

# Challenges and strategies of developing internet hospital: Combining qualitative interview and documentary research

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## Abstract

**Objectives:** As an innovative technology, internet hospitals have the potential to improve healthcare services. However, the pioneering nature of internet hospitals means that they are still in the early stages of development. This study aimed to investigate the challenges and strategies involved in establishing internet hospitals by public medical institutions in China.

**Methods:** In this study, a qualitative research combined qualitative interview and documentary research was conducted at an internet hospital affiliated with a public tertiary hospital in China. With the documentary collection, interviews were completed with the hospital's decision makers, operators, information technology personnel, clinicians, and pharmacists, as well as the internet hospital's operators, technicians, and external technical partners. Thematic analysis was employed to interpret all the materials collected.

**Results:** Totally 20 participants took part in the interviews. The main challenges in developing internet hospitals include low physician motivation to participate in internet hospital services, low acceptability of internet hospital services among patients, lack of service specifications, and insufficient versatile talents. In the development planning, four phases were established: first, the development of primary services; second, the integration of online and offline services; third, the provision of online prescriptions; and fourth, a focus on differentiation. The service model innovation highlighted four key dimensions, including: (1) the importance of patient and department classification in defining the value proposition; (2) the pivotal role of a high-level coordination department with resource coordination capability in key processes; (3) the significance of independent platform construction and talent cultivation as guarantees of key resources; and (4) the revolutionary profit formula of personalized digital health and patient-centric services.

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**Conclusions:** In internet hospitals, primary challenges are evident in physicians' cognition, patient education, and management skills. Internet hospitals, designed to offer personalized digital health and patient-centric services, necessitate more substantial innovations in service models and clinical care.

## Keywords

Internet hospital, development challenge, development strategy, service model, China

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## Introduction

The Chinese government has been promoting the development of innovative medical service models within the "Internet + Health Care" framework, with a focus on internet hospitals. These Internet-based technologies aim to enhance access to healthcare and improve the delivery, quality, and efficiency of healthcare services.<sup>1,2</sup> Due to the increasing demand for medical services in China, the traditional medical service model is unable to adequately meet these needs. As a result, internet hospitals, which are a crucial aspect of the "Internet + Health Care" initiative, are being promoted to facilitate the new healthcare reform and offer high-quality, efficient, and accessible medical services.<sup>3</sup> The transformation is underpinned by advancements in payment systems, hospital governance frameworks, community-level skill development, health literacy initiatives, etc., alongside the adoption of digital technologies to enhance operational efficiency and healthcare standards.<sup>4-6</sup>

Under the structured advancement of national policies, internet hospitals facilitate the enhancement of medical services through technological innovation and are swiftly emerging as a novel model for healthcare delivery.<sup>7,8</sup> According to various sources, internet hospitals can be categorized into three types: those established by public medical institutions, which have played a key role in the development of internet hospitals; those established by private medical institutions; and those established by entities such as internet companies and venture capital firms.<sup>2</sup> The emergence of internet hospitals is contributing to the enhancement of medical service efficiency, reduction of healthcare costs, and the continuous fulfillment of the public's need for diverse and high-quality medical services.<sup>9,10</sup> During the COVID-19 epidemic in China, internet hospitals played a crucial role in meeting the outpatient needs of patients, particularly those with chronic diseases, while also effectively mitigating the risk of cross-infection in the offline hospital settings.<sup>11-13</sup>

The emergence of internet hospitals represents a nascent phase in their development, with ongoing debate surrounding the foundational principles of their model design.<sup>14</sup> The

evolution of internet hospitals, which rely on medical resources, medical technology, and information technology, displays regional variability.<sup>15</sup> The advent of internet hospitals presents an opportunity to enhance patients' access to high-quality medical resources and to minimize the time burdens experienced by patients and their families. However, it is important to note that internet hospitals do not inherently bring financial or technical advantages. As such, the full potential of internet hospitals remains largely untapped.<sup>16</sup> The field of online medical diagnosis and treatment presents numerous challenges related to safety and quality. These challenges include issues of poor timeliness, inadequate doctor-patient interaction, user-unfriendly experiences, heavy reliance on out-of-pocket payment, inadequate patient privacy protection regulations and technologies.<sup>17</sup> Numerous factors, including the shortage of Internet-based medical professionals and the lack of medical insurance coverage, pose constraints on the advancement of online hospitals. Studies have indicated that enhancing resources pertaining to the working environment and conditions (e.g. work conditions, resource-related support, and administrative innovation) within online hospitals can promote proactive stress management among physicians over a sustained period.<sup>18</sup>

The service mode of internet hospital pharmacy service predominantly depends on labor-intensive operation, giving rise to challenges such as cumbersome and inefficient processes.<sup>19</sup> The current operational processes and management of internet hospital services with drug delivery lack standardization, particularly with respect to accessibility and user-friendliness for elderly individuals.<sup>20</sup> Consequently, while internet hospitals have been encouraged by the Chinese government to optimize healthcare resource use, the innovative experience of internet hospitals is still in the exploration stage, which demands academic investigation.<sup>21</sup>

Therefore, this study aimed to investigate the challenges and strategies involved in establishing internet hospitals by public medical institutions in China. The findings from this study are anticipated to enhance the innovation of internet hospitals in China and offer insights for the global

advancement of internet hospitals focusing on personalized digital health and patient-centered services.

## Methods

### Research design

This study applied a qualitative research design combining qualitative interviews with participants and documentary research.

### Research site: Internet Hospital of the Nanfang Hospital of Southern Medical University

The Nanfang Hospital of Southern Medical University, established in 1941, is a Class A tertiary hospital. According to the data published by the Publicity Department of Southern Medical University in October 2023, the outpatient volume of Nanfang Hospital exceeds 3 million people/year, and the inpatient volume is about 1000 people/day. In 2018, it pioneered an integrated medical service system that combines online and offline services through its WeChat official account and self-service terminals. By 2019, it had introduced Internet-based medical services, including registration, medical consultation, and drug supply. The year 2020 saw the implementation of an electronic health code, integrating online and offline medical processes, and the realization of the medical service Yimatong (a unified medical ID code for the same-medical services both online and offline). In January 2022, it was selected as one of the first “Internet + medical health” demonstration hospitals in Guangdong Province due to its advancements in internet hospital development. As a result, the Internet Hospital of Nanfang Hospital of Southern Medical University was chosen as the case of this qualitative study.

