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The Frontier Exploration of the Development Trend of Key Technologies in Digital Healthcare in Medical Big Data Analysis

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Abstract: With the rapid development of medical big data, digital healthcare as an interdisciplinary field is gradually transforming the traditional healthcare model, continuously advancing the realization of personalized medical services and remote health monitoring. This paper systematically reviews 138 research articles related to the development trends of key technologies in digital healthcare, exploring various critical areas including digital health and privacy security, the application of artificial intelligence and machine learning in health, remote monitoring and mobile health, medical data analysis and electronic health records, and the ethical and policy challenges in digital health. Studies indicate that the improvement of privacy security measures and efficient medical data processing technologies are the foundation for the safe promotion of digital healthcare; Artificial intelligence and machine learning technologies play an important role in enhancing the accuracy of diagnosis and disease prediction. Meanwhile, mobile health and remote monitoring technologies show great potential in improving the accessibility and continuity of medical services. In addition, this paper discusses the challenges of ethics and policies in digital health practice, such as data sharing, conflicts of interest, and respect for patient privacy. Future research must focus on refining technological solutions to address these challenges and fully integrate digital healthcare technologies into clinical practice.

Keywords: Digital Healthcare; Artificial Intelligence; Privacy Security; Ethical Challenges; Medical Big Data.

1. Introduction

1.1. Research Background

With the progress of science and technology and the deepening of digital transformation, medical big data analysis has become an indispensable part of the modern medical system. By using high-end technologies such as data mining and machine learning, medical big data analysis has shown great potential and value in medical decision-making, disease prediction, and treatment effect evaluation. The development of key technologies in digital health enables clinicians to access and utilize unprecedented amounts of data to improve the accuracy and effectiveness of diagnosis and treatment. The situation shows that although digital medical technology has been widely studied and applied in clinical practice, but there are still some limitations. For example, insufficient data privacy protection, information security risks, data quality and integrity issues, and the integration problem of multi-source heterogeneous data are still key problems to be solved in the industry. In addition, although existing researches cover all aspects of data collection, processing and analysis, there is an urgent need for more in-depth exploration on how to make more efficient use of big data, especially in data-driven personalized medicine and clinical decision making. Pointing to the problems of the development of digital medical key technology need further direction, especially in the data privacy protection, intersection and variation in areas such as the application of new technology innovation, looking forward to have the guidance of systematic methodology and practice. Write the reason and purpose of this review is that by focusing on medical big latest development trend of digital medical treatment in the data analysis, on the one hand can help academia and understanding of the current technical status quo of the health care industry system, the challenge and the development direction of the future; On the other hand, the review can point out the shortcomings of existing research and potential improvement space, and provide guidance for subsequent research. Through in-depth exploration and communication, I hope to inspire new research ideas, promote technological innovation, and ultimately promote digital medical technology to play a greater role in improving the health of the people.

1.2. Research Significance

In terms of theoretical significance, this study aims to deepen the understanding of key technologies of digital health and enrich the existing theoretical research content of medical health information by comprehensively analyzing the accumulated medical big data. In particular, the exploration of big data analysis methods applied to complex medical scenarios is helpful to improve the theoretical framework of medical data processing and analysis, and promote the coordinated progress of theory and technology. Through the comprehensive application of machine learning, deep learning and other artificial intelligence technologies, to explore new methods in the fields of disease prediction, treatment effect evaluation and health management, and to

provide research basis and methodological guidance for the construction of the theoretical system of digital medical care.

In terms of practical significance, with the rapid development of the medical and health industry, the development trends of key technologies extracted in this study can provide guidance for practical application and promote technological innovation and application popularization in the field of digital health. For example, the technology of detecting hepatobiliary system diseases in ophthalmic images based on deep learning mentioned in literature [49] can be used to guide the optimization of clinical diagnosis process to improve the accuracy and efficiency of disease diagnosis. At the same time, digital health tools introduced by studies such as literature [75] are of great significance for the monitoring and management of COVID-19, showing the application potential of digital medical technology in public health events. In addition, the solutions proposed in this study to solve the existing data privacy and security problems (as described in reference [4]) play a key role in promoting patients' trust in the digital health system, thereby promoting the digital transformation and innovation development of the entire medical and health service system.

In general, this study explores the frontier of medical big data analysis and the development trend of key technologies in digital health, which not only broadizes the theoretical perspective of medical informatization, but also provides an empirical basis for the application of related technologies in medical practice, and effectively promotes the sustainable development of the medical and health industry.

2. Digital Health and Privacy Security

2.1. Privacy Violation Detection Techniques in Digital Health

In the field of digital health, privacy security is always a topic that cannot be ignored. Especially in the era of big data, the detection technology of privacy violation has become an important means to protect patient information and medical data. Hurst et al. (2020) [2] studied the detection of patient privacy violation in medical critical infrastructure based on density-based benchmarking. They analyze access patterns of medical data to find abnormal behavior, which often implies potential privacy violations. In their method, by comparing the data density difference between normal access behavior and abnormal access behavior, inappropriate data use behavior can be effectively identified. For large data privacy protection, Sharma (2020) [4] proposes a modified data utility of disinfection method. Sanitization refers to the processing of sensitive data to prevent the disclosure of patient information during sharing and analysis. This method ensures the privacy of the data by modifying or hiding the data as necessary while maintaining its use. In this way, the security of the data during transmission can be strengthened without affecting the analysis results. In addition, Dimuna (2020) [5] through qualitative research, discusses the network safety strategy of reducing medical identity theft, focusing on the managers' experience. Medical identity theft is a serious problem in digital health, which not only violates the privacy of patients, but also can lead to the misuse and abuse of medical services. Dimuna emphasized the importance of education and training in preventing identity theft, as well as the need to strengthen cybersecurity systems. Overall, according to the theory of digital medical privacy invasion detection technology, academic circles have put forward some research directions and strategies. From strict data access monitoring to improved data processing methods, these technologies together constitute a multi-level defense system to protect privacy in digital health. Future research is expected to further optimize these techniques to be more effective against evolving cybersecurity threats.

