

# Development of Medical Informatization in the Era of Big Data

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**Abstract:** The purpose of this paper is to discuss the development of medical informatization in the era of big data. Through literature review and theoretical analysis, the development of medical informatization in the era of big data is deeply discussed. The results show that medical informatization has developed rapidly in the era of big data, and its role in clinical decision-making, scientific research, teaching, and management has become increasingly prominent. The development of medical informatization in the era of big data has important purposes and methods, which can produce important results and conclusions and provide strong support for the development of the medical field.

**Keywords:** Electronic medical record system; Digitization of medical images; Clinical decision support system

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## 1. Introduction

With the rapid development of science and technology, human society has entered the era of big data. In this era, the collection, processing, and analysis of data provide an unprecedented perspective and opportunity to understand various complex phenomena<sup>[1,2]</sup>. The medical field is no exception. The application of big data technology is promoting the development of medical informatization, which has a far-reaching impact on medical research, diagnosis, and treatment.

## 2. Challenges faced by the development of medical informatization under the background of the big data era

### 2.1. Data security and privacy protection

Medical data involves patients' privacy and confidential information. Ensuring the security and privacy protection of these data is vital<sup>[3]</sup>, as any data leakage or unauthorized access may lead to serious consequences, including identity theft and insurance fraud.

### 2.2. Data quality and reliability

Medical data often involves a variety of sources, including medical records, laboratory tests, image inspection,

and so on. The quality and reliability of these data have an important impact on the accuracy of analysis and decision-making <sup>[4]</sup>. However, there may be errors in the process of data collection and processing, hence it is essential to ensure the quality and reliability of data.

### **2.3. Data processing and analysis capabilities**

Medical data usually involves a large number of data, including structured data (such as electronic medical records) and unstructured data (such as images and pathological images) <sup>[5]</sup>. Strong data processing and analysis capabilities are required to effectively process and analyze these different types of data and extract valuable information from them.

### **2.4. Legal and ethical issues**

In the development of medical informatization, a series of legal and moral issues are involved, including patient privacy protection, data sharing and use, medical responsibilities, and obligations. Navigating the complex landscape of adhering to pertinent laws, regulations, and ethical standards to ensure legal compliance poses a formidable challenge.

### **2.5. Technology development and update**

The development of medical informatization needs to constantly track and adapt to the latest technological developments, including big data technology, artificial intelligence, cloud computing, and so on. Meeting the challenge of staying abreast of rapid technological progress and harnessing new technologies to enhance support for medical research and healthcare services is paramount.

## **3. The development of medical informatization under the background of the big data era**

### **3.1. The popularity of electronic medical records**

An electronic medical record is a computer-based medical record system for patients, which can record information such as diagnosis, treatment, and nursing of patients.

- (1) The popularity of electronic medical records has greatly changed the storage mode of medical information. Traditional paper medical records not only occupy space but also are not conducive to preservation and search <sup>[6]</sup>. The electronic medical record system can store the patient's medical information electronically, which is convenient for doctors to view and edit anytime and anywhere. At the same time, electronic medical records can also share medical information across institutions and regions, which makes it convenient for doctors to make comprehensive diagnoses and treatments of patients.
- (2) The electronic medical record system has powerful medical record retrieval and statistical analysis functions. Through keyword or condition screening, doctors can quickly find the needed patient information <sup>[7]</sup>. At the same time, the system can also carry out statistics and analysis on a large number of patient data, help doctors understand the disease distribution and epidemic trends of patients, and provide data support for clinical decision-making.
- (3) Electronic medical record systems can collect patients' medical information in real-time, including physical sign data, diagnosis results, medication, etc. <sup>[8]</sup>. Based on these data, the system can monitor and warn the health status of patients in real-time, find the abnormal situation of patients in time, and provide timely intervention and treatment for doctors.

