

# Study on the Informatization Construction of Public Stomatological Medical Institutions in China

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**Abstract:** With the deepening of healthcare system reform in China, the competition in the oral healthcare market is becoming stronger day by day. The public hospital is the main body of the medical service system in China, its degree of informatization greatly affects rational market competition and then affects the allocation of resources and the quality of medical service. By analyzing the problems existing in the current informatization of China's public stomatological medical institutions, this paper discusses how to strengthen the informatization of China's public stomatological medical institutions, and puts forward targeted optimization measures, to provide a reference for the innovation and development of smart hospital construction of the stomatological industry.

## 1. Introduction

In recent years, the National Health and Wellness Committee of China has released two significant documents, namely the "Healthy China 2030" Planning Outline and the "Healthy Oral Action Plan (2019-2025)". As a result, there has been a growing demand for oral diagnosis and treatment among Chinese citizens. Consequently, the oral medical market in China has become highly competitive [1]. In the year 2019, the People's Republic of China established the evaluation criteria for categorizing hospital smart services, as well as providing a clear definition and understanding of smart hospitals. Currently, within the medical sector in China, smart hospitals primarily encompass three key domains: "smart medical care" targeting medical personnel, "smart service" serving patients, and "smart management" addressing hospital administration [2]. Against the backdrop of the ongoing medical reform in China, public stomatological hospitals must address operational challenges, enhance the quality of healthcare services, and effectively serve patient demands. This necessitates the advancement of oral medical care from the conventional model to a novel paradigm characterized by intelligence and information, thereby facilitating its scientific transformation. Stomatological specialty hospitals are special compared to general hospitals. For example, the degree of standardization of treatment operations is high, the treatment process involves a variety of instruments and consumables, the individual treatment of outpatients is relatively

time-consuming, and there are more auxiliary examinations such as imaging. Adopting an information-based management model can further improve the quality of medical services, simplify the medical process [3], and be more conducive to improving patient satisfaction and social benefits [4]. Although many studies have discussed the development level of informatization in Chinese stomatological medical institutions, the demonstration of its specific development process is still not clear enough. This paper analyzes a representative case study of a tertiary specialized university-affiliated stomatological hospital in Guangzhou to further understand the development process of informatization in Chinese public stomatological healthcare institutions in a microcosmic way, which helps to explore the problems and challenges of informatization construction in Chinese public stomatological healthcare institutions at different stages and propose corresponding countermeasures for the development of informatization in public stomatological hospitals.

## 2. Concept definition

Hospital informatization refers to the use of modern means such as computer software and hardware information technology to manage the personnel, finance, and materials of various departments in the hospital, and to collect and store the data generated by the hospital and its related departments [5]. The informatization of a stomatological hospital refers to the optimization of quality control, performance management, and operation

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management in a stomatological hospital based on business processes and computer technology. By integrating all the management information of medical treatment, teaching, scientific research, finance, and logistics, all kinds of information inside and outside the hospital can be shared and effectively used, thus improving the refined management level and market competitiveness of the hospital<sup>[6]</sup>.

### 3. Exploration of informatization platform construction of a university-affiliated stomatological hospital

Guangdong Province, located in China, stands out as the most economically advanced province in the country. Additionally, it boasts the highest concentration of medical resources across the nation. Guangzhou, serving

as the administrative center of Guangdong Province, is renowned for its abundant medical resources, positioning it as a prominent city in China in terms of healthcare provisions. The subject of analysis in this study is a specialized stomatological hospital in Guangzhou, known as the 3A-grade hospital. This hospital is recognized for its advanced stomatological specialty development and its high level of diagnosis and treatment, which positions it as a leader in the field within the southern region of China. Throughout the course of a 15-year medical information reform, the hospital has successfully established an information service system that prioritizes patients, with electronic medical records serving as the central component and refined management serving as a crucial aspect. This development has laid a solid groundwork for the implementation of a smart medical model, as depicted in Figure 1.

