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Promoting Hierarchical Medical System at County Level via University-Hospital-Community Linkage – A Case Study of the Seventh Affiliated Hospital of Southern Medical University

WANG Silang

Doctor of Management

Supervisor:
PhD Sara Ramos, Assistant Professor,
ISCTE University Institute of Lisbon

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Abstract

China's current county-level diagnosis and treatment system has problems such as unclear responsibilities of medical institutions at all levels, unbalanced distribution of human resources and benefits, barriers to talent and information flow, and a lack of mature referral mechanism for incomplete basic information of patients.

Public hospitals and grassroots health facilities are like the two sides of a scale. It is rather difficult to balance the interests of the two. As a result, it is very difficult and expensive for people to see a doctor. There are many studies in China that look into this problem through different lenses, but there is few research approaches that can be generalized.

In response to this problem, we proposed a new model to explore and try to address the in-depth problems in the hierarchical medical system. This thesis takes the Seventh Affiliated Hospital of Southern Medical University as the research object, and studies a new type of university-hospital-community linkage model to promote the development of the county-level hierarchical medical system, so as to achieve a win-win situation for the government, universities, hospitals, grassroots facilities and patients, and to provide references for follow-up research.

We first determined the factors influencing how the linkage model runs through several strategies: i) literature review on the development status of the HMS, and its related concepts, connotations, related theories, and the development of clinical practices at home and abroad; ii) expert consultation in the fields of health policies, health economics, hospital administration, and hospital reform; iii) questionnaire survey to different groups of respondents, including hospitals, communities and patients; iv) interviews with key informants; v) and hospital indicators analysis.

Then, a reliable mathematical model was established based on the key factors combined with the hospital operation data. The relationship between the factors was analyzed using the model.

Finally, through the case study, the operational effect of the model was examined, and improvement measures were proposed for existing problems. In the case study, we summarized some contributions and shining points and plan to follow up the relations between the measures and the results in the long term.

Keywords: hierarchical medical system; university-hospital-community linkage; two-way referral policy at county level; medical alliance (medical community)

JEL: I11; I18.

Resumo

O atual sistema de diagnóstico e tratamento ao nível municipal da China apresenta vários problemas, como por exemplo responsabilidades pouco claras das instituições médicas em diferentes níveis, distribuição desequilibrada de recursos e benefícios humanos, barreiras ao fluxo de talentos e de informações e falta de mecanismos de referência maduros para lidar com informações básicas incompletas por parte dos pacientes.

Hospitais públicos e unidades de saúde de base são como os dois lados de uma escala, sendo bastante difícil equilibrar os interesses de ambos. Como resultado, é também muito difícil e caro para as pessoas consultarem um médico. Existem muitos estudos na China que analisam este problema através de diferentes pontos de vista, mas há poucas abordagens se pesquisa que possam ser generalizadas. A outros contextos.

No sentido de responder a este problema, propusemos um novo modelo para explorar e tentar resolver as falhas identificadas no sistema médico hierárquico. Esta tese tem como objeto de pesquisa o Seventh Affiliated Hospital of Southern Medical University e estuda um novo tipo de modelo de articulação universidade-hospital-comunidade para promover o desenvolvimento do sistema de diagnóstico e tratamento ao nível municipal, de modo a alcançar uma situação vantajosa (*win-win*) para o governo, universidades, hospitais, instalações de base e pacientes, e para fornecer referências para a pesquisa de acompanhamento.

Numa primeira fase, foram determinados os fatores que influenciam o modo como se processa o modelo de ligação, através de diversas estratégias: i) revisão da literatura sobre o status de desenvolvimento do HMS, e seus conceitos relacionados, conotações, teorias relacionadas e o desenvolvimento de práticas clínicas no país e no exterior; ii) consulta de especialistas nas áreas de políticas de saúde, economia da saúde, administração hospitalar e reforma hospitalar; iii) questionário dirigido a diferentes grupos de entrevistados, incluindo hospitais, comunidades e pacientes; iv) entrevistas a informantes-chave; v) e análise de indicadores hospitalares.

Em seguida, foi estabelecido um modelo matemático confiável com base nos principais fatores combinados com indicadores da atividade hospitalar. A relação entre os fatores foi analisada utilizando o modelo.

Finalmente, por meio do estudo de caso, foi examinado o efeito operacional do modelo,

sendo propostas medidas de melhoria para os problemas existentes. No estudo de caso, resumimos algumas contribuições e pontos de destaque, com o objetivo de orientar e acompanhar as relações entre as medidas e os resultados a longo prazo.