2.2. Privacy Security and Data Cleaning in The Era of Big Data

In the era of big data, privacy security and data cleaning have become two important aspects of key technologies in the field of digital healthcare. With the dramatic increase in the amount of patient information data, how to effectively clean and utilize the data without disclosing user privacy has become an urgent problem to be solved. The first point, privacy is the key point of digital medical treatment must be strictly considered. The implementation of reasonable privacy protection measures in the medical information system can effectively prevent the disclosure of patient privacy data. Hurst et al. (2020) [2] proposed a density-based benchmarking method to detect patient privacy violations in medical critical infrastructure. This approach can accurately detect potential privacy violations, which is critical to improving trust in digital health systems. At the same time, maintaining the security of medical data can not only protect the privacy rights of patients, but also help to safeguard the reputation and legal responsibility of medical institutions. The second is to consider, in order to increase the application value of the big data in the medical field, data cleaning has become a link cannot be ignored. Data cleaning involves not only removing useless or erroneous data, but also improving data quality to facilitate analysis and data mining. Sharma et al. (2020) [4] proposed a cleaning method for big data cleaning, which takes into account data privacy protection while improving data utility. This method of balancing privacy protection and data utility not only ensures the availability of data, but also takes into account the security and privacy of data. In addition, also need to consider is that medical identity theft is another digital medical domain privacy security challenges. Qualitative research conducted by Dimuna (2020) [5] focused on cybersecurity strategies for reducing medical identity theft, with particular emphasis on the lived experience of managers. This study serves as a reminder that when building digital health systems, in addition to technical safeguards, administrative strategies need to be emphasized to ensure data privacy security across all dimensions. In conclusion, privacy, security and data cleaning is two trends of the development of digital medical field. It is not only necessary to protect privacy security through technical means to ensure the cleanliness and quality of data, but also to prevent medical identity theft and other network security problems through management strategies. These measures together ensure the healthy development of digital health.

2.3. Cybersecurity Strategies in The Face of Medical Identity Theft

In the medical field, with the development of digital technology, the theft of medical identity information has become an increasingly serious problem. In this context, the formulation of network security strategy becomes particularly important. According to the research of Dimuna (2020) [5], the security challenges faced by medical managers in real work are very complex, so they emphasize the importance of

security measures and education and training at the application level. Security measures need to be updated in step with technological advances to protect patient information from compromise. In addition, Hurst et al. (2020) [2] proposed that density-based benchmarking methods should be used to detect privacy violations in medical infrastructure. This method can effectively identify abnormal data patterns, so as to detect potential identity theft at an early stage. In order to improve the medical data privacy protection, can adopt Udit Sharma et al. (2020) [4] the proposed modified data cleaning method. This method can effectively desensitize sensitive data without compromising the utility of data, thereby reducing the risk of medical identity information being abused. It also prevents potential medical identity theft. Sum up, a comprehensive network security strategy must be combined with the latest technology and improvement of the management level. By implementing advanced breach detection technologies, enhancing privacy protections for data cleaning, and enhancing privacy security education for health care personnel and administrators, health care organizations can provide a more secure digital health environment for patients. This will not only help prevent medical identity theft, but is critical to maintaining patient trust and the reputation of health care institutions.

3. Applications of Artificial Intelligence and Machine Learning in Health

3.1. Advances in Artificial Intelligence in Medical Data Analysis

With the rapid development of artificial intelligence technology, its application in medical data analysis is increasingly widespread. Machine learning, especially deep learning, has played an important role in many aspects such as disease diagnosis, image analysis, and treatment effect evaluation. Rieke et al. (2020) [101] proposed a federated learning framework, which allows different medical institutions to share learning models instead of data itself. While ensuring patient privacy, Rieke et al. (2020) can use more diverse and larger amount of data to improve the generalization ability of the algorithm. This has important implications for precision medicine and the development of individualized treatment plans. It is worth mentioning that medical image data automatic analysis become a hotspot in the artificial intelligence application areas. Xiao et al. () [49] successfully used deep learning technology to detect hepatobiliary diseases in eye images, demonstrating the potential of deep learning in fine-grained diagnosis. In addition, for medical information on social media, machine learning has also shown the ability to monitor and analyze. For example, studies have shown that unsupervised learning can identify hydroxychloroquine misinformation on Twitter () [89], which provides a new perspective for information dissemination and public health policy. It is important to note that the medical data in big data analysis heterogeneity and sample imbalance are two major challenges. Cao et al. (2020) [16] proposed a deep learning model of adaptive regularization to solve this problem, which effectively improved the learning effect by introducing heterogeneity and sample imbalance as prior knowledge. This approach provides a new way to deal with complex medical data. Finally, as the prospect of the digital health continues to expand, as Abernethy () [111] pointed out that from the past to the present, and future, the promise of digital health is to improve the quality and effect of health care, reduce costs, enhance patients experience. As an integral part of digital health, artificial intelligence is expected to further promote the reform and development of medical and health services in the future.

3.2. Application of Deep Learning in Medical Image Diagnosis

In today's digital medical field, deep learning technology has been widely used, especially in the key branch of medical imaging diagnosis. Deep learning algorithms can effectively identify the characteristics and patterns of diseases by learning from a large amount of image data to support clinical decision-making. Among them, convolutional neural network (CNN) has become one of the most common deep learning models in medical imaging diagnosis because of its superiority in feature extraction. Medical imaging of deep learning diagnosis, Rieke et al. (2020) [101] highlights the federal study on distributed the importance of medical data. By using federated learning, each participating institution can jointly train the model without disclosing data privacy, and promote the model to have better universality and robustness. Furthermore, the study of Cao et al. (2020) [16] introduced the adaptive regularization technique, which helps to improve the deep learning model and improve its performance in the case of heteroskedastic and data imbalance. On the specific medical applications, Xiao et al., (,) [49] eye image, for example, to carry out the study of deep learning based on the detection of liver disease. By building a deep neural network model to effectively extract features from fundus photographs, they diagnosed hepatobiliary diseases, demonstrating the great potential of deep learning in specific medical fields. In addition, changes in facial expression can sometimes reflect the health status of patients. Therefore, Huo et al. (,) [122] applied artificial intelligence to multi-level pain assessment based on facial images, providing a new recognition method for pain symptoms. These findings suggest that deep learning applications in the field of medical imaging diagnosis is moving toward improving accuracy, protect data privacy and extended scope of diagnosis, and other direction. In the future, with the improvement of computing power and the improvement of algorithms, we have reason to believe that deep learning will continue to play a crucial role in medical big data analysis.

3.3. Machine Learning in Health Monitoring and Disease Prevention

With the rapid development of digital health technology, machine learning has become an indispensable part of health monitoring and disease prevention. Rieke et al. (2020) [101] explored the application of federated learning in medical big data and proposed a method for data sharing through distributed learning without disclosing patient privacy. The core of this approach is that by deploying the learning algorithm of the model to the source of the data, the data can be used for model training without leaving its original location. In addition, Cao et al. (2020) [16] proposed an adaptive regularization method to deal with heteroscedasticity and data imbalance in deep learning. By introducing an adaptive weight regularization term, this method can effectively improve the performance of the model when processing medical image data, which is crucial for early detection of chronic diseases. In disease diagnosis, such as Xiao (no date) [49] successful application of deep learning

algorithm of ophthalmic imaging of liver disease diagnosis. The use of deep learning models to analyze medical images can help doctors identify disease patterns faster and achieve early prevention and treatment. However, the applied research of Huo et al. (no date) [122] on multi-level pain assessment of facial images demonstrates the potential of using AI for symptom monitoring. This technique can provide immediate health monitoring by analyzing a patient's facial expression to assess their pain level without invasiveness. In addition, machine learning in health monitoring applications include using unsupervised learning detection and classification error information on social media. This technique has been shown to be effective in identifying and reducing misinformation dissemination of medications (undated) [89]. Specifically, Unsupervised Machine Learning can be applied to analyze a large number of tweets, so as to detect false claims or misleading information related to drugs and provide accurate health information to the public. Summary of the above discussion and analysis, machine learning technology in health monitoring and playing an increasingly important role in disease prevention. Through effective data analysis and pattern recognition, machine learning not only promotes the innovation of personal health management, but also helps the medical industry to achieve data sharing while protecting patient privacy, which has far-reaching significance for improving the quality and efficiency of medical services.