- (4) Electronic medical records contain a lot of patient information, including genetic information, living habits, and so on. Through the application of big data technology, we can analyze these data, find out the occurrence and development law of diseases, and provide patients with more accurate personalized treatment programs. At the same time, electronic medical records can also record the doctor's treatment process and effect, and provide valuable data for clinical research and teaching effect evaluation.
- (5) The electronic medical record system has accumulated a large number of patient data, which is of great significance for disease prevention and control. Through data mining technology, we can extract valuable information from electronic medical records for epidemiological research, understand the distribution and spread of diseases, and provide the scientific basis for disease prevention and control.
- (6) Electronic medical records contain important private information of patients, such as illness and personal information. Protecting patients' privacy and data security is an important prerequisite for the popularization of electronic medical records. The electronic medical record system needs to take strict security measures, including data encryption, access control, audit tracking, etc., to ensure that patient information is not leaked or abused.
- (7) The popularization of electronic medical records can improve the efficiency and quality of medical coordination. Doctors can view patients' information on the same platform for diagnosis and treatment. At the same time, the standardization of electronic medical records can reduce unnecessary medical accidents and disputes caused by writing errors or misunderstandings. Through the quality control and supervision mechanism of electronic medical records, the standardization and quality of medical services can be improved.

### 3.2. Digitization of medical images

Medical imaging is an important diagnostic method, and the pathological changes in patients can be observed intuitively through image data. With the popularization of digital medical images, doctors can easily obtain and share image data, which improves the accuracy and efficiency of diagnosis.

- (1) Digitization of image acquisition refers to obtaining medical images through digital equipment. These devices include X-ray machines, computed tomography (CT) machines, magnetic resonance imaging (MRI) machines, ultrasound machines, and so on<sup>[9]</sup>. These devices can convert the original physiological signals into digital signals and generate various types of medical images, such as X-ray films, CT scans, MRI scans, and ultrasound images. Digital equipment can provide high-definition and high-resolution images, which significantly improves the accuracy of diagnosis.
- (2) Digitization of image storage refers to storing medical images in digital form in a computer system. Compared with traditional paper images, digital images have the advantages of easy storage, retrieval, and transmission<sup>[10]</sup>. Digital images can be saved in different file formats, such as TIFF, JPEG, DICOM, etc. Among them, the DICOM format is the standard format of medical images, which can contain a lot of image information and related metadata. Digital images are stored in a database or cloud, which can be preserved for a long time and shared across institutions.
- (3) Digital image transmission refers to the digital transmission of medical images to needed places, such as doctors' offices, diagnosis rooms, and wards<sup>[11]</sup>. Digital transmission can greatly shorten the time of image acquisition and diagnosis and improve the efficiency of diagnosis. Digital transmission can be realized through local area networks, the Internet, wireless networks, and other ways. In addition, telemedicine and mobile medicine are also applications of digital transmission in the field of medical

imaging.

- (4) Digitization of image printing refers to printing digital images into paper images by a printer. The printed paper images can be used for diagnosis, treatment, and consultation. Compared with traditional film printing, digital printing has a higher resolution and lower cost. Digital printers can choose different paper and ink to get different print results with different quality and resolution.
- (5) Digitization of image processing refers to the use of computer software to process medical images to improve image quality and extract useful information. Image processing includes contrast adjustment, brightness adjustment, edge enhancement, and noise reduction. Digital image processing can improve the clarity and readability of the image and help doctors diagnose the disease better.
- (6) Digitization of image analysis refers to the analysis of medical images by computer software to extract useful diagnostic information. For example, by analyzing X-rays, we can judge whether the lungs are abnormal; By analyzing MRI scans, we can judge whether there are brain lesions. Digital image analysis can improve the accuracy and efficiency of diagnosis and reduce human error.
- (7) Digitization of image interpretation refers to the automatic interpretation and diagnosis of medical images by computer software. This technology combines artificial intelligence and deep learning technology, which can identify the abnormal performance in the image and give corresponding diagnosis suggestions. Digital image interpretation can improve the speed and accuracy of diagnosis, but in some complex cases, doctors still need to participate and judge.