Palavras-chave: sistema médico hierárquico; ligação universidade-hospital-saúde local; política de referência bidirecional ao nível municipal; comunidade médica (aliança médica)

JEL: I11; I18

摘 要

中国当前县域分级诊疗体系存在信息不完备、利益分配不均衡，转诊机制不成熟等问题。

公立医院和基层社区之间始终像天平的两端，无法达成利益的统一。老百姓看病因此长期呈现“看病难、看病贵”的问题。国内对于该现状有从不同角度分析的研究论文，但一直缺乏共性的研究手段。

针对此问题，我想提出一种新的模式，探索和初步解决分级诊疗方面深层次的问题。本文以南方医科大学第七附属医院为对象，研究一种新型的大学—医院—社区联动模式推动县域分级诊疗制度的发展，以期望实现政府、大学、医院、社区和患者多方共赢，并为后续相关研究提供参考数据和案例。

本文的研究过程如下：1、回顾了分级诊疗制度、相关概念、含义和理论、以及国内外临床实践的相关文献调研；2、就卫生政策、卫生经济学、医院管理以及医院改革开展了专家咨询；3、针对医院、社区和患者开展了问卷调查；4、关键人员访谈；5、医院指标分析。

然后参照关键因素结合医院运营数据建立可靠的数学模型，使用模型分析了各因素之间关系。

最后，通过案例分析考察模式的运营效果，针对现存问题提出了改进措施。在案例研究中，本文总结了一些贡献和闪光点，并计划长期跟踪措施与结果之间的关系。

关键词:分级诊疗；大学-医院-社区联动；县域双向转诊政策；医共体(医联体)

JEL: I11; I18

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List of Abbreviations

SMU	Southern Medical University
CDC	center for disease control
NHS	National Health Service
HMS	Hierarchical medical system
JCI	Joint Commission International
TCM	Traditional Chinese Medicine
WHO	World Health Organization
NHC	National Health Commission
NHS	National Health Service
GP	general practitioner
GDP	gross domestic product
WHO	World Health Organization
NHC	National Health Commission
OECD	Organization for Economic Cooperation and Development
DRG	diagnosis related group
ADF	Augmented Dickey-Fuller
ACF	autocorrelation function
PACF	partial autocorrelation function
MAPE	mean absolute percentage error
VIF	variance inflation factor
OLS	ordinary least squares
BG	Breusch-Godfrey
MDT	multi-disciplinary diagnosis and treatment
COVID-19	Coronavirus disease 2019
TMI	total medical income
BU	bed utilization
NOE	number of outpatient and emergency visits
NHFC	National Health and Family Commission

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Chapter 1: Introduction

1.1 Research background

1.1.1 China's medical reform

The development of China's medical system has gone through several stages. In the planned economy period that is before the reform and opening-up, the medical system was relatively closed and solidified. As government's service window and governing commitment to the public, health care was almost free of charge, which greatly highlighted the socialistic characteristic of "a big government and people orientation". In 1978, with China formally starting its reform and opening-up, the society witnessed a rapid development, which fundamentally transformed the domestic economic system. The planned economy was gradually replaced by the market economy, and various industries began to break free from the original constraints to embrace the market and participate in the market competition. Health care and education, the two last lines of defense of Chinese people's livelihood, although not so willingly, had undergone revolutionary transformations along with the development of society and economy. In general, after the marketization of the medical system, medical institutions have become profit-oriented and various chaos has emerged, leaving some people in the dilemma of difficult and expensive access to medical care. In order to solve this problem, the Chinese government carried out medical reform, aiming at solving the difficulties and high costs of medical service for the public. In this context, the Chinese government proposed an exploratory system of the hierarchical medical system. Different from the hierarchical medical system in western countries, China's hierarchical medical system emphasizes four principles, which generally include treating acute and chronic diseases separately, combination of prevention and treatment, initial diagnosis and treatment at grassroots medical institutions and two-way referral.

In the first planned economy period, China designed and established a relatively effective hierarchical medical system. In most urban areas, a management model based on the labor medical care and publicly-funded medical care was implemented for the medical treatment and referral, and the pattern of "barefoot doctors" (who were medical staff with certain medical knowledge and abilities approved and assigned by the grass-roots government and usually part-

time rural grass-roots medical personnel who work in agriculture during the day and deliver medicines at night.) providing basic medical services for urban residents as “gatekeepers” was formed. Since the reform and opening-up, the commonweal nature of China’s medical and health services has changed along with the marketization. Medical institutions became increasingly profit-driven, the allocation of medical resources was seriously out of balance, and the hierarchical medical system gradually broke down.

