THE INFLUENCE OF TELEMEDICINE ON CAPACITY DEVELOPMENT OF
RESPIRATORY DEPARTMENT IN PUBLIC PRIMARY HOSPITALS
IN CHINA

by

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Abstract

With the rapid development of telemedicine equipment and information communication technology, telemedicine has developed rapidly and is used widely around the world as a new mode of medical service. This new technology has been used widely in China and has benefited a large number of patients. China-Japan Friendship Hospital has actively carried out telemedicine practice. Since the first batch of telemedicine pilots were launched in 1998, three telemedicine centers have been established, including the National Telemedicine and Internet Medical Center, the National Health Commission's telemedicine management and training center, and the National Health Commission's grass-roots telemedicine development guidance center.

On the basis of reviewing the development process and current situation of telemedicine at home and abroad, this study is aimed to analyze and study the telemedicine construction of China-Japan Friendship Hospital, mainly including the following three aspects: First of all, collect and analyze the data related to the telemedicine construction of China-Japan Friendship Hospital in the form of questionnaires and descriptive statistics; Secondly, introduce the characteristics of telemedicine construction of China-Japan Friendship Hospital, especially the application of the latest technology such as AI and 5G in telemedicine; Thirdly, introduce and analyze other telemedicine related cases of Guangdong province to provide a more comprehensive understanding of telemedicine.

Advisor: Leiyu Shi
# Table of Contents

Abstract.......................................................................................................................... ii

Table of Contents ............................................................................................................. iii

List of Tables...................................................................................................................... vi

List of Figures..................................................................................................................... vii

1. Background and Literature Review............................................................................ 1
   1.1 Overview .................................................................................................................. 1
      1.1.1 Concept and developing history of telemedicine.............................................. 1
   1.2 Foreign development status .................................................................................... 5
      1.2.1 First-generation telemedicine ......................................................................... 5
      1.2.2 Second generation telemedicine ...................................................................... 6
      1.2.3 Third-generation telemedicine ........................................................................ 8
   1.3 Telemedicine in China ............................................................................................. 10
      1.3.1 Development history and professional literature publication ......................... 11
      1.3.2 Development status ......................................................................................... 13
      1.3.3 Issues and Challenges ....................................................................................... 19
   1.4 Telemedicine future development trend ................................................................... 24
      1.4.1 Artificial intelligence has become an important technical support .................. 24
      1.4.2 Internet hospital model is valued and promoted .......................................... 25
      1.4.3 Telemedicine plays an important role in chronic disease management ......... 26
      1.4.4 Data security becomes an important concern for telemedicine development .... 27
   1.5 Literature review of telemedicine ........................................................................... 28
      1.5.1 Research of service model ................................................................................. 28
      1.5.2 Research of disease application ........................................................................ 29
      1.5.3 Research of policy and institutional ................................................................. 31
      1.5.4 Telemedicine and COVID-19 .......................................................................... 32
      1.5.5 Discussion ......................................................................................................... 33

2. Methods ....................................................................................................................... 35
   2.1 Quantitative research .............................................................................................. 35
   2.2 Qualitative research ............................................................................................... 38

3. Case of China-Japan Friendship Hospital................................................................... 39
3.1 Overview .................................................................................................................. 39
3.2 Telemedicine construction ....................................................................................... 44
  3.2.1 Basic information .............................................................................................. 44
  3.2.2 Telemedicine Implementation ......................................................................... 49
  3.2.3 Services ............................................................................................................. 51
  3.2.4 Service Effectiveness ...................................................................................... 54
3.3 Telemedicine construction characteristics of China-Japan Friendship Hospital ...................................................................................................................................................................................................................... 59
  3.3.1 Specialized medical associations lead the construction of talent and technology elements .......................................................................................................................................................................................... 60
  3.3.2 Telemedicine helps new system of high-quality development ................. 62
  3.3.3 Establish a collaborative system of specialized Targeted Poverty Alleviation to help poor and remote areas link up with rural revitalization .... 68
  3.3.4 Establishment of third-party operation and maintenance mechanism ...................................................................................................................................................................................................... 73
3.4 The radiation effect of telemedicine on the primary hospitals .................. 74
  3.4.1 Set up the telemedicine management and training center to radiate the primary hospitals ............................................................................................................................................................................................................ 74
  3.4.2 Helping primary hospitals improve medical quality to gain patients' trust .................................................................................................................................................................................................................. 79
  3.4.3 Establish specialist medical association and promote standardized training of specialist physicians .......................................................................................................................................................................................... 80
  3.4.4 Promoting healthy poverty alleviation and reducing poverty caused by illness and returning to poverty due to illness ...................... 83
3.5 Telemedicine Major Project of China-Japan Friendship Hospital ............ 84
  3.5.1 Carry out pilot projects for remote collaborative services integrating elderly health care and medical care .................................................. 85
  3.5.2 Digital auscultation teleconsultation .............................................................. 88
  3.5.3 5G + Internet hospital construction ............................................................. 91
3.6 Future developing trends of telemedicine ......................................................... 96
  3.6.1 Online and offline integration ....................................................................... 96
  3.6.2 Co-development with medical association medical community .......... 97
  3.6.3 Internet medical development has given rise to new things ................. 98
4. Other Related Cases of Telemedicine ................................................................. 99
4.1 Guangdong Provincial People's Hospital: 5G Internet New Hospital ........ 99
  4.1.1 Background .................................................................................. 100
  4.1.2 Main methods ............................................................................... 101
    a. Five application terminals ............................................................... 101
    b. Five functional systems .................................................................. 101
  4.1.3 Achievements ............................................................................... 102

4.2 JingDong Health Internet Hospital .................................................... 103
  4.2.1 Background ............................................................................... 103
  4.2.2 Highlights and Characteristics of Internet Hospital Construction
       ........................................................................................................ 103
  4.2.3 Key points for future construction of internet hospitals .......... 106

5. Summary and Discussion ..................................................................... 108
  5.1 Discussion of the effect of telemedicine on primary hospital development
     ........................................................................................................ 108
    5.1.1 Organization Structure ................................................................. 109
    5.1.2 Process ...................................................................................... 111
    5.1.3 Outcome ................................................................................... 115
    5.1.4 Telemedicine and comprehensive development of discipline .... 119
    5.1.5 Summary ................................................................................. 122

5.2 Discussion of the application of 5G in telemedicine ...................... 124
  5.2.1 Overview of 5G ........................................................................ 124
  5.2.2 The application of 5G in telemedicine ..................................... 126
  5.2.3 Case Analysis ............................................................................ 129

5.3 Summary ....................................................................................... 132

References .......................................................................................... 136
List of Tables

Table 1. China's telemedicine development history.................................................. 12
Table 2. China's telemedicine policy documents ......................................................... 14
Table 3. Main Variables .............................................................................................. 36
Table 4. Main types of telemedicine services ............................................................... 52
List of Figures

Figure 1. Four Stages of Telemedicine ................................................................. 3
Figure 2. Participation in telemedicine network institutions ................................. 45
Figure 3. Composition of telemedicine network service personnel ....................... 46
Figure 4. Educational level of the personnel ......................................................... 47
Figure 5. Telemedicine network construction costs .............................................. 47
Figure 6. Sources of telemedicine network construction costs .............................. 48
Figure 7. Average cost of a single telemedicine service (per visit) ......................... 49
Figure 8. Average cost per hour for telemedicine services (charged by hour) ...... 49
Figure 9. Network types of Telemedicine .......................................................... 50
Figure 10. Telemedicine data storage .................................................................. 51
Figure 11. Teleconsultation method .................................................................... 52
Figure 12. Telemedicine service usage ............................................................... 53
Figure 13. Distribution of telemedicine service departments ............................ 53
Figure 14. Average length of a single telemedicine service ................................. 54
Figure 15. Average waiting time for teleconsultation patients ........................... 54
Figure 16. Number of patients discharged from hospital .................................. 55
Figure 17. Average number of days in hospital .................................................. 56
Figure 18. Patient satisfaction ............................................................................ 56
Figure 19. Employee satisfaction ......................................................................... 57
Figure 20. Relationship between average consultation time and patient satisfaction 58
Figure 21. Relationship between average waiting time and patient satisfaction ...... 58
Figure 22. Conceptual Framework ..................................................................... 108
1. Background and Literature Review

1.1 Overview

1.1.1 Concept and developing history of telemedicine

Telemedicine can be broadly defined as the use of telecommunication technologies to facilitate the delivery of healthcare at a distance (Perednia & Allen, 1995). Exactly speaking, telemedicine refers to the use of advanced science and technology such as telecommunication technology, hologram technology, new electronic technology and computer multimedia technology to take advantage of the medical technology and equipment of large medical centers to provide long-distance medical information and services to poor medical and health conditions and more special environments. It mainly includes medical activities such as telemedicine consultation, telemedicine education, and establishment of multimedia healthcare consultation system. Telemedicine consultation establishes a new link between medical experts and patients, so that patients can receive consultation from remote experts and receive treatment and care under their guidance in the same place or hospital. At the same time, telemedicine uses computers, communications, medical technology and equipment to realize off-site "face-to-face" consultations between experts and patients, experts and medical staff through the long-distance transmission of data, text, voice and image information, which brings great convenience to doctors and patients.

The development of telemedicine has a history of more than 50 years, which started with the use of communication between doctors to collaborate with each other. For example, in 1877, 21 doctors practising in neighbouring areas set up the first telephone exchange to communicate more easily with local pharmacies (Starr, 1982).

According to Cipolat and Geiges (2003), telemedicine can be divided into four stages: (a) the development of basic technological capabilities, (b) the development of relevant applications, (c) the integration and diffusion of technical applications within a complex environment, and
(d) the transformation of the operating environment to incorporate the new innovations (Figure 1).

In stage one, the development of new types of technology involved in various stages of the healthcare delivery process. These technologies may involve information capturing, information transmission, or interpretation. In stage two, initial development of applications meet the capabilities of the new technologies. As these technologies begin to be used in a variety of healthcare applications, practitioners can envisage the adoption of such innovations on a larger scale. In Stage three, issues relating to reimbursement, licensure, credentialing, and standards are still being debated at the national level. In stage four, telemedicine is employed to transform the environment, and tele-radiology can be seen a significant example. As technologies are integrated into specific applications, new technologies are developed to improve the efficiency and quality of existing systems. At this point, the cycle begins again.
In summary, telemedicine is a new type of medical service mode which use remote communication technology to completes interactive information transition (Li, 2013). The aim is to improve the allocation efficiency of national medical resources, to provide high-quality medical services for medically underserved designation, and to meet the medical services needs of the masses. This fast-growing medical treatment encompasses disease diagnosis, treatment, prevention, continuing education for healthcare providers and consumers, as well as ongoing research and evaluation. In recent years, with the development of Internet technology, Internet communication has become a hot spot, and the concept of "Internet+" has been rapidly recognized by all walks of life. Telemedicine has also gradually become the focus of medical field.

1.1.2 Advantages and disadvantages of telemedicine

Telemedicine is conducive to improving the enthusiasm of doctors, revitalizing the medical resources, improving the usage of resources, realizing the sinking of high-quality medical resources, effectively alleviating the constraints of personnel, salary, welfare in hospitals.

At the same time, for primary hospitals, telemedicine can provide assistance for primary hospitals through remote comprehensive consultation, remote surgery, remote monitoring and mobile ward rounds and other remote diagnosis and treatment. For example, "face-to-face" consultation mode and remote ward rounds can achieve targeted treatment by superior experts for patients in primary hospitals (Ma, 2014). The authoritative diagnosis of the remote medical experts can also help the primary doctors to grasp the patient's condition.
more accurately. E-commerce drug platform also greatly mitigate the problems of limited
drug types in primary hospitals, and the problem of connecting with superior hospitals, and
improves the follow-up treatment of remote consultation. The re-education and training
system of distance education for primary doctors is beneficial to timely solve the clinical
emergencies. The real-time interactive learning between the masses and remote experts can
also be realized through distance health education, so as to promote their early screening and
regular check-up in primary hospitals, to promote their understanding of primary medical
institutions and to enhance their trust in the primary care.

Developing technology is making online answers available to more and more patients
almost anytime, anywhere. And the widespread use of telemedicine offers opportunities for
patients who face other barriers that make it difficult to access care. Even if patients have
received offline treatment, telemedicine can still provide more superior and convenient
services for them (Chaet D, 2017).

Whether telemedicine is appropriate for a particular patient may also depend on what
kind of health care an individual would otherwise have access to. For some patients,
in-person care may not be possible in some cases, and telemedicine services may be
appropriate. For example, for staff on submarines or in space, telemedicine may be the only
way to provide medical care. Telemedicine can be more convenient even if patients already
receive care in person. But it's worth noting that while such innovations have great potential
to benefit patients, they also pose some challenges.

Of particular interest are the concerns expressed in many studies about new or
heightened risks to privacy and confidentiality, the limitations of electronically mediated
physical interaction, and the potential disruption of patient-physician relationships. The
electronic exchange of health information and delivery of care may create new risks to the
quality, safety and continuity of care, all of which may threaten the patient-physician
relationship.

Nor is telemedicine an appropriate model for all medical conditions. Telemedicine is not the preferred approach when hands-on physical examination is necessary or when critical data can only be collected through direct physical contact, i.e. when technology does not allow doctors to meet established clinical standards (Barry G, 2020).

The technological development and quality of telemedicine also significantly affect the ultimate outcome of care itself. For example, if the resolution of medical diagnostic images transmitted to hospitals from remote areas is poor, some lesions or anatomical areas affected or injured by the disease may not be detected, thus interfering with the final outcome (Combi C, 2016).

1.2 Foreign development status

Telemedicine first appeared in the United States in the 1950s as an application of two-way television systems in radiology, and in the late 1950s, the American scholar Wittson first used two-way television systems for medical treatment; in the same year, Jutra and others founded teleradiology. (Yang,2005) Since then, people in the United States have been using communication and electronic technology for medical activities, and the term "Telemedicine" has emerged. The development of foreign telemedicine has gone through the following three stages.

1.2.1 First-generation telemedicine

Telemedicine activities from the early 1960s to the mid-1980s are considered the first generation of telemedicine. in the early 1960s, NASA established a telemedicine testbed in
Arizona to provide telemedicine services to astronauts in space, with satellite and microwave technology as the means of communication to transmit medical information including ECGs and X-rays. In this period, Canada, Australia and other countries also carried out research in telemedicine. The development of telemedicine at this stage was slow, mainly based on telephone, cable TV network, microwave technology and a simple remote consultation or diagnosis system of satellite system to achieve. From an objective analysis, the information technology was not developed enough at that time, the information superhighway was at a new stage, the information transmission volume was extremely limited, and the development of telemedicine was constrained by the communication conditions.

1.2.2 Second generation telemedicine

Since the late 1980s, with the emergence and development of communication technology, coding technology and information compression technology, the transmission of multimedia information such as data, pictures, voice and video has been realized and its transmission performance has been continuously improved. In Europe and the United States, a series of high-value projects have been launched to promote the development of telemedicine monitoring, and their momentum and influence far exceed those of the first generation of telemedicine, which is regarded as the beginning of the second generation of telemedicine. From the number of literature included in Medline, the number of literature on telemedicine has increased geometrically in the 10 years from 1988 to 1997. In the implementation of telemedicine systems, the United States and Western European countries
have developed the fastest, with contacts mostly via satellite and integrated service data network (ISDN), and have made great progress in teleconsultation, teleconsultation, long-distance transmission of medical images, teleconferencing and military medicine.

In 1988, the United States proposed the concept that a telemedicine system should be an open distributed system, that is, in a broad sense, telemedicine should include modern information technology, especially two-way audio-visual communication technology, computer and remote sensing technology, to transmit medical services to distant patients or information exchange between doctors. Meanwhile, American scholars also define the concept of telemedicine system as follows: A telemedicine system is a whole that provides medical services to a specific group of people through communication and computer technology. This system includes a variety of functions such as remote diagnosis, information services, and distance education, etc. It is based on computer and network communication, and is aimed at multimedia technology of medical information for long-distance video and audio information transmission, storage, query and display.

The Georgia System of Educational Medicine (CSAMS) is currently the largest and most extensive tele-education and telemedicine network in the world, allowing wired, wireless and satellite communication activities, of which the telemedicine network is a part. Europe and the European Union have organized large-scale telemedicine system promotion experiments involving 3 biomedical engineering laboratories, 10 large companies, 20 pathology laboratories and 120 end-users to promote the spread of telemedicine. Australia, South Africa, Japan, Hong Kong and other countries and regions have also carried out various
forms of telemedicine activities. In December 1988, a strong earthquake occurred in the former Soviet Republic of Armenia, and with the support of the U.S.-Soviet Joint Working Group on Space Physiology, NASA conducted the first international telemedicine, enabling a hospital in Armenia to link up with four hospitals in the United States for consultation. This demonstrated the ability of telemedicine to cross international political, cultural, social, and economic boundaries.

Although telemedicine in the United States started early, its judicial system once prevented the full implementation of telemedicine. The so-called remote is limited to one state, because the U.S. requires a license to practice medicine in the state where it is located, and there are legal issues involved in practicing medicine across state lines. According to statistics, in 1993, about 2,250 patients in the U.S. and Canada were seen through the telemedicine system, of which 1,000 were seen by a designated physician in Texas for a kidney dialysis consultation of only 3 to 5 minutes; the average consultation time for the remaining conditions was about 35 minutes. Telemedicine projects in the U.S. have earmarked funding, in part from states and federal funding boards. $85 million was allocated for telemedicine in fiscal year 1994 from at least 13 different federal grant programs, and $8 million from Georgia alone to establish six regional telemedicine networks.

1.2.3 Third-generation telemedicine

In the 21st century, telemedicine has been further developed with the help of store-and-forward technology under high-speed digital information networks, which is known
as the third-generation telemedicine system. In the United States, telemedicine services have
developed about 200 telemedicine networks in various technology models, connecting more
than 3,000 remote sites and more than 80,000 residents using telemedicine and health
monitoring services, and the total market value of remote devices and services in 2013 is
estimated to exceed $18 billion. In Europe, the EU started the E-Health initiative as early as
2004, and by the end of 2008, health organizations in most EU countries had carried out
teleconsultation, remote prescription, remote health monitoring and other telemedicine
services respectively, and many countries have clearly elevated telemedicine to the level of
national strategy. Other major developed countries, including Australia and Japan, have also
reported a number of telemedicine applications. In China, the most significant telemedicine
development has focused on infrastructure construction, and the construction of three major
telemedicine networks involving the whole country was started back in the mid-1980s,
namely the Golden Health Project (GHN) led by the Ministry of Health, the IMNC network,
and the PLA telemedicine network. In order to further develop telemedicine networks and
make up for the large gap in medical resources and the extreme imbalance in distribution in
China, through the policies and financial support of the Ministry of Health and the Ministry
of Science and Technology, regional central hospitals in many provinces have developed and
built their own telemedicine networks, such as Zhejiang, Henan, Shandong, and Sichuan.
Among them, as a regional telemedicine center in Henan Province, the First Affiliated
Hospital of Zhengzhou University has started the construction of a telemedicine network in
Henan Province for sharing medical resources in remote rural areas, fully providing quality
medical services for medical patients in remote rural areas of the province and solving the problem of insufficient and uneven distribution of quality medical resources in the province.

Since 2010, telemedicine has gradually entered the community and family, and is more oriented to individuals, providing targeted and personalized services. With the development of Internet of Things technology and the popularity of smart phones, telemedicine also began to combine with cloud computing and cloud services. Numerous intelligent health care products gradually came out, such as remote blood pressure meter, remote electrocardiograph, and even remote fetal heart rate meter, providing more convenient and intimate daily medical prevention and medical monitoring services to the majority of ordinary users. At the same time, telemedicine has also developed from the stage of disease treatment to disease prevention. Some internationally renowned Internet companies such as Google are now quietly entering the increasingly popular field of telemedicine. Google has officially confirmed that it has started testing telemedicine services, where patients can be seen via video.

1.3 Telemedicine in China

Compared with the Western countries, telemedicine in China developed in a relatively short period of time, and is still an emerging industry (Duan, 2015). Telemedicine core technology, such as computer technology, communication technology, digital medical equipment technology, medical information management technology, have reached or approached the international advanced level (Bao, 2019). Next, we will review the
development of telemedicine in China from the perspectives of development history and professional literature publication, development status and issues and challenges.