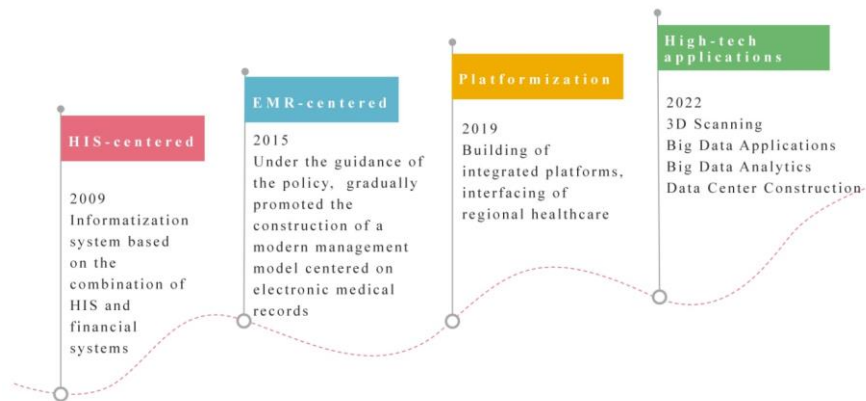


Figure 1. Case hospital informatization construction process

#### 3.1 Informatization construction with electronic medical records as the core

From 2012 to the present, the hospital has transitioned from a single-machine business system stage to a hospital-wide information management system. This transition has involved a shift in focus from outpatient, financial, and drug management to patient-centered information construction. The progression of

informatization construction has witnessed significant transformations, encompassing the digitization of hospital operations, the expansion of health information systems at a regional level, and the comprehensive growth of industrial chains such as telemedicine, mobile medical care, and Internet cloud medical care. Furthermore, there has been a shift from textual data to the utilization of structured data, as depicted in Figure 2.

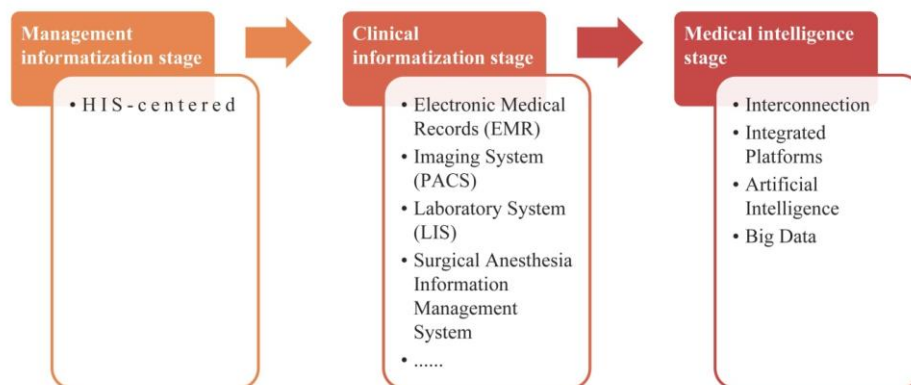
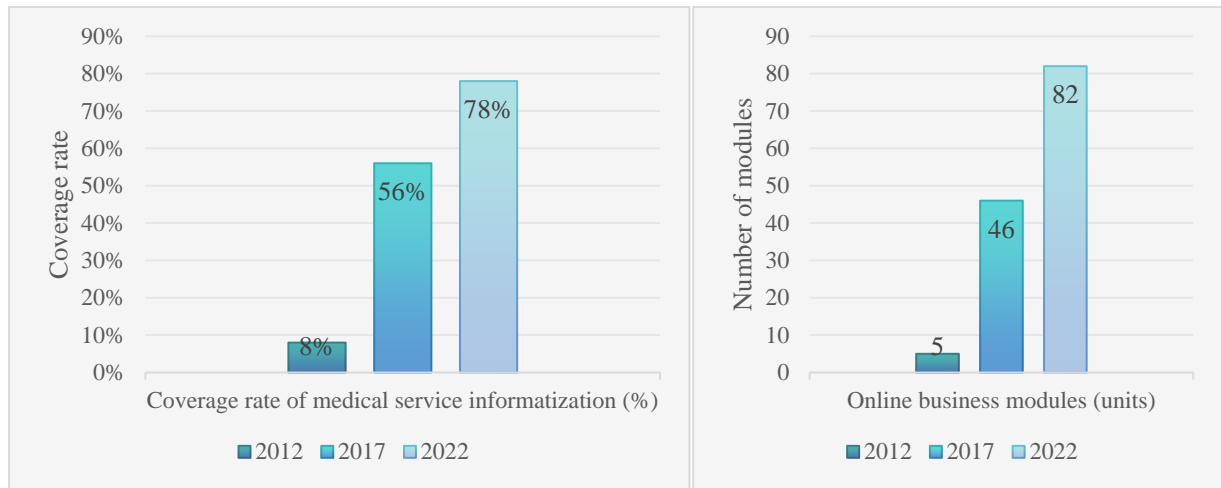
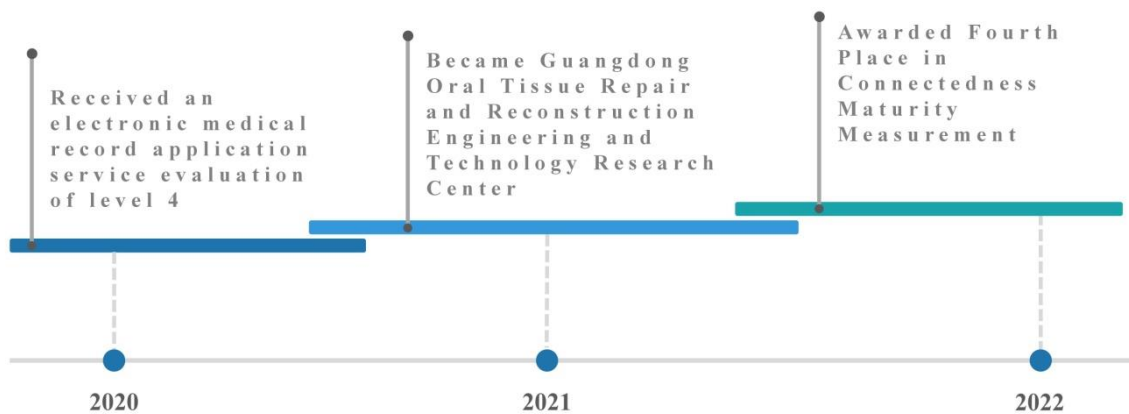