Under normal circumstances, the resource distribution of medical institutions should present a situation in which primary health care institutions are in the majority, while the senior medical institutions occupy the minority. Viewed from the big data’s statistical model, this distribution should present a pattern of “positive pyramid”. However, the reality is, because China has always lacked a complete and scientific strategic plan for medical development and medical management system, under the impact of the market economy and the guidance of the market system, the number of large-scale medical institutions has mushroomed rapidly, and these large medical institutions are still expanding and growing because of their nature of profit-seeking, thus gradually monopolizing high-quality medical resources and talents. At the same time, as patients are unwilling to go to primary health care institutions, it occurs in these institutions that their revenues reduce and their staff, obtaining lower income, show less willingness and enthusiasm for their work. In the long run, more and more people are reluctant to work in primary health care institutions, resulting in a vicious cycle. In addition, the medical institutions at all levels in a same region have different systems and mechanisms. It is difficult for them to find the optimal mode of benefit distribution if they only consider their own interests. There is also a lack of work and service mechanism, as well as the motivation for further cooperation among them. As a result, many resources of the primary health care institutions remain idle. The original intention of the tertiary general hospital is to solve acute, serious and complicated diseases, but because of people’s unwillingness to seek medical treatment there and the deficiencies in the development of primary medical institutions, a large number of their resources are used for common, frequently-occurring and chronic diseases. As the limited resources have not been scientifically used and the contradiction between supply and demand has been further intensified, the management efficiency of medical institutions has also been reduced. As a result of the superposition of the above factors, China’s medical and health service management system has been in the stage of low efficiency and low quality for a long time with unsatisfactory effect.

The year of 2009 was the first year of China’s new medical reform. After three years, the plan officially entered the implementation stage, whose core was to alleviate and meet the

greatest needs of the people through hierarchical medical system, namely, to cure patients conveniently, quickly, economically and effectively. Subsequently, China's central government continuously issued a number of documents with guidance and opinions, which directly pointed out to the crux of the problem and determined the prominent role of hierarchical medical system, so as to actively promote the implementation of the system in the government and health authorities at all levels. The exploration of the medical reform witnessed the emergence of many modes, including Xiamen mode in Fujian, Tianchang mode in Anhui, Luohu mode in Shenzhen, Chaoyang mode in Beijing, and Chongming mode in Shanghai. In 2015, Guiding Opinions on Promoting the Construction of Hierarchical Medical System was specifically formulated, in which the experiences of different regions were summarized and sorted out. It especially pointed out that it was necessary to build a coordination system for up-and-down linkage and labor division between public service and the basic medical healthcare. With innovative methods and bold exploration, it further constructed and implemented hierarchical medical system, enhanced the training of doctors, and contributed to the professional training for family doctors. Practice has proved that the highlights of medical reform in various areas are related to hierarchical medical system, which is of great significance to the rational allocation of medical resources, especially for the primary medical resources, as it can ensure the expansion of more high-quality medical resources to primary medical institutions, so as to ensure the fair and just development of public medical and health undertakings in urban and rural areas. Hierarchical medical system is of great significance in promoting the continuous improvement of China's medical cause, ensuring the health of the whole people, guaranteeing and improving the medical quality and environment.

In recent years, the main systems and measures that focus on solving the problem of "difficulty of accessing medical service" include the medical alliance coordination system, hierarchical medical system and social medical system. The policies that can effectively deal with the difficulty of "high costs of accessing medical service" include the clinical path system, medical insurance system, zero-markup drug system, essential drugs system, and medical service price reform. The corresponding policies focusing on solving the related problems of "difficulty and high costs of accessing medical service" include the supplementary reform of public hospitals, the comprehensive supplementary reform of primary health care institutions, and the reform of hospital governance system.

However, it is clear that China's new medical reform has not achieved the expected success. People are not satisfied since it is still hard to see a specialist; per capita health expenses keep increasing; and the rate of out-of-pocket medical expenses exceeds 40%. The government is

not satisfied since increasing spending reaps limited effectiveness; medical expenses grow too quickly; funds for health insurance and social insurance are wasted and exceeded seriously; and people's livelihood is faced with arduous challenges. Hospitals are not satisfied since increasing government spending is still a drop in the bucket and public hospitals are unable to make ends meet; and the responsibilities and interests of public hospitals are mismatched. The government still possess a steadfast and strict stance on pricing, leading to a continuous decline in hospital profit margins. Medical staff are not satisfied since prominent doctor-patient conflicts make it too risky to practice medicine. There is a clear gap between the payroll of medical and nursing staff and the workload and the risks they have to take.