1.3.1 Development history and professional literature publication

Compared with the developed countries in the world, telemedicine in China started late. As shown in the table below, the remote case discussion of neurosurgery between PLA General Hospital and a hospital in Germany via satellite in 1988 was the first modern telemedicine activity in China.

Since the late 1990s, telemedicine in China has made progress in a real sense: in 1994, Huashan Hospital and Shanghai Jiaotong University conducted a consultation demonstration by telephone; in the same year, the State Ministry of Health led and launched Project No. 2 of the "Golden Health Project" - the construction of an all-military medical and health information network. In 1995, the teleconsultation project of Shanghai Education and Research Network and Shanghai Medical University was launched, and a teleconsultation research office was established. In 1997, China Jinwei Medical Network, a satellite network of the Ministry of Health, was officially opened; in the same year, the PLA General Hospital conducted a telemedicine consultation with a hospital in Jinan Military Region by e-mail, and formally established the "Telemedicine Center" in the same year.

At present, dozens of hospital sites including Peking Union Medical College Hospital, Chinese Academy of Medical Sciences, Fu Wai Cardiovascular Hospital, Chinese Academy of Medical Sciences and other hospitals in more than 20 provinces and cities nationwide,
which have been accepted and officially put into operation, have conducted remote, off-site, real-time, dynamic live TV consultations for hundreds of patients with difficult and serious illnesses from all over the world, successfully broadcasted the whole process of large international conferences, and organized domestic and international special lectures. The above activities has greatly promoted the development of remote medical services in China.

**Table 1. China's telemedicine development history**

<table>
<thead>
<tr>
<th>Development Stage</th>
<th>Logo content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start-up stage</td>
<td>In 1986, Guangzhou Ocean Shipping Company conducted telegraphic cross-sea consultation for crew members; in 1988, the PLA General Hospital and German hospitals conducted neurosurgical case discussions via satellite technology.</td>
</tr>
<tr>
<td>Rapid Development Stage</td>
<td>In 1994, Huashan Hospital of Shanghai Medical University and Shanghai Jiaotong University conducted consultation by telephone; in August 1997, the General Hospital of the People's Liberation Army established the &quot;Telemedicine Center&quot;; in the 1990s, the hospital gradually deepened the contents related to telemedicine, such as teleconsultation and telemedicine education.</td>
</tr>
<tr>
<td>Stable advancement stage</td>
<td>In 2003, the first brain surgery using remote control robot was successfully completed in China's Naval General Hospital; in the 21st century, the development of information technology has promoted the popularization of</td>
</tr>
</tbody>
</table>
telemedicine, and the public has tried to seek medical consultation through this mode.

In the past 10 years, China's telemedicine has entered the practical application stage, and Shanghai Jiaotong University has developed the first wireless remote ECG monitoring technology service platform in China, which can convert human physiological signals into digital signals in real time and enable medical experts to obtain diagnosis and early warning of cardiovascular diseases in the first time through mobile network. In 2011, China's first emergency remote monitoring room was opened in the Emergency Monitoring Center of the Armed Police General Hospital, with real-time remote ECG monitoring through GPRS technology. The caller can communicate with the doctor through the "Heart Care" monitor.

The literature shows that there are very few articles related to telemedicine in China before the mid-1990s. Since 1996, the number of published articles has increased rapidly, and relevant studies have emerged. In 2014, the publication of "Online medical care" related articles, indicating that China's telemedicine research has entered a new stage (Bao, 2019).

1.3.2 Development status

With the development of information technology and network communication technology, China's telemedicine has been developed for many years. The policy system has been gradually improved, the construction of telemedicine collaboration network and Internet hospital have made certain achievements, and telemedicine plays a great advantage in
optimizing the allocation of medical resources, driving the development of primary medical institutions, reducing the cost of patient care, and improving the patient care experience.

Policies are the driving force for the development of telemedicine. As shown in the table below, since the introduction of the Opinions on Promoting Telemedicine Services in Medical Institutions in 2014, a number of supporting policies have been promulgated at the national level to support the development of telemedicine. In recent years, policy attention and support for telemedicine has increased significantly, and the policy system for regulation, pricing, and medical insurance payment for telemedicine has been gradually clarified, and development has entered the fast lane. Beijing, Hubei, Jiangsu, Zhejiang, Guangdong and other provinces have used their established Internet platforms to launch online physician consultation and fever clinics, follow-up consultations for common chronic diseases and online prescription services, effectively relieving the pressure on physical medical institutions for consultation.

Table 2. China's telemedicine policy documents

<table>
<thead>
<tr>
<th>Time</th>
<th>Policy Papers</th>
<th>Published content</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>Notice on the promotion of telemedicine services in medical institutions</td>
<td>Optimize the allocation of medical resources and realize the sinking of medical resources</td>
</tr>
<tr>
<td>2017</td>
<td>Guidance on promoting the construction and development of medical consortium construction pilot, to</td>
<td>Comprehensively launch a variety of forms of medical consortium construction pilot, to</td>
</tr>
<tr>
<td>Year</td>
<td>Description</td>
<td>Details</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2018</td>
<td>Guidance on the promotion of &quot;Internet + medical health&quot; development</td>
<td>Clearly pointed out that a sound &quot;Internet + medical health&quot; service system includes seven major aspects, defining the concept of Internet hospitals and the scope of services.</td>
</tr>
<tr>
<td>2018</td>
<td>Telemedicine service management specifications (for trial implementation)</td>
<td>Clearer regulations on the basic conditions of remote services, service processes and other related content.</td>
</tr>
<tr>
<td>2020</td>
<td>Notice on the in-depth promotion of the &quot;Internet + medical health&quot; &quot;five one&quot; service action</td>
<td>Gradually expand the scope of medical insurance payment for common and chronic diseases &quot;Internet+&quot; medical services, and promote regional information sharing and mutual recognition.</td>
</tr>
<tr>
<td>2022</td>
<td>&quot;Fourteenth Five-Year Plan&quot; National Health Information Technology Plan</td>
<td>Deepen the &quot;Internet + medical health&quot; service system as one of the eight major tasks during the &quot;14th Five-Year Plan&quot;. Proposed &quot;Internet + family doctor contracted services&quot; &quot;Internet + maternal and child health&quot; &quot;Internet + pharmacy services&quot; and other new models, to build a full coverage of the</td>
</tr>
</tbody>
</table>
China's telemedicine started late, but thanks to the support of policies, it has made considerable achievements in telemedicine coverage and Internet hospital construction and is in a rapid development stage. Since the establishment of China's first Internet hospital—Wuzhen Internet Hospital which was built in 2015, most provinces have built and laid out Internet hospitals by the end of 2020. By June 2021, the number of Internet hospitals in China has exceeded 1,600. From 2017 to the end of 2020, the proportion of telemedicine services carried out by public medical institutions above the second level in China rose from 43.3% to 63.2%, the telemedicine collaboration network covered all prefecture-level cities with more than 24,000 medical institutions, and 89.5% of urban medical groups and county medical communities achieved telemedicine internally.

Medical treatment combination has been implemented for many years as a way to promote hierarchical diagnosis and treatment in medical institutions at all levels, especially after the state formally issued guidelines for the implementation of hierarchical diagnosis and treatment, local health care commissions and medical institutions at all levels have made
various attempts, including innovation of various models. In 2017, National Health Planning Commission condensed four major models for achieving graded treatment after analyzing successful experiences and summarizing laws nationwide, namely: urban compact medical association, county medical community, specialty alliance, and telemedicine collaborative network. All of the above forms of medical association have applied the telemedicine coordination system, so telemedicine has become an important strategy to promote the hierarchical diagnosis and treatment system.

In order to explore the practice of telemedicine system, the National Health and Family Planning Commission established the Telemedicine Management and Training Center (hereinafter referred to as Telemedicine Center) in 2012, which was set up in China-Japan Friendship Hospital, a hospital directly under the National Health and Family Planning Commission. Its main functions are: 1) to build a national telemedicine demonstration system.; 2) to establish telemedicine quality and technical standards and quality control system; 3) to train the clinical diagnosis and treatment ability of primary care physicians.

The core resource of the telemedicine system application is the medical collaboration platform. The Telemedicine Center has jointly developed a software system with Heart Medical International Digital Medical Technology Co., Ltd. which is good at software technology development, China Mobile Group, and Zhejiang Hao Luo Wei Medical Technology Co. At the same time, it can be more convenient to link collaborative units across the country and realize the rapid convergence of telemedicine collaborative system. In the design of the software platform, functions such as organization registration management,
practitioner management, business process management, medical quality management, and data statistical analysis management are implanted, allowing each user to have a personal customized sense of convenience and autonomy.

Through this system platform, information technology resources are integrated with the needs of clinical application scenarios, incorporating audio and video conferencing systems, PACS image decoding and analysis systems, pathology image analysis systems, laboratory data pooling systems, and information management systems. These software resources provide support for clinical application scenarios, including interactive teleconsultation, multidisciplinary teleconsultation, medical imaging remote diagnosis and so on. For some academic exchange activities, training courses and other projects, online live broadcast is realized through the network platform, which effectively expands the influence of superior disciplines and increases the learning opportunities of primary physicians. The telemedicine collaborative platform is erected on a cloud platform, which can facilitate users from all over the country to log in conveniently. Meanwhile, due to the continuous improvement of business, remote consultation cases converge to become big data, and the database stored in the cloud gradually forms a big data management center covering the whole country and realizes the national unified management standard. The cloud platform helps the collaborative system cover the whole country, in which it forms a docking with provincial centers, municipal centers and county-level medical communities, forming a hierarchical structure of medical treatment based on technology stratification, which is an important means to promote hierarchical treatment.
1.3.3 Issues and Challenges

Although the construction of telemedicine in China has achieved great success with the strong support of national policies, there are still some problems that cannot be ignored and need to be solved.

First, the laws and regulations are not sound. At present, the regulation of telemedicine in China is mostly found in policy documents and has not yet been upgraded to national level laws and regulations, and the regulations on medical institutions, practitioners, medical insurance fund supervision, medical liability determination, data security, etc. are mostly equivalent to offline treatment, which lack proper authority and scientificity. This is reflected in the fragmentation of regulatory functions, the lack of clarity in the determination of medical liability, and the risks of data security and patient privacy leakage.

Second, the service pricing and compensation mechanism is not perfect. The price of telemedicine service not only affects the willingness of medical institutions to provide the service, but also largely affects the acceptance and demand of patients for this form of medical service. At this stage, China's financial compensation mechanism for the construction of telemedicine systems in medical institutions is not yet sound, and the purchase of telemedicine equipment, the construction of telemedicine platforms, system maintenance and personnel training require a large amount of investment, which is difficult for general medical institutions to afford.

Third, the development and maintenance of information technology is time-consuming. Telemedicine development needs strong support of information technology, and the operation
and realization of an Internet hospital or telemedicine platform requires pre-construction, medium-term operation technology guarantee and follow-up multi-equipment maintenance and business coordination, which is costly and time-consuming. The lack of communication resources in some remote areas, the gap in the utilization of medical network communication resources, and the limited maturity of technology directly affect the widespread development of practical telemedicine services. Difficulties in resource sharing is another problem, such as remote outpatient and follow-up consultations, which require viewing or cross-hospital sharing of patients' electronic medical records. Due to the non-uniformity of development specifications and medical data standards, there is a possibility of incomplete viewing and sharing of patients' electronic medical records, resulting in blocked sharing of medical resources and "information silos" or duplication of treatment activities.

Fourth, the participation of both doctors and patients is insufficient. From the doctor's perspective, medical personnel rarely receive professional training before carrying out telemedicine services and are not familiar with the operation of telemedicine systems, diagnosis and treatment norms and related regulations, and some primary medical personnel have a one-sided understanding of the significance and role of telemedicine. Patients are mainly reflected in the degree of their awareness of telemedicine. At present, the main body of medical services in China is physical medical care, and services related to telemedicine are at the exploration stage. Patients will habitually choose physical medical care in the first place when they have medical needs, and a considerable number of patients still have doubts about the mode of telemedicine consultation and medical diagnosis. On the other hand,
elderly patients are not well versed in new medical technologies and not proficient enough in the operation of smart devices. Most of them have a "digital divide" and are more worried about the use of telemedicine services, therefore preferring to The "face-to-face" physical medical care.

Fifth, the lack of professional and technical personnel. In terms of staffing, telemedicine management is mainly the part-time responsibility of medical or information personnel. There is a lack of full-time telemedicine managers and technical maintenance personnel, and there are very few compound talents who understand telemedicine technology and have a certain medical background. The construction of a team of telemedicine professionals, especially the cultivation of compound telemedicine professionals should not be delayed.

Finally, in terms of medical system, the telemedicine system is applicable to all disciplines, but it is necessary to establish corresponding operation systems according to the characteristics of disciplines in different fields. For example, for medical technology projects of auxiliary diagnosis, medical imaging telediagnosis center, electrophysiology telediagnosis center, pathology telediagnosis center, ultrasound testing telediagnosis center and auscultation telediagnosis center are established respectively; for clinical disciplines, specialist medical consortium is established according to specialties, and under the structure of specialist medical consortium, special disease collaboration group and single technology collaboration group are set up. Through the telemedicine platform, the personnel of the same discipline are connected and the medical data are linked together to form the shared resources for discipline construction.
Telemedicine, which can provide remote training for primary care providers because of its convenience and timeliness, should play a more important role in remote training. In the previous reform of the medical mechanism system, governments and medical institutions at all levels had explored many ways and means. For example, sending expert medical teams to make in-depth visits to the primary hospitals; county (district) hospitals invited experts to come to their hospitals regularly for outpatient clinics and consultations and so on. However, after the expert teams left the primary hospitals, they did not leave much new technology and methods behind, except for the expensive costs. In addition, experts in the regional medical association of primary outpatient help, often meet some problems such as incomplete equipment and facilities, shortage of drugs and equipment which can not carry out the corresponding treatment. Therefore, these ways of help are a drop in the bucket, with extraordinary investment but little effect. Since China's medical education system is relatively complicated and the structure of primary physician groups is relatively complex, it is necessary to establish a standardized training system for physicians from different groups.

In county (district) level two hospitals, the standardized training of specialist physicians is particularly important; in the community, township health centers and other first-level medical institutions, the standardized training of general practitioners is particularly important. General practitioners are the main force of family contract physicians, and it is necessary to build a training system for the purpose of improving family health care and chronic disease management. In the countryside, there is also a group with Chinese characteristics - village doctors. Due to the limited medical education background of village
doctors, it is crucial to enhance the practicality of continuing medical education training for village doctors. At the same time, the development of a basic training program for family doctors is an important issue before the medical community. With the promotion of the contract signing system, the contract signing rate of family doctors has increased rapidly, reaching 70% in many areas, but the compliance rate is low, even less than 30%. The positioning of the function of family physicians has long been an issue worth exploring. For example, if a family has a patient with chronic obstructive pulmonary disease, the family doctor needs to guide the patient and his or her family members to learn how to carry out daily care and rehabilitation and how to avoid the recurrence of complications; while another family may have a diabetic patient, the family doctor needs to be able to guide the patient to learn to control blood sugar through diet and to regularly review glycated hemoglobin to prevent complications. By receiving basic training, family physicians can learn to follow up on chronic diseases in the long term, be able to advise and guide family members in their medical consultations, and help family members make correct and quick referrals, which is a prerequisite for improving the compliance rate of contracted family physicians.

The above issues are the key concerns of the new round of medical reform, and telemedicine can greatly complement the shortcomings of expert rounds and other methods, provide a more convenient and efficient learning platform and opportunity for primary medical staff, and is also of great significance to the improvement of primary medical and health service capacity.
1.4 Telemedicine future development trend

1.4.1 Artificial intelligence has become an important technical support

As a representative of the new generation of intelligent technology, the application of artificial intelligence in the medical industry has a broad prospect. The future of telemedicine will commonly use AI technology to provide doctors and patients with more efficient and accurate medical services. AI technology can monitor the health status of patients through the analysis of mobile terminals, detect changes in patients' conditions in a timely manner and serve as an early warning. At the same time, AI technology can also help doctors with case diagnosis and treatment planning, assisting in improving the efficiency and accuracy of medical services. It can be said that AI will play a crucial role in the development of telemedicine. Meanwhile, with the latest AI technology, there will be some innovations in smart medical devices. Due to the increasing focus on health and quality of life, the market demand for smart health devices such as exercise monitoring, sleep monitoring, blood pressure monitors and blood glucose meters will continue to grow. Regional medical institutions and healthcare providers are also rapidly applying and popularizing these devices to a new generation of medical and lifestyle management services supported by data monitoring. The application of artificial intelligence and big data technology also empowers these devices, enabling them to have more intelligent and accurate data monitoring capabilities. In the future, it is believed that these devices will become an important basis for telemedicine.
1.4.2 Internet hospital model is valued and promoted

Internet medical service is actually a new medical service model that moves medical services from outside the hospital to online. It is based on Internet technology, medical technology and mobile terminals, and is the inevitable development trend of the future medical industry towards full vertical integration. With the state's emphasis and support on telemedicine, the Internet hospital model will become more mature and stable, and the market scale will continue to expand. The promotion of the Internet hospital model will not only save people's time in registration, queuing and examination, thus improving the efficiency of medical consultation, but also avoid the risk of contracting diseases by going out unnecessarily. In addition, the construction of Internet hospitals can also help to promote the rationalization of medical resources and graded treatment, the current health insurance policy is also gradually tilted to the Internet medical. July 21, 2020, the General Office of the State Council issued a "carry forward to further optimize the business environment to better serve the implementation of the views of market players," which proposed to ensure medical safety and quality premise, to further relax the scope of Internet medical treatment. The State Council's General Office issued the "Opinions on the Implementation of Further Optimizing the Business Environment to Better Serve Market Players," which proposed to further relax the scope of Internet medical treatment, incorporate eligible Internet medical services into the scope of medical insurance reimbursement, and develop and publish nationwide unified approval standards for Internet medical treatment, indicating that Internet medical treatment
will receive strong support from the state and policies and gradually spread nationwide in the future.

1.4.3 Telemedicine plays an important role in chronic disease management

Telemedicine is now providing patients with more convenient and cost-saving access to care for a number of everyday basic and minor illnesses, and is gradually being extended to chronic disease management and a small number of complex diseases such as headaches, skin diseases, musculoskeletal disorders, mental health, gastrointestinal symptoms such as constipation, and chronic diseases such as diabetes. However, there are still many difficulties in chronic disease management in China. Firstly, there is huge pressure on outpatient doctors in large hospitals; Secondly, the experience of patients is poor (chronic disease patients are usually elderly); Finally, there is too much pressure on medical insurance administration. The arrival of telemedicine and digital health care brings hope to solve the above problems.

Digital therapies are a class of digital health solutions, which are evidence-based therapeutic interventions in the form of software for the prevention and management of somatic disorders and diseases. In recent years, digital therapies have been developed for the treatment of diabetes, chronic respiratory diseases, and side effects of substance abuse, and clinical studies have confirmed their clinical efficacy and safety. In the future, with the accelerated development and approval of digital therapies, the idea of "software as prescription" will gradually move from ideal to reality, gradually enriching different disease areas, and there will be more virtual medical software like prescription drugs prescribed by
our clinicians to patients to meet more unmet needs of patients. Digital Therapeutics (DTx) can reduce the cost of treatment and promote a healthy lifestyle change for patients, complementing or even replacing traditional treatment methods.

1.4.4 Data security becomes an important concern for telemedicine development

Data security has always been a topic of concern, and the healthcare industry is no exception. With the continuous development and promotion of telemedicine, patients' important personal information is stored through the data platform, which brings certain convenience but also increases the risk of privacy leakage. Therefore, how to ensure the security of patients' medical data has become the focus of future telemedicine development.

At present, national regulations on privacy protection are gradually being improved. At the national level, three laws and regulations, namely the Network Security Law, the Data Security Law, and the Personal Information Protection Law, have been introduced this year, which put forward the basic specifications and requirements for the security of the medical industry. At the industry level, the Opinions on Promoting the Development of "Internet + Medical Health" and the Opinions on Promoting and Regulating the Development of Health Care Big Data From the industry level, the "Opinions on Promoting the Development of "Internet + Medical Health" and the "Guiding Opinions on Promoting and Regulating the Development of Health Care Big Data Applications" basically determined two major directions for the medical industry: Internet medical and big data applications. Subsequently, the introduction of regulations such as "Measures for the Management of National Health
Care Big Data Standards, Security and Services", "Measures for the Management of Internet Medical Treatment (for Trial Implementation)", "Measures for the Management of Internet Hospitals (for Trial Implementation)", and "Management Standards for Telemedicine Services (for Trial Implementation)" ensured the implementation of the relevant guidelines. At the same time, medical institutions and companies are also paying more and more attention to data security and protecting privacy security by means of information technology. Therefore, in the future, it is believed that patients' confidence in telemedicine will be stronger, while the use and promotion by medical institutions will be smoother.