Figure 2. The informatization construction process of the hospital with electronic medical records as the core.



**Figure 3.** Information coverage rate and online module changes of case hospitals



**Figure 4.** Exploration results of informatization construction in this hospital

Since 2015, the hospital has implemented electronic medical records as the central component to achieve comprehensive electronic management of doctor's orders, prescriptions, and medical records. In the year 2012, the medical service information coverage rate of the hospital was approximately 8%, accompanied by the presence of 5 online business modules. Subsequently, in 2017, the coverage rate increased to around 56%, with the inclusion of 46 online business modules. Looking ahead to the year 2022, it is projected that the coverage rate will reach 78%, with the implementation of approximately 82 modules (refer to Figure 3 for further details). Among the years 2020 and 2022, the hospital successfully achieved a rating of four levels in the evaluation of electronic medical records and interconnection maturity (refer to Figure 4).

Nevertheless, there exists a discernible disparity between the current state of hospitals and the objective of constructing smart hospitals, primarily about the provision of substantial data support and the implementation of business scenarios. The outpatient medical records found in general hospitals typically

consist of individualized medical records, lacking any significant correlation or continuity across multiple visits. Nevertheless, the stomatological hospital exhibits distinct features such as uninterrupted provision of outpatient services, interdisciplinary diagnosis, and a substantial number of patients requiring follow-up care. Consequently, the electronic medical record system for dental diagnosis and treatment must address the challenge of maintaining continuity between successive visits. Before orthodontic treatment, it may be necessary to collaborate with surgical specialists to facilitate the extraction of teeth. Similarly, in the context of dental implantation, it is imperative to address and manage periodontal disease in the periodontal department before proceeding with the implantation process. Simultaneously, the outpatient payment procedure within the field of stomatology exhibits a diverse range of methods. Consequently, the system must prioritize the patient's ability to be identified upon their return to the clinic. Furthermore, the system must be adaptable to various payment processes, including post-diagnosis payments, payments for different visits, package

payments, and staged payments<sup>[6]</sup>. Furthermore, the electronic medical record system utilized in dental clinics must also incorporate the collection of data on the positioning of multiple teeth, as well as the diagnosis and charting of multiple dental conditions. Nevertheless, the current electronic medical record system implemented in this hospital is primarily designed to serve the operational needs of general hospitals, rendering it ill-suited to meet the specific business process requirements of stomatology.