### **3.3. Clinical decision support system**

- (1) Diagnostic decision support is one of the important functions of a clinical decision support system. The system can provide diagnosis suggestions and relevant evidence by analyzing the patient's medical history, signs, and laboratory tests, and help doctors diagnose diseases more quickly and accurately. Diagnostic decision support can also provide risk assessment and prognosis prediction of diseases, and provide reference for doctors to formulate personalized treatment plans.
- (2) Treatment decision support is one of the core functions of the clinical decision support system. According to the patient's condition, physical condition, and treatment history, the system can provide doctors with a variety of treatment proposals, and give detailed information such as the advantages and disadvantages, possible risks, and expected effects of each scheme <sup>[12]</sup>. According to this information, doctors can choose the most suitable treatment plan for patients, and improve the treatment effect and patient satisfaction.
- (3) Drug decision support is one of the important functions of a clinical decision support system. According to the patient's illness, drug allergy history, and medication history, the system can provide doctors with appropriate medication advice, including drug types, dosage, administration methods, and so on. Drug decision support can also provide tips on drug interactions and adverse reactions to help doctors avoid potential risks.
- (4) Follow-up decision support is one of the important functions of a clinical decision support system. The system can provide follow-up suggestions for doctors according to the patient's condition and treatment, including follow-up time, follow-up items, and follow-up standards. Follow-up decision support can help doctors find the changes in the disease in time, adjust the treatment plan in time, and improve the treatment effect and the survival rate of patients.
- (5) Prevention of complications is one of the important functions of the clinical decision support system. According to the patient's condition and treatment, the system can provide doctors with prevention



suggestions for complications, including preventive measures, monitoring indicators, and early warning standards. Prevention of complications can help doctors reduce the risk of complications during treatment and improve the quality of life and treatment effect of patients.

- (6) Clinical guidelines refer to the norms and guidelines formulated and issued by professional institutions to guide clinical practice. The clinical decision support system can convert clinical guidelines into digital form and combine them with doctors' diagnosis and treatment process to remind doctors to follow relevant guidelines in the diagnosis and treatment process. This can help doctors ensure the standardization and consistency of diagnosis and treatment, and improve the treatment effect and patient safety.
- (7) Electronic medical record data is an important data source for clinical decision support systems. Clinical decision support systems can use electronic medical record data for data mining and analysis, and extract useful information such as patient's condition, treatment history, and drug allergy history. This information can provide doctors with more comprehensive and accurate diagnosis and treatment suggestions, and improve medical quality and patient satisfaction.

### **3.4. The development of personalized medical care**

Personalized medical treatment is a method to tailor the treatment plan for patients according to individual genes, living habits, and other information <sup>[13]</sup>. Through the application of big data technology, we can analyze a large number of patient data, find out the occurrence and development law of diseases, and provide patients with more accurate personalized treatment programs.

### **3.5. Application of telemedicine and intelligent medicine**

The application of telemedicine and intelligent medical treatment enables doctors to remotely obtain the medical information of patients and provide timely telemedicine services for patients <sup>[14]</sup>. The application of these technologies improves the coverage and efficiency of medical services and reduces the cost of patient medical treatment.

### **3.6. Application of medical research and data mining**

The application of big data technology enables medical research to analyze the occurrence and development mechanism of diseases, explore new drug treatment methods, and evaluate treatment effects based on a large number of patient data <sup>[15-17]</sup>. The application of data mining technology can help doctors find valuable information from a large number of medical data and provide support for clinical decision-making.

## **4. The development significance of medical informatization under the background of the big data era**

### **4.1. Serving residents**

Residents' health guidance services provide precise medical care and personalized health care guidance so that residents can maintain continuity in hospital, community, and online services. Miao Health provides a professional team of doctors who can help users solve various diseases online and give health guidance. Residents can also buy daily medicines in their pocket pharmacies, which is convenient and fast.