1.5 Literature review of telemedicine

The research on telemedicine mainly includes service model research, disease application research, policy and institutional research. With the COVID-19 pandemic, telemedicine research based on the background of covid-19 has gradually emerged in recent years.

1.5.1 Research of service model

In terms of the telemedicine service model, a large number of foreign scholars have conducted research in this field from different perspectives. By conducting a cross-sectional study, some scholars have determined the feasibility of the telemedicine service model in hospitals in the United States in 2018 (Jain S et al., 2020). And others conducted systematic research on remote medical cases and found that the model of remote medical care is feasible,
but it is necessary to continuously explore best practices to promote the successful implementation of remote medical care (Freed J et al., 2018). Morgan Waller et al. (2018) believe that telemedicine is worth practicing through market reports and satisfaction surveys on telemedicine. Scholars such as Heui Sug Jo. (2010) used market segmentation to understand the usage and impact characteristics of internet medical and health information, and thus concluded that the main internet medical service models in South Korea include general health information reminders, special disease information acquisition, online health product purchases, and online hospital appointments. At the same time, the selection of service models is influenced by factors such as age, income level, education level, living area, and location. Devin Mmann et al. (2020) pointed out that the outbreak of COVID-19 has led to a rapid growth in the use of telemedicine in the United States. And through the research, they have also obtained data on the feasibility and impact of patients and medical service providers in using telemedicine, as well as its impact on the U.S. health system to provide emergency and non-emergency medical services. The widespread use of diversified telemedicine platforms will drive the transformation of medical service models.

1.5.2 Research of disease application

Xu T et al. (2018) studied the application of telemedicine in type I diabetes. The article believes that it is safe to provide professional nursing for diabetes through telemedicine, and it can save time and cost, thus improving patient satisfaction. SC Mehl et al. (2022) explore differences in demographics of expectant mothers evaluated pre- and post-telemedicine
implementation and to explore the patient experience with telemedicine. Farguell J et al.(2022) described their experience using telemedicine to follow-up on patients with intraductal papillary mucinous neoplasms during the COVID-19 era and analyze those factors associated to patients' satisfaction, finding that telemedicine allows a new follow-up strategy that can be used in selected patients with intraductal papillary mucinous neoplasms and the absence of previous abdominal pain is associated with patient satisfaction during follow-up. S Rabbe et al.(2023) evaluate the effects of a non-invasive telemonitoring intervention on mortality, healthcare costs, and hospital and pharmaceutical utilisation in patients with chronic heart failure (CHF) of a large statutory health insurer in Germany, suggesting that the telemonitoring intervention led to a significant decrease in mortality and a shift in costs from the inpatient to the ambulatory care sector 36 months after intervention. Klonoff David C et al.(2023) discusses the benefits of using telemedicine to make shared medical appointments for patients with Type 1 diabetes and type 2 diabetes, pointing out that shared telemedicine appointment also has the potential to improve the self-management of diabetes in adult type 2 diabetes patients, reduce the burden of treatment and improve the psychosocial outcomes. Mpa, L. M. B. et al(2023) introduces the application of telemedicine to kidney failure patients and specific hemodialysis and peritoneal dialysis use cases, technical requirements, and use cases.

MG Coku et al.(2023) summarize the evidence about telenutrition applications in the management of IBD patients, and give an overview of the acceptance and impact of these interventions on health outcomes.
1.5.3 Research of policy and institutional

Scholars from various countries have conducted in-depth research on the policy and institutional aspects of internet healthcare. Simon bo larsen et al.(2016) designed the "Shared Service Center" (SSC) project for remote healthcare as a starting point to explore cross disciplinary implementation plans and related systems for remote healthcare. They elaborated on relevant financial policies and legal systems to avoid the "gray zone" of internet medical services. Jordan Harrod. (2019) systematically studied the Health Insurance Circulation and Accountability Act (HIPPA) in the United States, which regulates various healthcare services; With the development of internet healthcare, the security of medical information data is facing greater challenges. Therefore, HIPPA continues to add additional regulations to ensure the security of patient medical information, regulate the protection of medical data by medical institutions, and propose medical data protection measures for relevant institutions. Robin Ohannesian et al.(2020) pointed out that most countries lack a regulatory framework for authorization, integration and reimbursement in the field of telemedicine services, and the outbreak of the COVID-19 epidemic exposed the weakness of telemedicine in response to public health problems, promoting countries to improve the regulatory system, so as to ensure that telemedicine can be promoted.

Sen, Sevinc Elif et al.(2022) investigate the changing experiences of remote consulting for patients in Latvia and plan effective health policies and provide a full analysis of the policy for telemedicine applications and solutions based on the current conditions, pointing out that telemedicine is fast expanding and it is important to provide a good environment for it to
expand, setting strategies and visions on how those new approaches will be regulating normatively and administratively.

1.5.4 Telemedicine and COVID-19

A Giacalone et al. (2022) discuss evidence supporting the effective implementation of eHealth, telehealth, and telemedicine during the coronavirus disease 2019 pandemic, and point out that in the current socio-economic climate, it is essential to implement a telehealth model aimed at efficiency and continuity of healthcare, as well as leading to an improvement in the quality of life of patients, whilst optimising existing resources and reducing costs. Denise D Payán et al. (2022) conduct in-depth interviews with clinic personnel and patients during the pandemic in two federally qualified health centers that primarily serve Chinese and Latino immigrants and find that bilingual personnel who provided language concordant care were seen as essential for efficient and high-quality patient telemedicine experiences. Audio-only visits were of particular benefit to reach patients of older age, with limited English proficiency, and with limited digital literacy. As for the COVID-19, Asia, one of the first areas of the world to be hit by the new coronavirus, quickly understood the benefits of telemedicine in this scenario. Before engaging in large-scale telemedicine Asian countries still need to resolve several issues related to the users and providers of healthcare, the organisation of healthcare systems, the availability of technology and the existing legal framework. Even so, Asia might experience a dynamic boost in telemedicine due to the
pandemic (VL Raposo, 2023). Splinter Marije J et al. (2023) expose patient perspectives on virtual compared to in-person consultations, including determinants of these preferences, suggesting that healthcare providers should consider patients’ complex care needs and evaluate the potential added value of nonverbal communication and physical examination before scheduling a virtual consultation.

1.5.5 Discussion

The above literature mainly talk about telemedicine from the perspective of service model research, disease application research, policy and institutional research, and telemedicine based on the background of COVID-19. In addition to these aspects, future research on telemedicine should focus on the following aspects:

Technology and Infrastructure. This focuses on developing and evaluating the technical infrastructure required for telemedicine, including telecommunication networks, video conferencing platforms, electronic health record systems, wearable devices, and remote monitoring tools. Research in this area aims to improve the reliability, security, interoperability, and scalability of telemedicine technologies.

Clinical Applications and Efficacy. This research area explores the application of telemedicine in various clinical specialties and conditions, such as telecardiology, telepsychiatry, teledermatology, telestroke, and remote chronic disease management. Studies
aim to assess the effectiveness, efficiency, and safety of telemedicine interventions compared to traditional in-person care.

Patient and Provider Perspectives. Research in this area investigates the attitudes, acceptance, satisfaction, and experiences of patients and healthcare providers with telemedicine. It focuses on understanding factors that influence adoption and utilization, identifying barriers and facilitators, and evaluating patient and provider outcomes and preferences related to telemedicine.

Health Outcomes and Cost-effectiveness. This research domain examines the impact of telemedicine on health outcomes, including clinical outcomes, patient-reported outcomes, quality of care, and patient safety. It also investigates the economic considerations of telemedicine, such as cost savings, cost-effectiveness, and return on investment.

Legal, Ethical, and Regulatory Issues. This research area addresses legal, ethical, and regulatory challenges associated with telemedicine, such as licensure, jurisdiction, privacy and security, informed consent, malpractice, and reimbursement policies. Studies aim to inform policy development and the creation of guidelines and standards for telemedicine practice.

Implementation Strategies and Best Practices. Research in this area focuses on identifying implementation strategies, models, and best practices for integrating telemedicine into existing healthcare systems. It includes evaluating workflow redesign, provider training, patient education, organizational factors, and overcoming barriers to successful telemedicine adoption.
Health Equity and Access. This research domain explores the role of telemedicine in addressing healthcare disparities, improving access to care for underserved populations, and reaching remote and rural communities. It investigates the impact of telemedicine on equitable healthcare delivery, patient engagement, and health outcomes.

In a word, the research on telemedicine is a dynamic and evolving field, driven by advancements in technology, changing healthcare needs, and lessons learned from practical implementation experiences. It aims to generate evidence, inform policy and practice, and guide the development of guidelines and standards to optimize the use of telemedicine in healthcare delivery.

2. Methods

2.1 Quantitative research

This study mainly distributed questionnaires to 29 hospitals in the network of the National Telemedicine Management and Training Center, collected data, and made descriptive statistics and correlation analysis between variables to understand the development of China-Japan Friendship Hospital telemedicine.

Data source: This study is mainly based on descriptive statistics, and the relevant data mainly comes from questionnaires filled out by 29 hospitals in the network of the National Telemedicine Management and Training Center. Study population including patients and staff members.
**Study variables:** The variables of this study mainly include whether joining the telemedicine network or not, hospital level, hospital staff number and education, source and expenditure of construction costs, service fee, employee satisfaction, patient satisfaction and so on. The details are shown in the table below.

**Table 3. Main Variables**

<table>
<thead>
<tr>
<th>Variable dimension</th>
<th>Variable Name</th>
<th>Variable Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic information</td>
<td>Telemedicine join</td>
<td>0=No; 1=Yes.</td>
</tr>
<tr>
<td></td>
<td>Hospital level</td>
<td>1=primary hospital; 2=Second level hospital; 3=tertiary hospital</td>
</tr>
<tr>
<td></td>
<td>Number and education</td>
<td>≥0 and integer</td>
</tr>
<tr>
<td>Execution dimension</td>
<td>of hospital employees</td>
<td>Below undergraduate/Bachelor/Master</td>
</tr>
<tr>
<td></td>
<td>Source of construction costs</td>
<td>1=government funding; 2=Hospital self funded; 3=research funding; 4=Corporate sponsorship; 5=Other</td>
</tr>
<tr>
<td></td>
<td>Service fee</td>
<td>≥0 and integer</td>
</tr>
<tr>
<td></td>
<td>Network</td>
<td>1=Virtual network; 2=Public network; 3=3G/4G network</td>
</tr>
<tr>
<td></td>
<td>Execution dimension</td>
<td>1=Independent storage (independent remote medical data center or computer room)</td>
</tr>
<tr>
<td>Data storage</td>
<td>Service type</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>2=Shared with other departments of the hospital</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3=Shared with other hospitals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4=No storage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5=Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1=remote consultation; 2=Distance education; 3=Remote ward rounds;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4=Remote surgical teaching system; 5=Remote pathological system;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6=Remote image diagnosis system; 7=remote intensive care; 8=remote outpatient service;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9=remote care; 10=remote two-way referral; 11=Remote ward rounds;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12=remote chronic disease management; 13=remote first aid;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14=Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Service dimension</th>
<th>Service method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service method</td>
<td>1=Use computer and video conferencing software with the software name ____;</td>
</tr>
<tr>
<td></td>
<td>2=Hardware video conference communication method with embedded architecture;</td>
</tr>
<tr>
<td></td>
<td>3=email; 4=Telephone; 5=Other</td>
</tr>
<tr>
<td>Effect dimension</td>
<td>Patient satisfaction</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Service usage</td>
<td>≥0 and integer</td>
</tr>
<tr>
<td>Single service duration</td>
<td>≥0 and integer</td>
</tr>
<tr>
<td>Patient waiting time</td>
<td>≥0 and integer</td>
</tr>
<tr>
<td>Number of discharged patients</td>
<td>≥0 and integer</td>
</tr>
<tr>
<td>Average length of stay</td>
<td>≥0 and integer</td>
</tr>
<tr>
<td>Patient satisfaction</td>
<td>1=Very dissatisfied; 2=Quite dissatisfied; 3=General satisfied; 4=Quite satisfied; 5=Very satisfied.</td>
</tr>
<tr>
<td>Employee satisfaction</td>
<td>dissatisfied; 3=General satisfied; 4=Quite satisfied; 5=Very satisfied.</td>
</tr>
</tbody>
</table>

### 2.2 Qualitative research

This study mainly uses literature analysis method, case analysis and in-depth interviews of department/discipline leaders in the hospitals using telemedicine to find out the main characteristics of China-Japan Friendship Hospital telemedicine development such as establishing a specialized medical consortium, a collaborative system of specialized Targeted Poverty Alleviation. In the third part of this research report, we will mainly introduce the case of China-Japan Friendship Hospital. In the forth part, there will be another two cases of telemedicine in Guangdong province and a summary in the last part.
3. Case of China-Japan Friendship Hospital

3.1 Overview

China-Japan Friendship Hospital ("CJH") is a hospital directly under the National Health and Wellness Commission of the People's Republic of China, which was opened on October 23, 1984. It has 1,700 beds (including the North and West Districts) and combines medical treatment, teaching, scientific research, rehabilitation and preventive health care, and undertakes the tasks of central health care medical rehabilitation, national health emergency rescue team, as well as the telemedicine management and training center of the National Health and Family Planning Commission. The hospital's endocrinology, thoracic surgery, Chinese medicine rheumatology, Chinese and Western medicine combined with oncology, Chinese medicine pulmonary disease, clinical nursing specialty, respiratory medicine, anorectal medicine, rheumatology and immunology, pain, geriatrics, emergency medicine and other departments and specialties have been awarded national key clinical specialty construction projects. The hospital has a 365-day holiday-free clinic and is a Class A designated medical institution in Beijing.

"Internet + medical health" is a new concept established in the Opinions on Promoting the Development of "Internet + Medical Health" issued by the General Office of the State Council (Guo, 2018), and the National Health and Wellness Commission subsequently issued the supporting "Internet The document clarifies the new production relationship of Internet + medical health: Internet diagnosis and treatment and telemedicine are two new types of services; Internet hospitals are new types of medical institutions. The state implements
practice access management for Internet diagnosis and treatment forms and Internet hospitals respectively.

China-Japan Friendship Hospital actively responds to the national call for early and pilot medical reform, takes the lead in Internet+medical practice and promotes the practice of the hierarchical diagnosis and treatment system. Since the first batch of telemedicine pilot was launched in 1998, three telemedicine centers have been established one after another, including the National Center for Telemedicine and Internet Medicine, the Telemedicine Management and Training Center of the National Health and Health Commission, and the Guidance Center for Primary Telemedicine Development of the National Health and Health Commission. 2012 saw the establishment of the Beijing Chaoyang East Regional Medical Consortium; 2016 saw the establishment of the Specialist Medical Consortium and the Telemedicine Collaborative Network, which was selected as the National Health and Health Commission's model medical consortium.

The Management and Training Center uses the telemedicine system network and telemedicine services to integrate medical specialists, doctors and medical information (medical knowledge, patient records and medical images and other medical information) effectively. It increases the coverage of medical services in time and space, broadening the scope of medical services, enabling people in remote areas to share medical resources in developed areas, promoting the vertical flow of quality medical resources and improving accessibility of medical services (China-Japanese Friendship Hospital, 2021). It is developing Regional synergy system for medical institutions. The National Telemedicine Management
and Training Center has established a regional medical collaboration network with medical institutions and has connected more than 4,000 medical institutions from 31 provinces and autonomous regions across China. It also connects with the Earl Ren Hospital in Macau and the University of Traditional Chinese Medicine Hospital in Taiwan. Currently, 35 provincial-level telemedicine regional collaboration centres and 103 municipal-level medical association regional collaboration centres have been established, relying on 35 provincial-level hospitals in 24 provinces and municipalities, and are gradually being extended to communities and towns with the help of the telemedicine platforms of the provinces and municipalities (Geng, 2019).

China-Japan Friendship Hospital and China Mobile Group's Lianren Health Medical Big Data Technology Co., Ltd. jointly built an Internet hospital, which officially received the first batch of practice access permits from the Beijing Municipal Health Care Commission in April 2021, and "China-Japan Friendship Hospital Internet Hospital" (referred to as: China-Japan Internet Hospital) officially launched its practice as the second name operation. China-Japan Friendship Hospital is the first batch of pilot units for high-quality development of public hospitals established by the National Health and Wellness Commission. Internet+medical health, as one of the major strategic directions for the future development of the hospital, has set up a leading group and working group for the development of Internet hospital and a management office led by the hospital leadership, and the hospital development office coordinates the work in a unified manner.
The main business form of Sino-Japanese Internet Hospital is to carry out telemedicine and Internet diagnosis and treatment, including both online follow-up consultation of patients in the hospital and remote consultation and Internet diagnosis and treatment services by experts from all over China. Based on the basic principle of guaranteeing medical quality and patient safety, the business forms of Internet diagnosis and treatment, telemedicine, family contracting service and medical care integration are integrated into the comprehensive platform of the Internet hospital to achieve resource interoperability and overall deployment, and to build a continuous business chain of medical care for different condition needs. The main business types includes: 1) pre-consultation and consultation guidance; 2) remote joint outpatient clinic; 3) remote consultation/MDT and two-way referral; 4) remote training, teaching visit and case discussion; 5) remote follow-up and online review; 6) chronic disease management and primary rehabilitation; 7) specialist medical association counterpart support; and 8) remote coordination of medical and health care integration for the elderly.

Internet hospitals need an efficient management and operation system. Internet hospitals are a new type of medical institution that involves all aspects of medical operation, and the establishment of a third-party operation support system is an essential complement to public hospitals running Internet hospitals. China-Japan Internet Hospital uses its self-developed comprehensive business platform to accept partner hospitals and operating organizations to "turnkey" the platform for free, and all medical personnel are managed according to the main practice registration unit, and can join the specialist medical association or expert working committee to enjoy the Internet qualifications and resources equally under the Internet
hospital management structure. The incentive mechanism based on price and distribution policies is applicable to all medical staffs who live in the platform and practice according to the law. Medical institutions and medical staff only need to log in and register through the main entrance webpage of the Internet platform according to the instructions, and they can carry out regular business after being qualified by examination. The technology integration and innovation system of the Internet hospital is the support foundation to keep the platform running efficiently. As the scale of business expands, the demand for communication capacity and computing power becomes higher and higher. 5G mobile communication, cloud-side collaborative computing, big data, artificial intelligence, blockchain and other technologies are constantly introduced into the Internet medical treatment system. ICT technology is used to integrate practice access and process management, standardized processes, data and information security protection, and resource deployment onto the platform, helping medical staff to more easily carry out joint diagnosis and treatment, talent training, and research collaboration. Digital auscultation physiological sound map intelligent analysis system, skin imaging diagnosis intelligent assistance system, dynamic electrocardiogram intelligent diagnosis assistance system, radiological imaging remote diagnosis intelligent assistance system, etc. have been implanted in the Internet platform.

China-Japan Internet Hospital is the specific business implementation platform of the National Center for Telemedicine and Internet Medicine, the National Health and Health Commission Telemedicine Management and Training Center, and the National Health and Health Commission Primary Telemedicine Development Guidance Center. It has explored
and researched in practice, and has undertaken a number of major pilot projects, including the pilot project of financial technology, the 5G health care industry construction standard, the national block chain pilot project, and the national telemedicine collaboration system of medical and health care integration for the elderly. Adhering to the public welfare of large public hospitals and the role of the national team, China-Japan Internet Hospital has been exploring the new model of "Internet+medicine" to promote the high-quality development of hospitals, provide patients with a high-efficiency and high-quality medical treatment model, provide primary hospitals with resources for discipline construction and the synergy of graded diagnosis and treatment, provide the government with practical experience and medical reform. It also provides the government with practical experience and a basis for decision-making on health care reform, and promotes the implementation of the Health China Strategy.