China's new health care reform had good intentions and starting points, and the initial results of the reform were obvious, as health insurance achieved wide coverage and the increase in medical costs was significantly controlled. Nevertheless, various complicated problems cause the incompleteness of the reform and numerous obstacles on the way to reform.

1.1.2 Cooperation with university

In China, most of the high-quality medical resources are concentrated in medical colleges and universities. More than 70% of the top 100 hospitals in China are affiliated to universities or medical colleges. The influential and prestigious medical schools include Peking University Health Science Center and Cheeloo College of Medicine of Shandong University, while well-known medical universities include Capital Medical University and Peking Union Medical College.

As the best independent medical university in South China, Southern Medical University (SMU) has had a bumpy ride. It was first founded in Qiqihar during the war, then moved to Changsha and was finally established in Guangzhou in 1951. Its well-known predecessor, First Military Medical University, is one of the four prestigious military medical universities in China. In 2004, after years of development, SMU was officially transferred to the jurisdiction of Guangdong Province. Thus, it became a unique university in this region, jointly built by the province and ministries. At the same time, it is also the first university adopting the eight-year medical education program that covers bachelor, master, and doctoral degrees in China. At present, the comprehensive strength and scientific research strength of this university ranks the top three among the domestic independent medical colleges and universities. Besides, its doctor scale ranks the second among all medical colleges and universities, and its disciplines, including immunology, pharmacology and clinical medicine, rank the top 1% according to the essential science indicators in the world.

By 2020, SMU has a total of 13 directly affiliated hospitals, which were distributed in the Pearl River Delta and the surrounding cities. In Guangzhou, among the seven affiliated hospitals, Nanfang Hospital ranks the second in the province and it also always ranks high in China, whose scientific research and academic ability is among the top 10 in China. Zhujiang Hospital ranks the top 10 in Guangdong and top 100 in China. Orthopaedic Hospital of Guangdong Province ranks among the top in the province in terms of comprehensive strength of orthopaedics. In Traditional Chinese Medicine (TCM)-Integrated Hospital (the Fourth Affiliated Hospital of SMU), the most famous disciplines are clinical medicine and oncology. Guangdong Provincial Dermatology Hospital is the best dermatology hospital in the province. Stomatology Hospital, the former Stomatology Hospital of Guangdong Province, ranks the first in Guangdong Province in terms of its comprehensive strength. As for the two affiliated hospitals in Foshan, Nanhai Hospital (the Seventh Affiliated Hospital of SMU), is the key case of this study. Located in the north of Foshan and in the core of the contiguous area of Guangzhou-Foshan, it focuses on the development of general medicine, and its construction of a regional medical alliance has achieved the initial results. Shunde Hospital (the Eighth Affiliated Hospital of SMU) ranks the third in Foshan City in terms of the comprehensive strength, and the first in Shunde District. It is famous for its emergency and serious diseases discipline. Among the three affiliated hospitals in Shenzhen, Shenzhen Hospital (the Sixth Affiliated Hospital of SMU) and the “three famous (famous doctors, famous hospitals and famous clinic)” project model hospitals have become the regional medical centers in Shenzhen with a rapidly growth of business scale; Shenzhen Stomatology Hospital and Shenzhen Stomatology Hospital (Pingshan) are also under rapid construction and development. In addition, SMU also has 49 non-directly affiliated hospitals and teaching hospitals, whose comprehensive strengths are at the forefront of China’s medical colleges and universities.

Most of the affiliated hospitals are positioned as national medical centers or regional medical centers. How to create a benchmark of health care reform for the grassroot or county level medical institutes through its superior disciplines and strengths and assume the due responsibility in the national medical reform to support the development of grassroot medical institutions, have been questions that SMU is pondering.

1.1.3 Entrusted by the government

Lishui Town is one of the most important areas of Nanhai District, Foshan City. Located in the northeast of Nanhai District, adjacent to Huadu District of Guangzhou in the north, Baiyun District in the east, Dali Town in the south, and Shishan Town in the west. It is 20 kilometers

away from the central urban area of Guangzhou and Foshan. Up to now, the town has a total area of 148.28 square kilometers, with 200,000 residents population and a total population of more than 500,000. With a beautiful environment and talented people, Lishui Town has also advanced the titles of National Strong Town of Education and National Health Town. Its comprehensive strength has been at the forefront of China for a long time, and especially in 2018, it was among the top 10 in China. There is a large public medical institution in the town, that is, the former Third People's Hospital of Nanhai District.