### Qualitative interviews

**Participant recruitment.** We employed purposive sampling to select participants who represented the service, operation, management, and development teams of the sample internet hospital in this study. We managed to select participants in all the different positions of their team, including the vice president of the hospital, director of the medical service division, director of the smart medical project department, technicians of the smart medical project department, operators of the smart medical project department, head of the information section, respiratory physicians, oncologists, plastic surgeons, pharmacists, and technicians in the outsourced services. The interviews, conducted between August and November 2021, adopted a semi-structured format by following our tailor-made interview outline.

**Data collection.** Prior to conducting the interviews, we obtained informed consent from the participants. The Participant Information Sheet and informed consent forms can be found in the Supplemental Materials. All interviews were carried out in person and involved questions centered on practical challenges and development strategies. With the participants’ consent, we recorded the audio of each interview and transcribed it verbatim. To ensure the accuracy of the transcription from the interview recording, two researchers first transcribe the recording independently. The two transcripts were then compared, with unclear and differing sections marked. Next, a third researcher reviewed these marked sections against the recording. Finally, if any ambiguities remain, we verify the unclear parts with the participant. On average, the interviews lasted approximately 45 min.

### Documentary data collection

In parallel, we undertook a thorough documentary analysis of its operations and services to reveal the panorama of the features and developments of the Internet Hospital at Nanfang Hospital of the Southern Medical University. The Smart Medical Project Department of the Internet Hospital at Nanfang Hospital of the Southern Medical University collected all these documents and provided them to us. Thus, our study encompassed reviewing documents pertaining to the hospital’s operations and services from August 2020 to July 2021, with authorization from the hospital administration.

### Data analysis

Our data analysis employed a structured framework, consisting of development challenges and development strategies as the two major themes.<sup>2,22</sup> We also created two subthemes under the development strategies, namely phased development plans and service model innovation for internet hospitals. Initially, we examined the practical challenges the internet hospital faced. Then, we adopted a macro perspective to scrutinize the phased development plans of the internet hospital. Finally, we investigated the service model of an internet hospital from a micro perspective, comprising the value proposition, key resources, key processes, and profit formula. The value proposition pertains to how internet hospitals enhance patient services, while key processes and resources refer to the operational and managerial aspects and assets necessary for delivering the value proposition. Furthermore, the profit formula delineates how internet hospitals create and deliver value to both themselves and their patients.<sup>22</sup>

Throughout the data analysis process, several key steps were taken. Initially, two researchers completed a thematic analysis separately to gain a preliminary understanding of

the development challenges and strategies of the sample internet hospital. Subsequently, these two researchers discussed the commonalities and differences in their analysis results. Next, other three researchers were involved to evaluate the differences and conducted a triangulation test. Finally, all researchers came together to discuss and finalize the results of the qualitative investigations. Furthermore, the original words of the participants will be quoted directly as evidence.

### Ethics considerations

The research ethics application together with study protocol and informed consent form were reviewed and approved by the ethics committee of the University of Macau (approval number: BSERE20-APP004-ICMS). Before the formal interviews, written informed consent was obtained from the participants.

## Results

### Characteristics of participants

The interviews included 20 participants, and their characteristics are presented in eTable 1 of Supplemental Materials. Of the participants, 55.0% were male and 45.0% were female. In terms of education, 30.0% held doctoral degrees, 45.0% held master's degrees, and 25.0% held undergraduate degrees. The participants' working experience ranged from 3 to 23 years, with an average of 8 years.

### Summary of key themes

As shown in Figure 1, the challenges and strategies in developing internet hospitals have been summarized based on the thematic analysis. The main challenges in developing internet hospitals include low physician motivation to participate in internet hospital services, low acceptability of internet hospital services among patients, lack of service specifications, and insufficient versatile talents. In the development planning, four phases were established: first, the development of primary services; second, the integration of online and offline services; third, the provision of online prescriptions; and fourth, a focus on differentiation. The service model innovation highlighted four key dimensions, including: (1) the importance of patient and department classification in defining the value proposition; (2) the pivotal role of a high-level coordination department with resource coordination capability in key processes; (3) the significance of independent platform construction and talent cultivation as guarantees of key resources; and (4) the revolutionary profit formula of personalized digital health and patient-centric services.

### Challenges of developing internet hospitals

*Low motivation of physicians to participate in internet hospital services.* The doctors who offer services at the internet hospital are all from Nanfang Hospital. Currently, most doctors have low motivation for participating in internet hospital services. The main reasons behind are unfamiliarity with

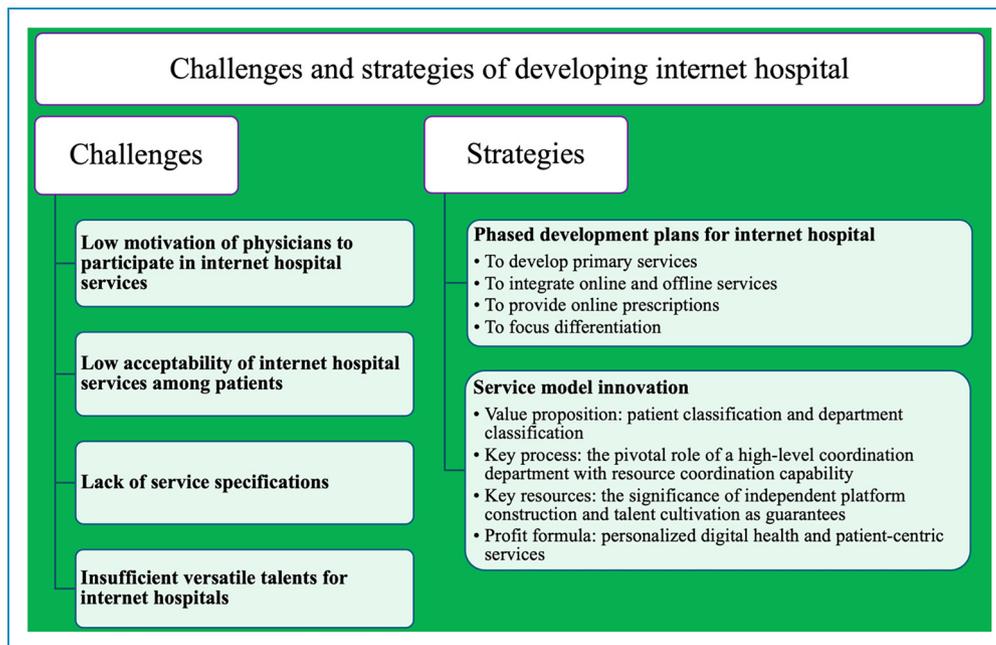


Figure 1. Summary of key themes of challenges and strategies.

the service process, heavy workloads, and low financial incentives.