3.2 Telemedicine construction

3.2.1 Basic information

Up to now, a total of 29 hospitals in 11 provinces, including Hebei, Gansu, Hubei, Shaanxi, Jilin, Anhui, Jiangxi, Qinghai, Guangxi, Inner Mongolia and Shandong, have been included in the Sino-Japanese Friendship Hospital telemedicine system. As shown in the chart below, they mainly include 1 primary hospital, 16 secondary hospitals and 12 tertiary hospitals. The cumulative number of beds in all hospitals exceeds 36000. By 2022, the combined annual outpatient volume of all hospitals for internal medicine, surgery and
Chinese medicine will total more than 33.41 million visits, of which telemedicine consultation is an important part.

![Figure 2. Participation in telemedicine network institutions](image)

Regarding the specific operation of the telemedicine network, first of all, each local institution has made special personnel division and adjustment specifically for the construction of the telemedicine network and established a special telemedicine management department. Members of the department mainly consist of four categories: medical personnel, equipment and maintenance personnel, management personnel and other personnel.

As shown in Figure 3, in terms of the personnel composition of the construction of the telemedicine network, medical personnel were the most numerous, accounting for 94% of the total number of personnel; equipment and maintenance personnel followed, accounting for 3% of the total number of personnel; and managers and other personnel accounted for 3% of the total number of personnel. In terms of the educational composition of the personnel involved,
as shown in Figure 4, those with a master's degree or higher accounted for the majority, or 87% of the total; those with a bachelor's degree accounted for 11% of the total; and those with less than a bachelor's degree accounted for 2%. This shows that the overall education level of the personnel joining telemedicine is high and the overall quality is high.

![Diagram showing composition of telemedicine network service personnel.]

**Figure 3. Composition of telemedicine network service personnel**
In terms of telemedicine cost situation, it mainly includes both construction cost and service cost. In terms of construction costs, as shown in Figure 5 and Figure 6, telemedicine construction costs include equipment costs, system and network construction costs and other costs. On the other hand, it mainly come from government sponsorship and hospital self-funding, accounting for 48% of the total costs respectively, with the remaining 4% being corporate sponsorship. The main expenditure channels are equipment costs (66%), system and network set-up costs (25%), and other costs (9%).

Figure 5. Telemedicine network construction costs
In terms of service cost, it can be divided into single service cost (per service charge) and hourly service cost (per hour). As shown in Figure 7 and 8, between 2016 and 2021, the average single service cost shows a gradual upward trend, rising from RMB 507 per service in 2016 to RMB 807 per service in 2021; the average hourly service cost also shows a gradual upward trend, rising from RMB 989 per hour in 2016 to RMB 1,490 per hour in 2021.
Figure 7. Average cost of a single telemedicine service (per visit)

Figure 8. Average cost per hour for telemedicine services (charged by hour)

3.2.2 Telemedicine Implementation
The networks used to build telemedicine mainly include virtual network, public network, 4G/5G network and internal hospital private network. As shown in Figure 9, the vast majority of hospitals use public network and public network + 4G/5G network, each accounting for 36% of the overall, 14% use 4G/5G network, and 11% use all the three types, while there are also hospitals use internal private networks within the hospital to support the telemedicine network. In terms of patient and treatment and other data storage, 37% of hospitals choose to share information between departments within the hospital; 33% choose to store independently in a separate telemedicine data center or room; 19% will share with other hospitals; and 11% choose not to store or store in other ways.(Figure 10)
In terms of data security, 24 of the 29 hospitals surveyed take secure and complete data backup, data recovery, data encryption transmission, data collection security and support for commercial password algorithms to protect patient’s data, while the other five do not currently take special measures to protect data security. This shows that the current telemedicine construction work is still lacking in terms of data storage and security protection. Not all institutions can store data well, and there is a lack of clear privacy security when sharing information among different institutions, leading to the risk of leakage of patient and other information.

3.2.3 Services

At present, telemedicine services are mainly carried out by institutions in the form of remote outpatient clinics, remote nursing care, remote room visits, remote consultations, remote education, remote emergency care, remote surgical teaching systems, remote pathology systems, remote image diagnosis systems, remote intensive care, remote two-way referrals, and remote chronic disease management. Specific ways include the use of computers and video conferencing software (such as Tencent Conference, KU, Cloud Vision, etc.), hardware video conferencing communication methods with embedded architecture, telephones, etc. There are also hospitals such as the Second Affiliated Hospital of Nanchang University that have specifically built their own teleconsultation systems to provide services for patients.
Table 4. Main types of telemedicine services

<table>
<thead>
<tr>
<th>Remote Clinic</th>
<th>Telecare</th>
<th>Remote Room Check</th>
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<tbody>
<tr>
<td>Teleconsultation</td>
<td>Distance Education</td>
<td>Remote First Aid</td>
</tr>
<tr>
<td>Remote Surgery Teaching</td>
<td>Remote Pathology System</td>
<td>Remote Image</td>
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<tr>
<td>System</td>
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<td>System</td>
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<tr>
<td>Remote Intensive Care</td>
<td>Remote two-way referral</td>
<td>Remote Chronic Disease</td>
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<td></td>
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<td>Management</td>
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As shown in Figure 1, during 2016-2021, telemedicine has been rapidly popularized and developed with the support of policies, and more and more medical institutions have joined the telemedicine network, and the volume of telemedicine services in each institution has shown a gradual increase, totaling more than 5,000 times by 2021. The use of telemedicine services is mainly based on internal medicine, surgery and Chinese medicine.

As shown in Figure 2, during 2016-2021, telemedicine has been rapidly popularized and developed with the support of policies, and more and more medical institutions have joined the telemedicine network, and the volume of telemedicine services in each institution has shown a gradual increase, totaling more than 5,000 times by 2021. The use of telemedicine services is mainly based on internal medicine, surgery and Chinese medicine.

As shown in Figure 3, surgery is the most frequently used telemedicine service, accounting for 57% of the total; internal medicine follows, accounting for 35%; and Chinese medicine is
the least used, accounting for 8% of the total, which is closely related to the consultation characteristics of each disease, patient needs and other factors.

![Figure 12. Telemedicine service usage](image1.png)

![Figure 13. Distribution of telemedicine service departments](image2.png)

In terms of service length and waiting time (from the receipt of a consultation request to the start of the consultation), as shown in Figure 14 and Figure 15, with the continuous maturation and improvement of telemedicine construction work, both of which showed a gradual decrease during 2016-2021, reflecting the continuous improvement of the work proficiency of relevant medical personnel and the continuous improvement of the process of
telemedicine and the related regulatory system. The decrease in waiting time also helps patients to get medical advice immediately, get medical help as soon as possible, and reduce the time and stress of illness and pain.

![Figure 14. Average length of a single telemedicine service](image1)

![Figure 15. Average waiting time for teleconsultation patients](image2)

### 3.2.4 Service Effectiveness
In the service effectiveness dimension, there are mainly variable indicators such as the number of discharged patients, the average number of hospital days, and patient and employee satisfaction. As can be seen in Figure 16 and 17, with the continuous improvement of the telemedicine system, the number of discharged patients who have received telemedicine has been increasing year by year and by a large margin from 2016 to 2021, from less than 100,000 initially to nearly 900,000 in 2021. This shows that telemedicine plays a significant role in the daily delivery of healthcare. At the same time, as technology advances and physicians become more proficient in teleconsultation, the number of days in the hospital is gradually decreasing, shortening by nearly 48 hours, which helps to improve bed turnover and alleviate the current situation of hospital resource constraints.

![Figure 16. Number of patients discharged from hospital](image)
In terms of satisfaction, Figure 18 and 19 show that both patient and employee satisfaction increased year by year between 2016 and 2021 while maintaining a high level, indicating that the advancement of telemedicine has brought convenience to patients, while the personnel involved have reaped some material and moral incentives to carry out their work with a high level of job satisfaction due to more adequate management coordination.
Regarding the factors influencing satisfaction, this study focuses on the relationship between the average consultation time and average waiting time of telemedicine and patient satisfaction. As shown in Figure 20 and Figure 21, from 2016 to 2021, there was a negative correlation between average consultation time and patient satisfaction, as well as between average waiting time and patient satisfaction.

That is to say, patient satisfaction increased year by year from 2016 to 2021 as the average consultation time and average waiting time continued to decrease. It can be inferred that the length of consultation and the length of waiting time to receive the consultation are two important factors that affect patients' satisfaction when they use the telemedicine platform for consultation.
Figure 20. Relationship between average consultation time and patient satisfaction

Figure 21. Relationship between average waiting time and patient satisfaction
3.3 Telemedicine construction characteristics of China-Japan Friendship Hospital

Under the leadership of the national health care administration, China-Japan Friendship Hospital has established the "Telemedicine Center" in 1998 and the "Telemedicine Management and Training Center of the Ministry of Health" in 2012. Then, with the help of the National Development and Reform Commission, the National Health and Family Planning Commission and the Ministry of Finance, China-Japan Friendship Hospital launched the national telemedicine policy pilot project in 2015 to explore the management mechanism, operation mechanism, price and medical insurance policy, payment mechanism and third-party cooperation management mechanism in the field of telemedicine and Internet medicine, a number of research results have been accepted as national policies in related industries.

Based on the foundation of the Telemedicine Management and Training Center of the Ministry of Health, the National Health and Health Commission established the National Center for Telemedicine and Internet Medicine in January 2018, which is managed by China-Japan Friendship Hospital. It aims to address the major social contradiction between the growing needs of our people for a better life and the unbalanced and insufficient development, integrate and optimize the supply-side structure of medical resources, integrate and innovate Internet and information technology, establish management norms and technical standards, and build a national team in the field of telemedicine and Internet medicine in China.
The National Center for Telemedicine and Internet Medicine aims to improve the capacity building of primary care and information for the benefit of the people. With the driving force of Internet+medicine and internet hospital construction, the National Center for Respiratory Medicine, the Center for Integrative Medicine and Chinese and Western Medicine and the National Key Clinical Specialties Group take the leading advantage to provide telemedicine, tele-teaching and tele-training services to primary care institutions to improve the accessibility of high-quality medical resources and the overall efficiency of medical services.

3.3.1 Specialized medical associations lead the construction of talent and technology elements

China-Japan Friendship Hospital builds a collaborative network of medical institutions at all levels by forming a specialized medical association; integrates expert resources with expert committees, and actively plays a leading role in developing standards and norms for telemedicine in related disciplines by forming 22 specialized disease expert working committees to guide the application and promotion of new technologies related to telemedicine at the primary level.

As of January 2022, China-Japan Friendship Hospital has formed 17 specialty-specific medical associations, namely: respiratory, pain, combined Chinese and Western medicine oncology, nursing, anorectal, hair, upper cervical spine, child growth and development, liver disease, interventional ultrasound, international medical, ultrasound visualization needle
technique, urology, pathology, nephrology, micro non-invasive diagnosis and treatment, etc. The members come from more than 3,100 medical institutions in 31 provinces and cities.

China-Japan Friendship Hospital uses the specialist medical association as the organizational form to train medical personnel at the primary level in multiple channels and ways, carries out remote consultation and two-way referral of difficult and serious diseases with the help of telemedicine cooperative network, holds special technical training courses, organizes discipline backbone to national medical centers for further training, training and field visits, drives the training of specialist talents and special techniques down to the primary level, and promotes the standardization of specialist system in primary hospitals.

The specialist medical association actively implements medical reform policies and graded diagnosis and treatment policies, and promotes the standardized construction of the specialist system in grass-roots hospitals. It carries out remote consultation and two-way referral of difficult and serious diseases with the help of telemedicine cooperative network, holds special technical training courses, and organizes discipline backbones to go to national medical centers for further training, training and field visits, so as to drive the cultivation of specialist talents and the sinking of special techniques in grass-roots hospitals.

Taking the Respiratory Medicine Federation established in 2016 as an example, under the leadership of the National Center for Respiratory Medicine, it has successfully established 10 specialized "collaboration groups" and helped 20 provinces nationwide to establish provincial respiratory specialty medical associations with 1,465 member hospitals. The standardized construction of respiratory and critical care specialties (PCCM) project has
completed the field certification and awarding of licenses to 1552 hospitals nationwide; the "Happy Breathing" - standardized and graded diagnosis and treatment project for chronic obstructive pulmonary disease has covered 51 localities nationwide, serving 2848 doctors and 1.6 million people at the primary level; the capacity building project for prevention and treatment of pulmonary embolism and deep vein thrombosis has been implemented in 24 provinces nationwide. The project has carried out more than 1659 cases of referral of difficult and critical illnesses, more than 1800 cases of remote consultation, 79 training sessions of various respiratory specialties with nearly 19,720 participants, 53 sessions of remote training with 1,170,900 people learning online, and received more than 1,500 visits from primary respiratory specialists to our hospital for further training.

During the Covid-19 epidemic, China-Japan Hospital was commissioned by National Health Commission to establish the "National Telemedicine Platform for Covid-19 Pneumonia Patients with Serious and Critical Illnesses", which provided more than 160 remote consultations for critical illnesses in the epidemic area, 5 overseas consultations, and 39 million people were covered by live science broadcasts.

3.3.2 Telemedicine helps new system of high-quality development

Relying on the construction of three national remote centers, China-Japan Friendship Hospital focuses on many aspects such as policy research, business models, technological innovation and demonstration and promotion, actively participating in the research of policies
related to Internet+medicine and making demonstration models in the management fields of access, operation, supervision, price, medical insurance and payment. The telemedicine collaboration network has laid down technical support and operational guarantee for the collaboration of various types of medical associations at all levels, carried out innovative models such as remote consultation and teaching visits, improved the ability of standardized treatment and medical quality at the primary level, improved the efficiency of leading and radiating high-quality resources, and helped establish a new system for high-quality development.

At present, the telemedicine collaborative network of China-Japan Friendship Hospital presents the characteristics of wide coverage, full-cycle and new technology. First of all, it has a wide coverage. At present, through each provincial telemedicine center and 17 specialist medical associations, it has been able to connect more than 6,000 medical institutions nationwide, among which city and county hospitals account for most of them, realizing six levels of coverage at provincial, city, county, township, village and medical and health care institutions. The National Telemedicine and Internet Medicine Center Expert Working Committee has registered more than 36,000 physicians, covers all clinical specialties. It has carried out more than 30,000 cases of remote consultation for difficult and serious diseases, more than 8,000 cases of two-way referral of patients; conducted more than 200 sessions/year of national medical standards dissemination and remote training lectures for clinical specialties, and trained health technicians for more than 9 million. It has been selected by the national health administrative authorities as a typical case of graded diagnosis
and treatment in medical association and an excellent case of action to improve medical services for several times, and has accumulated influence and appeal with leading advantages in the field of Internet+medical health, laying a good foundation for integrating high-quality medical resources nationwide.

Secondly, full-cycle. Through the establishment of the Internet hospital connected to the Internet pharmacy, supply full course management for the online follow-up patients and timely deliver the prescription drugs to home. Establish a national tele-coordination system for the integration of medical and health care for the elderly, supporting the integration of chronic disease management and medical and health care at the primary level. It will also guide the standardized and intelligent service system of grass-roots telemedicine, and establish a system that covers the whole life cycle of residents from health management to maternal and child emergency, emergency and critical care consultation, to community rehabilitation, chronic disease management and home care.

The last characteristic of the telemedicine collaborative network of China-Japan Friendship Hospital is new technology. China-Japan Friendship Hospital is leading a pilot project on blockchain technology for medical applications, guiding the primary hospitals to establish a full life-cycle resident medical health record and an intelligent authorization management system for the whole business chain, and promoting the authorization and sharing of resident medical data in the telemedicine collaboration network. Apply 5G to carry out remote intraoperative consultation, and apply high technology such as ultrasound intervention and intraoperative rapid frozen pathology diagnosis to the primary hospitals.
China-Japan Friendship Hospital has actively participated in the research and demonstration of relevant national policies and carried out a lot of practical exploration in the fields of practice access, business supervision, 5G health standards, telemedicine price and medical insurance policies of “Internet+medicine”, making the management of “Internet+medicine” more scientific, standardized and precise, and also made certain contributions to the introduction of relevant national policy documents. With the advantage of telemedicine synergy, it has taken the lead in establishing the remote synergy network for emergency and critical illnesses of women and children in Beijing, and the national remote synergy system for aging health and medical care integration. Participated in the development of national telemedicine standards such as the Technical Guideline for Construction of Telemedicine Information System, Technical Specification for Telemedicine Information System and Telemedicine Quality Control Specification. In terms of medical insurance policy, guide the third-party operation and maintenance mechanism by economic laws, and a benefit distribution mechanism is established based on the cost-sharing principle. Promote the price formation mechanism and medical insurance payment system, and guide commercial insurance to support the application of new technology. Play the role of high-quality medical resources to drive the surrounding industrial chain, promote the gradual integration of the telemedicine system with the elderly industry, home care, pharmaceutical guidance and other businesses, promote the existing resources to play a greater benefit, and drive the development and transformation of Internet+ innovative products and technologies. Establish
a standardized and orderly Internet + health care model, and drive the overall development of the industrial chain in the field of big health, big data and artificial intelligence.

At the same time, China-Japan Friendship Hospital carries out various specialty technology innovations such as joint remote outpatient clinic, remote teaching room, 5G visualization Chinese medicine needle knife ultra-minimally invasive treatment technology system, 5G real-time ultrasound joint diagnosis system, 5G remote intelligent listening system, 5G real-time intraoperative pathology consultation system and so on to provide new productivity for promoting the development of telemedicine collaborative network. Led the research "Research on the standard requirements for the application of 5G technology in the healthcare industry" and the national blockchain pilot project - "Intelligent authorization management system for medical data based on blockchain technology" . Participated in the development of national telemedicine standards such as the Technical Guideline for Construction of Telemedicine Information System, Technical Specification for Telemedicine Information System and Telemedicine Quality Control Specification. Carry out various specialized technical innovations such as joint remote outpatient clinic, remote teaching room, 5G visualization Chinese medicine needle knife ultra-minimally invasive treatment technology system, 5G real-time ultrasound joint diagnosis system, 5G remote intelligent listening system, 5G real-time intraoperative pathology consultation system and so on to provide new productivity to promote the development of telemedicine collaborative network.

In June 2021, it was awarded the International Mobile Telecommunications Association (GSMA) "Global Mobile Communications (GLOMO) - 5G Anti-epidemic Technology
Innovation Award", becoming the first time for China's medical sector to receive the highest international award in the field of mobile communications.

Led by the National Center of Telemedicine and Internet Medicine, it can connect to more than 5,400 medical institutions nationwide through direct registration on telemedicine platforms and interconnection of provincial telemedicine centers and urban medical associations, and has achieved parallel and compatible synchronized operation with the Internet hospital of China-Japan Friendship Hospital. The telemedicine collaboration network has registered more than 32,000 physicians with the help of 14 specialized medical associations and 21 specialized disease expert working committees. It conducts more than 6,000 cases of remote consultation for difficult and serious diseases each year, carries out more than 200 sessions/year of national medical standards dissemination and remote training lectures for clinical specialties, and has trained more than 7 million people in total over the past 5 years.

During the Covid-19 epidemic in 2020, our hospital relied on the telemedicine collaborative network to carry out online follow-up consultation and Internet diagnosis and treatment + delivery of prescriptions to patients at home, so that patients could receive follow-up guidance from experts at home, with a total of 16,160 users, effectively reducing the risk of cross-infection; established the "National Telemedicine Platform for Covid-19 Patients with Serious and Critical Illnesses", with more than 160 remote consultations, 5 overseas consultations, and 37 million people covered by live science broadcasts; carried out digital auscultation and multidisciplinary consultations. For the first time in Wuhan, it has
obtained digital lung auscultation sounds of patients with severe neoconiosis, combined with real-time sign data and image data, and reached the remote expert end through 5G transmission + artificial intelligence analysis to realize multidisciplinary real-time consultations. Experts from the National Center for Respiratory Medicine remotely instructed Xinjiang Autonomous Region Hospital for the treatment of patients with severe patients with COVID-19, achieving excellent treatment results.

In June 2021, the "5G Application Solution to Combat the New Coronary Epidemic" won the highest award of the Global System for Mobile Communication Association (GSMA) - "GLOMO-Best Innovation Award", becoming the first time for China's medical industry to win the highest international award in the field of mobile communication. In October 2021, CCTV made a special report on CCTV One's "Instant China: Medical Diagnosis for Thousands of Miles" and CCTV Two's "Economic Half Hour", and there were special interviews on "Half Moon Talk" and People's Daily Health Client.