### **4.2. Serving doctors**

Medical health big data can provide doctors with more comprehensive and accurate patient information, and

help doctors better understand the patient's medical history, disease development law, treatment effect, and other aspects, thus improving the doctor's treatment accuracy. For example, using medical health big data can quickly identify abnormal points in multi-dimensional data such as biochemical indicators and imaging, predict the development trend of diseases in advance, and carry out corresponding intervention treatment.

### **4.3. Service scientific research**

Service scientific research including disease diagnosis and prediction, improving statistical tools and algorithms for clinical trial design, analysis and processing of clinical trial data, such as identifying disease susceptibility genes and extreme expression groups for major diseases, and establishing personal health medical records. The establishment of personal health medical records can share personal medical information, let doctors know the patient's past medical history directly and quickly, avoid the phenomenon of repeated consultation, and enable patients to receive treatment in time and effectively.

### **4.4. Acceleration of drug research and development**

Medical health big data can effectively improve the efficiency and success rate of drug research and development. By analyzing a large number of clinical trials and drug research and development data, we can fully understand the efficacy, safety, and other characteristics of different drugs, and provide a valuable reference for the development of new drugs. Using medical health big data, we can also screen drugs for different groups of people and different diseases, especially in dealing with massive medical literature data and screening effective drug components, to determine the dosage and usage of drugs, thus shortening the cycle of drug research and development quickly and efficiently. Compared with the traditional manual method, it has obvious advantages and greatly saves the cost of drug research and development. For example, Atomwise Company in the United States used supercomputers to carry out drug research and development and completed the analysis and testing of more than 7,000 drugs within 24 hours when developing drugs to treat the Ebola virus. However, if traditional methods are used, it will take at least several months or even years to complete the testing process.

### **4.5. Auxiliary diagnosis and treatment services**

Big data technology has been widely used in medical image recognition, medical data analysis, comparative effect research, precision surgery, and other aspects, effectively improving the efficiency and quality of disease diagnosis and treatment. For example, Watson, developed by IBM, collects professional knowledge and clinical experience in the clinical diagnosis and treatment of rare tumors and applies these data to personalized treatment and imaging diagnosis after processing and calculation. The Medical College of the University of North Carolina in the United States tested its learning ability through 1,000 cases of cancer patients. As a result, 99% of the treatment schemes provided by Watson were consistent with those suggested by oncologists, and many auxiliary suggestions were put forward on its own initiative, 30% of which were unexpected by doctors.

### **4.6. Promotion of the genetic medical research progress**

Genetic medical products and technologies such as gene sequencing are evolving from laboratory research to clinical application research, in which big data plays a key role. In particular, technologies such as cognitive computing can achieve large-scale workloads and completion accuracy that conventional manpower cannot operate. At present, the focus of genetic medicine research is to study individual genetic variation and susceptibility to specific diseases by analyzing genome data, to determine who is susceptible to certain diseases and provide timely early diagnosis and personalized treatment for patients. The United States launched the Precision Medical Program in 2015 and is committed to promoting individualized genomics research and

formulating personalized precision medical programs through technologies such as big data and artificial intelligence.

#### **4.7. Realization of smart medical care**

Medical health big data is a necessary condition to realize smart medical care. The collection, integration, analysis, and application of medical and health big data can achieve the goals of clinical diagnosis and treatment decision support, life-cycle health management of patients, improvement of medical service delivery efficiency, control of medical expenses, and improvement of public health literacy. Smart medical care can comprehensively improve the quality of medical services and optimize the allocation of medical resources, to better meet the medical needs of the people.

#### **4.8. Service management organization**

Service management organization includes normative drug use evaluation, evaluation of preventive interventions and measures for epidemics and acute diseases, as well as public health monitoring, optimization of clinical pathways, etc.

#### **4.9. Public health services**

Public health services include monitoring and early warning of health-threatening factors, network platforms, community service, and so on. Miao Health relies on Miao+, the largest health data platform in China, to provide customers with a series of services such as health management through data collection, risk assessment, and health intervention.