“There are three reasons for physicians’ low motivation: first, physicians have not formed the habit of providing medical services with pictures or videos; Second, the pricing of medical services in internet hospitals is low, and the financial incentive is low; Third, most physicians ‘offline outpatient are already full load, and the assessment pressure of outpatient is high, so it is difficult to ensure the motivation of physicians in terms of time and motivation.” [Interviewee #2, female, 17 years in the role]

#### *Low acceptability of internet hospital services among patients.*

It is perceived that a significant portion of patients, particularly elderly individuals, continue to rely on traditional offline medical services. The emergence of internet hospital services has not been widely embraced by patients due to ingrained medical habits and previous service experiences, thereby resulting in a low level of acceptability for internet hospital services.

It is mainly reflected in two aspects: first, patients have not formed the habit of online medical consultation, but are still used to the traditional offline medical consultation; second, patients are not familiar with the process and functions of online medical services in internet hospitals, they are generally unfamiliar with how to select departments or doctors for appointment registration and how to use online medical services, so they cannot easily obtain the required medical services. In practice, it is also found that the utilization rate of many internet hospital departments is not high. [Interviewee #2, female, 17 years in the role]

*Lack of service specifications.* At the national level, several policy interventions have been implemented to guide the systematic development of Internet-based hospitals. However, there is still a lack of specific service standards to direct frontline service delivery.

Now, there are no specific policy documents for the medical services provided by internet hospitals, such as health data management, service content, service process, service fees, expense reimbursement, etc., the existing policy documents only clarify the general direction, and there are no specific measures. Among them, the cost challenge is particularly urgent. Currently, the state has no clear pricing system for the medical services of internet hospitals, so the payment process and standard of service fees are unclear. With the increase of medical services of internet hospitals, the pressure on hospitals and physicians is also increasing. [Interviewee #3, female, 6 years in the role]

*Insufficient versatile talents for internet hospitals.* The emergence of internet hospitals has ushered in a new era of medical service revolution. The fusion of “Internet + Health Care” has greatly influenced the skill sets of healthcare professionals and traditional service models, resulting in changes to personnel requirements. Individuals involved in establishing and managing internet hospitals must possess a diverse skill set, combining expertise in medical practice and traditional healthcare services with a fluency in Internet-based thinking.

For example, although the information department staff of the hospital have technical capabilities and understand traditional medical services, they generally lack internet thinking and have low cognition of the internet hospital model. Therefore, although the internet hospital business department was established to actively recruit team members with both medical knowledge and internet thinking, it was found to be very difficult. Practice has found that the current feasible method is to cultivate versatile talents in internet hospitals. [Interviewee #3, female, 6 years in the role]

#### *Phased development plans for internet hospital*

The interviews found that a multi-phase development plan was formulated to address internet hospitals’ practical challenges. Initially, the internet hospital was positioned as a part of the Health Information System (HIS), with the goal of improving traditional medical services and hospital operation management. In later stages, the internet hospital will independently develop various functional modules, such as the medical record system, inquiry system, and payment system, to become an “independent hospital”. This development is divided into four phases.

*Phase 1: to develop primary services.* In 2017, Nanfang Hospital started developing “Internet +” medical services using information technology. They created the Yiwutong APP, which offered Internet-based registration and outpatient payment services. The main goal during this stage was to introduce and promote the use of “Internet +” medical services among physicians and patients.

The first stage, in fact, I think it should be from 2017 to 2018, when it is to develop a very elementary internet function business. It is not an internet hospital, it is only to use internet technology to do some corresponding patient services, which should be a relatively primary stage. For example, the internet-based registration and payment, we named it “Yiwutong”, which was not widely promoted. [Interviewee #1, male, 23 years in the role]

In the early stage, by providing some convenient services, both patients and medical staff are gradually accustomed to Internet medical services, which is also a process for hospitals to gradually become familiar with Internet medical services. [Interviewee #3, female, 6 years in the role]

*Phase 2: to integrate online and offline services.* In September 2018, Nanfang Hospital established the smart medical department and officially began construction of an internet hospital. The goal was to integrate online and offline medical services through software and hardware development. The first step involved selecting departments and diseases suitable for providing “Internet+” medical services based on physicians’ opinions, disease characteristics, and service processes. Subsequently, an internet hospital service platform was built using WeChat official accounts and mini-programs, gradually transitioning traditional services online for seamless integration with offline services. The internet hospital offered various services, including online registration and payment, in-hospital navigation, appointment scheduling for medical tests, medical consultations, access to medical reports, inpatient catering, discharge transfer, and patient satisfaction surveys.

At the end of 2018, our hospital may have entered the second stage. At this stage, I think it has truly entered the integration of online and offline. We have built a systematic patient service structure containing a lot of content. Compared with our first stage, we have used some related services in the outpatient clinic, such as navigation, image report query, text report query, and satisfaction survey. [Interviewee #1, male, 23 years in the role]

Later, we added inpatient services, starting from the patient applying for the hospitalization certificate, filling in the hospitalization information, paying the deposit, paying the fee, pushing the daily list to the patient, even ordering meals, as well as non-emergency transfer and discharge medicine after discharge. In fact, the closed loop of our entire process has been built very well.

In the second stage, in fact, it mainly builds a basic functional facility, such as in-hospital navigation, inspection appointments, online follow-up visits, report queries, and patient satisfaction surveys. [Interviewee #3, female, 6 years in the role]

*Phase 3: to provide online prescriptions.* The first phase was to realize the function of online prescription and form a complete closed-loop service of internet hospitals. The second was to solve data security issues and ensure the safe and stable operation of computer and mobile services. The third was connecting with medical insurance to realize the opening of data

ports, but it had not yet been used online due to policy restrictions. In addition, continuous research on hospital management departments, doctors, and patients provides empirical evidence for continuously optimizing service processes.

Then in the third stage, starting from June this year, we have just launched the core internet prescribing function, realizing a relatively complete closed loop of online diagnosis and treatment.