3.3.3 Establish a collaborative system of specialized Targeted Poverty Alleviation to help poor and remote areas link up with rural revitalization

In June 2021, the National Health Commission together with the National Development and Reform Commission and the Ministry of Civil Affairs and other eight departments, jointly issued the Notice on the Implementation of the Opinions on Consolidating and Expanding the Achievements of Poverty Alleviation and Rural Revitalization, pointing out that in order to consolidate the achievements of basic medical care, promote the construction
of a healthy countryside, and prevent poverty from returning to poverty due to illness, inter-agency medical support is tilted to the key counties of rural revitalization in the western region. The provincial and municipal financial arrangements for health projects should be further tilted to the areas out of poverty and rural revitalization key help counties. In January 2022, the National Health Commission further issued a notice on the issuance of a work plan for the 14th Five-Year Plan period for tertiary hospitals to help county hospitals, pointing out that the supporting hospitals should strengthen specialty capacity building, cultivate skilled personnel, actively carry out new technology and new business, continuously improve the level of scientific management of hospitals, and enrich the form of counterpart support. China-Japan Friendship Hospital actively responds to the national policy, carries out "group" aid to Tibet and Xinjiang, sending various experts at all levels to Xinjiang and Tibet to carry out counterpart support work and in-depth investigation, looking for the biggest shortcomings of community health work. Use scientific research thinking and methods to help community medical personnel to improve medical service capabilities, providing community residents with more accurate medical health services and improve the effectiveness and efficiency of community medical services. In particular, we have successfully built a preliminary and perfect scientific research system for community health centers through the following aspects.

First, make it clear that the significance of building a scientific research system in community health service centers is to improve the health service capacity of medical personnel in community centers, to perform their main functions as primary health care
institutions better, and to provide more accurate medical and health services to community residents in the district. Second, develop a scientific research plan for community health service centers, including the establishment of a complete scientific research work management system, community research group and so on.

Third, establish a system for the management of community scientific research work and topics, including the management of scientific research plans, regulations on the management of scientific research funds, regulations on rewards for scientific research work, regulations on the use of scientific research funds, regulations on the work of academic committees, and methods for the evaluation of scientific research projects and academic papers.

Fourth, strengthen the scientific research training of community health service personnel: through a series of three modules of theoretical training, including the selection and design of clinical scientific research, data collation and statistical analysis, and the writing and skills of medical papers, we will initially cultivate the clinical scientific research ability of medical personnel in community health service centers. Fifth, determine the scientific research directions and research fields of community health service centers: combining the daily work of community health, main functions and available database information, three major scientific research directions were determined, including cross-sectional studies of common chronic diseases, analysis of risk factors and dynamic development of common chronic diseases, health management of chronic diseases and early intervention in the community. Four research areas of community clinical research were identified, including community prevention and treatment of infectious diseases, community screening of malignant tumors,
community management of chronic diseases, and community early intervention of Tibetan medicine and rheumatic diseases. Sixthly, a community research group was established and a research team was initially set up and the "mentorship system" was adopted as well. The main members of the Tibetan aid team will be the scientific research instructors, and they will be responsible for the theoretical training and scientific research practice through a combination of offline and online systematic scientific research training.

After nearly three years of efforts, we have now successfully built a preliminary and perfect scientific research system for community health service centers, officially opening the road of scientific research in Tibetan communities and making up for the biggest shortcomings of community health work. At present, community medical and health service personnel have learned how to organize, analyze and utilize various types of data of the community, presenting data related to the representative Tibetan groups in Lhasa, Tibet. On this basis, they can continue to analyze the risk factors associated with various chronic diseases and the dynamic development of diseases, which can provide a theoretical basis for early intervention and health management in the community. In turn, the scientific research work can also serve the clinical, chronic disease health management and early intervention in the community, helping to improve the capacity of community health services and further explore new models of community health services.

From the viewpoint of scientific research results, take Barkhor Community Health Service Center for example, the relevant medical personnel have completed seven academic papers, published in the "China-Japan Friendship Hospital Journal", "Tibet Science and
Technology", "Gansu Medicine" and "Medical Theory and Practice" magazine. At the same time, they actively applied for various subjects and currently jointly undertook a subject called "Formulation of Physical fitness Safety Training Standards for Plateau (Lhasa) with an Altitude of 3650m", which is the special scientific research project of the Culture and Tourism Bureau of Chengguan District of Lhasa City.

The counterpart aid work in Tibet is a major strategic decision made by the Party Central Committee and the State Council from the overall situation of the Party and the State. The "group-type" assistance to Tibet by medical personnel is a concrete manifestation of the importance the Party Central Committee attaches to the work in Tibet and its concern for the health and well-being of the Tibetan people of all ethnic groups, and is a major decision made by the Sixth Symposium on Tibetan Work of the Central Committee on the basis of an in-depth summary of the experience of health assistance to Tibet in the past decades. The "original intention" it adheres to is to cultivate a number of good hospitals and create a high-level medical team for Tibet through continuous support in one cycle after another, so that people of all ethnic groups can receive better medical care without leaving Tibet, and constantly enhance the people's sense of health, happiness and security.

China-Japan Friendship Hospital conscientiously studies and implements the important speeches and instructions of General Secretary Xi Jinping during his visit to Tibet and the spirit of the Seventh Symposium on Tibetan Work of the Central Government, in accordance with the requirements of the National Health Commission, and actively and effectively promotes the "group" support work of medical talents to promote the comprehensive strength
of the recipient hospital, the level of treatment services, the ability of radiation and drive, and the fundamental transformation from "blood transfusion and oxygen supply" to "blood production and oxygen production". The cadres sent by the hospital to aid Tibet to adhere to their responsibilities and work hard to significantly improve the work of the recipient hospital medical education and research, training a "medical team that can not leave". China-Japan Friendship Hospital's assistance to Tibet opened the road of scientific research in Lhasa Community Health Service Center, using scientific research to guide community health and medical work, which can comprehensively improve the health service capacity of community medical personnel, provide more accurate medical and health services to community residents, making the community's medical and scientific research work on a higher level. All of this work have fully affirmed by the National Health Care Commission Medical Affairs Bureau.

Medical personnel assistance to Tibet is a concrete measure to realize the great unity of all ethnic groups, equality for all and building a community of human destiny. The hospital will continue to carry out solid aid work in Tibet and make new and greater contributions to promote the development of Tibetan health and improve the health level of Tibetan people of all ethnic groups.

3.3.4 Establishment of third-party operation and maintenance mechanism

The National Development and Reform Commission, the National Health and Family Planning Commission, and the National Ministry of Finance jointly established a special
project for provincial-hospital cooperation in 2014, with the China-Japan Hospital, the Union Hospital, and the General Hospital of the People's Liberation Army docking five provinces and autonomous regions, namely Yunnan, Guizhou, Tibet, Inner Mongolia, and Ningxia, respectively, to pilot research on a series of policy-based guarantee systems such as management rules and cost accounting for the third-party operation mechanism. The core of the third-party operation mechanism is to establish a price formation mechanism based on the principle of cost-sharing. The inviting party, the invited party and the operation and maintenance party involved in telemedicine have respectively invested corresponding operation costs in the telemedicine business chain, including manpower, material resources and funding. Therefore, the price should include the costs of the three participants and determine the proportion of revenue distribution according to the proportion of cost-sharing. This cost-sharing mechanism, which is not profit-oriented, is in line with the economic laws of the operation mechanism and upholds the public welfare of the health care industry. China-Japan Hospital has been expanding the scale of third-party operation cooperation, and has greatly promoted the development of the telemedicine system by signing cooperation agreements, introducing social resources, and docking the resources of all parties needed for telemedicine.

3.4 The radiation effect of telemedicine on the primary hospitals

3.4.1 Set up the telemedicine management and training center to radiate the primary
In October 2012, the General Office of the former Ministry of Health issued the Letter on the Establishment of the Telemedicine Management and Training Center of the Ministry of Health at China-Japan Friendship Hospital (No. 57, 2012), approving the establishment of the "Telemedicine Management and Training Center of the Ministry of Health" at China-Japan Friendship Hospital. It mainly carries out the following tasks: collecting and analyzing information about telemedicine at home and abroad, studying and proposing opinions and suggestions on the construction and development of China's telemedicine system; assisting the National Health Commission in establishing a national telemedicine quality control network, organizing and guiding quality control work; organizing the drafting of norms and standards related to telemedicine management, and carrying out training for telemedicine-related professionals.

During the 13th Five-Year Plan period, with the vision of "being a source of advanced ideas and strong power source for China's medical career", China-Japan Friendship Hospital has been actively practicing the new national medical reform policy. Under the leadership and support of the National Development and Reform Commission, the National Health and Family Planning Commission and the Ministry of Finance, the hospital has carried out pilot projects on telemedicine policy with Yunnan, Guizhou, Qinghai and Inner Mongolia Autonomous Region, developed its own telemedicine platform to connect more than 2,000 medical institutions at home and abroad, built a "telemedicine collaboration network", and incorporated it into one of the four models of graded medical association established by the
National Health and Welfare Commission. Combining telemedicine and primary hospitals clinical training, it expands the influence of outstanding disciplines, supports nationwide specialist medical associations and regional medical associations, and promotes the construction of standardized treatment capacity of primary hospitals. On the other hand, it leads the transformation and innovation of information technology, optimizes the telemedicine collaboration system, establishes up-and-down linkage and two-way referral, and promotes patients' access to medical care and graded treatment. In the pilot process, the management system of telemedicine service management specification, telemedicine quality control specification, telemedicine third-party joint operation mechanism and other management systems have been gradually established, and the pricing system and distribution mechanism of telemedicine have been gradually explored, providing a feasible basis for the National Health Commission to formulate policies related to access, regulation, pricing, medical insurance and payment of telemedicine health.

The development purpose of the Telemedicine Management and Training Center is the standardized management and demonstration promotion of innovative business. In the process of piloting telemedicine policy, we have gradually created and improved various businesses such as teleconsultation, remote diagnosis, multidisciplinary joint interactive consultation, remote joint outpatient clinic, remote teaching room, remote typical case discussion, remote lecture, and remote specialized special technical training. Based on the principle of guaranteeing medical quality and patient safety, the telemedicine process is optimized. The current telemedicine collaboration network can already connect more than
6,000 medical institutions nationwide, with an average response time of 8 hours for remote consultation and a waiting time of no more than 24 hours for patients at the primary level. The various business volumes are growing rapidly, with an average annual consultation volume of more than 10,000 cases. The remote center actively organizes training seminars in various professional fields such as clinical, nursing, pharmacy, medical technology and hospital management, and conducts more than 200 times of various remote training seminars each year, with a total of more than 9 million training sessions.

Information and communication technology (ICT) is developing rapidly, and the industry's demand for ICT is increasing day by day. In order to better optimize the telemedicine platform, optimize the service capability and do a good job of demonstration and promotion for the primary medical institutions, the remote center has continuously integrated and innovated, independently developed the telemedicine collaboration platform, won the second prize of Science and Technology Progress of China Communications Association (provincial and ministerial level), and formed a series of platform construction standards for medical care: telemedicine business collaboration platform, high-definition video remote interaction system, remote surgery demonstration and teaching system, and Tele-education and academic live platform, etc. In the telemedicine center, different demonstration model rooms such as remote consultation rooms, remote training rooms and multi-functional consultation rooms have been set up respectively according to the demand characteristics of hospitals of different levels, and several sets of telemedicine systems of different levels and adapted to various conditions have been configured. Communication
technology has been upgraded, from SDH Ethernet private line (>10M bandwidth), international VPN network, Internet (2-20M bandwidth) and other multi-channel forms during the 12th Five-Year Plan, to the current pilot of 5G mobile network. China Mobile, China Telecom, China Unicom, Huawei and other partners have brought 5G communication capability improvements driving blockchain, cloud-side collaborative computing, big data, and artificial intelligence applications. 5G's application in fighting the new crown epidemic has won the GSMA-GLOMO award from the 2021 Global Communication Technologies and Systems Association, establishing an industry-leading position in the field of 5G network construction and innovation applications. CCTV-1 and CCTV-2, Half Moon Talk, People's Daily Health Client and other mainstream media have made special reports for many times.

The National Commission Telemedicine Management and Training Center has experienced various periods of history from telemedicine to Internet+medicine, adhering to the hospital motto of "Prosperity and Progress, Righteousness and Strength". Under the leadership and support of China-Japan Friendship Hospital, we are exploring the management standard of "patient demand-centered", integrating high-quality medical resources, taking medical quality and patient safety as the starting point, establishing long-term operation mechanism, integrating new technology transformation and innovation, and supporting the construction of medical association and graded treatment system. In the future, it will keep exploring the new trends and dynamics of Internet + medical health development in line with China's national conditions, and contribute to the high-quality development of hospitals.
3.4.2 Helping primary hospitals improve medical quality to gain patients' trust

Primary care institutions in China mainly refer to county or district level and its affiliated township or community level hospitals and public health service centers, including village level medical and health stations set up in rural areas. Medical personnel practicing in these primary care institutions are required to have appropriate practice qualifications. The total number of primary care hospitals nationwide has reached more than 50,000, which is responsible for the health care of 2/3 of the population. The core work of graded treatment is to allow common and multiple diseases to be treated in primary hospitals, however, based on the existing foundation of China, how to make patients voluntarily go to county (district) hospitals, the first step is to improve the treatment capacity of primary hospitals and solve the problem of residents' trust in the treatment capacity of county (district) hospitals.

The clinical diagnosis and treatment capability of medical institutions is a comprehensive system. In a secondary county hospital, for example, specialist physicians are crucial, but the supporting comprehensive security also directly affects the evaluation of the diagnosis and treatment capabilities, such as medical and technical auxiliary examinations, laboratory tests, pathology, nursing, pharmacists, management, which will directly affect the execution of the diagnosis and treatment results. For medical imaging and laboratory tests, if county hospitals fail to perform test scans in accordance with the requirements of specialized diseases, a significant portion of the test results will not be recognized by experts in large hospitals, and mutual recognition of test results cannot be achieved. The mutual recognition of examination results is not an economic problem, but a technical problem, which needs to
be solved by experts through a remote training system. Experts guide county-level physicians and auxiliary examination technicians to do a good job of examination according to the characteristics of specialized diseases, and the special structures of special parts can be fully expressed through medical imaging, which is of great help to confirm the diagnosis of diseases. By the same token, for clinical pharmacists and clinical nursing, if they can execute medical prescriptions and complete treatment operations according to the characteristics of the specialty, they can effectively implement the treatment plans proposed by experts.

Currently, the telemedicine collaborative network has integrated 32 provincial telemedicine centers, 103 municipal medical association and more than 5400 medical institutions at all levels to build a full geographical coverage of the Internet medical network. Therefore, in the border areas, farmers and herdsmen could enjoy the quality of medical services in large cities such as Beijing and Guangdong without going further; the assessment of remote online teaching and the method of mentoring could also cultivate excellent medical teams for remote areas; the development of technology and the continuous upgrading of smart healthcare could extend high-quality medical resources to the primary level; more and more people living in remote mountainous areas can receive assistance from large hospitals through remote consultations and other means. All of this are good to improve the service capacity of primary medical and health institutions, improve patient satisfaction and enhance their trust for the hospital.

3.4.3 Establish specialist medical association and promote standardized training of
The long-term role of telemedicine is to improve the level of discipline construction in primary hospitals. The practice and popularization of telemedicine requires the establishment of a mechanism for in-depth collaboration from the specialty area. A specialty medical association is a consortium formed between medical structures, with specialty collaboration as the link. Integrating high-quality medical resources from peers through specialized medical consortia to jointly assist primary hospitals, not only requires completing medical collaboration, but also establishing a specialized physician training system.

The training of specialist talents can be divided into three levels: standardized training system for specialist physicians, standardized advanced training system for specialist physicians, and single technology advanced training system, which are applicable to different levels of specialist physician training. At a time when there is a shortage of specialists at the primary level, it is of great practical significance to implement some complementary training systems. The National Health and Family Planning Commission issued a guideline on piloting the standardized training system for specialist physicians, and the Chinese Medical Association also selected the first batch of standardized training bases for specialist physicians. At the same time, three specialties including neurosurgery, respiratory and critical care medicine and cardiovascular medicine, took the lead in starting the pilot of the standardized training system for specialist physicians, which became an important milestone for the specialist physician education system. However, it will take time to implement the standardized training for specialists and promote the scale. The specialist training system is
based on the standardization of the current system of physician trainees, and is a good complementary form for regions or specialties that have not yet established specialist training bases.

Remote teaching visit is a very practical form of teaching, and China-Japan Friendship Hospital has made full use of the technical platform of the Internet to open a teaching visit program. Primary hospitals submit typical medical records or difficult medical records through the remote teaching visit platform, and after the professors review them, they can synchronize on the video conference system at the appointed time, and one professor can conduct teaching visits for specialists from more than ten hospitals at the same time. Through this form, we train primary care specialists to learn to report medical records, present clinical thinking, carry out diagnosis and differential diagnosis, and interact with experts. The professor analyzes and teaches this medical record through questions, discussions, and lectures. In a limited time, primary care physicians can explain the key points of diagnosis, differential diagnosis, clinical thinking process, and domestic and international progress of a certain disease to the specialist physicians of more than ten hospitals at the same time. It was impressive and practical, and was generally welcomed by the primary care specialists. It is also good to make up for the shortcomings of our current continuing medical education and allocate quality instructors for primary care specialists.

Single technology refresher system is a training system set up for the promotion of a certain single technology, treatment method, etc. At the primary level, it can effectively support the practical application of new technologies and projects in primary hospitals. Take
endoscopy for example, many doctors only learn the basic operation, but do not know in what part to take the biopsy, which needs to accumulate experience over a long period of time.

China-Japan Friendship Hospital established a single technology remote training program with a combination of offline refresher training and online guidance model. Starting from the initiation stage, sent technical teams (including instrument nurses) to go to large hospitals for refresher training, and when they return to the primary hospital to carry out the operation independently after learning, they can book experts on the Internet platform to give remote guidance during the key moment of the operation process. It will effectively improve the consultation and treatment effect of a single technology.

3.4.4 Promoting healthy poverty alleviation and reducing poverty caused by illness and returning to poverty due to illness

The form of specialized medical association is rapidly gaining recognition at all levels of hospitals. With the establishment of a business channel linking primary care doctors and specialists within the system of the specialist medical association, precise poverty alleviation for a single disease can be realized. Health poverty alleviation is a very important task, and the establishment of a single disease business synergy system can help primary care institutions to correctly diagnose diseases and reduce poverty caused by diseases and return to poverty due to diseases.

Relying on the respiratory specialty medical association, China-Japan Friendship Hospital has tried to carry out a precise poverty alleviation system for chronic obstructive
pulmonary disease. Chronic obstructive pulmonary disease accounts for a very large proportion of the population groups who are poor due to diseases and return to poverty due to diseases. In several national poor counties in Guizhou, we found that many families with chronic obstructive pulmonary disease are poor because they cannot control the progressive damage of lung function due to the poor effect of long-term medication. As a result, they lose their ability to work and lack of income, which leads to poverty. Based on this, China-Japan Friendship Hospital established an interconnection platform with Guizhou provincial government and provincial telemedicine center, launched a provincial center of respiratory specialist medical association in Guizhou province and set up an expert group. With this health center, patients can get treatment by the experts without leaving the county. With the support of basic medical insurance and the New Agricultural Cooperative, primary hospitals doctors can manage patients with chronic obstructive pulmonary disease. Once their condition worsens, they can be referred to provincial hospitals or China-Japan Friendship Hospital smoothly. By establishing a telemedicine system where patients are guided by primary care general practitioners, patients can be diagnosed without leaving home, receive proper treatment, and recover their labor force; they do not have to spend high travel expenses to go out for medical treatment, which can save families a large amount of travel expenses incurred for medical treatment and is of great importance to the Healthy poverty alleviation.

3.5 Telemedicine Major Project of China-Japan Friendship Hospital
3.5.1 Carry out pilot projects for remote collaborative services integrating elderly health care and medical care

The results of the seventh national census data released by the National Bureau of Statistics show that China's aging population exceeds 260 million people, a new record high. China is approaching a moderate aging society. In the context of deepening aging, how to establish a sound health service system for the "silver hair" group has become an issue which worth thinking about. In order to actively respond to this situation, the Fifth Plenary Session of the 19th CPC Central Committee proposed to implement a national strategy to actively cope with the aging of the population, and the Outline of the 14th Five-Year Plan also proposed to build an "elderly care service system that is coordinated with home and community institutions and combined with medical care and health care". In the face of China's "9073" (90% of the elderly age at home, 7% of the elderly rely on community support, 3% of the elderly in institutions), the combination of medical care is seen as an important support for the "Chinese" elderly service system to cope with the aging population.