In 2012, the government began to plan the construction of a new hospital with 1,200 beds and over 1,000 parking spaces, covering an area of 100 *mu* (about 66666.67 square meters) and a floor space of 160,000 square meters. The change in the hospital environment needed the support of high-level medical resources. To this end, in May 2016, the Government of Lishui Town and SMU reached a cooperative intention to accelerate the construction of the Third People's Hospital of Nanhai District.

Since 2019, the hospital has become a direct unit of the university, namely its seventh affiliated hospital. The ownership of the hospital belongs to the local government, while the right of operation and management belong to the university. It is hoped that with the brand advantages as well as discipline talent resources of SMU, vitality and innovative elements could be injected into the Third People's Hospital of Nanhai District for its construction and development, so as to improve Lishui Town's medical conditions as a whole. It is planned to build the hospital into a medical center in the contiguous area of Guangzhou-Foshan in three to five years to truly realize the goal of building a healthy town whose residents do not need to see doctors out of the town when they have serious diseases.

1.1.4 Reform in the community

The Community Health Service Center of Lishui Town has a certain influence on the local area. It is a public institute administrated by the government of Lishui Town, and its channels of revenues and expenditures are separated for management. The Community Health Service Center has set up one headquarter (Heshun District Hospital), 18 medical stations and two vaccination clinics, and employs nearly 300 people, including nearly 100 general practitioners (GPs). The Community Health Service Center mainly undertakes the responsibilities of basic medical care, public health services, preventive health care, rehabilitation, health education, family planning guidance, and patriotic health. It also provides comprehensive diagnosis and treatment services. Since 2014, The Community Health Service Center has been separated from the hospital, mainly responsible for primary health care and all public health work in Lishui

Town. Due to the large foreign population in Lishui Town, public health work was quite difficult to carry out, coupled with the lack of community manpower, the pay mechanism was not perfect, the relevant work was not smooth, the results were not obvious. The community has a strong desire for reform, in order to establish a regional medical alliance and coordinate development.

In terms of the disease spectrum of Lishui Town, at present, the center for disease control (CDC) only counts two major chronic diseases, hypertension and diabetes, and does not have comprehensive data on the diseases of the town's residents. According to statistics released by Lishui Town CDC, hypertension and diabetes increased from 12,770 and 4,164 cases in 2016 to 14,171 and 4,221 cases in 2017. From 2016 to 2019, the disease spectrum of the Seventh Affiliated Hospital of SMU has not changed much and it mainly consisted of fracture, tracheitis, coronary heart disease, and diabetes. In 2019, it was mainly dominated by chronic diseases, which accounted for 35.57% of the cases, including diabetes mellitus, hypertension and coronary heart disease.

1.2 Concept definition

1.2.1 The hierarchical medical system at the national level

Hierarchical medical system (HMS) usually refers to that various levels are designated for hospitals according to the specific conditions of different hospitals, and that patients are graded according to various factors such as the degrees of their conditions and their treatment. Then, patients go to corresponding hospitals to seek specific treatment at their graded level, so that medical resources can be used scientifically. This model not only allows patients to receive excellent medical services, but also saves medical expenses and improves overall medical efficiency. Moreover, hospitals treating patients according to the graded level not only reduces the burden of large hospitals, but also increases the income of primary health care institutions (P. Q. Fang et al., 2014; X. G. Huang et al., 2013).

HMS means that according to the degree of illness and the complexity of the diagnosis and treatment, the level of treatment will be targeted, patients with different degrees of severity will be triaged, different medical organizations will be tasked with the corresponding treatment, medical treatment will gradually change from the original general practice to the direction of medical specialization, to ensure that each family can receive scientific health consultation services. HMS can also guide people to seek medical treatment in primary medical institutions for minor illnesses and go to large and medium-sized hospitals for serious diseases, thus

guaranteeing a sustained and harmonious healthcare system. When patients can rationally choose medical institutions at different levels according to their own conditions, the convenience and efficiency of medical services and the cost-effectiveness of medical resources will all be enhanced significantly.

In order to enable medical organizations to bring quality medical services, China has creatively proposed HMS, which generally includes initial diagnosis and treatment at grassroots medical institutions, differential treatment of acute and chronic diseases (grassroot medical institutions mainly treat patients with chronic diseases, while higher-level medical institutions treat acute diseases), and collaboration between medical institutions at higher and lower levels (grassroots medical institutions should maintain close contact with medical institutions at the higher level).