Another thing is the connection with medical insurance. The data port has been opened up, but the current policy has not been released, so it cannot really be used online. [Interviewee #1, male, 23 years in the role]

We have been collecting opinions from various stakeholders to optimize the function. [Interviewee #3, female, 6 years in the role]

*Phase 4: to focus differentiation.* The future development strategy involves a comprehensive approach that includes remote consultation, referral services, and precise health management for patients. Leveraging Nanfang Hospital’s exceptional medical resources and reputation, the focus will be on developing remote consultations for complex conditions in fields such as gastroenterology, neurosurgery, plastic surgery, nephrology, and stomatology. Additionally, utilizing Nanfang Hospital’s high patient volume, the emphasis will be on establishing a referral center to facilitate the efficient transfer of patients within the medical alliance, particularly for patients with high Case Mix Index (CMI) values, and to optimize bed resource utilization. Furthermore, harnessing health big data, the strategy centers on developing precise health management for patients, including the use of wearable devices for continuous health monitoring to offer personalized health interventions.

For future development, I believe that each internet hospital may go in a different direction.

For us, there may be two directions in the future. One direction is that many hospitals are actually like this, that is, remote consultation and referral... We are thinking about how to admit patients with high CMI values to better Serving such patients... The second is the precision health management of patients, which may involve some follow-up health management, which may include IoT information from wearable devices to help patients monitor health data. [Interviewee #1, male, 23 years in the role]

## Service model innovation of internet hospital

### Value proposition

*Patient classification.* To improve the patient’s medical experience and efficiency of medical resource utilization,

it is necessary to accurately identify patients who are suitable for internet hospital medical services. Patients were divided into three categories (as shown in Table 1) according to their different service needs.

The first and second categories of patients require in-person visits to outpatient clinics, whose needs cannot be fully fulfilled by internet hospitals. However, internet hospitals can offer convenient services such as pre-diagnosis appointment scheduling, virtual waiting rooms, online payments, and follow-up care. The third category of patients can be provided with comprehensive solutions through online hospitals, without much need of in-person clinic visits. By categorizing patients based on their service needs, we can effectively identify the specific service challenges faced by different patient types, so as to offer corresponding solutions. For online follow-up patients, it is important to note that they have chronic diseases, and the physicians at online hospitals should be able to accurately assess patients' conditions.

**Department classification.** Based on the experience summary of internet hospital operation, three types of departments suitable for internet hospital medical services were selected: (1) departments that can relatively easily evaluate patients' conditions and prescribe prescriptions, such as gastroenterology and endocrinology; (2) departments that can judge patients' conditions without too much imaging examinations, such as rheumatology and

immunization department, nephrology center; and (3) departments that can accurately identify the external characteristics of patients through images to judge the condition, such as plastic surgery.

**Analysis of patient characteristics.** According to the statistics of Nanfang Hospital Internet Hospital from August 2020 to July 2021, 93.4% of the patients were from Guangdong Province. Specifically, patients in Guangdong Province mainly came from Guangzhou (70.2%), followed by Foshan (5.9%) and Shenzhen (4.2%) (as shown in eFigure 1 of Supplemental Materials).

Regarding the department service of internet hospital, the highest proportion of patients was gastroenterology (18.7%), followed by urology (8.0%), endocrinology (7.4%), plastic surgery (5.4%), and cardiovascular medicine (5.3%). The top 10 departments in terms of patient service accounted for 65.7% (as shown in eTable 2 of Supplemental Materials).

Regarding the disease service of internet hospital, a total of 207 diseases were served. The highest proportions of patients' conditions were gastrointestinal dysfunction (8.5%), followed by chronic gastritis (8.0%), *Helicobacter pylori* infection (4.8%), hepatitis B surface antibody antigen carriers (3.4%) and gastroesophageal reflux disease without esophagitis (3.0%), respectively. The top 10 disease service accounted for 35.7% (as shown in

**Table 1.** Patient classification.

Type	Definition	Challenges	Service innovations of internet hospital
First-diagnosis patients	Patients who do not have a clear diagnosis and need to go to the hospital for a face-to-face consultation with a doctor, or even need a clinical examination before a clear treatment plan can be made.	Medical services can only be obtained from hospital outpatient clinics.	To provide convenient internet hospital services before and after diagnosis, including Internet-based registration service, Internet-based payment service, in-hospital navigation, Internet-based follow up.
Offline countercheck patients	Patients with definite diagnosis but need medical assistance, such as postoperative wound management and bone injury recovery.	Medical services can only be obtained from hospital outpatient clinics.	To provide convenient internet hospital services before and after diagnosis, including Internet-based registration service, Internet-based payment service, in-hospital navigation, Internet-based follow up.
Optional offline countercheck patients	Patients with definite diagnosis and whose main needs are continuation of prescription or follow-up management, and who need to make an appointment for hospitalization and inspection.	The required medical services can be solved through the internet hospital, without the need to spend time and money to go to the offline hospital.	To provide full process solutions.

**Table 2.** The cooperative network of online prescription service in internet hospitals.

Type	Cooperator	Activities
Within the hospital	Smart medical project department	Responsible for overall coordination
	Finance department	Responsible for cashiers, prices, charges, etc.
	Medical insurance department	Responsible for health insurance policy implementation and patient reimbursement
	Information department	Responsible for resolving technical issues in the business department
	Outpatient departments	Responsible for managing the departments that provides Internet-based medical services
	Pharmacy department	Responsible for Internet-based drug supply service
	Quality management department	Responsible for quality control of electronic medical records
Outside the hospital	DongHua	Responsible for platform development, implementation, operations, and technical management
	WangZhengTong	Responsible for the technical development of the platform
	MuLaoRenKang	Responsible for intelligent review of prescriptions
	ShunFeng	Responsible for drug distribution
	Beijing Manji	Responsible for mobile security management
	Tencent	Responsible for providing a platform for internet hospital operation

eTable 3 of Supplemental Materials). In addition, 2.5% were health consultations.

Based on the number of services that doctors can provide and the number of patients registered in internet hospitals from January to July 2021 (as shown in eFigure 2 of Supplemental Materials), the overall utilization rate is not high, and the average utilization rate is only 20.8%.

In July 2021, 39 Internet-based outpatient departments arranged 14,819 medical services. And the top 20 Internet-based outpatient departments accounted for 84.4% of the total (as shown in eTable 4 of Supplemental Materials). Among them, the Internet-based outpatient service volume of spine orthopedics is the largest (2577, 17.4%), followed by the gastroenterology Internet-based outpatient service (2269, 15.3, and traditional Chinese medicine (TCM) intractable diseases Internet-based outpatient service (964, 6.4%). In terms of utilization of Internet-based outpatient service, the top three are gastroenterology Internet-based outpatient service (527, 18.7%), urology Internet-based outpatient service (224, 8.0%), and endocrinology Internet-based outpatient service (207, 7.4%). From the perspective of utilization rate, the

highest is the urology Internet-based outpatient service (70.7%), followed by endocrinology Internet-based outpatient service (58.1%) and liver cancer center Internet-based outpatient service (57.4%).