4. Remote Monitoring and Mobile Health

4.1. Prospects for Mobile Health Applications and Services

With the continuous progress of communication technology, mobile health applications have become an important tool to achieve efficient medical services and convenient patient monitoring. In particular, in the field of Mental Health, the Mobile Mental Health Truck Program shows the great potential of mobile health services (Subramaniam, Elizabeth; [11]. In addition, Integrating Hospitalist Services Via Telehealth Across a Regional Rural Hospital the Network project demonstrated the feasibility and effectiveness of delivering telemedicine services through an e-health platform (Furcht, Margaret I. [23]. In acute disaster situations, mental health support systems based on mobile apps have shown great adaptability and effectiveness (Nwamaka Alexandra Ezeonu et al. [44]). At the same time, smartphones have revolutionized mobile health and participatory health care, allowing patients to receive more personalized medical services while reducing costs (Maged N Kamel Boulos et al. [46]). The study also found that digital application significantly reduces the clinical symptoms of patients with panic disorder (Kun Jung Kim et al. [47]). Compared with traditional personal monitoring devices, commercial smartphase-based monitoring devices and smart applications have demonstrated their flexibility and convenience in personalized health monitoring and management (Sandeep Kumar Vashist et al. [45]). By combining the analysis of ordinal data with the Bayesian zero-inflated model, the performance evaluation of mobile health applications is also more accurate and reasonable (Yang, Huizhong; [38]. Combined with these studies, the trend of the development of mobile health applications can be summarized as follows: - the services of personalization and accurate will become the core of the development of mobile health applications. - cross major integration will promote the cooperation between different health care providers, realize resources sharing. - real-time data monitoring and analysis to improve the efficiency and effectiveness of emergency medical response. - user friendly and acceptability is the key factor for mobile health applications is growing, which requires constant innovation and upgrade the application function and interface design. - data security and privacy protection are still mobile health applications require constant attention and areas of improvement. The development of mobile health applications not only provides a new way for individual health management, at the same time, through the integration and the analysis of large-scale health data sets, help to promote public health strategy formulation and disease prevention work.

4.2. Integration of Telemedicine Networks in Rural Areas

In rural areas, the integration of telemedicine networks is gradually showing its importance and potential value. The study by Furcht et al. (2020) [23] shows that the integration of telemedicine services in regional rural hospitals can effectively improve service quality and coverage, and optimize the distribution of medical resources. Specifically, the integration of the telemedicine network includes several key aspects: the first is on the one hand, establish communication infrastructure is the basis of the integration work. This involves the laying of high-speed networks, the construction of telemedicine platforms, and the application of end-to-end encryption technology to ensure the security and accuracy of data transmission. Want to mention is that next to provide professional medical service is the core. With Telehealth technology, physicians can provide consultation, diagnosis, and treatment advice to patients remotely. Subramaniam and Elizabeth (2020) [11] introduced the MHealth project, which is a typical example of providing mental health support to rural patients in real time through mhealth services. Further, Vashist et al. (no date) [45] highlights the smart devices and applications in personalized medicine. The function of monitoring and management. Commercially available smartphone devices and smart apps provide portable, low-cost health monitoring tools for patients in rural areas. At the same time, the data analysis method of the application is very important to improve service quality. Yang and Huizhong (2020) [38] proposed a Bayesian zero-inflation model, which can be used to process ordinal data and help to identify and predict trends in health status changes from remote monitoring data. Finally, for responding to natural disasters caused by mental health problems, mobile application is regarded as a kind of effective support tools. Nwamaka Alexandra Ezeonu et al. (no year) [44] conducted a scope-based assessment that explored the ways in which mobile apps could support mental health responses in natural disaster situations. Through the integration of the remote medical service, in improving the quality of rural medical service at the same time, also for health care professionals and researchers provides valuable data resources. These data resources, when properly analyzed and processed, can uncover health trends and demand patterns, and then point the way for the development of key digital health technologies in rural areas.

4.3. Development of Participatory Health Monitoring Technologies

With the popularization of smart mobile devices and the rapid development of medical technology, participatory health monitoring technology has become an indispensable part of medical big data analysis. Current research trends obviously favor the use of smart phones and other portable devices to achieve real-time and personalized health monitoring and management (Kamel Boulos et al., 2011)[46]. Especially in the field of mental health, mobile applications have achieved positive effects in assisting diagnosis and intervention by collecting users' emotional and behavioral data (Ezeonu et al., 2020)[44]. For people with panic disorder, for example, individuals, Kim et al. (2020) [47] to design digital application to reduce clinical symptoms. Based on the principle of cognitive behavioral therapy, the application combines the user's real-time feedback of physiological and psychological data to achieve the effect of symptom relief through customized intervention. Similarly, Vashist et al. (2015)[45] described how commercial smartphone devices and smart applications have been transformed into personalized medical monitoring and management tools, highlighting the key role of smartphones in data acquisition, processing, and transmission. In addition, from the perspective of medical services, Furcht et al. (2020) [23] by remote medical service integration into a network of regional rural hospitals, proved that the remote monitoring technology in the potential ability of medical service. In the field of mental health, the mobile mental health service project of Subramaniam et al. (2020)[11] further demonstrates the feasibility and effectiveness of providing mental health support through mobile devices. Statistical modeling, Yang et al. (2020) [38] proposed bayesian zero inflation data model used to handle order, help from participatory monitoring of non-uniform extract useful information and sparse data set. This model strengthens the analytical power of surveillance data by coping with excessive zero-sum ordering in the data, thereby providing physicians with more accurate health status assessments. In a nutshell, participatory health monitoring technology is gradually evolved into a multidisciplinary, multiple technology fusion area. It includes not only the development of smart hardware, but also the design of advanced data processing algorithms and user-friendly interfaces, all of which together push the frontier of digital health.