### 3.2 Convenience of patients seeking medical treatment and knowledge of medical services

By employing a comprehensive approach encompassing top-level design and systematic implementation, the hospital achieves complete closed-loop management of electronic information and integrated management of both online and offline medical services. The introduction of the "Internet plus Accurate Appointment" system has significantly reduced the waiting time for patients arriving at the hospital, resulting in a decrease from an average of 50 minutes to 23 minutes. This improvement has been

implemented to facilitate efficient patient care. The data presented in Figure 5 indicates a significant increase in the proportion of outpatients with scheduled appointments, rising from 30% to 95%. Additionally, the follow-up rate achieved a full 100% during the observed period. Based on the diagnostic and therapeutic provisions, each clinical department offers informative guidelines including the diagnostic and therapeutic procedures, cost details, and important considerations. These provisions aim to facilitate patients in scheduling appointments for their diagnostic and therapeutic needs. Nevertheless, the hospital continues to face a deficiency in advanced technological applications, such as ChatGPT and artificial intelligence. Additionally, the utilization of AI diagnosis and CDSS clinical decision support systems has not yet fulfilled the existing demand. There remains a need to augment investment in information infrastructure, facilitate physicians in enhancing precision, accuracy, and efficiency in decision-making, and further enhance the overall medical service experience for patients.

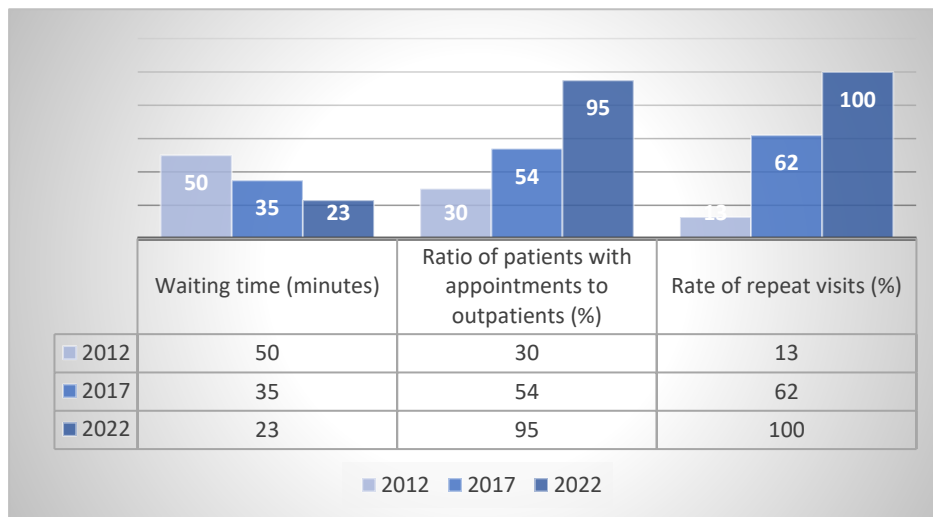


Figure 5. "Smart service" for patients in this hospital (2012-2022)