In recent years, with the support of relevant departments, from the approval and establishment of medical and nursing care service institutions to the innovative practices of local and medical service institutions, all have shown positive results.

In 2020, the National Health Commission organized the pilot project of combined remote collaborative services for health care of the elderly, with China-Japan Friendship Hospital (National Center for Telemedicine and Internet Medicine) as the project office. The focus of the pilot project is to establish a complete set of combined medical and health care
system for the elderly with the help of the telemedicine collaboration platform, and to establish a new model of "joint contracted elderly care services" by using telemedicine, chronic disease management, follow-up medicine delivery, care guidance, personnel training and popular science lectures, etc. Through the joint medical and nursing care, joint general practice and specialty, social work and social care, and joint medical and nursing care, we can realize the combination of medical and nursing care with "a doctor around the elderly and a system behind the doctor".

The "Joint Contract Elderly Care Services" model is a service system that establishes joint contracts between general practitioners, nursing, specialist doctors, and social worker volunteers based on the needs of elderly care. Through remote joint outpatient services and other forms, it realizes remote medical treatment, data mutual recognition, and collaborative services between medical and elderly care institutions and medical institutions, gradually exploring a mechanism for collaborative cooperation between general practitioners and specialist experts. Establish a communication and collaboration system between experts through internet platforms, improve the quality of medical and specialized care in medical and nursing institutions, and solve the problem of difficulty in obtaining high-quality medical resources for primary medical and nursing institutions. In July 2020, the project launched the first phase of pilot work, and 174 medical and nursing institutions were recruited as the first batch of pilots nationwide, with 2,691 registered medical personnel. Through the establishment of a collaborative network across urban medical associations and county medical communities, radiating medical and health care institutions, and joint collaboration
with physicians from medical and health care institutions, institutional and community-based senior citizens can enjoy telemedicine, chronic disease management, follow-up medicine delivery, and care guidance without having to leave home.

In order to solve the problem of difficult referrals for serious illnesses in the pilot institutions, China-Japan Friendship Hospital explored the service model of "remote expert clinic + intelligent health monitoring". In response to the weak technical level of outpatient medical services in the combined medical and nursing institutions, the national remote collaborative service platform for combined medical and nursing services of aging health carried out "remote expert outpatient clinic". Taking advantage of the "national-regional" synergy, the platform is connected to intelligent monitoring devices to monitor the physical signs of more than 100 elderly people in the pilot institutions in real time. The monitoring functions include bedside respiratory status monitoring, bedside heart rate status monitoring, sleep abnormality monitoring and so on. It realizes data concurrency among institutions, guardians, the elderly themselves and the platform, and establishes a closed-loop service of "sign detection, abnormality warning, remote consultation, prescription flow and drug delivery", radiating to institutions, communities and home care. As the first pilot, two tertiary hospitals in Wuhan City, Hubei Province have already provided regular remote clinic support for the combined medical and nursing institutions, receiving hundreds of patients and achieving hundreds of prescriptions flow.

In order to solve the problem of difficulty in improving the ability of primary doctors, China-Japan Friendship Hospital explores the service model of "distance learning". The
platform offers weekly remote teaching courses and invites domestic and foreign experts to carry out live streaming teaching activities on elderly diseases such as stroke, Alzheimer's disease, and respiration, covering multiple fields such as diagnosis and treatment, rehabilitation, nursing, nutrition, psychology, and medication management. In April 2021, a special activity of case guidance was added, inviting experts to provide peer-to-peer guidance for patients' rehabilitation programs. The project office will also cooperate with well-known domestic and foreign rehabilitation care manufacturers and authoritative associations such as the China Rehabilitation Society to enrich the resources of rehabilitation care experts, provide specialized discipline construction and home care services for the elderly in pilot institutions, and gradually build a closed-loop "comprehensive screening + special assessment + diagnostic recommendations + rehabilitation intervention" process.

In October 2021, the second phase of the pilot project of medical and health care integration has been launched, focusing on innovative business models, establishing old-age pension files, supplementing and improving residents' health records, and realizing a remote collaboration system of medical and health care integration supported by medical and health data through the national blockchain application pilot. Starting from medical and nursing institutions, we will gradually expand the remote services to the community and home care and explore experience and models for future large-scale promotion.

**3.5.2 Digital auscultation teleconsultation**

In August 2020, the kick-off meeting of the Digital Audiology Project of the National
Center for Telemedicine and Internet Medicine was held in the National Center for Telemedicine and Internet Medicine of China-Japan Friendship Hospital, and since then, the Digital Audiology Project of the National Center for Telemedicine and Internet Medicine was officially launched. The Digital Audiology Project of the National Center for Telemedicine and Internet Medicine includes "Digital Audiology Clinic" and "Digital Audiology Remote Room Check". Under the guidance of the National Telemedicine and Internet Medicine Center's Expert Committee on Clinical Audiology, and relying on the telemedicine platform of the National Telemedicine and Internet Medicine Center and China-Japan Friendship Hospital telemedicine platform, the telemedicine service featuring digital audiology is established together with the telemedicine collaborative unit and consists of offline initial consultation, digital audiology, remote outpatient consultation and follow-up visits.

The digital auscultation equipment was used in the 2016 project of the National Key Research and Development Program for Prevention and Control of Major Non-Communicable Diseases undertaken by China-Japan Friendship Hospital, and the digital auscultation platform of the National Center for Telemedicine and Internet Medicine is the translation application of the research results of this national key research and development project, which uses acoustic principles to collect human heart sounds, lung sounds and intestinal sounds through digital stethoscopes, upload them to the digital auscultation platform, and apply technologies such as intelligent algorithms for lung sound characteristics, so that doctors can make medical judgment and disease diagnosis quickly and scientifically by combining objective information of patients.
In the special period of fighting with the Covid-19, well-known hospitals around the world actively promoted remote outpatient, remote consultation and online review to further expand the scope of medical services by serving the majority of patients through "Internet+" with the power of technological innovation. Digital auscultation made lung sounds can be collected in remote auscultation clinics, primary hospitals, community hospitals, recreational institutions, and even directly at home; with the remote platform of digital auscultation service platform, remote real-time high-definition digital auscultation can be realized. At present, the digital stethoscope equipment can realize the effect of actual clinical auscultation through real-time network transmission, and realize one person collecting and multiple people listening at the same time. On the one hand, the lossless audio files collected by the stethoscope can be transmitted losslessly in real time through the network; on the other hand, in addition to audio file collection, the platform can also provide respiratory health graphical visualization files such as lung sound characteristic spectrograms, waveform graphs, 3D spectrograms, diagnostic index tables, and diagnostic results for real-time diagnosis by doctors.

With the development of 5G technology, telemedicine technology ushers in new development opportunities. The development of new infrastructure for medical reform has become a driving force to boost the progress and development of the industry. The sinking of quality medical consultation and the construction of expert networks will become a booster for telemedicine in the future. The application of innovative technologies, including digital audiology and AI diagnosis, will definitely benefit more people. The digital audiology project
is a key telemedicine collaboration project promoted by the National Center for Telemedicine and Internet Medicine, and an important measure to expand the scope of medical services by sinking high-quality resources to China-Japan hospitals. In the future, the National Center for Telemedicine and Internet Medicine will further promote projects such as smart medical care, smart medical care and the construction of standardized units for the promotion of telemedicine technology on the basis of telemedicine collaboration projects such as digital audiology. Digital auscultation is an important breakthrough in telemedicine technology, and has changed the current telemedicine model with consultation as the main means. Digitalization and intelligence are important development directions for future telemedicine.

3.5.3 5G + Internet hospital construction

After years of development, China's communication standard has evolved from the 1G analog era to the 5G all-digital, all-connected era. 5G is not a simple extension of 4G, but a truly converged network that provides high-speed, free and secure connectivity between people, things and things. 5G as a new generation of mobile communication technology, is characterized by high speed, wide spectrum, low latency and the interconnection of everything. According to statistics, the 5G transmission rate (compared to 4G) is 10-100 times higher, with a theoretical peak of 10Gb/s, and the time delay is reduced by about 9/10, reaching the millisecond level, enabling access to millions of devices per square kilometer.

At present, China is gradually promoting the application of 5G in various industries, and healthcare is one of the important application areas. Since 2019, several medical institutions
in China have started to explore the application of 5G scenarios, and telemedicine has ushered in new development opportunities. In October 2019, based on the guidance of the National Health Commission, 94 medical institutions, communication research institutes, telecom operators and other multi-disciplinary joint release of the "Medical Network Construction Standards Based on 5G Technology", which clarifies that the 5G network will become the new generation network infrastructure. According to incomplete statistics, several medical institutions in China have carried out 5G pilot projects, including medical imaging applications, remote emergency, remote surgery guidance and remote consultation, among which remote surgery is the most piloted, followed by remote consultation and the integration of 5G and emergency services. Currently, more than 500 hospitals nationwide have deployed 5G networks and launched pilot and commercial 5G medical applications. As one of the first 5G network pilot hospitals in China, China-Japan Friendship Hospital has completed the deployment of 5G indoor digital systems by China Telecom, China Mobile and China Unicom, laying a solid foundation for the exploration and practice of 5G telemedicine services.

In terms of 5G-related innovative applications, in addition to 5G+digital auscultation, China-Japan Friendship Hospital has made the following four explorations and attempts. The first is ultrasound acupuncture + 5G mobile video cart. China-Japan Friendship Hospital invoked ultrasound technology to acupuncture surgery in 2005, pushing acupuncture technology into the visualization era. Ultrasound becomes the doctor's third eye, capturing the lesion site and accurately reaching the lesion, fundamentally eliminating
medically-derived injuries and effectively solving the traditional problem of treating painful body surface soft tissues only by hand. The technology has been applied to nearly 20 provinces and cities, most of the 500,000 doctors using the technology nationwide are at the primary level or even at the village and township level hospitals. However, after training, doctors in primary hospitals still have the problem of inaccurate surgery, and it is urgent to achieve remote guidance and teaching through needle knife, ultrasound, and video methods, in order to improve primary hospital’s diagnosis and treatment capabilities. In 2020, the visualization of Chinese medicine needle knife technology combined with the application of 5G will enable the rapid popularization of minimally invasive technology and objectively promote the process of modernization of Chinese medicine.

The second application is 5G remote ultrasound combined diagnosis. Ultrasound is a common bedside diagnostic device used for abdominal, neck and liver examinations, and is the most widely used and trusted imaging tool among all imaging tools. Ultrasound operation requires experience, including technique, angle and intensity, etc. Currently, there are only 200,000 ultrasound doctors practicing in China, and most of them are at the primary level. Misdiagnosis and missed diagnoses often occur in primary hospitals. The problem of a huge shortage of ultrasound doctors can be solved by accessing ultrasound equipment to telemedicine platforms through 5G technology at the bedside, operating room, ICU and other areas to realize the guidance and teaching of higher-level hospitals to lower-level hospitals. China-Japan Hospital has already established an ultrasound laboratory, and part of the work is ultrasound 5G remote experimentation. 5G instruments and equipment are already in place,
which will realize intra-hospital networking from the ultrasound department and other departments within the hospital, as well as remote networking between the ultrasound medicine department of China-Japan Hospital and the primary hospitals.

The third is 5G pathology diagnosis. Pathology is the process of taking tissue from the human body and making slices and pathologists view images from the slices and combine clinical information to make the most accurate diagnosis. The diagnostic accuracy of pathology can reach over 99.8%. 5G pathology consultation plays an important role in intraoperative freezing consultation, which generally requires a diagnosis within half an hour. The time required is high. The size of a section is determined according to the size of different tissues, and large frozen sections can be scanned digitally, and the file can reach 2~3G at 40 times, which requires particularly high transmission speed. In several 5G teleconsultations this year, the pathology images and video conference images helped patients and primary hospitals to make timely diagnosis without any time delay, receiving high patient satisfaction.

Finally, it is a 5G intelligent rescue vehicle. The 5G intelligent rescue vehicle can realize the three-level quality control management of the whole hospital's emergency, remotely monitor the quantity and expiration date of the whole hospital's emergency medicine items, and make in-hospital transfer according to the usage of the ward to respond to emergency or reduce the loss. Most community health centers are equipped with emergency rooms and basic emergency equipment and drugs, but they do not fully utilize their emergency functions. Based on the 5G intelligent rescue vehicle, the hospital-community health secondary linkage
primary community health rescue system can be built to give full play to the community health center's nearby emergency function. In case of emergency resuscitation, qualified personnel can use the resuscitation vehicle to resuscitate patients, and through the remote consultation function on the vehicle, the emergency department of the hospital can provide guidance to the medical personnel of the community health center, so as to win the maximum time for resuscitation. In addition, hospitals can remotely monitor the resuscitation situation of their community health centers, the management of resuscitation drugs and items and so on.

In 5G era, smart medical solutions will build AI-aided diagnosis applications based on 5G technology, which can effectively solve the problems of serious imbalance in supply, high rate of misdiagnosis and missed diagnosis, and long time consuming in China. The General Office of the National Health and Welfare Commission issued the Notice on Issuing the Health and Health Standards Project Plan for 2020 (National Health Office Regulations Letter [2020] No. 714) in August 2020, establishing the project of "Standards Research on the Application of 5G Technology in the Healthcare Industry" led by China-Japan Friendship Hospital, and also jointly undertaking 5G with all relevant hospitals, research institutes and 5G technology industry leaders Medical and health care industry standard research. Meanwhile, more than 10 large institutions such as China-Japan Friendship Hospital have jointly undertaken the National Development and Reform Commission's new infrastructure 5G project, which has been launched. In the future, China will establish a national unified standard and uniform quality medical 5G network, which will play the role of promoting 5G
medical application innovation, regulating 5G medical terminal industry development, and supporting the infrastructure of smart hospitals.

### 3.6 Future developing trends of telemedicine

#### 3.6.1 Online and offline integration

First, the synergy of online and offline business. When traditional medicine changes to modern medicine, the medical ecosystem will change from disease diagnosis and treatment to health management. Patient services, payment, health and disease management will be transferred to online, medical payment mode will change from payment by item to payment by value, hospitals will no longer be fighting alone, but emphasize more on business synergy. Patient services such as guidance, registration, examination, surgery, medication, and patient follow-up management need to be coordinated in the era of telemedicine. The Internet hospital breaks the closed-loop model within the walls of the hospital and achieves online "breakthrough", doubling the space for development.

Secondly, we can realize the synergy of business within and outside the hospital across regions and time and space. For example, an orthopedic patient is admitted to a primary care institution, comes to a large hospital for surgery, and then returns to the primary care institution for rehabilitation, and doctors from different hospitals form an inter-hospital working group to jointly manage the patient. Someone guides and someone specifically performs the rehabilitation, and the intra- and extra-hospital business synergy is carried out around the patient's disease treatment. These all contribute to providing patients with better
and more convenient services, which can improve patient satisfaction.

3.6.2 Co-development with medical association medical community

Medical consortia, medical communities, specialty alliances, and telemedicine collaborative networks are mechanisms introduced by the National Health Commission on the management of medical resource deployment. The purpose of medical consortium construction is to establish a collaborative mechanism between two medical institutions that is not limited by some current management bottlenecks, and to use the form of medical consortium to establish a collaborative relationship between hospitals at the upper and lower levels to form a contractual mechanism. Under the consensus of the medical association, it is possible to achieve staff interchange, data interchange, and medical insurance interconnection, a kind of synergistic mechanism.

Internet hospital is a new institution which is different from medical association, but the two are interrelated, and the medical association and the Internet hospital construction and development cannot be viewed in isolation. The medical association is the business demand side, and the Internet hospital is the supply platform. The biggest benefit of this platform is the links, including links to hospitals, links to doctors, links to patients, links to doctors and doctors, links to hospitals and hospitals, and possibly links to the government, disease prevention and control and other public health institutions, thus helping the medical association medical community business synergy and the realization of true hierarchical diagnosis and treatment. County hospitals, for example, now have a significant percentage of
resources that are idle, with serious shortfalls in staff workload, bed utilization, and equipment utilization. The existing quality medical resources in China are less than 10%, and mainly concentrated in a few large hospitals in big cities. Now we need to let the quality resources at the primary level be utilized, so that the tertiary hospitals at the local and municipal levels can develop better and become quality medical resources, and at the same time do a good job of positioning the functions of primary and secondary medical institutions, and the Internet hospital can play the function of linking and coordinating the resources and advantages of all parties. Internet hospitals are equivalent to linking up hospitals at different levels, which is a tool. But the prerequisite for this linkage is the establishment of business cooperation between medical institutions. (Lu, 2021)

3.6.3 Internet medical development has given rise to new things

The development of a new industry is bound to give rise to a series of related new things. Take "Internet + medical" as an example, with the rapid growth of Internet hospitals in the number and user penetration, the demand for online consultation is also gradually rising, in order to improve the professionalism and efficiency, Internet hospitals began to transform to specialty. For example, Jingdong has established 18 specialty centers of Internet hospitals and Dole Internet hospital liver disease Medical Center has also been established. At the same time, Internet healthcare has also given rise to new industries and career positions. From a business perspective, Internet healthcare will promote changes in the business landscape of
the drug and device industry, for example, pharmaceutical companies are now actively laying out digital pharmaceutical marketing. In addition, a number of new industries and occupations, such as respiratory therapists, health care workers, elderly ability assessors, and other emerging occupations, are being spawned in the future as Internet healthcare continues to develop.

To sum up, “Internet+medical health” has become an important national policy and an important means to support the graded treatment of medical association. Based on the advantages of national telemedicine and Internet medical center and other disciplinary platforms, China-Japan Friendship Hospital is actively integrating resources, exploring models, innovating technologies, facing the whole country, gradually improving telemedicine service specifications, exploring the development mode of medical association graded diagnosis and treatment in line with China's national conditions with the opportunity of Internet hospital and smart hospital construction, practicing the important measures of national medical reform. Based on all of the above, we will contribute to the high-quality development of hospitals and promote the strategy of "Healthy China".

4. Other Related Cases of Telemicine

4.1 Guangdong Provincial People's Hospital: 5G Internet New Hospital
4.1.1 Background

In recent years, the situation of aging population and complex disease spectrum has become increasingly serious, especially during the breakout period of Covid-19, the shortage of medical resources and the imbalance between supply and demand have become more prominent, and there is an urgent need to enhance the efficiency of medical services and expand the supply of medical services through the application of "new technology" to promote the structural reform of the medical supply side. On July 19, 2021, Guangdong Mobile joined hands with Guangdong People's Hospital to build the province's first 5G Internet hospital online.

The new 5G Internet hospital will build a panoramic ecology of Internet medical care that is interconnected, collaborative, intelligent and accurate by virtue of its personalized diagnosis and treatment big data service capability. For patients, it will create a whole process of intelligent medical consultation, enhance patients' consultation experience with diversified forms of consultation, and keep the gate for people's health and well-being with integrated innovative services of dynamic health data detection and intelligent warning; for medical care, it will create intelligent workstations to achieve diversified forms of consultation, intelligent diagnosis and treatment assistance, and zero distance between doctors and patients with online graphic consultation; for hospital management, it will realize multi-directional visibility, management and control with an integrated platform. For hospital management, realize multi-directional visualization, management and control, and "intelligent follow-up" and other functions to help refine the operation.
4.1.2 Main methods

The 5G Internet New Hospital Platform takes Guangdong Provincial People's Hospital as the main construction body and combines third-party technical service providers such as large telecom operating companies to create five major application terminals and five major functional application systems.

a. Five application terminals

Combining the comprehensive technology development and channel capabilities of telecom operators, provide the Internet hospital platform with an application system covering public number or small program, 5G message small program, online doctor's personal consultation room, mobile client, and health channel.

b. Five functional systems

Internet diagnosis and treatment: provide intelligent consultation, consultation and appointment, and online diagnosis and treatment services; realize the function of doctors' online medical prescriptions such as examination and test, treatment and electronic prescription based on the platform; push the examination and test results of patients to the doctor's side and patient's side in the form of electronic reports; provide customized follow-up mode according to different diseases for Internet outpatients.