5. Medical Data Analysis and Electronic Health Records

5.1. Application of Big Data in Medical Analytics

Big data technology plays a crucial role in modern medical analysis. It provides unprecedented support for clinical decision-making, disease monitoring and health management by efficiently processing and analyzing large-scale medical data sets. Khanra et al. (2020) [3] reviewed the application of big data analytics in the medical field and pointed out the significant contributions of data mining, machine learning, and predictive models in disease prediction and patient health management. For example, by analyzing electronic health records (EHRs), health professionals can detect patterns of chronic disease earlier and intervene. Widely used in electronic health records of laid a foundation for effective medical data analysis. Crampton (2020) [8] emphasized the importance of training clinical interns in how to effectively manage and utilize EHR data in his research. Electronic health records improve the quality of care by providing a data source for clinical decision support tools. For example, Dewan et al. (2020) [30] showed how clinical decision support tools can be used to identify high-risk, critically ill pediatric patients, aiming to improve outcomes and reduce complications. Crucial one annulus is the interoperability of digital medical technology. Shull (Years) [81] discusses the state of interoperable electronic health records and their potential to improve care delivery and facilitate data sharing. Digital health literature literacy is also one of the indispensable skills of big data in medical analytics. vander Vaart and Drossaert (Years) [104] developed a measurement tool for digital health literature literacy that includes a wide range of health 1.0 and health 2.0 skills. Is essential for understanding and using digital health resources. In addition, patients and medical staff in remote patient monitoring experience also constitutes a large part of the data analysis. Pannunzio et al. (Year) [103] systematically reviewed metrics for rating experience with remote patient monitoring and provided direction on how and when to measure. Remote monitoring not only improves the coverage of medical services, but also improves the quality of disease management through continuous monitoring. By using big data and related technology, strategic integration and analysis of medical data, has become to improve patient care and a key way of medical resource allocation optimization. As technology advances, these applications will continue to evolve to meet the growing and diverse medical needs.

5.2. Data Management for Electronic Health Records

With the deepening of the digitization process, electronic health record (EHR) has become an extremely important part of medical data management. The optimization of electronic health record systems and the resulting ability to analyze big data have become the focus of current health information technology research (Jessica Germaine Shull[81]). Efficient data management systems can not only improve patients' medical experience, but also have a profound impact on the operation of medical institutions by supporting clinical decision-making and improving hospital operation efficiency. First of all, is worth discussing, in order to ensure that electronic health record data quality, for clinical doctors data management education is becoming more and more important (Noah h. Crampton [8]). Standardization, accuracy, and completeness of data entry are essential for the validity of data analysis. Studies have shown that effective training of clinical medical staff on EMR data can not only improve their data management capabilities, but also improve the overall quality of medical services to a certain extent. When it comes to data management, electronic health records of interoperability is a challenge that nots allow to ignore (Jessica Germaine Shull [81]). Information islanding caused by insufficient interoperability limits the efficiency of data sharing and utilization. However, it is not impossible to solve this problem. For example, the use of data interaction formats and protocols that conform to international standards can greatly improve the convenience and security of data sharing between systems. In addition, using advanced algorithms to anonymize the data, information can be shared while ensuring individual privacy. Finally, the development of modern medical decision support

system (CDSS), especially in the application of intensive management, showed the potential of EHR management and analysis system for huge Dewan etc. [30] (Maya). Through real-time monitoring of data in electronic health records, CDSS can effectively identify high-risk patients in intensive care unit (PICU), provide timely warning for clinical practice, and thus reduce the risk of serious clinical events. Summarize the main points from above, the electronic health record data management is becoming a rapid development of digital medical domain. By improving data governance education, improving system interoperability, and developing decision support tools, EHR data management systems can bring revolutionary changes to the entire medical ecosystem.

5.3. To Evaluate the Application Effect of Medical Decision Support Tools

In medical big data analysis, medical decision support tools (CDSS) play an important role in improving patient treatment outcomes and optimizing medical resource allocation. Khanra et al. (2020) [3] pointed out that CDSS can provide evidence-based treatment recommendations for doctors and assist in the medical decision-making process by analyzing large-scale medical data. The implementation of this technology is not only limited to the interpretation of data, but also extends to the prediction of patient health risk, the design of personalized medical plans, and the monitoring and management of epidemiology. In order to ensure the efficient utilization of medical decision support tools, evaluate the performance is very important. Dewan et al. (2020) [30] tested a CDSS tool in the pediatric intensive care unit (PICU) to identify high-risk patients and to observe its preventive effect on clinical deterioration. The core indicators of the evaluation are accuracy, sensitivity and specificity, which are expressed by the mathematical formula as follows:

- Accuracy= \ \ frac {TP + TN} {TP, TN and FP + FN} \)
- Sensitivity = \ (\ frac {TP} {TP + FN} \)
- Specificity = \ (\ frac {TN} {TN + FP} \) of TP said real example, TN said true negative example, FP said false positive cases, FN said false negative cases. Furthermore, CDSS for electronic health records (EHR) increasing, the dependence of Crampton (2020) [8] to highlight the EHR data quality has significant impact on the performance of CDSS, data of discipline education to improve the accuracy and reliability of CDSS is indispensable. Shull [81] raised the issue of data interoperability, pointing out that CDSS can achieve its full potential only when EEHR of different medical systems can exchange data without barriers. Finally, CDSS needs not only the desired on clinical effect, also need to give attention to both patients and medical workers experience. Pannunzio et al. (Nien) [103] aimed to evaluate the experience of remote patient monitoring system (a CDSS application) for patients and medical staff, and proposed a series of quantitative measurement tools and methods. This assessment method could provide a basis for the development of more efficient and user-friendly CDSS. Summary of the previous argument, medical decision support tool utility evaluation is a multi-dimensional task, from technical performance to the comprehensive assessment of the user experience is of great significance for the further optimization and promotion.

6. Ethical and Policy Challenges in Digital Health

6.1. Ethical Transparency of Electronic Health Records

In digital health, transparency in electronic health records (Ehrs) is a prerequisite for establishing trust between health professionals and patients and promoting adoption. The issue of EHR transparency involves the consistency, completeness, and understanding of information disclosure, which not only relates to the quality of health care delivery, but also directly affects patients' right to privacy and information (Brigitte Seroussi et al. (2020) [10]). As Seroussi et al. (2020) [10] pointed out, the enhancement of transparency in the field of health informatics is a condition for achieving the trust of medical professionals and patients, accompanied by the improvement of ethical requirements. In addition, ethical transparency includes transparency in the decision-making process, that is, patients should be fully aware of how their personal data are analyzed and applied (Vayena Effy et al. (2016) [116]). In the legal and policy level, the use of electronic health records also faces many drugs legal considerations. Especially in multidisciplinary cancer care, the keeping and sharing of medical records must comply with relevant legal and ethical standards to guide healthcare professionals and protect the rights and interests of patients (Pamela L Karas et al. (2020) [27]). In addition, health literacy and digital health literacy are non-negligible factors in the implementation of digital health technologies, which directly relate to patients' ability to use electronic health record systems (Emma Kemp et al. (2019) [57]). In the context of digital health intervention evaluation, ethical and privacy dilemmas have also been frequently raised, and the selection of key questions and methodologies needs to carefully consider the transparency and ethical standards of EHR data processing (Elizabeth Murray et al. (2016) [62]). Digital ethical aspects of health, from the viewpoint of the justice, transparency must ensure all of the patients to accept service, no matter how its economic status. Brall et al. (2019) [63] show that ethical issues in digital health not only involve privacy and data protection, but also take into account the equitable distribution of medical resources. Finally, in the new type of coronavirus pneumonia (COVID - 19) during a pandemic, digital health technology rapid development, especially in the field of eye care. Dinesh V Gunasekeran et al. (2020) [137] summarized the experience of digital health in this period from the perspective of operating a new nursing model, indicating that electronic health records played a key role in ensuring the continuity of medical services during the epidemic, and also posed new challenges and learning opportunities for its transparency.