#### Key resources

**Service platform.** As one of the key resources, the service platform refers to the infrastructure of the internet hospital. It mainly includes electronic health record database, Internet-based medical service platform for hospital management, Internet-based medical service platform for physicians, Internet-based medical service platform for patients, and auxiliary medical decision-making system. According to different service value propositions, the service platform can be divided into three modules: (1) Basic platform, which is mainly composed of an electronic health record database and electronic health code that identifies patients. It aims to realize the onlineization of offline medical services; (2) Functional platform, including Internet-based registration service platform, Internet-based payment service platform, Internet-based medical consultation service platform, and information push service platform;

and (3) Intelligence platform, referring to the auxiliary medical decision-making platform based on health big data.

“The construction of the service platforms are roughly divided into three steps. The first step is the basic construction. The patient’s health record database must be built. According to business needs, the patient’s identity authentication must be done through electronic health codes. These are the most basic. The second step is the development of functional platforms, such as internet-based registration service platform, internet-based payment service platform, internet-based medical consultation service platform, and information push service platform, which are constantly advancing. Then, the third step is intelligence, making good use of our big data, including medical record data and traditional brick-and-mortar examination data, to make intelligent decision-making and health intervention.” [Interviewee #3, female, 6 years in the role]

**Medical staff.** Healthcare professionals, including physicians, pharmacists, and nurses are the core medical resources of internet hospitals. All healthcare professionals who provide services in Nanfang Hospital Internet Hospital are the staff of the Nanfang Hospital. Nanfang Hospital has 2300 physicians at different ranks, among which 477 provide services in the internet hospital, accounting for 20.7%. The number of physicians in different Internet-based outpatients is dynamically adjusted according to changes in medical service demand. According to the July 2021 statistics (as shown in eTable 5 of Supplemental Materials), the number of physicians providing services at Huiqiao Medical Center Internet-based outpatient is the most,<sup>23</sup> followed by gastroenterology Internet-based outpatient<sup>24</sup> and neurosurgery Internet-based outpatient.<sup>25</sup>

**Internet hospital administrators.** In practice, it is found that those who are competent in internet hospital administration should have the following experience and attributes: first, they should have experience in hospital work and understand traditional medical procedures; second, they should have internet-oriented thinking and be familiar with internet service models; Third, it is very important to be good at communication, especially with the hospital business department.

Some of our colleagues are transferred from the pharmacy department. They know these processes very well, and they have the ability to communicate and coordinate, so they can get started very quickly. When they talk about some business scenarios, it is easy to understand. [Interviewee #8, female, 3 years in the role]

In fact, this person who has worked in the hospital and is willing to do this kind of operational work would be the

best, but it is very difficult to find. If they are inexperienced, you have to start training from scratch. [Interviewee #2, female, 17 years in the role]

**Cooperation network.** The cooperation network in the key resources refers to the internal and external cooperation network at the business and product levels. Inside the hospital, it is mainly a business cooperation network with the finance department, medical insurance department, information department, outpatient departments, pharmacy department, and quality management department. Outside the hospital, it is mainly a product cooperation network with third parties, such as technology companies, WeChat platforms, logistics distribution companies, and auxiliary medical decision-making system companies.

For example, the pharmacy department is responsible for pharmacy services, the medical department is responsible for the medical process, the finance department is responsible for charging, and the medical insurance department manages medical insurance reimbursement, and the quality management department manages quality control through cases. In fact, we internet hospitals also need a model similar to this. Although it is a new business, if you put it in a public hospital to do this, some of its corresponding management functions are still inseparable from offline business departments. They have to rely on them to do everything, just change the model, and need new processes and management methods. [Interviewee #3, female, 6 years in the role]

This MuLaoRenKang is a third-party service company for intelligent prescription review, providing us with technical support for prescription review, because they have a knowledge base and can integrate their platform into our workstation through technology to assist our hospital pharmacists to review prescriptions. [Interviewee #4, female, 5 years in the role]

The online prescription service of internet hospital is a typical example of utilizing a cooperative network (as shown in Table 2). The Smart Medical Project Department is the general coordinator. Within the hospital, this position was to coordinate the business cooperation of the finance department, medical insurance department, information department, outpatient departments, pharmacy department, quality management department and other departments. Outside the hospital, this position was to coordinate the product development and operation cooperation of the software development company (DongHua), the product development company (WangZhengTong), and auxiliary medical decision-making system companies (MuLaoRenKang).

**Service specifications.** Regarding the physicians who provide Internet-based medical consultation services, the

“Interim Regulations on the Management of Internet Hospital Services in Nanfang Hospital of Southern Medical University” has been issued to manage the qualifications, training, procedures of physicians, and service-related hardware requirements. Moreover, the patient’s informed consent is used to protect the rights, obligations and privacy. It is the core part of the service specifications of internet hospitals, but continuous improvement is still undergoing. In addition, in terms of core medical services, there is still a lack of service specifications related to service quality, electronic medical records, and online prescriptions.

We have only issued a management regulation for outpatient services, which we can grasp, that is, what kind of physicians can provide services in internet hospital, what kind of qualifications he has, what kind of training he needs, and whether you are using the corresponding software. When the time comes, what rules do you have to abide by, etc., because the most important thing for us is to control the bottom line of safety. [Interviewee #5, female, 4 years in the role]

We have patient informed consent, but we can’t standardize it because it is always changing. We don’t know what kind of patient’s informed consent is more reasonable, what patients should know and what they must know, we are all groping by ourselves. Through the actual problem found, and then continue to improve. [Interviewee #6, female, 4 years in the role]

Compared with some offline regulations, such as the regulations on the management of electronic medical records, the regulations on the management of electronic prescriptions, there are many online regulations that I have no way to formulate now... What should an online electronic medical record look like? No one knows now, and the government has not clearly stipulated it. Now each hospital decides on its own, and it is all made by itself, and it is all summed up through practice. Therefore, we have not issued these regulations related to the medical service business. [Interviewee #3, female, 6 years in the role]

### Key processes

**Setting up a smart medical project department.** The first step is to establish a smart medical project department, which is affiliated to the medical affairs department reporting directly to a vice president. This department consists of technical, operation, brand, design, and research groups. It is fully responsible for the project planning, resource integration, project implementation, project operation, and other matters of the internet hospital.