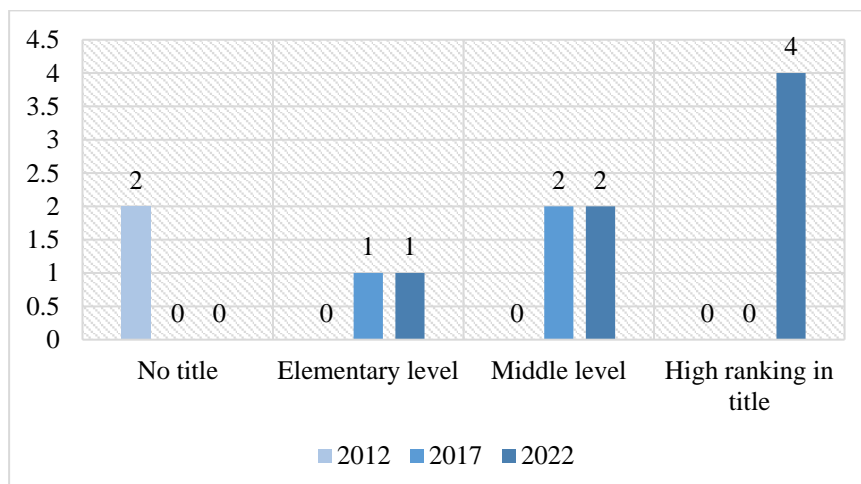


Figure 6. Changes in the number and title of information departments in this hospital (from 2012 to 2022)

Based on a survey conducted in 2021 by the Institute of Hospital Management of the National Health and Wellness Commission, involving 9376 second- and third-level hospitals, there is significant variation in the average staffing levels within the information departments of hospitals at different levels. Specifically, the average number of personnel in third-level hospitals was found to be 10.2 individuals<sup>[7]</sup>. The information department of the aforementioned hospital employs a total of seven full-time staff members as of the year 2022. Over approximately a decade of construction, there has been evident advancement in both the quantity and caliber of talents specializing in hospital information technology, as depicted in Figure 6. Despite being a specialized stomatological hospital, the demand for information departments is comparatively lower in comparison to general hospitals. However, in light of the imperative for comprehensive information transformation, it is recommended that the hospital enhances the development of its information talent pool.

### 3.3 Smart Hospital Information Integration Platform

The construction of multi-campus medical institutions has emerged as a significant development trend in line with China's policy of actively and comprehensively promoting the allocation of high-quality medical resources<sup>[8]</sup>. Stomatological hospitals exhibit the operational characteristic of having multiple districts within a single facility, which is commonly referred to as "one hospital with multiple districts" or "multi-district management." Campuses are frequently constructed in multiple phases. The proliferation of multi-campus facilities and the growing inventory of equipment have led to an escalation in security risks. Consequently, the complexity and significance of security measures have also intensified. The implementation of a multi-campus integrated management system presents a novel challenge to the existing hospital information system, which was originally designed for single-campus operations.

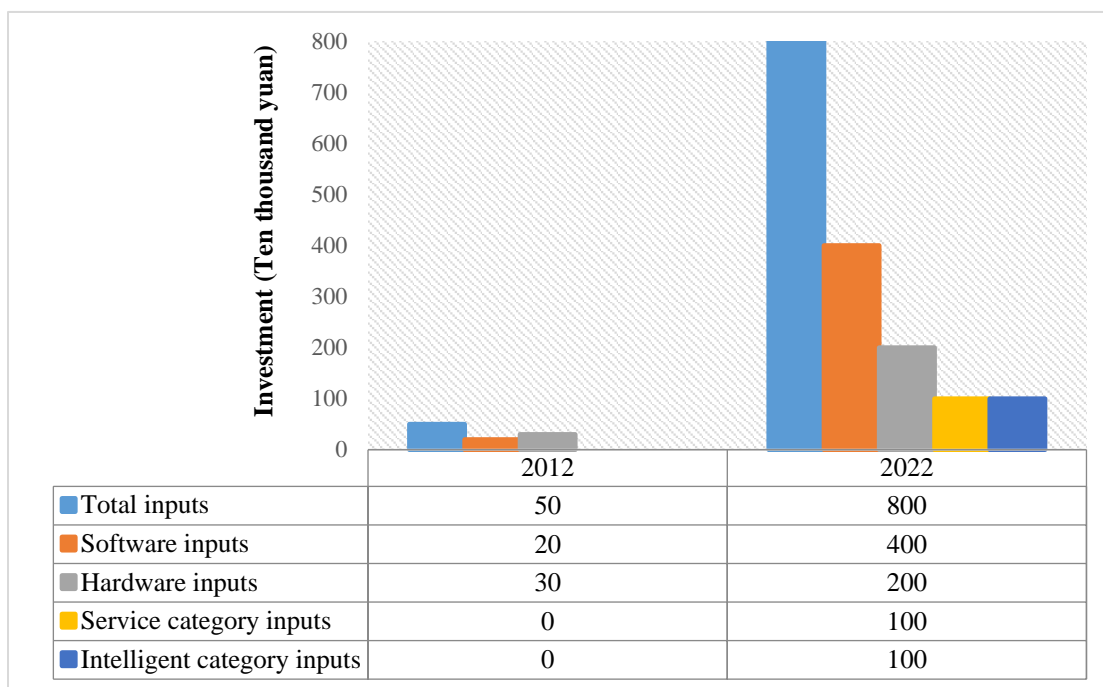
Before 2009, the hospital discussed in this paper operated a financially oriented Health Information System, which solely relied on a conventional information business system centered around billing functionality. Since the year 2019, the hospital has successfully implemented the integration of over 80 business systems, including Hospital Information Systems, Electronic Medical Records, Picture Archiving and Communication Systems, and Laboratory Information Systems. The hospital possesses a vast array of over 200 data interfaces, facilitating the exchange of data between various systems within the hospital. On a daily basis, these interfaces handle an average of 2 million data exchanges. The concept of information integration encompasses a wide range of domains, including hospital medical treatment, administrative