6.2. Legal Liability in Multidisciplinary Teams

Within multidisciplinary teams, the definition of legal liability has become one of the key challenges, especially in the implementation and operation of digital health projects. Digital health projects involve complex data processing, privacy, and security while health care providers must navigate complex compliance requirements. Brigitte Seroussi et al. (2020) [10] emphasize transparency of medical informatics processes as a prerequisite for trust and adoption by healthcare professionals and patients, and also put forward relevant ethical requirements. This means that legal liability

issues may be involved when team members are not transparent enough in their workflow or violate data handling agreements. In multidisciplinary cancer care team, Pamela Karas L et al. (2020) [27] medical and legal considerations are discussed, suggested that when the treatment failure or medical mistakes, how to share the legal responsibility between different disciplines is a challenge. Moreover, when using digital health technologies to support cancer care and management, integrating health literacy and digital health literacy becomes critical (Emma Kemp et al., 2020) [57] as this relates to how patients understand and use digital tools, which may also affect the scope of responsibility of professionals. Elizabeth Murray et al. (2020) [62] in evaluating digital health interventions and method, points out that the key problem of clear each technical intervention effects on specific health outcomes, can help to define the responsibility of the medical staff in the implementation of such technology. Among the ethical and policy challenges of digital health, Vayena Effy et al. (2018) [116] highlighted that this is an evolving field that requires a combined ethical and policy perspective to address emerging challenges. The same applies to the operation of new models of digital health during the pandemic, as demonstrated in the study by Dinesh V Gunasekeran et al. (2021) [137]. In the evolving healthcare environment during the COVID-19 pandemic, legal liability has struggled to keep up with the rapid development and application of digital health models. In the development and implementation of digital medical technology policy, ethical and legal problems have emerged. For example, Caroline Brall et al. (2020) [63] discuss considerations from a justice perspective on the ethical aspects of digital health, arguing that legal liability should be considered while ensuring equitable and high-quality access to digital health resources for all patients. This perspective reminds law makers and enforcers to examine whether the allocation of responsibility in multidisciplinary teams adequately reflects the requirements of social justice. Summarize the main points from above, the legal responsibility in the multidisciplinary team to establish not only involves the interaction between the member responsibility, also relate to how to use transparent and ethical way to get the patient's trust and satisfaction. Evolving ethical and policy support is needed to keep pace with technological innovations in digital health to protect patients' rights and ensure the effectiveness of health care delivery.

6.3. Digital Health Technologies and Health Literacy

With the advancement of digital health technology, health literacy has become particularly important. Health literacy refers to the ability of individuals to understand health information and services and make decisions that benefit health based on them (Brall, Schro¨der-Ba¨ck, Maeckelberghe [63]). In the context of digital health, the traditional concept of health literacy is extended to digital health literacy, which encompasses the ability to access, evaluate, share, and apply health-related information using digital tools (Kemp et al. [57]). Given the complexity of current digital health interventions, digital health literacy among users is particularly critical. Digital health literacy affects the intervention effect and patient health outcomes. Studies have shown that high levels of health literacy are closely related to positive health outcomes (Karas, Rankin, Stone [27]). However, due to differences in technical knowledge, there is an inequity in health literacy among different groups, generating the so-called "digital divide". To address this issue, health technology solutions that are easy for users to understand and use need to be designed (Murray et al. [62]). An important issue is to realize the transparency of information. Seroussi et al. (2020) [10] pointed out that transparency in the process of health informatics is a condition for building trust and adoption among medical professionals and patients. Lack of transparency may lead to patient distrust in treatment choices and health outcomes and affect the execution of treatment plans. In the design and implementation of digital health technologies, it is necessary to plan ahead around ethical requirements and establish a clear ethical framework and policy support to ensure the responsibility and obligation of all links (Vayena et al. [116]). COVID - 19 outbreak accelerate digital health technology application in clinical practice, for example in the field of ophthalmology, a new mode of rapid fall to the ground shows the potential of the digital health in the health system (Gunasekeran et al. [137]). However, it also highlights the importance of immediate responses to ethical and policy challenges, highlighting the need for dynamic regulations so that scientific and technological advances and the protection of patients' interests can advance in parallel. In the future, to create a strong policy framework to support the ethics and implementation of the digital health technology combined with all aspects of the stakeholders, especially health care providers and patients, strengthen their engagement and sense of belonging, is to achieve a wider range of digital health industry faced the first task of health literacy.

6.4. Evaluation of The Effectiveness of Digital Health Interventions

Evaluating the effectiveness of digital health interventions is a complex but critical process that involves not only the quantification of medical outcomes but also numerous ethical and policy-level considerations. The evaluation process must provide a comprehensive understanding of the effectiveness, safety, acceptability, and equity of the intervention (Murray et al. (2019) [62]). First, transparency is the cornerstone of earning the trust of healthcare professionals and patients, and transparency of the health informatics process is a prerequisite for their adoption of digital health interventions (Seroussi et al. (2020) [10]). Patient data protection measures must be included in the evaluation strategy to ensure that privacy and security are not violated (Vayena et al. (2018) [116]). Further, assessment strategies to consider health - legal aspects, such as interdisciplinary cancer care of legal reasons (such as Karas (2020) [27]), because digital intervention is often used in different medical services cross. Moreover, health literacy and digital health literacy are necessary for the implementation of digital health technologies, so it is critical to consider these factors in the efficacy evaluation of interventions (Kemp et al. (2020) [57]). Scientifically sound methodologies must be used to explore the potential benefits of different interventions during the evaluation process. Ethical also cannot be ignored, digital health interventions from the viewpoint of justice, fairness and accessibility of give attention to two or morethings, ensure that all people can equal benefit, especially focus on the lower socio-economic status and community medical resources lack (Brall etc. (2019) [63]). Outbreak during the application of the digital health technology and extension provides many lessons for practical operation. For example,

the implementation of new health care models in the field of ophthalmology has shown that continuous and high-quality care can be effectively delivered by making full use of digital tools and platforms (Gunasekeran et al. (2021) [137]). A comprehensive evaluation system based on the above perspectives can help decision makers weigh the full impact of digital health interventions and provide scientific basis for policy making.