In the process of constructing the HMS, a complete and sound collaboration network of medical and health care services will be built between urban and rural areas. With the help of a cooperation platform for medical institutions at different levels, high-quality medical resources could be provided for grassroot medical institutions, which can promote the utilization rate of medical and health resources.

At present, the HMS mainly has three levels. The medical and health institutions at the primary level are mainly responsible for providing patients with basic medical services; those at the secondary level are responsible for problems that institutions at the first level cannot solve, common operations, and the treatment of some acute diseases. Hospitals at the tertiary level mainly focus on the diagnosis and treatment of intractable and complicated diseases.

1.2.2 University-hospital-community linkage

The leading core of the project implementation team is the Seventh Affiliated Hospital of SMU, which also include Lishui Town Community Health Service Center of SMU. SMU and its affiliated hospital have jointly formed a team of professional management and technical personnel, realizing the modern hospital management, remote consultation, multi-disciplinary diagnosis and treatment (MDT), science and education improvement, Joint Commission International (JCI) quality control, medical quality control, and construction of the emergency and critical referral system. SMU's School of Nursing, School of Traditional Chinese Medicine (TCM) and School of Basic Medicine have leveraged their advantageous resources to help health service centers as well as hospitals to jointly form public health teams, family doctor teams, health care teams, quality caregiver teams, disease prevention and control teams and other public health and basic medical health service functions.

Under the guidance of the university, a family doctor team has been formed in the region, which is composed of the hospital and community health service center and guided by SMU. A grid approach is used to ensure the implementation of contracting services of community-based family doctors, to implement the national basic public health tasks, and to provide targeted medical and health services to citizens in the area according to their realities. This constitutes a three-in-one hierarchical diagnosis and treatment mechanism with the tertiary hospital as the core of the system, the community health service center and the health station to build and improve the health security systems for medical treatment, rehabilitation, TCM, and public health.

In the process of promoting the construction and development of the medical alliance in an all-round way, SMU has done some innovative work in the following three aspects:

(1) Management team: SMU introduced an excellent management team and talent team through the “general practice + medical alliance” in SMU.

(2) Technologies: Guangdong Provincial Institute of Public Health directly participates in the construction of the general practice center of the medical alliance and provides guidance for the construction of the regional health management information platform. The strength of the Seventh Affiliated Hospital of SMU has been improved in all aspects with the help of the academic strength of Nanfang Hospital and the Third Affiliated Hospital of SMU.

(3) Brand influence: the influence of SMU is undeniable. As one of the top medical universities in China, its brand influence and value are increasingly evident in the construction of Guangdong-Hong Kong-Macau Greater Bay Area. At the same time, the high-quality graduates of SMU have taken up important roles in many important positions, which once again drives and strengthens the brand of SMU.

The governments of Lishui Town and Nanhai District are responsible for the performance of the basic functions of public hospitals and institutions, which not only provides three basic elements, namely capital investment, land resources and human resources but also provide strong policy support.

(1) Land resources: providing land support in different aspects, such as scientific research, service management and logistics support.

(2) Capital investment: the governmental departments at all levels in Foshan City, Nanhai District and Lishui Town provide financial support to meet the diversified needs of different subjects in the construction of medical alliance.

(3) Human resources: coordinating the team of GPs to change the current situation of structural shortage of medical and health service personnel; issuing more advantageous policies

for talent introduction, so as to attract top talents from home and abroad.

1.2.3 The informatization of medical services

The unifying information platform can create a medical sharing information platform, on which diagnosis and treatment, medical records and other related information sharing can be realized, and orderly transmission of referral information can be accessible. With the help of different informatization methods, the level of mobility of medical information can be improved, and the utilization rate of resources can be maximized. In order to promote the hospital to move forward in an orderly and all-round way, patients should be respected as the center; the quality control should be strictly conducted; the allocation of medical resources should be strengthened and optimized; the information should be well shared in the region; service processes should be optimized, and the management efficiency should also be enhanced. In addition, in medical management and cost accounting, it is necessary to improve the operation of informatization, work out an intelligent hospital construction model, and form the prototype of a digital hospital.

1.2.4 Medical alliance

Medical alliance, short for medical treatment alliance, refers to a standardized, orderly, convenient, and fully functional medical and health service system, formed through the optimization and integration of the medical and health resources in a certain large area. It is a more reasonable, scientific, and effective system. Now, there are several medical alliance modes in China, including the mode with a tertiary hospital as the main body and the remaining secondary and primary hospitals as the supplements, and the mode in which the tertiary hospital and the secondary hospital are closely collaborated to promote the development of the first-class hospitals in the surroundings. At present, China's medical alliance in various forms can be classified from different angles, which will be explained in detail in the following chapters.