functions, public services, and various business sectors. Since the year 2022, hospitals have integrated advanced technologies, including multidimensional data and artificial intelligence, in order to offer decision support for fundamental medical research. Currently, the hospital has achieved the standardization of information systems across different areas by establishing direct optical fiber connections from the core computer room. This measure has been implemented to ensure the security of the hospital's information systems.

Regarding financial support, the investment in the construction of hospital informatization primarily encompasses six components: server equipment, terminal mobile equipment, network information equipment, basic system software, development or procurement of application information systems, and costs associated with information technology maintenance. In 2012, the hospital's budgeted investment in information technology construction was 500,000 yuan, all of which was government financial resources. In 2017, it was 2 million yuan, of which 800,000 yuan was from the government and 1.2 million yuan was from the hospital's self-funding. In 2022, it was 8 million yuan, of which 5 million yuan was government financial resources and 3 million yuan was from the hospital's self-funding. Between 2012 and 2022, there has been a 160% rise over the decade (see Figure 7 below). The increase in capital investment is due to the fact that in 2022, Guangzhou was identified as a city with a national demonstration project for public hospital reform and high-quality development, and the construction of smart hospitals is supported by special government funds.

According to the data presented in Table 1, it is evident that the hospital allocated a total investment of 4 million yuan towards software in the year 2022, constituting 60% of the total investment. Additionally, hardware category received an investment of 2 million yuan, accounting for 20% of the total investment. The service category received an investment of 1 million yuan, representing 10% of the total investment. Lastly, the intelligent category received an investment of 1 million yuan, also accounting for 10% of the total investment. The majority of the financial resources allocated to hospitals are directed toward the advancement of software development, while comparatively less emphasis is placed on investments in hardware, the service provision, and intelligence. Consequently, the industry encounters challenges pertaining to inadequate government funding, disparities in the capital allocation, and a disproportionate focus on software development. Furthermore, despite a significant increase in investment in hospital informatization construction, it has yet to reach the national average investment in hospital informatization construction, which stands at 9,362,400 yuan<sup>[8]</sup>. Hence, to ensure the continuous and comprehensive implementation of hospital information construction in the future, it is imperative to secure adequate capital investment.





**Figure 7.** Comparison of investment in informatization construction of this hospital from 2012 to 2022 (Ten thousand yuan)

**Table 1.** The proportion of all kinds of information construction funds invested in this hospital from 2012 to 2022

Year	Input situation	Software input	Hardware input	Service input	Intelligent input
2012	Investment (ten thousand yuan)	20	30	0	0
	Proportion of budget input (%)	40%	60%	0%	0%
2022	Investment (ten thousand yuan)	400	200	100	100
	The proportion of budget input (%)	60%	20%	10%	10%