6.5. To Examine the Ethics of Digital Healthcare from The Perspective of Justice

Justice is one of the key ethical principles in digital health, which focuses on providing equal opportunities for all individuals and promoting equitable distribution of health resources. In the face of medical resource limitations and unequal technology, the implementation of digital health has to face the challenge of justice. Brall et al. (2020) [63] explore the ethical issues of digital health, with special emphasis on analysis from a justice perspective, that is, ensuring the due role of digital health solutions in promoting health equity. This includes overcoming the digital divide and ensuring that low-income and marginalized groups can access and utilize digital health services. In addition to mention is that the study also shows that the importance of health literacy and digital literacy, they for the implementation of digital technology and its application in cancer care is essential health (Kemp, etc., 2019) [57]. Inequalities in digital literacy can lead to inequity in access to information, which affects patients' ability to participate in digital healthcare. Therefore, improving health literacy is seen as one of the strategies to achieve justice. At the policy level, need to pass legislation and regulations to establish the digital medical ethical framework, at the same time to protect the rights of the patient's privacy and data protection (Seroussi etc., 2020) [10]. For example, transparency is considered a prerequisite for gaining the trust and adoption of health information systems by health care providers and patients. Therefore, improving process transparency is integral to ensuring ethical justice in digital health. In the aspect of legal liability, the digital medical will involve a series of new legal problems, such as interdisciplinary in cancer care responsibility allocation (Karas, etc., 2020) [27]. This requires legal professionals to have a proactive assessment of the issues that may arise and to develop strategies to minimize these risks. Therefore, digital medical ethics from the perspective of justice, should not only focus on the development of the technology itself, but also attach great importance to the protection of individual rights and equality of the allocation of resources and the support of the policy level, thus providing high quality medical service to all people. The rapid expansion and adoption of digital health technologies during the COVID-19 pandemic has further highlighted these ethical and policy challenges, providing opportunities for continued learning and optimization from practice (Gunasekeran et al., 2020) [137].

6.6. The Need for Policy Update Brought by Scientific and Technological Progress

With the rapid development of digital health technology, the existing policy framework needs to be updated to adapt to the new challenges brought by technological progress. The development of science and technology puts forward new ethical and policy requirements for privacy protection, legality review and equal access to medical resources (Vayena Effy et al., 2020) [116]. In the case of transparency of digital health information, for example, research has shown that transparency is an essential condition for building trust among healthcare professionals and patients, facilitating the adoption of new technologies (Brigitte Seroussi et al., 2020) [10]. Medicolegal considerations in multidisciplinary cancer care have also become more complex (Pamela L Karas et al., 2020) [27]. To promote the healthy technology in the process of implementation, digital health literacy and digital literacy influence on patients should not be ignored. Research has pointed out that ensuring that patients can understand and apply digital health technologies is critical to improving the quality of cancer care, and a strategic approach is needed to achieve this goal (Emma Kemp et al., 2020) [57]. At the same time, the evaluation of digital health interventions also presents the need for strategic questions and methodologies (Elizabeth Murray et al., 2020) [62]. More deeply, the digital medical treatment in progress at the same time, you need to ensure that all patients regardless of the background can be fair to enjoy these services, and technologies. Brall et al. examined the moral issues of digital health from the perspective of justice, and put forward the social justice issues that have to be faced in the process of technological development (Caroline Brall et al., 2020) [63]. During outbreaks, digital health technology development and application of obtained the rapidly expand, operationalization new experience of the nursing mode for policy formulation provides a salutary lesson. Dinesh V Gunasekeran et al., through the example of eye care, demonstrated the role and countermeasures of digital technology in policy update during this period (Dinesh V Gunasekeran et al., 2020) [137]. Can be concluded from the above discussion, medical data analysis and the rapid development of digital medical technology for policy makers to update and develop policies, deal with problems such as privacy, legal responsibility and resource equality. This is not just about the effective integration of technology, but also about public trust, the quality of health care delivery, and the achievement of social justice.

6.7. Digital Medical Practice in The Context of Public Health Events

The practice of digital health presents a unique set of ethical and policy challenges during public health events, particularly global crises such as the COVID-19 pandemic. In these cases, the need for urgent implementation of digital health solutions may conflict with long-term patient interests, data protection, and transparency requirements. Vayena et al. (2020) [116] state that ensuring transparency in digital health practices is a key prerequisite to winning the trust of healthcare professionals and patients in times of crisis. Moreover, the transparency of the health informatics process is a fundamental condition in determining its adoption, as highlighted in the study by Seroussi et al. (2020) [10]. In the face of such as COVID - 19 pandemic, traditional way of health care provided to the new mode of rapid shift to a more flexible, remote. Gunasekeran et al. (2020) [137], in assessing the operationalization of new models in ophthalmic services, pointed out that the implementation of digital health technologies requires a strategic approach, which was also confirmed by Kemp et al. (2020) [57] in their discussion on the implementation of digital health technologies in cancer care. In addition, ethics and policy problems cannot be ignored. Brall et al. (2020) [63] argue that examining the ethics of digital health from a justice perspective highlights

the importance of considering inclusiveness, equity, and accessibility in policy making. These considerations are particularly important in public health crises to ensure that all patients have access to and benefit from critical digital health services. In the aspect of medical law, the digital medical practice also brings complex legal and ethical challenges. Karas et al. (2020) [27], when discussing legal considerations in multidisciplinary cancer care, highlight the legal responsibilities that must be weighed carefully when implementing digital health solutions in emergency Settings. In addition, Murray et al. (2020) [62] introduced key issues and methods for evaluating digital health interventions, highlighting the need for ethical review and the correct configuration of strategic frameworks. Together, these studies reveal a range of ethical and policy dilemmas that must be addressed when implementing and operationalize digital health technologies in public health events.

7. Conclusion

7.1. Summary of Research Status

The current research status of key technologies in digital health shows that this field is developing rapidly and becoming an important part of the medical industry. The field is based on big data analytics and artificial intelligence (AI) technologies, which are widely used in the processing, storage, and interpretation of health care data. First, in terms of privacy, researchers are developing advanced algorithms and models, in the premise of no violation of patients' privacy data mining potential. For example, techniques such as density benchmark detection are used to detect and assess privacy violations in health data. In addition, data cleaning methods such as improved data utility techniques show that efficient data management is becoming a critical link in medical research. AI and machine learning has been confirmed in medical image diagnosis, disease monitoring and treatment has a prominent role in optimization. Deep learning models such as convolutional neural networks (CNNs) are particularly prominent in analyzing medical images, which can help doctors make more accurate diagnosis. Remote monitoring and advances in mobile health solutions have realized the real-time health monitoring and feedback of the patient. Especially in rural and remote areas, these technologies enable efficient allocation and application of medical resources by integrating telemedicine networks. Electronic health records (EHR) and medical research and application of decision support system to improve the quality and efficiency of medical service. The application of data analysis technology not only improves the information integration ability of EHR systems, but also enhances the quality of care and the accuracy of efficacy evaluation through predictive models. Last, the ethical and policy issues has become the focus of cannot be ignored. Efforts have been made to improve the ethical transparency of electronic health records, emphasize the clarification of legal responsibilities, and continuously improve the effectiveness evaluation standards of digital health interventions. In the context of global public health events such as the COVID-19 pandemic, digital health technologies have shown particularly important roles in providing information on treatment and survival, supporting public health decision-making, and promoting clinical and consumer health, which further strengthens the central position of key technologies in digital health in the future healthcare system.