Why do we have to set up a project department to lead it? Because we found that it is inappropriate to set up the

internet hospital in the medical department. Although many hospitals set up the internet hospital in the medical department, you will find that the medical department does not have the relevant ability to do these things. For example, if you want to do business promotion, drainage, and even project management of many smart hospital informatization projects, traditional medical personnel have no relevant ability and thinking. For example, the quality management department can’t keep up too, they don’t know what this business is doing. When I asked them to make quality control plans for online cases and prescriptions, they were at a loss.....The type of business determines its leading department. Anyway, there is a very strong feeling in our hospital. We need someone who does not belong to any original department to coordinate this work, because other people cannot understand this new work. [Interviewee #2, female, 17 years in the role]

There is a group to manage the operation of users, that is, doctor operation, patient operation, and some daily business processing and training management. The second group is marketing. For online business marketing, to revitalize the business, it is necessary to do some new business or do some promotion. It can also be called the brand group. The third is the design group, responsible for the art design. We just mentioned that in the fourth stage, to do some precision health management, we need to carry out big data mining, then we will also set up a research group accordingly. [Interviewee #3, female, 6 years in the role]

**Branding the internet hospital.** The Internet-based department name management of internet hospital is the first step. Based on the principle of ensuring the convenience of patients, the name of an internet hospital department is generally the name of an offline department followed by a suffix of “Internet-based outpatient”. Due to patients’ different needs and positioning for offline and online services, the number and types of Internet-based departments cannot be completely the same as those of offline departments and need to be continuously adjusted during the service process based on patient feedback.

We are now setting up online departments, basically adding a “network department” after the original department name. [Interviewee #3, female, 6 years in the role]

But it can’t be 100% synchronized. Let me give you an example and you will understand, such as offline nursing services. These patients mainly come for follow-up treatment, such as trauma dressing changes, injections, etc. We do not provide these online. [Interviewee #7, male, 3 years in the role]

For example, dental clinics are divided into many subspecialties, but only one “stomatology internet-based

outpatient” is set up, and subspecialties are no longer subdivided, just because doctors feel that they can be comprehensively treated, which can be processed online, and which need to go to offline clinics. [Interviewee #9, male, 4 years in the role]

The second step is the department publicity of internet hospital that aims to attract patients. There are two outstanding challenges: one is that some departments are relatively weak and less attractive to patients; the other is that many patients do not know the disease service areas of a specific department, so they do not know how to choose an appropriate department. There are few patients in some departments, resulting in low utilization of medical resources. Therefore, it is necessary to strengthen the publicity of those departments, specifically, advertisement, video, or live broadcasts for doctors and departments, to improve patients’ understanding of the department’s medical services.

Many patients, and even people inside our hospital, said that even after arriving at the department, they did not know that the department could provide such medical services. [Interviewee #3, female, 6 years in the role]

For example, some key departments are very strong, so there are many patients, but there are also some non-key departments that are deserted. As mentioned earlier, the first is that many patients do not know you have this department, and do not know your strength. This is most likely a propaganda issue. [Interviewee #8, female, 3 years in the role]

For some departments that we call hungry, they still need to do publicity, such as shooting videos or helping them publish some articles for publicity. Our internet hospital has a column, including free registration, a live broadcast of popular science, and some relevant popular science articles. In this case, I believe that we will invest more resources to do these things for many departments whose brands are not particularly popular. In fact, it is just propaganda and drainage. [Interviewee #8, female, 3 years in the role]

#### *Setting up Internet-based medical consultation service.*

According to the different care needs, various service portals are set up, including Internet-based medical consultation (internet-diagnoses and prescription for counterchecked patients, health consultation for the first-diagnosis patients), payment, report viewing, prescription management, Internet-based pharmacy outpatient service (as shown in eFigure 3 of Supplemental Materials).

There are two types of services models, i.e. image-text medical consultation and video medical consultation. In

terms of image-text medical consultation, physicians could make Internet-based diagnoses and order a prescription for counterchecked patients, but only health consulting services for first-diagnosis patients. Video medical consultation can be used to make an Internet-based diagnosis and order a prescription after reviewing specific health-related information. So far, due to policy restrictions, physicians’ Internet-based medical service fees are at a low level. To ensure the motivation of physicians, the hospital will provide financial subsidies.

In fact, we mainly use image-text medical consultation. Compared with image-text medical consultation, video medical consultation requires higher environmental conditions and physician’s time. [Interviewee #10, male, 8 years in the role]

Some departments and some diseases are suitable for image-text medical consultation, and some are suitable for video medical consultation. For example, in dermatology, physicians need to look at skin problems, but they don’t want to serve patients in a messy environment, which easily affects the effect. [Interviewee #15, male, 10 years in the role]

The fees for image-text medical consultation and video medical consultation are the same, because now we can only charge one service fee. [Interviewee #8, female, 3 years in the role]

In order to ensure the motivation of physicians, our hospital gives subsidies to physicians, which is to reward them according to their offline standards. [Interviewee #3, female, 6 years in the role]

*Planning the medical insurance services.* At present, medical insurance cannot be used for medical services in internet hospitals except for the Internet-based outpatient medical consultation service fee of hypertension and diabetes. In fact, in terms of the technical level, the internet hospital has realized the data port intercommunication with the Medical Insurance Bureau. When the policy allows, internet hospital medical insurance services can be provided.

Except for the special outpatient service for hypertension and diabetes, other services cannot be covered by medical insurance. Moreover, because of the hypertension and diabetes, which was specifically allowed by the Medical Insurance Bureau last year, the registration fee can be reimbursed. [Interviewee #11, male, 14 years in the role]

Medical insurance payment requires an open port from the medical insurance bureau. In fact, it has already been

opened, and we have passed the test. However, the current medical insurance bureau does not recognize it. For example, if there is a business transaction, the medical insurance will not give this part of the money to our hospital, because from a policy perspective, the medical insurance reimbursement for these businesses has not yet been recognized. As long as the medical insurance is released, we can realize medical insurance reimbursement immediately. [Interviewee #10, male, 8 years in the role]

**Managing the Internet-based drug supply service.** For prescriptions of Internet hospitals, the first step is to review them through the intelligent prescription review system, which mainly reviews irrational drug use and online prescription control drug list. The second step is a manual review by a pharmacist.