### **5. Suggestions on the development of medical informatization under the background of the big data era**

#### **5.1. Acceleration of the establishment and improvement of the standard system of healthcare big data**

Since 2016, our Committee, together with the Central Network Information Office and the National Development and Reform Commission, has continued to promote the construction of the standard system of health care big data, compiled the National Measures for the Management of Health Care Big Data Standards, Security and Services (Trial), the Information Security Technology Health Care Data Security Guide and other documents, and effectively promoted the construction of the standard system of health care big data.

#### **5.2. Optimization of China's healthcare big data security control and personal privacy protection**

It is suggested to promote the construction of big data security norms and regulations for health care, clarify the responsibility for network information and data security, and continuously improve the security protection capability. It is also crucial to strictly implement the network security law enforcement inspection, and carry out special actions for network security inspection, important data, and personal information protection in the whole industry.

#### **5.3. Establishment of a socialized healthcare information exchange mechanism**

To comprehensively standardize and promote the application and development of healthcare data, and constantly improve the functions of the national health information platform, we will further strengthen the

research on public health and social management relying on healthcare big data on the basis of improving the databases of residents' electronic health records, electronic medical records, and the total population, and further promote the sharing and opening of health care big data.

#### **5.4. Promotion of the application of big data in healthcare**

The deepening of the application of health care big data in industry governance and public health should be continued. During the epidemic prevention and control period, the epidemic prevention and control group of the State Council joint prevention and control mechanism set up a special group on big data analysis to gather multi-source data and use digital technologies such as big data and artificial intelligence to strengthen epidemic monitoring and trend judgment, which strongly supported accurate epidemic prevention and control.

#### **5.5. Promotion of the development of the healthcare big data industry**

It is imperative to promote the national pilot project for the construction of healthcare big data centers and industrial parks, promote the deep integration of healthcare business and big data technology, and strengthen the exploration and application of healthcare big data in clinical scientific research, the transformation of research results, and the research and development data sharing mechanism. There should be an active exploration of healthcare big data as a market factor, with initial emphasis on data collection, consolidation, resource integration, open sharing, data mining and application, security protection, etc. By establishing and improving the socialized health care big data information sharing mechanism, we will further accelerate the cross-departmental, cross-industry, and cross-level interconnection of health care big data, promote the deep integration of health care and pension, tourism, Internet, food, and other fields, actively build a health care big data industrial chain, and continuously improve the development level of health care big data application.

#### **5.6. Formulation of laws and regulations on medical big data**

It is suggested that we should always adhere to the "people-centered" development idea, formulate and improve the laws and regulations on information development under medical big data as soon as possible, fully respond to the needs of the people in the digital age, promote the rule of law, institutionalization, standardization, proceduralization, and science and technology in the use of big data, establish and improve a comprehensive supervision system with mutual cooperation and collaborative supervision among various departments, implement fair policies and payment methods for online and offline medical services, further improve the use efficiency of big data and protect patients.

#### **5.7. Usage of big data technology to completely solve the problem of insurance fraud**

At present, various emerging biometric technologies are becoming more and more mature, and the application scenarios are constantly expanding. It is suggested to gradually build a cross-platform, open, extensible, and national unified multi-modal big data patient identity authentication system. By flexibly combining various biometric technologies such as fingerprint, face, iris, finger vein, voiceprint, gait, etc., according to different application requirements and scenarios, the appropriate combination method is chosen to cover more application scenarios and improve the safety, accuracy, stability, and authentication efficiency of patient identity authentication and identification in various scenarios.