1.2.5 Health services management

Management related to the health services industry can be collectively called health services management, which belongs to a branch of public management. Therefore, the HMS can be studied from the perspective of public management. From the theories of public management, the theories about hierarchical diagnosis and treatment include public goods theory, Pareto optimality theory, and synergy theory.

1.2.6 Hierarchical medical system characteristics

In HMS, patients are graded according to the severity of their disease and the difficulty of treatment, ensuring that medical institutions and medical personnel at all levels can treat diseases that match their actual medical skills, and that the corresponding diagnosis and treatment can be carried out according to the traits of the diseases.

In fact, the reason for the HMS is conducted is to effectively improve the professional level of hospitals, promote the balanced development of medical resources in the medical institutions at all levels, and alleviate the heavy medical diagnosis work in large and medium-sized hospitals. Under HMS, some of the general outpatient care and post-rehabilitation that primary medical institutions can complete are handed over to primary medical institutions.

HMS can ensure that everyone can receive scientific health consultation services, and guide people to seek medical treatment in primary medical institutions for minor illnesses, and large and medium-sized hospitals for serious diseases. It is also ensured that patients can rationally choose the medical institutions at different levels according to their own conditions, so as to improve the convenience and efficiency of medical services, and significantly improve the cost-effectiveness of medical resources.

At the same tie, under HMS, large and medium-sized medical institutions can not only relieve their daily stress, but also devote more energy to the treatment of difficult and complicated diseases. Patients are thus relieved of their burden. As various difficult and complicated diseases are treated, the technical level of medical institutions will also be enhanced. In addition, primary medical organizations are required to take the basic medical work as the basis, providing important medical assistance in the diagnosis and treatment of common and frequently-occurring diseases. The entire medical service system circulates more smoothly, realizing a virtuous circle.

The following hierarchical medical models are currently practiced in China.

(1) Initial diagnosis and treatment at grassroots medical institutions. The representative province is Qinghai Province. Qinghai is one of the first batches of provinces in China to implement this model, aiming at maximizing the use of health insurance to provide more assistance for patients who are seeking medical treatment. For patients, they should turn to primary designated hospitals for their first visit, and then to secondary medical institutions for targeted treatment if treatment is found to be unavailable. After a period of treatment, if the patient's condition still does not improve, in such a case, he or she should be sent to a tertiary designated hospital. The governmental medical insurance does not cover and will not reimburse

the medical expenses incurred without the referral.

(2) Treating acute and chronic diseases separately. Hunan Province is a representative. Primary medical institutions are mainly responsible for dealing with common and frequently-occurring diseases. Secondary hospitals generally undertake the treatment of discipline-specific diseases as well as technically simple, medium risky surgeries at levels two and three. Tertiary hospitals focus on the diagnosis and treatment of difficult and complex conditions as well as surgical operations at levels three and four with high risk and complicated processes.

(3) Two-way referral. The representative province is Anhui Province. The primary hospitals are generally responsible for the treatment of common and chronic diseases. In other cases, in particular, acute and critical diseases and incurable and difficult diseases that cannot be handled by the technology and equipment of the primary medical institutions, or the cases that seriously exceed the scope of primary institutions are referred to higher-level medical institutions. At the same time, patients who are being cared for in secondary or tertiary hospitals and whose diseases are under control are able to be transferred to primary hospitals for subsequent care. A smooth and fast channel is established between the two sides.

(4) Regional medical alliance. The representative region is Beijing. In China, Chaoyang District of Beijing has taken the lead in establishing a medical alliance, and now it has built district-level alliances in four different regions, namely, the central, northern, southern, and eastern parts of the district. Among them, the medical alliance infrastructure is deployed according to the needs of the people, breaking the previous administrative affiliation, and each district is formed with one to two large tertiary public general hospitals as the service base and medical core.

1.3 Research at home and abroad

At present, the well-known and well-established HMS around the world are in the United Kingdom, the United States, Japan, and Germany.

Since the concept of the tertiary hospital service model, the predecessor of HMS was proposed by World Health Organization (WHO) in 1957, it has been spread worldwide. In the 1990s, western countries introduced a set of healthcare service models that is still advocated and promoted at present, including grassroots first diagnosis model, the two-way referral model, and HMS model (Shi et al., 2012).