We have designed a review process consisting of two parts: system and manual. First, MuLaoRenKang does the pre-review of prescriptions, whether there is irrational drug use, whether there are drugs that violate policy control, we have established a drug database, and will continue to update it. Then, the prescription will come to our pharmacy, and the pharmacist of the pharmacy will do another review, which is relatively safe. [Interviewee #17, female, 6 years in the role]

After receiving the approved prescription, patients can have the drugs delivered home by a third-party logistics company. The process of Internet-based drug supply service is shown in eFigure 4 of Supplemental Materials.

The online prescription is valid from the time when the doctor issues the prescription to 24:00 of the next day, which is different from the traditional prescription valid on the same day in terms of time limit. This will prevent patients from being unable to process prescriptions that take effect at night, thereby affecting the supply of drugs.

For the offline prescription, after the doctor prescribes the prescription, if the patient does not pay in time, the prescription will expire after 12 o'clock that night. However, for online prescriptions, we have extended the time limit of the prescription, because we found that many doctors work at night, and it is possible that he prescribes the prescription at 11 o'clock in the evening, and the patient does not pay for it. So, then we postponed to 12 o'clock in the evening the next day. [Interviewee #18, male, 6 years in the role]

**Profit formula.** At the current stage, the internet hospital is mainly used to improve the overall utilization rate of medical resources through effective patient diversion. According to the patient classification, we found that most of the patients' medical services can be met through

internet hospitals. After the patients are diverted to the internet hospital, the first benefit is to minimize the pressure of offline outpatient service, which will then help to improve the operation efficiency of the hospital and the quality of physicians' services; the second is to improve patients' satisfaction; the third is to help prevent and control COVID-19 by reducing face-to-face contacts.

Our outpatient clinic has been established for 20 to 30 years. At that time, the daily outpatient service volume was designed to be 5000 person-times, but now it exceeds 12,000 people-times per day. Therefore, we must improve the overall efficiency of patients' consultation, and improve hospital operational efficiency. [Interviewee #3, female, 6 years in the role]

As a supplement, internet hospitals can improve the limitations of insufficient physical space in hospital, improve its efficiency. Patients can also access medical services more easily. [Interviewee #2, female, 17 years in the role]

Then, it is to strengthen the publicity of internet hospitals and improve service utilization. The first is to carry out patient education to improve patients' understanding of internet hospitals. The second is to strengthen the publicity of internet hospitals and physicians to build brand effects. Especially focus on the publicity of departments with few patients.

On the one hand, it is related to the patient's medical habits, and patients still do not agree with the model of internet-based medical services. On the other hand, our physicians did not promote it with patients." [Interviewee #8, female, 3 years in the role]

"In addition to shunting, hospitals will also consider using Internet hospitals to acquire some patients, which is to increase our patient flow and attract patients. [Interviewee #8, female, 3 years in the role]

In some departments, patients do not know what it is for. For example, some patients with hair loss do not know that they can find a dermatology department. In some departments, patients can choose to come or not, and it may be inconvenient to come, so patients do not come or go to other hospitals. These departments, we must focus on promoting them in the future. [Interviewee #3, female, 6 years in the role]

The investment structure depends on the development strategy. The construction and operation of internet hospitals are based on the budget system and supported by the hospital's special fund. The main investment in Phase I, Phase II and Phase III is for platform development. In the

future, it will focus on platform operation, including talent team construction and promotion.

For our internet hospital, we also need to report the budget. The hospital is given to us with special funds. [Interviewee #3, female, 6 years in the role]

In fact, the cost of our platform development is still relatively high, because we are currently in the construction period, which may account for 50% to 60%. [Interviewee #9, male, 4 years in the role]

This year, I am working hard to promote it, such as shooting videos and making some promotional materials. The cost of publicity is actually very high. The market price of a video is 10,000 to 20,000, just a small video. [Interviewee #9, male, 4 years in the role]

At present, internet hospitals are not profitable. However, in the future, they should differentiate their development in terms of internet medical consultation, remote medical consultation, and chronic disease management, especially to provide precision health management for postoperative patients. In the future, it is necessary to reshape the profit formula from medical services.

## Discussion

### Principal findings

Based on the above research results, we can compare the differences between internet hospitals and traditional medical institutions in the following aspects.

### Comparison of development challenges between internet hospitals and traditional medical institutions

Albeit internet hospitals' potential, it is also worth noting that health care is much more complicated than most other commodities and services delivered via the internet. Regarding the vision, it reflects the development characteristics of internet hospital. According to "Internet Hospital Administrative Measures",<sup>26</sup> internet hospitals must rely on traditional brick-and-mortar medical institutions, and services are only allowed under three situations for the time being: (1) if patients are served in the traditional brick-and-mortar medical institutions, physicians can invite other physicians to provide Internet-based medical consultation service for the patients through internet hospitals, and the online diagnostic opinions and prescriptions are allowed; (2) if patients are not served in the traditional brick-and-mortar medical institutions, physicians can only deliver follow-up services to patients for common and

chronic diseases through the internet hospitals; (3) internet hospitals are allowed to deliver the health services of family physician. The vision of internet hospitals is to integrate high-quality medical resources across the country to fulfill the increasing demands of patients for high-quality health services.<sup>17,27</sup>

Until December 31, 2020, in terms of sponsors, 69.4% internet hospitals were established by public traditional brick-and-mortar hospitals; in terms of the level of traditional brick-and-mortar hospital, 81.7% internet hospitals were established by tertiary hospitals; in terms of traditional brick-and-mortar hospital type, 69.1% internet hospitals were established by general hospitals.<sup>28</sup> The public tertiary hospitals were the main actors in developing internet hospitals, which have distinct advantages in terms of medical equipment, finances, physicians, and patient sources.<sup>25</sup> Furthermore, most high-level physicians and medical facilities are concentrated in public tertiary hospitals.<sup>29</sup> With the influence of policy interventions and medical resources, the reality is that the main services of internet hospital still only offer a supplement to the traditional brick-and-mortar medical institutions, especially to the traditional non-clinical parts, such as Internet-based registration services, Internet-based medical consultation service, Internet-based payment service, and other convenience services.<sup>30</sup> Due to these developmental characteristics of internet hospitals at this stage, it will not be surprising that they face these development challenges that lack practical norms and versatile talents, the low cognition and motivation of physicians, and the low recognition of patients. This is a necessary stage for the development of emerging medical services.

