparency.

The traceability mechanism gives significant evidence in the early clinical evaluation of medical artificial

intelligence systems in terms of safety assessment. Medical facilities may quickly determine possible safety hazards and develop corresponding preventive actions by routinely recording and evaluating every facet of AI decision-making. The harmful effects that AI applications might cause are effectively decreased by this preventive method of risk management.

In addition to encouraging the value orientation of medical artificial intelligence systems, the use of the traceability mechanism is another way that the latter are carried out. System crews can include ethical principles in the algorithm design phase by clearly defining the rights of patients and the extent of privacy protection. When giving decision support, AI systems can always show respect and care for people because of this "technology for good" orientation.

6.2.3. Feedback and adjustment from medical institutions

Medical institutions continuously compile and analyze real-world data to evaluate and improve the effectiveness of responsibility mechanisms applied to AI diagnostic systems. Feedback from multiple institutions indicates that the transparency and explainability of medical AI systems have significantly improved as a direct result of implementing these mechanisms. However, many institutions emphasize that regulatory and institutional frameworks for AI tools still require further development. To address this, several organizations have started integrating ethical principles into algorithm development and increasing ethical training for medical staff to raise awareness of AI-related issues. Additionally, medical institutions actively collaborate with companies and research bodies to optimize accountability mechanisms, tackling critical challenges such as medical injury traceability and responsibility allocation.

In line with medical practice, institutions recommend positioning physicians as patient-centered leaders, with algorithmic technologies serving as supportive tools. This approach prioritizes the protection of patients' fundamental rights and aims to enhance trust between doctors and patients by continuously optimizing AI algorithms. Such adjustments not only safeguard the professional judgment of physicians but also clearly establish ethical standards for AI systems.

7. Discussion and suggestions

7.1. Discussion of research results

This paper emphasizes the principal ethical issues surrounding the use of medical artificial intelligence (AI), focusing particularly on the challenges posed by algorithmic opacity. It systematically examines the ethical and regulatory practices involved in AI-driven medical decision-making. According to recent reports, AI algorithms in medicine hold great promise for enhancing diagnostic accuracy, treatment effectiveness, and optimizing medical services. However, these benefits are accompanied by significant moral hazards, including the potential substitution of doctors' decision-making authority, erosion of patients' fundamental rights and interests, and a growing crisis of trust between physicians and patients. The literature closely aligns with these concerns, highlighting issues such as algorithmic opacity, fairness, and responsibility.

In studying the traceability of accountability mechanisms, this paper identifies the "algorithmic black box" phenomenon as a major barrier to responsibility attribution. When medical decisions rely on complex deep learning models, the lack of transparency in the decision-making process obscures accountability boundaries. As emphasized by the four principles of medical ethics, this opacity compromises patients' rights to informed consent

and autonomy, while also undermining trust in clinical decision-making.

The value of accountability mechanisms can be expressed in terms of transparency, which reflects legal compliance; in instances where transparency exists, appropriate weighting coefficients can be assigned to measure compliance levels.

Further analysis reveals that effective accountability requires multi-stakeholder cooperation. Building a sense of community between doctors and patients and fostering shared values are essential to resolving trust issues. Simultaneously, the regulation and governance of AI algorithms must clarify their complementary role in medical decision-making, not a substitute for human judgment. Medical AI systems should serve as tools to assist clinicians, with final decision-making authority remaining firmly with medical professionals who bear ethical responsibility.

At the legal level, this study finds that existing laws in our country lack clear definitions regarding patients' data rights and privacy protections. There is an urgent need to establish a comprehensive legal framework to safeguard patient privacy. Drawing on China's rich tradition of medical ethics, emphasizing benevolence and compassion. Integrating modern technical ethics can provide robust support for addressing challenges posed by medical AI.

7.2. Suggestions for future research

With the rapid advancement of medical artificial intelligence (AI) and ongoing research, it is crucial to deeply integrate accountability and algorithmic ethics in clinical applications. To ensure that AI decision-making fully respects patients' rights to informed consent and autonomy, medical AI systems must establish a comprehensive ethical framework bridging medicine and technology. Developers should incorporate principles of justice, data acquisition, and decision outcomes into ethical frameworks, drawing on practical examples such as Google's healthcare AI system.

Future research should focus on creating dedicated algorithm ethics testing platforms that simulate diverse social contexts to evaluate whether AI decisions meet ethical standards across scenarios, providing optimization feedback based on deviations. Privacy protection and fairness principles must be prioritized as foundational elements for building trusted medical AI systems. Additionally, research should emphasize human-centered values, aiming to enhance health and well-being while ensuring that the autonomy of healthcare providers and patients remains paramount, without being supplanted by technology.

Addressing algorithmic challenges requires applying medical ethics regulations to guide machine behavior, supported by a "top-down" governance approach. Future studies could explore how moral principles might be translated into "computable" ethical rules programmed into AI behavior, akin to Asimov's three laws of robotics. Given the current lack of clear legal definitions regarding patients' data rights in our country, protecting patient privacy must become a central focus of ethical governance in medical AI.

Ultimately, medical AI should reaffirm the primacy of doctors as decision-makers, with algorithms serving as supportive tools, thereby enhancing clinical judgment and safeguarding patient rights. Emphasis should also be placed on continuous algorithm optimization, ethical regulation of technology, risk management, and strengthening trust between doctors and patients. Through these multifaceted efforts, the ethical and accountability systems of medical AI can be significantly improved.

8. Conclusion

There were previously unheard-of medical changes and problems as a result of the rapid development of artificial intelligence in the medical profession, particularly with regard to the extensive use of AI diagnostic systems. In this study, the main topics of this study are the creation and enhancement of accountability mechanisms for AI diagnostic systems, which highlight the main problems and solutions in the current ethical governance of medical AI, by looking into the application boundaries of algorithmic ethics in medical decision-making.

The research shows that the "black box" nature of artificial intelligence algorithms seriously affects the trust relationship between doctors and patients and the transparency of decision-making, while making the definition of responsibility attribution ambiguous. Under the classic medical model, the positions of medical institutions and doctors as service responsibility subjects were obvious, but the introduction of AI technology has brought about fundamental changes in the doctor-patient relationship, making the issue of responsibility determination increasingly complex [37]. The lack of current rules and regulations further worsens this situation, not only breaking the basis of social morality and legal responsibility, but also sowing the seeds of possible dangers, which explain the duties and obligations of those concerned in the system life cycle [38]. In addition, it is important for the government, enterprises, medical institutions and patients to work together to strengthen relevant laws and regulations, strengthen ethical supervision and establish a data security management system to solve ethical and legal issues in the application of AI in medical care [39].

The main goals of future study are to address the main problems that are related to patient privacy protection, the innovation of medical AI, and the privacy of patients, which in turn promotes the organic integration of algorithmic ethics and medical practice, as well as the healthy and sustainable development of AI diagnostic systems in the medical field. The benefits of artificial intelligence (AI) in enhancing medical efficiency and accuracy can only be used to the fullest extent possible, and the balanced development of patient rights and medical ethics can be guaranteed.

Disclosure statement

The authors declare no conflict of interest.

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