#### 4. Discussion

In 2019, the National Health and Health Commission of China proposed the concept of establishing a trinity smart hospital, emphasizing the need for hospital information infrastructure to encompass intelligent management, service, and medical care<sup>[8]</sup>. Based on the analysis conducted on the informatization development of a specific hospital, it can be inferred that the level of medical informatization has experienced significant advancements over approximately a decade. This progress is attributed to the hospital's ongoing construction efforts, which has been accompanied by a notable increase in the proportion of investment allocated towards informatization initiatives. The hospital has successfully implemented various information system modules, including the electronic medical record system and digital imaging system, resulting in significant optimization of the overall medical service process. Nevertheless, certain issues persist within the hospital setting, including a discrepancy between the level of information integration and the practical requirements of diagnosis and treatment, as well as deficiencies within the information technology team. The current level of information rating remains significantly below the standard expected for a "smart hospital". However, it is worth noting that the case hospital, being a leading institution, has achieved a commendable level of informatization in comparison to other hospitals in China.

This observation suggests that the overall state of informatization in China's stomatological hospitals is still sub-optimal.

The "Investigation on the Information Application Status of National Stomatological Medical Institutions in 2020" was conducted by the Stomatological Hospital Branch of China Hospital Association in June 2021. The findings of the survey indicate that the overall rating of stomatological hospitals in the evaluation of interconnection and grading of electronic medical records is relatively low. The majority of the surveyed hospitals have not achieved a Grade 4 B rating in interconnection evaluation and a Grade 4 rating in grading evaluation of electronic medical records. This suggests that there is still a significant gap in terms of information integration and unified data management in stomatological hospitals. Consequently, these hospitals are unable to meet the requirements of refined management and support towards the online and offline integrated medical service model<sup>[9]</sup>. According to the Insight Report on Oral Medical Services in 2023, which was released by Meituan and Arterial Network, prominent medical enterprises, there is a limited adoption of digitalization among dental medical institutions in the market. The survey reveals that only 7.59% of these institutions are in the pilot stage, 31.39% are currently piloting digitalization, and 51.77% have not yet initiated any digitalization efforts. Approximately 27% of institutions express the intention to enhance the service process of medical staff utilizing digitalization, while

roughly 16% aim to enhance the automation and intelligence of equipment and instruments through the same process<sup>[10]</sup>.

According to the research conducted by the China Hospital Information Management Association, there are currently four primary challenges that hinder the progress of informatization construction. These challenges include a scarcity of human resources within the information technology department, inadequate financial support, insufficient coordination among management departments, and a lack of attention from hospitals<sup>[8]</sup>. Insufficient emphasis has been placed on the specific aspects of enhancing the informatization, digitalization, and precision of oral diagnosis and treatment. Furthermore, China has a variety of dental medical information management systems, with some specifically designed for community clinics. However, these systems are characterized by their limited scope and functionality, which fails to adequately address the substantial patient demand in public stomatological hospitals. Additionally, certain systems have evolved from general hospital information systems, but they do not sufficiently consider the unique requirements of oral medicine<sup>[11]</sup>. Considering the aforementioned issues, we propose the following recommendations.

#### 4.1 Improve the service quality of information systems

The implementation of a hospital information system represents a significant milestone in the process of hospital informatization. Public stomatological hospitals should prioritize the development of software and hardware systems to effectively integrate electronic medical records and the appointment registration within the hospital's health information system<sup>[11]</sup>. Based on the diagnostic and treatment provisions, each clinical department offers explicit photographs of prevalent and frequently encountered oral diseases, along with postoperative comparative images. These resources are accompanied by informative guidelines encompassing the diagnosis and treatment procedures, cost details, and relevant precautions. The purpose of these resources is to facilitate patients in scheduling appointments for diagnosis and treatment, thereby enhancing convenience. The integration of "Internet plus Accurate Appointment" has significantly reduced patient waiting times for hospital visits and ensured a seamless doctor-patient consultation process. This not only aligns with the demands of advancing information medicine and societal trends but also fulfills the inherent criteria of enhancing the efficiency and standard of medical resource utilization. Consequently, it plays a constructive role in enhancing the quality of hospital services and optimizing the treatment procedure.