### Comparison of development strategies between internet hospital and traditional medical institution

The healthcare service of internet hospitals is still in the stage of exploration and many problems remain to be solved,<sup>8</sup> such as how to screen departments to provide internet hospital healthcare services, how to schedule physicians' online and offline services, how to ensure the service quality of internet hospitals, and how to protect the security and privacy of patient's medical data. As an emerging healthcare service, the development strategies should be formulated with the two-way interaction of supply and demand. Both the service model innovation of internet hospitals and patients' intention to use internet hospitals should be considered. The key dilemmas about innovative service models of internet hospitals in China include value proposition, leading party, level of healthcare, scope of service, primary source of revenue, and legal liability.<sup>14</sup> Although internet hospitals rely on traditional brick-and-mortar medical institutions, their operation and functions differ from those of traditional brick-and-mortar hospitals.<sup>24,31</sup>

As we know, the core purpose of internet hospitals is to serve patients.<sup>1,2</sup> Therefore, it is very necessary to understand the development strategies of internet hospitals from the perspective of patient intention. There is a need for Internet hospitals to deliver convenient healthcare services by optimizing the organizational service delivery design to enhance patients' intention to use Internet hospital services.<sup>32,33</sup> Firstly, perceived behavioral control and disease severity are the most important determinants of patients' intention to use Internet-based medical consultation services provided by internet hospitals, and perceived convenience is the highest indirect determinant. Secondly, it highlights that humanized Internet-based service design and reasonable assembly of high-quality physicians are crucial for patients' intentions. Although the creative adoption of new technology to improve healthcare utilization has been widely recognized, internet hospitals' service delivery design still needs improvement.<sup>34</sup> Therefore, the gradual development strategy of sample internet hospitals, from basic services, Internet-based medical consultation services, Internet-based drug supply services, and differentiated services, reflects their patient-centered service philosophy and has practical reference significance.

### *Comparison of service model between internet hospital and traditional medical institution*

In terms of value proposition, it is mainly reflected in the patient classification. In traditional brick-and-mortar medical institutions, the triage of patients was directly based on their disease characteristics. However, internet hospitals cannot directly deliver services to all patients. Under the dual influence of policy intervention and the level of medical resources of the traditional brick-and-mortar medical institutions it relies on, the healthcare services that internet hospitals can deliver are relatively limited.<sup>15</sup> To divide patients into different categories based on their medical service needs and distinguish the target patients of online services from those of offline services are the key value propositions.

Regarding the key resources, solving the supply of versatile talents of internet hospitals is a priority. Internet hospitals have two most obvious attributes: one is the internet attribute, and the other is the hospital attribute. The hospital attribute of internet hospitals is also reflected in the high complexity and professionalism of medical processes with involvement of various stakeholders. Thus, the versatile talents of internet hospitals should not only be familiar with the medical process but also have internet thinking for operation. Therefore, it is necessary to master the key resources by independently establishing the internet hospital platform and independently training versatile talents.

In terms of key processes, a special department with resource coordination capacity should be established. An

internet hospital is designed to integrate online healthcare service platforms with offline healthcare services. Using traditional brick-and-mortar hospitals' medical resources and internet technology, internet hospitals deliver patients with closed-loop healthcare services (i.e. Internet-based and offline medical services, including Internet-based registration, Internet-based medical consultation, Internet-based drug supply and support, and Internet-based payment services). The scope of internet hospitals encompasses telemedicine and electronic prescriptions, medical insurance, commercial health insurance, health management, hospital operation, and hospital logistics. Therefore, a strong organization is required to effectively coordinate various resources and ensure the smooth flow of complex processes. Establishing a Smart Medical Project Department, which the president directly manages to ensure the administrative level, would be the critical process of the service model.

The long-term profit model should be formulated based on the service characteristics of traditional brick-and-mortar medical institutions. Internet hospitals can hardly be independent from traditional brick-and-mortar medical institutions to deliver healthcare services, which is complementary to offline healthcare services. However, internet hospitals do not have direct financial and technical advantages. The service model of internet hospital needs more distinguished innovations to deliver personalized digital health and patient-centric services. According to the service status of Nanfang Hospital, mainly non-local patients and many surgeries, it is of innovative, practical significance to reshape the profit model of internet hospitals by focusing on differentiated services for postoperative patients.

### *Implication for international internet health services*

International internet health services, also known as telehealth or telemedicine, have been evolving globally, with various models and platforms emerging in different countries. They are mostly characterized as private sector-driven, telemedicine-focused, limited integration with traditional healthcare system, emphasis on acute care and specialist consultations, variable payment and reimbursement models.<sup>35</sup> In contrast, internet hospitals in China, as described in this study, often have the features of government-led initiative, integration with traditional healthcare system, emphasis on chronic disease management, use of digital medicine techniques, and public payment and reimbursement.<sup>23</sup> These differences reflect the unique characteristics of each country's healthcare system, regulatory environment, and technological landscape.

### *Strength, limitations and future research*

To the best of our knowledge, this is the first study that to analyze the challenges and strategies associated with

establishing internet hospitals within public medical institutions through in-depth qualitative interviews in China. However, there are several research limitations that cannot be ignored. First, we did not collect data from patients in this study. Second, this study lacked analysis on the service quality and cost-effectiveness of internet hospitals. Thirdly, this study lacked analysis of clinical intervention for the disease. Lastly, this study only analyzed one sample, reflecting the challenges and strategies of public internet hospitals, but lacked analysis of other types of internet hospitals in China.

The following points highlight possible areas for future research. Firstly, there is a need to conduct patient-centered research and analyze service models from the perspective of patients. Additionally, it is essential to explore the experiences of patients in internet hospitals. Secondly, there is a requirement for more extensive quantitative analysis to assess the service quality and cost-effectiveness of internet hospitals. Thirdly, future studies should utilize real-world data from internet hospitals to provide further evidence of their intervention in specific disease areas. Lastly, future research should consider expanding the sample size and encompassing all three types of internet hospitals in China.

## Conclusions

In the realm of internet hospitals, primary challenges are evident in the realms of physicians' cognition, patient education, and management skills. It is an effective development strategy for China's Internet hospitals to adopt a phased and progressive development approach. The ownership of medical resources affects the positioning and development strategies of internet hospitals and traditional brick-and-mortar hospitals. Internet hospitals are positioned as a complement to conventional medical services and are experiencing rapid growth in China. However, challenges related to policies, hospitals, physicians, patients, and talent still need to be addressed through practical solutions. Therefore, in the future, it is important to focus on innovating internet hospital service models and promoting innovative clinical medical services based on internet hospitals.

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