Science education: For post-visit patients, according to the visit data and the doctor's judgment, we will push the corresponding disease or health management-related science content.
5G active intelligent medical services: for patients who make appointments, build 5G message outpatient service message cards to support the message pushing of the whole process before, during and after the patient's visit; for inpatients, build 5G message inpatient service cards to provide inter-hospital services before, during and after the hospitalization.

Internet health applications: Integrate Internet products into hospital Internet health services, support the establishment of "and health", "and message", "and color ring" and other forms for users online health files, health voice assistant, health science and other effective health applications.

Joint innovative applications based on cutting-edge technology: standard data collection is realized through smart devices in homes and communities, supporting Internet health services such as remote health monitoring, TV consultation, and home visits by medical care, creating the future clinic of the home or community.

4.1.3 Achievements

At present, Guangdong Provincial People's Hospital 5G Internet New Hospital has 1100 doctors, 63 disciplines and more than 700 kinds of medicines for common diseases online. Through model innovation and service innovation, on the one hand, patients can get more convenient medical services, on the other hand, it can also reduce the duplicate allocation and waste of health resources, effectively control the operation cost of hospitals, realize the fine management of human and financial resources, and reduce the medical cost of patients.
4.2 JingDong Health Internet Hospital

4.2.1 Background

JD Health Internet Hospital was established in 2018 and is one of JD Health's core businesses. It is also one of the first platform based internet hospitals in China to obtain an internet hospital license. JD Health Internet Hospital's business scope can cover the entire process of patient diagnosis and treatment before, during, and after diagnosis. At the same time, the focus will be on exploring the innovation of internet medical and health service models for specialized diseases and diseases, and promoting the integrated development of prevention, treatment, and rehabilitation in the specialized field. As of December 31, 2020, JD Health Internet Hospital has over 110000 doctors stationed, with an average daily consultation volume of over 100000 people throughout the year. It has completed the construction of 18 specialized disease centers.

4.2.2 Highlights and Characteristics of Internet Hospital Construction

Internet Specialized Center Service Model. Since the end of 2019, JD Health Internet Hospital has established a specialized center service model to provide users with one-stop solutions for prevention, treatment and rehabilitation for specialized diseases. By the end of 2020, 18 specialized centers have been established, including heart center, ear nose throat center, Chinese medicine hospital, respiratory center, diabetes center, mental psychology center, etc. Taking the diabetes Center as an example, JD diabetes Health Center was launched in April 2020. Combining JD's supply chain advantages such as full industrial chain
resources and cold chain logistics, as well as its technological advantages such as artificial intelligence, Big data, and the Internet of Things, through online consultation, continued purchase of drugs, door-to-door drug delivery, and post diagnosis management services, it built an online and offline integrated diabetes management closed-loop model to provide intelligent and efficient health management services for diabetes patients, comprehensively improve the diagnosis and treatment efficiency and blood sugar control rate of diabetes.

Realize the integration and connectivity of multiple resources, and build a one-stop health service zone. Here, we still take the management of diabetes patients as an example. Through the one-stop diabetes comprehensive service platform, JD Health helps endocrinologists build personal cloud consulting rooms and equip professional doctor assistants, and improves patient management efficiency and service experience through intelligent hardware and management software. At the same time, JD Health is also collaborating with doctors' alliances and medical associations in various regions to jointly promote the implementation of chronic disease management. Taking Guangdong as an example, the "Blood Glucose Monitoring Map Project" promoted by JD Health and the Guangdong Provincial Center for Disease Control and Prevention takes the Healthy China Action as the platform, and collaborates with local doctors' specialized alliances to build a chronic disease prevention and control system. Every doctor in the alliance or society can establish a cloud consultation room on the platform, where patients can consult and communicate with doctors, And establish a data prevention and control platform for chronic alkali disease in the area through data tracing. In terms of intelligent hardware, JD Health
leverages its supply chain advantages and collaborates with multiple testing equipment manufacturers to achieve the integration of patient testing data and effective patient management. Through the intelligent Glucose meter, patients can choose to automatically upload the blood glucose index data to the background of the doctor's cloud consulting room. After viewing the data, medical assistants actively communicate with patients for active follow-up management. Meet the personalized and diversified service needs of patients. In addition to consultation and medical services, tap the diversified needs of diabetes patients, design and provide them with refined management health Service pack, including diabetes early glucose reversal service diabetes weight loss services, home monitoring guidance, personalized exercise programs, diet plans and other Service pack. Patients can purchase them quarterly, half a year or annually to carry out refined management on the daily life of diabetes patients.

The last one is family doctor. The family doctor product launched by the platform is an important supplement to the government's family doctor signing system. The family doctor service was launched in August 2020 and is an important component of the JD Health platform. This platform integrates online consultation, specialized referral, health management, various offline appointment and registration services, and provides them to users. Patients can communicate with family doctors anytime and anywhere. For problems that cannot be solved by family doctors, they will transfer these problems to specialized doctors and rely on the platform's powerful expert resources to solve them. For problems that cannot be solved online, they will be transferred to offline hospitals to improve the patient's
4.2.3 Key points for future construction of internet hospitals

First, integration of online and offline services. Online services mainly focus on pre-diagnosis consultation and post-diagnosis management to address patient health issues. In addition, explore cooperation with offline hospitals, local governments, third-party testing platforms, physical examination institutions, and consumer medical institutions, using the platform as the entry point to solve various health problems in the entire medical scene. For example, in cooperation with medical institutions and third-party inspection and testing platforms, patients can make advance appointments for offline hospitals and third-party inspection centers online after online consultation, and go to offline physical institutions for examination according to the appointment time. The examination report is directly uploaded to the JD Health Internet Hospital platform, and patients can go offline for consultation according to the appointment time with the doctor. After the patient returns home, you can also continue to keep in touch with doctors through online platforms, and doctors can adjust treatment plans or carry out rehabilitation management according to the patient's situation, achieving the integration of online and offline processes. In addition, by creating a benign platform ecosystem of offline hospitals building their own internet hospitals and third-party internet hospitals settling in, the operational capabilities of internet hospitals are enhanced to make high-quality medical resources more easily accessible to patients.

Second, the win-win cooperation. Collaborating with local governments and offline hospitals is an "integrated" smart solution for JD Health's future collaborative development of
online and offline internet healthcare. Currently, JD Health has signed agreements with more than 20 cities or regions "The strategic cooperation agreement for a healthy city covers many fields such as pharmaceutical retail, Internet hospitals, online medical insurance, and smart medicine. In addition, large public tertiary hospitals around the country are also key partners of JD Health. JD Health has cooperated with many hospitals in the fields of co building smart hospitals, A-assisted diagnosis and treatment, A-rational drug use systems, and health management.

Thirdly, the application of new technologies. JD Health uses the Knowledge graph of disease diagnosis Based on the consultation experience of clinical doctors, an intelligent pre consultation tool has been designed and developed for online consultation with high-frequency complaints. After the patient submits the main complaint, the intelligent pre consultation tool can generate a summary and provide it to the doctor. On the premise of not affecting the user experience, significantly improve the efficiency of doctors' online consultation, while ensuring the integrity and standardization of online consultation.

At the same time, the safety of online diagnosis and treatment has always been a focus of attention for all parties. Based on online consultation data, JD Health has developed intelligent quality control products for common problems in online diagnosis and treatment by using artificial intelligence technologies such as Natural-language understanding, combined with Knowledge graph capabilities, and actively explored and applied new technologies to maximize online diagnosis and treatment safety.
5. Summary and Discussion

5.1 Discussion of the effect of telemedicine on primary hospital development

In the following part, we will take the case of China-Japan Friendship Hospital as an example, to provide empirical evidence for the impact of telemedicine on primary hospitals development. The following conceptual framework could well analyse the impact of telemedicine on the development of primary hospitals. The conceptual framework includes three parts, structure, process and outcomes. It aims to interpret the effect of telemedicine on primary hospital development.

![Conceptual Framework](image)

Figure 22. Conceptual Framework

The organization structure contains two parts, the first one is China-Japan Friendship Hospital (National Management and Training Center), and the second one is primary hospitals (e.g., The Chifeng Hospital, Weifang second people’s hospital). Then, the process includes telemedicine education, training and consultation. Finally, four outcomes could be
regarded as indicators to evaluate telemedicine performance, they are improvement of patient and staff satisfaction, discharged patient number and hospitalization cost, comprehensive development of discipline and length of stay proportion of severe patients.

5.1.1 Organization Structure

Institutional cooperation refers to the cooperation between different medical institutions in order to jointly achieve a certain goal. In primary hospitals, institutional cooperation can be manifested as cooperation between different medical institutions or between medical institutions and other relevant institutions. Regardless of the form, institutional cooperation can bring many benefits to the development of primary hospitals.

Firstly, institutional cooperation can improve the medical level of primary hospitals. By collaborating with other medical institutions, primary hospitals can share advanced medical technology and experience to improve their medical level. In addition, institutional cooperation can also promote the sharing of medical resources, allowing primary hospitals to access more medical resources and equipment, further improving their medical level. Secondly, institutional cooperation can improve the management level of primary hospitals. By collaborating with other institutions, primary hospitals can learn from the management experience and models of other institutions and optimize their own management system. In addition, institutional cooperation can also promote talent mobility, enabling primary hospitals to attract more outstanding talents and improve their management level. Finally, institutional cooperation can promote connections between primary hospitals and communities. By collaborating with other institutions in the community, primary
hospitals can better understand the needs and demands of the community and provide medical services that are more in line with the needs of the community. In addition, institutional cooperation can also promote interaction and communication between primary hospitals and communities, enhancing mutual trust and cooperation.

From the point of structure’s view, as has introduced in Chapter 3, through National Management and Training Center, China-Japan Friendship Hospital has set up the Telemedicine Management and Training Center to collect and analyze information about telemedicine at home and abroad, study and propose opinions and suggestions on the construction and development of China's telemedicine system. At the same time, it also assists the National Health Commission in establishing a national telemedicine quality control network, organizing and guiding quality control work and organizes the drafting of norms and standards related to telemedicine management, and carries out training for telemedicine-related professionals. Relying on the Telemedicine Management and Training Center, China-Japan Friendship Hospital has launched a series of cooperation with Chifeng City Hospital, Weifang Second People's Hospital and other grass-roots hospitals to promote the development of grass-roots hospitals. These collaborations rely on the National Management Training Center to provide better training and learning opportunities for primary doctors, improve their professional level and diagnosis and treatment capabilities, and thus better serve local residents.

Primary hospitals are an indispensable part of China's healthcare system, undertaking important tasks such as initial diagnosis and treatment, health education, and disease
prevention. However, due to various factors such as historical reasons and regional differences, there is a significant gap in medical technology, equipment, and talent among primary hospitals, resulting in poor patient experience and unsatisfactory treatment outcomes. In order to solve this problem, China-Japan Friendship Hospital cooperates with basic level hospitals to improve the comprehensive quality and clinical level of basic level doctors through expert training, academic exchanges, technical guidance and other ways, so that they can better deal with various diseases and medical problems, and improve the service quality and treatment effect of basic level hospitals. In addition, the China-Japan Friendship Hospital also actively explores the cooperation model between primary hospitals and large tertiary hospitals, and sinks high-end medical resources to the primary level through remote consultation, referral and other ways, so that patients can get better treatment and care. This cooperation model can not only alleviate the pressure on large hospitals, but also improve the treatment level and service capacity of primary hospitals.

In a word, the cooperation between China-Japan Friendship Hospital and basic level hospitals not only helps to improve the professional level and diagnosis and treatment ability of basic level doctors, but also helps to improve the service quality and treatment effect of basic level hospitals, so that more patients can receive timely and effective treatment and care. We believe that with the joint efforts of both parties, primary hospitals will surely usher in a better development prospect.

5.1.2 Process
As for the process, through telemedicine education, training and consultation, the China-Japan Friendship Hospital has provided all-round support and assistance to primary hospitals, and has achieved a series of remarkable results.

Distance medical education is one of the important means for the China-Japan Friendship Hospital to promote the development of primary medical care. Telemedicine education refers to the training and education programs that focus on teaching healthcare professionals about telemedicine and how to effectively utilize telemedicine technologies in medical practice. It helps healthcare providers acquire the necessary skills and knowledge to provide virtual patient care and leverage digital communication tools for diagnosis, treatment, and monitoring of patients. Through the remote video conference system, experts from the China-Japan Friendship Hospital can directly communicate and interact with doctors in basic level hospitals, share the latest medical knowledge and technology, and improve the diagnosis and treatment level and skills of basic level doctors. At the same time, the China-Japan Friendship Hospital will regularly invite grass-roots doctors to the hospital for field observation and learning, so that they can experience the advanced medical equipment and technology, and further improve their clinical experience and ability. Overall, telemedicine education plays a vital role in expanding access to quality healthcare, improving healthcare efficiency, and empowering both healthcare professionals and patients. It enables the effective and safe delivery of virtual care, leading to positive outcomes for individuals and the healthcare system as a whole.
In addition to telemedicine education, the China-Japan Friendship Hospital also promotes the development of grass-roots hospitals through training and consultation. Telemedicine training refers to the education and training of medical personnel through the Internet and remote technology. This training mode can be achieved through online courses, virtual meetings, remote video demonstrations, and other forms. The advantage of remote medical training lies in its ability to overcome time and space limitations, allowing medical professionals to access high-quality educational resources anytime and anywhere. According to different needs and problems, the China-Japan Friendship Hospital will develop corresponding training plans and programs to provide systematic and comprehensive training services for grass-roots doctors. Through remote video conferencing, online education platforms, and other means, medical personnel in primary hospitals can communicate and learn from experts, acquire the latest medical knowledge and technology, solve problems, and improve medical quality. At the same time, doctors of primary hospitals can conduct cross-regional academic exchanges with doctors, professors and other experts of the China-Japan Friendship Hospital, share case experience and clinical technology, so as to improve the medical level and ability of basic level hospitals. By all these means, medical personnel in primary hospitals can receive professional training and guidance, and learn advanced medical management and service concepts. This helps to enhance the service capacity of primary hospitals, provide more comprehensive, efficient, and high-quality medical services, and meet the health needs of local residents, providing strong support for the continuous development of primary healthcare.
At the same time, China-Japan Friendship Hospital will also send professional teams to grass-roots hospitals for consultation and guidance to provide them with more professional and detailed services and support. By sending professional teams, China-Japan Friendship Hospital can share their expertise and knowledge with grass-roots hospitals, helping them enhance their medical capabilities and provide better healthcare services to their communities. The guidance offered by experienced professionals can be instrumental in improving the diagnosis, treatment, and overall quality of care at the grass-roots level. The professional teams can provide guidance on various aspects, including clinical practice, specialized treatments, the adoption of advanced medical technologies, and healthcare management. They can also help in refining the hospital’s processes, implementing quality control measures, and enhancing the overall efficiency of medical operations. Moreover, the presence of professional teams from China-Japan Friendship Hospital at grass-roots hospitals can boost the confidence and morale of local healthcare providers. It creates opportunities for collaboration, knowledge exchange, and the establishment of long-term partnerships between the hospitals. Overall, this initiative serves as a significant step towards strengthening healthcare services at the grass-roots level and improving the overall healthcare ecosystem. It demonstrates a commitment to bridging the gap between higher-level medical institutions and grass-roots hospitals, ultimately benefiting patients and communities in the process.

The China-Japan Friendship Hospital has made a series of achievements in promoting the development of primary medical care. Through telemedicine education, training and consultation, the China-Japan Friendship Hospital has helped grass-roots hospitals improve
their diagnosis and treatment level and skills, and improve service quality and efficiency. At the same time, the China-Japan Friendship Hospital has also provided more career development opportunities and space for grass-roots doctors, which has stimulated their enthusiasm for work. These achievements demonstrate the commitment of the China-Japan Friendship Hospital in supporting primary medical care and improving access to quality healthcare services at the community level. Through these efforts, the hospital can contribute to the overall development of primary care and the healthcare system as a whole.

5.1.3 Outcome

The above measures have achieved successful results, specifically manifested in the following four aspects: the improvement of patient and staff satisfaction, discharged patient number and hospitalization cost, comprehensive development of discipline and length of stay proportion of severe patients.

As shown in the previous part, the satisfaction of patients and staffs in telemedicine network has gradually increased between 2016 and 2021. In the medical industry, patient satisfaction is a very important indicator. With the continuous development of medical technology and the continuous improvement of medical service quality, patients' demands for medical services are also increasing. Improving patient satisfaction not only improves the quality of medical services, but also brings many benefits.

Firstly, improving patient satisfaction can increase the reputation and visibility of medical institutions. When patients are satisfied with medical services, they are willing to recommend the institution to their family and friends, thereby increasing its visibility and
reputation. This is very important for medical institutions as it can help them attract more patients, improve their performance and market position. Secondly, improving patient satisfaction can reduce the risk of medical disputes. When patients are dissatisfied with medical services, they are likely to file complaints or lawsuits. This not only brings economic losses to medical institutions, but also affects their reputation and image. Therefore, improving patient satisfaction can reduce the risk of medical disputes and protect the interests of medical institutions.

In addition, improving patient satisfaction can promote the continuous improvement of medical service quality. When patients are satisfied with medical services, they are willing to choose the institution again and recommend it to others. This has prompted medical institutions to continuously improve their service quality to meet the needs of more patients. This virtuous cycle can bring sustained performance growth and market competitive advantage. Finally, improving patient satisfaction can enhance the work enthusiasm and satisfaction of medical staff. When patients are satisfied with medical services, they will express gratitude and praise to the medical staff. This is a affirmation and encouragement for medical staff, which can enhance their work enthusiasm and satisfaction. This positive feedback can encourage medical staff to work harder and provide better medical services to patients.

At the same time, the development of remote medical networks in primary hospitals cannot be separated from a key factor, which is the satisfaction of staff.
Firstly, improving the satisfaction of remote medical network staff can improve service quality. In telemedicine networks, staff play a crucial role. They need to provide timely and accurate consultation, diagnosis, treatment and other services to patients, and the quality of these services is directly related to the health and life safety of patients. If staff are not satisfied with their work, they may not be able to fully utilize their abilities and professional skills, leading to a decrease in service quality. Therefore, improving staff satisfaction can effectively improve service quality and provide patients with a better medical experience.

Secondly, improving the satisfaction of remote medical network staff can improve work efficiency. In remote medical networks, staff need to face numerous patient consultations and service requests. If their work status is poor, it is difficult to ensure work efficiency. On the contrary, if staff are satisfied with their work, they will be more committed and conscientious in completing their work, thereby improving work efficiency. This not only increases service capacity, but also shortens patient waiting time and improves the operational efficiency of the entire remote medical network.

Thirdly, improving the satisfaction of remote medical network staff can enhance team cohesion. In a team, each member needs to cooperate and support each other in order to complete tasks. If someone in the team is not satisfied with their work, it may generate negative emotions, affecting the overall atmosphere and cohesion of the team. On the contrary, if every staff member is satisfied with their work, they will be more proactive in collaborating with the team and completing tasks together. This can enhance team cohesion and improve the overall collaboration efficiency of the team.
Finally, improving the satisfaction of remote medical network staff can enhance the image and reputation of the organization. In modern society, organizational image and reputation are very important. If an organization can leave a good impression and reputation, it will be easier to attract potential customers and partners. The image and reputation of an organization are often closely related to the satisfaction of its employees. If an organization can make employees feel satisfied and happy, then this positive emotion will be transmitted to customers and partners, thereby improving the organization's image and reputation.

China-Japan Friendship Hospital’s practice of telemedicine also have several effects on the number of discharged patients, hospitalization costs and length of stay proportion of severe patients. Here are some potential effects.

First of all, the increased number of discharged patients. Telemedicine allows for enhanced access to healthcare services, particularly for follow-up care and chronic disease management. By providing virtual consultations and remote monitoring, telemedicine enables healthcare providers to monitor patients’ conditions and address their healthcare needs without requiring in-person visits or lengthy hospital stays. This can result in more timely and efficient care, leading to a higher number of patients being discharged from hospitals and receiving ongoing care remotely.

Second, the reduced hospitalization costs. Telemedicine can help reduce hospitalization costs by preventing unnecessary hospital admissions and facilitating early discharge for certain patients. Through telemedicine consultations, healthcare providers can assess patients remotely and determine if hospitalization is necessary or if the patient’s condition can be
managed at home. This can lead to cost savings by avoiding inpatient stays, reducing the length of hospital stays, and minimizing healthcare resource utilization.