#### **5.8. Adoption of intelligent supervision of big data to effectively improve the level of supervision**

It is suggested that a cross-platform, intelligent, and real-time audit system should be constructed by using

emerging technologies such as big data, artificial intelligence, and blockchain, and the data of diagnosis, treatment, prescription, drug use, and service facilities of designated medical institutions in the region should be collected, sorted and classified to form systematic supervision rules and reasoning rules, and the whole process of patients' use can be reminded and monitored in real-time intelligently. By learning algorithms, the potential and undisclosed regular trend characteristics of medical biological information can be automatically mined, and the rule language can be applied.

## 6. Conclusion

In summary, the era of big data has brought great opportunities for the development of medical informatization. By making full use of big data technology, we can realize the informatization of medical data, promote the development of medical research and precision medical care, and improve the efficiency and quality of medical services. At the same time, it is also necessary to meet the challenges brought by big data, ensure patient privacy and data security, and ensure the healthy and sustainable development of medical informatization. It is believed that in the process of continuous exploration and improvement, medical informatization will make greater breakthroughs and development under the impetus of the era of big data.

## Disclosure statement

The authors declare no conflict of interest.

## References

- [1] Wang J, Gao F, 2020, Bibliometric Analysis of Domestic Medical Education Informatization. *China Health Industry*, 17(15): 177–180.
- [2] Tan M, 2020, Analysis of the Development of Medical Informatization Under the Background of Big Data Era. *Digital Communication World*, 2020(3): 261.
- [3] Wang R, Geng Z, 2018, The Process and Prospect of Medical Informatization. *Electronic Technology and Software Engineering*, 2018(21): 203.
- [4] Zhu T, 2018, Innovative Ideas of Medical Informatization Construction from the Perspective of Big Data. *China Strategic Emerging Industries*, 2018(32): 225.
- [5] Chen Q, 2017, Analysis of the Role of TCM Information Construction in Translational Medicine. *Communication World*, 2017(18): 269–270.
- [6] Wang D, Lu C, Bao D, et al., 2023, The Influence of Doctor's Indirect Use of Electronic Medical Record System on Job Performance. *Journal of Nanjing Medical University (Social Science Edition)*, 23(2): 162–167.
- [7] Nie Y, Zhang Y, Li H, 2023, Thinking About the Current Situation of Grading Evaluation of the Application Level of Electronic Medical Record System in Chinese Medicine Hospitals. *Journal of Medical Informatics*, 44(2): 64–68.
- [8] Kan Q, 2022, Promote the Construction of Electronic Medical Record System and Strengthen the Quality Management of Assessment Data. *China Health*, 2022(11): 26–27.
- [9] He X, Ling W, Zhang Y, et al., 2018, Multi-Modal Image Registration Simulation Under Digital Medical Imaging Technology. *Computer Simulation*, 35(12): 166–170.
- [10] Wen D, 2018, Research on Digital Collection and Storage of Medical Images. *World Latest Medical Information Abstracts*, 18(19): 164–165.
- [11] Fang S, 2017, Research on the Progress and Challenges of Medical Image Digitization. *Smart Health*, 3(6): 62–63.

- [12] Bai Y, Chen L, Yi L, et al., 2022, Present Situation and Thinking of Clinical Decision Support System of Traditional Chinese Medicine. *Jiangsu Traditional Chinese Medicine*, 54(12): 66–69.
- [13] Wang L, 2022, Analysis and Reflection on the EU Personalized Medical Plan. *China Medical Guide*, 24(1): 39–45.
- [14] Shen X, 2019, Personalized Medical Care: An Opportunity for Chinese Medicine to Go Global. *Chinese Medicine Herald*, 25(4): 1–5.
- [15] Ding F, Liu T, Chen J, 2017, Analysis of the Research Progress of Medical and Health Big Data. *Journal of Information Resources Management*, 7(4): 5–16.
- [16] Zhang Y, Li X, 2017, New Progress in Data Mining and Integration of Electronic Health Records. *China Digital Medicine*, 12(9): 41–44.
- [17] Lu Y, Huang Z, Yu S, et al., 2017, Research Status and Prospect of Clinical Medical Big Data. *Chinese Medical Equipment Journal*, 38(3): 112–115.

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