#### 4.2 Pay attention to information system security management

The primary hindrance to the digital advancement of China's stomatological hospital has consistently been the

integration, incorporation, and expansion of information systems. The overall implementation of information technology in hospitals is challenging due to the lack of compatibility among products from different manufacturers. A standardized system integration platform is constructed, drawing upon internationally recognized standards such as Integrating the Healthcare Enterprise, Digital Imaging and Communications in Medicine (DICOM), and Health Level 7 (HL7)<sup>[12]</sup>. This platform facilitates the formulation of a comprehensive system integration specification that encompasses all medical business processes. Subsequently, a system integration platform is developed based on this specification. The platform serves as a unified and standardized medium for data exchange and workflow collaboration across legacy, current, and future systems. The provision of integrated services for diverse medical application systems is facilitated by the utilization of standard communication protocols, including HL7 and DICOM. It is imperative to establish seamless interaction and collaboration among clinical information systems, with a focus on integrating workflow. This integration is essential for the comprehensive digitization of all medical services, thereby ensuring the utmost level of medical safety.

#### 5. Conclusion

In conclusion, the governance structure of public oral medical institutions in China faces several challenges. These include inadequate human resources in the information technology department, insufficient financial support, and a lack of emphasis on the unique requirements for promoting the informatization, digitalization, and accuracy of oral medical treatment. These factors collectively impede the rapid advancement of oral medical and health initiatives in China. This paper presents a summary of ideas and suggestions regarding the design and management of information systems in public stomatological hospitals, in conjunction with the challenges encountered during the process of hospital informatization construction. The primary objective should be to enhance the construction of application systems, particularly in areas such as medical services, operation management, convenience, and public welfare. This entails elevating the level of intelligent digitalization within hospitals to effectively cater to the development of application scenarios, such as smart hospitals. Doing so will offer valuable insights for the informatization construction of the oral medical industry and the innovative advancement of smart hospitals.

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## References

1. Zhou, X., 2019. National strategies and opportunities for the development of dentistry. In: The 23rd China International Dental Equipment Exhibition & Symposium Exhibition. DOI:10.26914/c.cnkihy.2019.021767.
2. Ying, Y. (2023) The "14th Five-Year Plan" for National Health Informatization was issued to lead and support the high-quality development of health care. *Adolescent Health*. 21(1):27-27.
3. Hung, M., Lipsky, MS., Phuatrakoon, TN., Nguyen, M., Licari, FW., Unni, EJ. (2022) Teledentistry implementation during the COVID-19 pandemic: scoping review. 11(2):e39955. doi: 10.2196/39955.
4. El Tantawi, M., Lam, W. Y. H., Giraudeau, N., Virtanen, J. I., Matanhire, C., Chifamba, T., ... & Folayan, M. O. (2023). Teledentistry from research to practice: a tale of nineteen countries. *Frontiers in Oral Health*, 4, 1188557.
5. Uslu, B. Ç., Okay, E., & Dursun, E. (2020). Analysis of factors affecting IoT-based smart hospital design. *Journal of Cloud Computing*, 9(1), 1-23.
6. Wang, Y. (2017) Construction of Intelligent Hospital Management Mechanism--The Affiliated Stomatological Hospital of Wenzhou Medical University as an Example. Zhejiang Normal University (Doctoral dissertation).
7. Li, H., Xu, F., Wang, K. (2022) Research on the Current Situation of Hospital Informatization Staffing in China. *Chinese Health Quality Management*. 29(1):4-7.
8. Ling, J., Gao, F., Fu, H., et al., 2023. The current situation and development trend of informatization construction in dental hospitals. In: The 7th National Symposium on Dental Hospital Management. DOI: ConferenceArticle/5aa6109ac095d72220e669e6.
9. Du, M., Tao, M. (2022) Research on the Path of Smart Hospital Construction for Multi-Hospital District Medical Groups. *Modern Hospitals*.22(01):108-109+114.
10. Liu, L., Meng, X. (2021) The role of optimizing the appointment process in improving the quality of outpatient work. *Oriental medicated diet*. 000(5):134.
11. Zhang, J., Zhu, S., Liu, Y., et al. (2021) Application of a digital total process diagnosis and treatment system in the training of orthognathic and joint surgery specialists. *China Health Industry*. 2(18):95-97.
12. Xing, M. (2021) Design of information management system for hospital drug allocation center with HIS architecture. *Information Technology*.(01):157-162+168. DOI:10.13274/j.cnki.hdzj.2021.01.028.