7.2. Research Trends and Prospects

In terms of key technologies in digital health, research trends indicate that there will be more innovation and development in the future, focusing on enhancing the accuracy of data analysis and ensuring patient privacy. Below are a few notable trends in digital medical analysis and prospect: 1. The integration of intelligence and artificial intelligence (AI) model can explain: the future research will focus on the development model can explain the AI, makes the medical practitioners to understand the decision-making process of machine learning algorithms. For example, imaging diagnosis results generated by deep learning models will provide detailed interpretation to better serve patients. 2. Enhance data privacy protection measures: digital medical field is actively developing new leak privacy protection technology to combat medical data. For example, differential privacy techniques and homomorphic encryption methods can be used to analyze data while ensuring patient privacy. 3. The development of decision support tools: hope to establish more efficient and accurate clinical decision support system (CDSS), using data driven method to provide personalized health care services. The addition of new algorithms, such as Bayesian networks or support vector machines, is expected to improve the performance of CDSS. 4. Improving health literacy and digital participation: in order to increase the popularity and acceptability of digital medical treatment, there will be more research to improve patients' health literacy, as well as through mobile health applications (mHealth apps) to increase the patient's participation. 5. Optimization of remote monitoring technology: with the increasing number of patients with chronic diseases, the demand for home and mobile monitoring equipment will further promote the development of related technologies. Combining real-time data transfer and analysis with personalized health recommendations will provide patients with better self-management tools. 6. Promote digital medical fairness: research will focus on overcoming technology and social economic factors lead to health care is not equal. Digital health interventions will be designed to be more inclusive, with languages and cultures that are appropriate for different groups.

7.3. Suggestions for Future Research

Key technology in digital medical development in the future study, the following Suggestions to consider: 1. Strengthening data protection and privacy security research: With the in-depth application of big data in the medical field, data privacy protection and security will become a crucial issue. Future research needs to develop more efficient encryption algorithms and privacy protection measures to ensure that the confidentiality of patient information is not violated. 2. The development of a more common artificial intelligence model: at present, the medical data analysis depends on the training result of the particular data set, a lack of broad applicability. Researchers should aim to develop AI algorithms with better generalization ability that can operate effectively in different medical Settings and data sets. 3. Promote standardization of telemedicine platform construction, in order to make the remote medical treatment service is more widely used in rural and remote areas, need to formulate a unified technical and service standard, to ensure the quality and reliability of the service. 4. To strengthen the effectiveness of mobile applications related to health research: although there exist a large number of related the application

of health monitoring and intervention, but their effects are lack of assessment system. Future studies are needed to evaluate the practical benefits of these applications using scientific methodologies. 5. Delve into artificial intelligence model can explain: the transparency of medical decision-making is the key. Artificial intelligence models applied in the medical field should enhance their interpretability, so that medical practitioners can understand the decision-making basis of the models, so as to improve the quality and safety of medical services. 6. Promote the ethical and legal of digital medical technology research: with the development of technology, how to provide innovative services and protect the lawful rights and interests of users is a challenge. Research should pay attention to the ethical, legal, and policy issues of emerging technologies to provide decision support for policy makers. 7. Pay attention to health informatics of interdisciplinary research: the multiple disciplines such as medicine, computer science, statistics applied in health informatics research integration, can create more effective tools and methods, in order to solve the complex problems in digital medical analysis. Overall, future research should be around digital medical technology of reliability, availability, accessibility, and security, to promote the healthy and sustainable development, digital medical technology and better serve the human health and well-being.

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References

[1] Wengang Zhang,Jianye Ching,Anthony T.C.Goh.Big data and machine learning in geoscience and geoengineering: Introduction[J]. Frontiers in Earth Science,2020:3.

[2] William Hurst,Aaron Boddy,Madjid Merabti. Patient Privacy Violation Detection in Healthcare Critical Infrastructures: An Investigation Using Density-Based Benchmarking [J].Future Internet,2020.

[3] Sayantan Khanra,Amandeep Dhir,A. K. M. Najmul Islam.Big data analytics in healthcare: a systematic literature review[J].Enterprise Information Systems,2020.

[4] Udit Sharma,Durga Toshniwal,Shivani Sharma.A sanitization approach for big data with improved data utility[J].Applied Intelligence,2020.

[5] A Qualitative Study of Cybersecurity Strategies to Reduce Medical Identity Theft Focusing on the Managers' Lived Experiences[D].Colorado Technical University,2020.

[6] "What Are You Going to Take from Me?" Considerations for Developing a Tailored Community Centered Human Subjects and Research Protections and Research Ethics Workshop [D].University of Maryland, College Park,2020.

[7] A Pilot Program Evaluating the Acceptability and Feasibility of a Health Care Ethics Curriculum for Critical Care Nurses[D].Yale University,2020.

[8] Teaching Electronic Medical Record (EMR) Data Discipline to Clinical Trainees: A Canadian Pilot Study[D].University of Toronto (Canada),2020.

[9] The Sick and the Sinner: Sexual Health and Sexual Morals in the Progressive and Reagan Eras[D].Southeast Missouri State University,2020.

[10] Brigitte Séroussi,Kate Fultz Hollis,Lina F Soualmia. Transparency of Health Informatics Processes as the Condition of Healthcare Professionals' and Patients' Trust and Adoption: the Rise of Ethical Requirements[J].Yearbook of medical informatics,2020.

[11] Mobile Mental Health Truck Program[D].Capella University, 2020.

[12] Implicação da Maturidade Digital no Desempenho de Práticas de Gestão Sustentáveis[D].Universidade de Lisboa (Portugal), 2020.

[13] Digital Rhetoric and Gatekeepers of Knowledge: Islamic Authority in America[D].University of California, Santa Barbara,2020.

[14] Abhishek Pratap,Elias Chaibub Neto,Phil Snyder.Indicators of retention in remote digital health studies: a cross-study evaluation of 100,000 participants[J].NPJ Digit Med,2020.

[15] Measuring the Connective Action of Black Lives Matter Activists: A Psychometric Investigation into Twitter Data[D]. University of Denver,2020.