Third, lower readmission rates. Telemedicine’s ability to provide remote monitoring and continuous care can help reduce hospital readmission rates. Patients can receive regular follow-up, medication management, and support from healthcare providers through telemedicine, which can help prevent exacerbation of their conditions and the need for a hospital readmission. This can result in cost savings by avoiding costly readmissions and promoting better patient outcomes.

Finally, reduced length of stay proportion of severe patients. Telemedicine enhances care coordination among healthcare providers involved in the treatment of severe patients. Through virtual consultations and collaborative platforms, specialists from different disciplines can come together to discuss treatment plans, share insights and recommendations, and make joint decisions. This streamlined communication and collaboration can help expedite care pathways, reduce delays in decision-making, and ensure more efficient utilization of resources, potentially leading to shorter hospital stays for severe patients.

5.1.4 Telemedicine and comprehensive development of discipline

The China-Japan Friendship Hospital's telemedicine initiatives had a positive impact on the comprehensive development of disciplines within primary hospitals. Here are some potential effects.

1. **Collaboration and knowledge exchange.** Telemedicine allows primary hospitals to connect with specialized medical professionals in different disciplines, both within the
China-Japan Friendship Hospital and beyond. This fosters collaboration and knowledge sharing between primary care providers and experts in various fields, facilitating the comprehensive development of disciplines within primary hospitals.

2. Access to specialized expertise. Through telemedicine, primary hospitals can access specialized expertise that may not be readily available locally. Specialist consultations can be conducted remotely, enabling primary care providers to seek advice, obtain second opinions, and consult on complex cases. This access to specialized knowledge enhances the capacity of primary hospitals to provide comprehensive care within their own setting.

3. Training and education. Telemedicine platforms can facilitate training and education for primary care providers. The China-Japan Friendship Hospital can use telemedicine to conduct virtual workshops, webinars, and educational programs, enabling primary hospital staff to acquire knowledge and skills in different disciplines. This enables comprehensive learning and development, enhancing the capabilities of primary care providers in delivering quality healthcare.

4. Improved care coordination. Telemedicine promotes effective coordination and integration of care within primary hospitals. By connecting primary care providers with specialists, telemedicine facilitates multidisciplinary consultations, case discussions, and treatment planning. This comprehensive approach ensures that patients receive well-coordinated care across different disciplines, resulting in better health outcomes.
5. **Research and innovation.** Telemedicine can support research and innovation efforts within primary hospitals. By enabling collaboration between primary care providers and researchers, telemedicine platforms can contribute to the generation of new knowledge, development of innovative practices, and implementation of evidence-based care. This drives the comprehensive development of disciplines by fostering research initiatives within primary hospitals.

6. **Patient-centered care.** Telemedicine promotes patient-centered care within primary hospitals. By utilizing telemedicine technologies, primary care providers can engage in remote patient monitoring, home-based care, and teleconsultations, ensuring that patients receive comprehensive care from the convenience of their own homes. This patient-centered approach supports the comprehensive management of patients’ health conditions.

7. **Ethical Consideration.** Addressing ethical issues and data privacy concerns necessitates a robust framework. Firstly, adhering to data protection regulations, such as the General Data Protection Regulation (GDPR) or the Health Insurance Portability and Accountability Act (HIPAA), is vital in handling and analyzing data. Secondly, when estimating causal effects, ensuring that the models and algorithms used are transparent, interpretable, and unbiased is crucial to uphold ethical considerations. Engaging with ethics committees and involving stakeholders in the decision-making processes will also help navigate through ethical dilemmas and safeguard interests, ensuring that the estimation of causal effects does not compromise ethical standards and data privacy.
In summary, the China-Japan Friendship Hospital's telemedicine initiatives have likely promoted the comprehensive development of disciplines within primary hospitals. By facilitating collaboration, expanding access to specialized expertise, supporting training and education, enhancing care coordination, fostering research and innovation, and enabling patient-centered care, telemedicine plays a crucial role in advancing the capabilities and comprehensive development of medical disciplines within primary hospital settings.

5.1.5 Summary

With the continuous progress of technology and the continuous development of the medical industry, telemedicine, as a new medical model, has gradually been widely applied in medical services. Remote medicine integrates medical resources through internet technology, achieving medical resource sharing and collaborative work, and providing more convenient, fast, and efficient medical services for patients. For primary hospitals, telemedicine also plays an important driving role.

Firstly, telemedicine can help primary hospitals improve their medical service levels. Primary hospitals often have insufficient medical resources, and remote medicine can connect remote experts and primary doctors through internet technology to provide specialized medical service support for primary hospitals. Through remote consultation, remote diagnosis, and other methods, problems encountered by primary hospitals in the diagnosis and treatment process can be solved in a timely manner, improving the treatment effectiveness and satisfaction of patients.

Secondly, telemedicine can help primary hospitals improve their medical management
level. There are many problems in medical management in primary hospitals, such as personnel management, drug management, equipment management, etc. Remote medicine can connect various primary hospitals through internet technology, achieving information sharing and collaborative work. Through remote medical platforms, it is possible to achieve unified management and allocation of medical resources in various primary hospitals, thereby improving the overall management level of primary hospitals.

Once again, telemedicine can help primary hospitals reduce costs. Primary hospitals face certain limitations and difficulties in terms of manpower, material resources, and financial resources, while remote healthcare can connect various primary hospitals through internet technology to achieve resource sharing and mutual assistance. Through remote consultation, remote diagnosis, and other methods, it can save manpower and material costs for primary hospitals, and reduce the cost burden for patients seeking medical treatment.

Finally, telemedicine can help primary hospitals improve their technological content. With the continuous progress of technology, telemedicine has become a new medical model. Through remote consultation, remote diagnosis, and other methods, primary doctors and patients can better understand and master the latest medical technology and knowledge, and improve the technological content and innovation ability of primary hospitals. In summary, telemedicine can help primary hospitals improve their technological content by providing access to specialist expertise, supporting training and education, enabling comprehensive patient care, facilitating quality improvement initiatives, optimizing resources, and fostering research and innovation. By embracing telemedicine, primary hospitals can enhance their
capabilities, expand their services, and improve patient outcomes in a technologically advanced manner.

5.2 Discussion of the application of 5G in telemedicine

5.2.1 Overview of 5G

5G refers to the fifth generation of wireless technology for cellular networks. It is the latest and most advanced standard for mobile communications. Compared to previous generations (such as 4G or LTE), 5G offers significantly higher data speeds, lower latency, and increased network capacity.

Some key features and benefits of 5G include: Faster speeds. 5G networks can provide download speeds up to 10 Gbps, which is much faster than 4G. This enables quicker data transfers, faster streaming, and improved user experiences. Lower latency. 5G networks have reduced latency, meaning the time it takes for data to travel between devices and the network is significantly decreased. This is particularly important for applications that require real-time responsiveness, such as remote surgery, autonomous vehicles, and augmented reality/virtual reality (AR/VR). Greater network capacity. 5G networks have the capability to connect a massive number of devices per unit area. This is crucial for the growing number of Internet of Things (IoT) devices that require reliable and high-speed connections. Improved reliability. 5G networks offer enhanced reliability compared to previous generations. They employ advanced technologies such as network slicing, which allows customized virtual networks to be created for specific applications, ensuring high availability and reliability. Enablement of
new use cases. 5G is expected to bring about transformative changes across various sectors, including healthcare, transportation, entertainment, and manufacturing. It enables innovative applications like remote surgery, smart cities, autonomous vehicles, and immersive AR/VR experiences. It’s worth mentioning that the full deployment of 5G networks can take time, and the availability and adoption of 5G vary across different regions and countries.

5G networks provide higher data transfer speeds and larger bandwidth. Compared to 4G networks, the speed of downloading, uploading, and transferring files is faster, allowing users to complete various online tasks faster. 5G networks have lower latency, which means shorter response time for data transmission. This is very important for real-time interactive applications and industries that require high-speed data transmission, such as autonomous driving, telemedicine, and virtual reality. It can support more connected devices, allowing more IoT devices and sensors to connect to the network simultaneously, creating more opportunities for fields such as smart cities, IoT, and industrial automation. Moreover, 5G networks also have introduced more technologies to enhance signal stability and coverage, providing more reliable wireless connections and maintaining stable network performance even when a large number of users are connected simultaneously. The popularization of 5G networks will drive innovation and development in different industries. It provides broader development space for various intelligent applications, the Internet of Things, industrial automation, etc., and assists in the rapid development of the digital economy.

There are also some disadvantages of 5G. First of all, the infrastructure construction cost. Due to the need for more base stations and equipment in 5G networks to support higher
frequencies and data transmission speeds, the cost of related infrastructure construction is relatively high, which may become a challenge.

Second, the limited signal coverage. Because of the use of high-frequency signals in 5G networks, their transmission distance is relatively short and the signal coverage is also relatively small. This requires more intensive deployment of base stations to achieve comprehensive coverage, especially in rural and remote areas, which may face challenges.

Third, device compatibility. 5G networks require 5G compatible devices to achieve their advantages, which means users need to purchase new devices or upgrade their devices. During the transition period, device compatibility may become an issue. Finally, electromagnetic radiation and health issues. Some people are concerned that the high-frequency signals of 5G networks may have potential impacts on human health. Although research has shown that the radiation levels of 5G networks are within a safe range, this is still a controversial topic.

5.2.2 The application of 5G in telemedicine

As the latest innovative technology, 5G has been widely used in telemedicine. 5G technology has the potential to revolutionize the field of telemedicine by enabling faster and more reliable communication between healthcare providers and patients. The first one is remote consultations: with the high-speed connectivity and low latency of 5G, doctors can conduct real-time video consultations with patients, even in rural or remote areas. This allows
for accurate diagnosis, medical advice, and prescription without the need for in-person visits. 5G connectivity can facilitate the remote monitoring of patients’ vital signs and health conditions. Wearable devices and sensors can transmit real-time data to healthcare providers, enabling them to monitor patients’ health status remotely and intervene if necessary. The third one is Tele-surgery and robotic-assisted surgeries: 5G’s low latency and high bandwidth capacity can support remote surgeries. Surgeons can perform procedures using robotic systems, controlling them from a different location. 5G ensures a seamless and near real-time connection between the surgeon and the surgical equipment. Meanwhile, 5G can also support medical imaging and diagnostics. High-resolution medical imaging, such as MRI and CT scans, generates large amounts of data that need to be transmitted and analyzed quickly. 5G enables the fast transfer of these data, allowing radiologists and specialists to analyze images remotely and provide timely diagnostic reports. And emergency healthcare services are also emerged because of the development of 5G. In emergency situations, paramedics or first responders can use 5G-enabled devices to transmit vital patient data, including images, videos, and live streaming, to hospitals. This helps doctors prepare for the arrival of the patient, make informed decisions, and provide immediate instructions for emergency treatments. The last one is enhanced virtual reality (VR) and augmented reality (AR): 5G’s high bandwidth and low latency make it ideal for delivering high-quality VR and AR experiences in healthcare. Surgeons can use AR to visualize and project medical images onto a patient during operations, enhancing precision and reducing risks.
There are also some research that explore the application of 5G in telemedicine.

F Jia et al. (2019) introduces the concept and characteristics of 5G communication technology and telemedicine, and expounds the application of 5G communication technology in telemedicine such as remote surgery, remote video consultation, telemedicine health monitoring, and public emergency command, pointing out that 5G communication technology will promote the development of telemedicine in China. 5G networks have an efficient effect in energy consumption and provide a quality experience to many communication devices. Device-to-device communication is one of the key technologies of 5G networks. Internet of Things (IoT) applying 5G infrastructure changes the application scenario in many fields especially real-time communication between machines, data, and people (TW Lin, 2021). The project is one of the "5G plus medical and health" application pilot projects in the country. The platform will be established by a 5G-powered eye hospital, which was jointly set up by the Xiamen Eye Center of Xiamen University, the Xiamen branch of China Telecom, and the tech giant Huawei (S Beer, 2022). Dongwei Fu. (2023) analyzes the different roles and characteristics of AI technology, robot epidemic prevention service, telemedicine service and Internet medical technology in the treatment and control of major epidemics. The results show that "AI technology+5G network" information technology plays an important role in early detection, monitoring and early warning, pathological sharing, diagnosis assistance and diagnosis and treatment improvement, effectively reducing cross-infection and treatment pressure, meet the needs of medical treatment and improve the efficiency of treatment. Xiaoren Zhong. (2023) Introduced the importance of using 5G
technology in the field of smart healthcare; secondly, the existing problems and practical applications were analyzed; finally, the market prospects were analyzed from the perspectives of achieving precision medical services, personal health management, remote medical collaboration and sharing, regional medical networking, and achieving network coverage within hospitals.

5.2.3 Case Analysis

As introduced before, Guangdong General Hospital built the province's first 5G Internet hospital. Relying on the personalized Big data service capability, they will build an interconnected, collaborative, intelligent and accurate Internet medical panoramic ecosystem. For patients, create a whole process of intelligent medical treatment, improve the patient's medical treatment experience through diversified forms of consultation, and provide integrated innovative services of dynamic detection of Health data and intelligent early warning to ensure the health and well-being of the masses of the people. Facing medical care, they will create intelligent workstations to achieve diversified forms of diagnosis and treatment, intelligent diagnosis and treatment assistance, and online graphic and textual consultation to facilitate zero distance communication between doctors and patients; Facing hospital management, an integrated platform is used to achieve multi-dimensional visibility, manageability, and controllability, with functions such as "smart follow-up" to assist in the development of refined operations.
We can see that 5G technology has played an very important role in the construction of Internet hospitals in Guangdong Province, specifically reflected in the following aspects:

First of all, remote outpatient service. Patients can engage in remote video outpatient service with doctors through the use of mobile phones or other devices. The high-speed connection and low latency of 5G ensure high-quality real-time video communication, allowing doctors to accurately analyze and diagnose patients' symptoms and provide appropriate medical advice. Through the 5G network, doctors can obtain real-time physiological data of patients. Patients can carry various sensor devices, such as heart rate, blood pressure, oximeter, etc., to transmit data to doctors for remote monitoring. Doctors can also evaluate the health status of patients based on these data and provide corresponding medical advice. Through 5G network, doctors can quickly transmit large Medical imaging files (such as CT scan, MRI, etc.) for remote diagnosis. This can save time for patients and doctors, avoid repeated examinations for patients, and improve medical efficiency.

Second, remote monitoring and health management. Patients can use intelligent wearable devices or home monitoring devices to transmit physiological parameters and Health data to hospitals through 5G technology, and doctors can monitor and manage patients' health status in real time. The coverage of 5G networks is broad, enabling cross regional integration of remote monitoring and health management. Patients can receive remote medical services anywhere, no longer constrained by distance and geographical location. Doctors can also provide medical consultation and management services for more patients through remote monitoring and management. The role of 5G in remote monitoring
and health management lies in real-time data transmission and monitoring, high-definition and stable video communication, cross regional medical resource integration, efficient remote diagnosis and consultation, and a comfortable and convenient health management experience. These advantages help to improve the medical experience and health management effectiveness of patients, and promote the rational allocation and utilization of medical resources.

Finally, remote surgical guidance. With the low latency and high-speed transmission capability of 5G, doctors can provide real-time guidance and support for other doctors' surgical operations through the remote surgical guidance system, improving surgical effectiveness and safety. Through the 5G network, doctors can overcome geographical barriers and provide surgical guidance and support to other medical institutions, even doctors in remote areas. This can promote professional medical resources and expert knowledge to a wider range of regions and improve medical standards. At the same time, the remote surgical guidance system can be used for medical education and training. Medical students or junior doctors can learn and understand surgical techniques and procedures by watching the remote surgical guidance process. This will help improve the technical level of medical students and doctors, and promote the inheritance and cultivation of professional skills. Overall, with the help of 5G technology, remote surgical guidance systems can provide real-time guidance and support, promote cooperation and innovation among doctors, and improve surgical effectiveness and safety. This innovative medical model helps to improve the allocation and utilization of medical resources, enabling more patients to benefit from professional medical
services.

Guangdong Mobile and Guangdong General Hospital have jointly built a series of innovative applications such as 5G Internet hospital, 5G telemedicine, 5G emergency first aid, 5G smart ward, image cloud service, etc. Next, Guangdong Mobile will fully leverage the advantages of digital and intelligent capabilities such as G+ACDE and information platforms to fully support the construction of "5G+smart healthcare. In the future, Guangdong General Hospital will also seize the development opportunity of the 5G era, further explore the application scenarios of Big data, artificial intelligence, 5G and other cutting-edge technologies in the medical field, improve the overall efficiency of medical services, and promote the development of health service system and model reconstruction.

5.3 Summary

Since the new round of health care system reform, the big health industry has given new momentum and vitality to the medical industry through digital technology. We are accelerating the integration of telemedicine with hardware, software and network communication, and using Internet technology to accelerate business collaboration and information interoperability among medical resources. The network communication technology in the 5G era provides possibilities for remote medical high-definition imaging, real-time synchronization, and massive data transmission needs. Relying on communication, sensors and other information, intelligent medical and mobile devices can realize the real-time collection and monitoring of human data to bring new opportunities for the
development of remote monitoring services. Telemedicine has been well popularized and
developed in China, based on the telemedicine system to establish synergy linking township,
district, county, local and provincial hospitals, forming a vertical care system from chronic
disease management to acute morbidity referral to critical care assistance, radiating to the
whole country through the Internet platform, forming a unified training standard and talent
growth standard, which is the basis for realizing graded treatment. Through the concept of
“Internet+” combined with telemedicine mode, it can change the working habits of doctors
and the medical habits of patients, and ultimately change the whole distribution structure of
medical resources, bringing patients a sense of access through medical reform.

At the same time, there is a large space for the development of laws and regulations
related to telemedicine in China, and the implementation of telemedicine services varies
greatly from region to region. In order to truly achieve large-scale application and sharing, it
is necessary to introduce unified management and operation norms, further clarify the
medical disputes and diagnostic challenges that may arise in the process of telemedicine and
strengthen the acceptance of telemedicine services for both patients and healthcare
professionals. With the policy support, we promote the use and graded application of
telemedicine services with patients as the center, and provide timely feedback and
improvement for the problems that arise in patients' participation in telemedicine treatment
experience, highlighting the characteristic advantages of telemedicine and improving patients' trust in this field. Aiming at the group of medical personnel, we will increase the publicity of
telemedicine for them, penetrate the value of telemedicine usage from an ideological point of
view, and sound the mechanism for medical personnel to engage in telemedicine services from a behavioral point of view. Medical personnel can be rewarded for using telemedicine technology to produce significant and high-quality results for patients or institutions. Strengthen telemedicine training for primary care staff, encourage the opening of distance learning courses, remote system instruction and other related contents, provide intelligent learning methods and practice opportunities for medical staff, and promote the rationalization of telemedicine.

At the same time, data privacy issues are a major concern. As it involves personal health information, it is crucial to protect patient privacy and data security. We need to use secure encrypted communication and transmission protocols to ensure that data is protected during transmission and storage. Use authentication and access control mechanisms to limit who has access to sensitive data. The education and awareness raising is also very important. Conduct data privacy and security awareness training for healthcare professionals and patients to strengthen their understanding of the importance of privacy protection. Besides, if third-party service providers or platforms are involved, ensure that confidentiality non-disclosure agreements are in place with them. Evaluate their security measures and data handling practices to ensure they meet privacy protection requirements. In a word, in the future, we need to try our best to ensure that data privacy issues in telemedicine are adequately addressed and protected.

Finally, it is also necessary to improve medical insurance and public awareness. China's medical insurance system has been operating for more than 20 years, but different regions
have not yet formed a unified standard. Under this situation, it is of great necessity to strengthen the top-level design and multi-linked sound medical insurance system in telemedicine. Telemedicine service center is to provide convenience for patients, reduce the burden of medical care for the masses, promote people's well-being, and alleviate the problem of unbalanced medical resources. We will actively promote the development of Internet medical care to a deeper level, quickly promote the service level and characteristics of telemedicine technology, and provide correct publicity and consultation guidance for the use of Internet platform telemedicine services, move from traditional medical care to a new model of medical industry development that integrates "online + offline". It also provides proper promotion and consultation guidance for the use of the Internet platform, moving from traditional medical treatment to a new medical industry development model of "online + offline" integration, increasing the usage and awareness of people of different age groups, and promoting the development of the medical health ecosystem.
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