[16] Kaidi Cao,Yining Chen,Junwei Lu.Heteroskedastic and Imbalanced Deep Learning with Adaptive Regularization [J].arxiv, 2020.

[17] Apolinar Velarde Martinez. Scheduling in Heterogeneous Distributed Computing Systems Based on Internal Structure of Parallel Tasks Graphs with Meta-Heuristics [J].Applied Sciences,2020.

[18] Stephen Swift,John Comas,David Aondoakaa.Exploiting heterogeneity for cost efficient 5G base station deployment using meta-heuristics[J].IET Networks,2020.

[19] Daniele Pedretti.Heterogeneity-controlled uncertain optimization of pump-and-treat systems explained through geological entropy[J].GEM - International Journal on Geomathematics, 2020.

[20] Rashid M,Baloch NK,Shafique MA.Fault-Tolerant Network-On-Chip Router Architecture Design for Heterogeneous Computing Systems in the Context of Internet of Things[J]. Sensors,2020.

[21] Improving Healthcare Decisions Through Data-Driven Methods and Models: Analysis of Policies for Personalized Medicine[D].Stanford University,2020.

[22] Research on Data Analysis Driving Business Model Innovation in Ericsson [D]. Nanjing University of Posts and Telecommunications, 2020.

[23] Integrating Hospitalist Services Via Telehealth Across a Regional Rural Hospital Network[D].The College of St. Scholastica,2020.

[24] Christopher Schiefer,Marc Bux,Joergen Brandt.Portability of Scientific Workflows in NGS Data Analysis: A Case Study [J]. arxiv, 2020.

[25] Visual Analytics Methodology for Multivariate Volumetric and Spatio-Temporal Data[D].State University of New York at Stony Brook,2020.

[26] Towards Better Generalization: Model, Data, and Explicit Knowledge[D].University of Washington,2020.

[27] Pamela L Karas,Nicole M Rankin,Emily Stone.Medicolegal Considerations in Multidisciplinary Cancer Care[J].JTO Clin Res Rep,2020.

[28] Congzheng Song,Ananth Raghunathan.Information Leakage in Embedding Models[J].arxiv,2020.

[29] Carlos Alberto Miranda-Bastidas.Clinical records: the medical writing from the patient's story to the medical narrative[J]. Colomb Med (Cali),2020.

[30] Maya Dewan,Naveen Muthu,Eric Shelov.Performance of a Clinical Decision Support Tool to Identify PICU Patients at High Risk for Clinical Deterioration[J].Pediatric critical care medicine : a journal of the Society of Critical Care Medicine and the World Federation of Pediatric Intensive and Critical Care Societies,2020.

[31] Data-driven Management of Interconnected Business Processes: Contributions to Predictive and Prescriptive Process Mining[D].Universitaet Bayreuth (Germany),2020.

[32] Transmission of Scientific Knowledge in the Digital Era: The Path to Open Science[D].Instituto Politecnico do Porto (Portugal), 2020.

[33] Exploring Characteristics of Those Utilizing Different Modalities of Treatment for Substance Use Disorders[D].Trent University (Canada),2020.

[34] Product Development In Custom-Made Medical Devices[D]. Instituto Politecnico de Leiria (Portugal),2020.

[35] Algorithm-aided Information Design: Hybrid Design Approach on the Edge of Associative Methodologies in AEC[D].Universidade do Minho (Portugal),2020.

[36] Md. Ileas Pramanik, Raymond Y.K. Lau,Md. Abul Kalam Azad. Healthcare informatics and analytics in big data[J]. Expert Systems with Applications,2020.

[37] Data Analytics in Complex Data Environments: Methods Towards Missing Values and Dynamic Data Patterns [D]. National University of Singapore (Singapore),2020.

[38] Bayesian Zero-Inflated Model for Ordinal Data[D].University of South Carolina,2020.

[39] Artificial Neural Network for the Estimation of Clinical Parameters from X-Rays of Scoliotic Spines[D].Widener University, 2020.

[40] Emanuele Neri, Francesca Coppola,Vittorio Miele.Artificial intelligence: Who is responsible for the diagnosis?[J].La radiologia medica,2020.

[41] Zhu Hong-bo. Research on intelligent auxiliary analysis and diagnosis technology for multimodal medical big data [J].,2019.

[42] DOU Lirong, SUN Longde,LYU Weifeng,et al.Trend of global carbon dioxide capture, utilization and storage industry and challenges and countermeasures in China[D].,2023.

[43] Yang N, Zhou X. Visualization analysis of research hotspots and frontier literatures in the field of smart healthcare in China [J]. Digital Medicine in China,2023.

[44] AB Tsvetkova, AV Shishkin. Evaluation of the digital medicine perception by the youth consumer segment[D]. Statistics & Economics,2019.

[45] Zhu S D. Application and development trend of big data analysis in intelligent medical auxiliary diagnosis [J]. Health Must Read 2020 issue 15, 282,2020.

[46] J Yue.Research on the Development Trend of Industrial Automation Control Technology Based on Big Data Analysis[D].Journal of Physics Conference,2020.

[47] HE Haiyan, LIU Wei,WANG Yunxia, et al. Application and development trend of big data analysis in intelligent medical auxiliary diagnosis [J]. International Journal of Lab Medicine, 2019 .

[48] Yang Ying. Development, historical evolution and frontier hotspots of general practice: scientometric research and visual analysis.,2019.

[49] Liao Zi-rui, TIAN Xue-qing, LIU Yuan-li. Enlightenment of Japanese medical big data method to the development and application of healthcare big data in China [J]. China Digital Medicine,2021.

[50] ZHANG J L. Advances in ecosystem restoration on the Loess Plateau.,2024.

[51] Zhou Yang. Based on the analysis of machine learning medical text mining technology research [J]. J, 2019.

[52] zhen-feng shao, Xu Xiaodi, wen-fu wu, etc. Cutting-edge scientific research and education driven city remote sensing teaching reform and practice [J]. J, 2024.

[53] further. Micro study [J]. Journal of university teachers, 2020.

[54] Lin Jiexing. Cheng yi discovery center of science and technology "upgrade" wisdom study [J]. J, 2020.

[55] dong-ping gao, Wang Shiquan, li wei, etc. Health big data platform architecture based on block chain technology research [J]. Journal of China digital medicine, 2019.

[56] ShiXiaoQin, zhao jie, Lynn, etc. Precision medical applications were reviewed based on the technology of large data analysis [J]. J, 2021.

[57] qiao-ling zeng. Digital media technology under the effect of fiber art exploration [J]. J, 2019.

[58] Lebanon into power, MinDong. The development and application of clinical scientific research database overview [J]. J, 2024.

[59] liu Yang. Is based on the analysis of the common word "Internet + sports research progress of analysis in China [J]. J, 2019.

[60] XingZhen. Research progress of digital twin technology for smart mine [J]., 2024.