The HMS in the United Kingdom. In-depth analysis shows that in the United Kingdom, there is generally a mandatory, targeted, tiered system of care, of which the National Health

Service (NHS) is the leading party, and there are generally: primary and secondary care services. The core and key of the entire hierarchical system is primary care, with 75% of the NHS spending on primary care. Patients must strictly follow the instructions and arrangements of their doctors and have no choice. In recent years, the United Kingdom tiered care system has undergone some changes, placing greater importance on patients, emphasizing GP (GP) workforce building, and the NHS purchasing the medical services provided by GPs (X. Q. Zhu & Zhou, 2016)

The HMS in the United States. The HMS in the US is essentially another compulsory hierarchical system dominated by insurance companies. The system is structured in healthcare networks managed by insurance institutions, including large hospitals, small clinics, examining rooms, and primary medical institutions. Patients can choose any provider within this network, but they cannot leave the network and choose another provider at will. The consequences of leaving the network are that the patient is responsible for any medical costs incurred. This system is a direct result of the already high cost of health care in the United States, and the implementation of tiered care in the United States is in fact easy and successful. Each network has its own policies and regulations, and the freedom of choice and the amount and proportion of reimbursement are also different. Patients can choose according to their willingness. Some of the better-known networks in the United States include Health Maintenance Organizations, Preferred Provider Organization, Point of Service, and Exclusive Provider Organization (X. Q. Zhu & Zhou, 2016).

The HME in Japan. The essence of the model is free guidance. In other words, the government does not mandate patients to seek medical treatment, but will guide them by means of financial incentives or medical insurance in disguise. In Japan, the “three-tier medical circle” is another term for HMS where primary health care institutions build the first level of the medical circle, and clinics, nursing institutions, and hospitals can refer to each other. However, in principle, patients cannot be referred at will. They can be referred to the next level of care if they have a doctor’s letter of referral, otherwise, the additional costs of the referral are not covered by the government and are fully borne by the patients (X. Q. Zhu & Zhou, 2016).

The HMS in Germany. Now, the medical service systems in Germany are specifically divided into the following four types: outpatient physicians (whose role is to provide medical consultation and conduct outpatient examinations), hospitals (whose role is to conduct inpatient care), rehabilitation facilities (whose role is to provide post-operative rehabilitation), and care homes and nursing services (whose role is to provide care and treatment for the elderly, sick, and disabled). The German government formulates differentiated regional health plans

according to the reality of different regions, and comprehensively promotes the construction of a “regional medical service system” (Liang, 2015). Patients are referred to a larger hospital for treatment if no good treatment is available, all through the primary care physician. If the hospital admits a patient without referral procedures, all the medical expenses incurred should be borne by the senior hospital, and the insurance department shall not compensate (Q. Zhou et al., 2009).

The HMS in China. China also started to implement the tertiary hospital model on a trial basis after the WHO proposed it. As China’s health care reform continues to increase and the Health China strategy is further promoted, Chinese residents are paying more attention to their health and their personal health care needs are increasing day by day. China is vigorously promoting the process of medical service reform, and the hierarchical diagnosis and treatment system in the tertiary hospital service model is a powerful guarantee for the reasonable allocation and rational use of medical and health resources. However, the vast territory, complex cultural background, and large population in China lead to the different development of a hierarchical medical system in various regions. At present, the average medical expenses remain at a high level all year round in China and it is still difficult to alleviate the current situation of “expensive and difficult access to health care”. According to the authoritative estimation of the Organization for Economic Cooperation and Development (OECD), the medical expenses of China will triple the present amount in 2060, which will account for 10% of the gross domestic product (GDP) of China then, but assuming that China takes measures now to avoid the above scenario in the future, China’s health expenditure will be less than 6% of GDP by 2060 (Maisonneuve & Martins, 2013).

An in-depth study of the China Health and Family Planning Statistical Yearbook (National Health and Family Commission [NHFC], 2017) clearly shows that, in 2016 alone, 436,663,000 visits were treated in China’s primary hospitals, accounting for 55.05% of the annual number of consultations (793,170,000 visits), while primary health care institutions (926,518) accounted for 94.22% of all health care organizations (983,394) in China. These data imply that the number of primary care institutions in China is very large, but the number of visits is disproportionately small, apparently because people’s consultation habits have not yet changed, and the concept of “going to a big hospital if you are sick” has not yet been completely transformed.

Shanghai is the earliest city to construct a regional medical alliance in China and its regional medical alliance is now the most mature one. In 2015, the Shanghai Municipal Commission of Health and Family Planning creatively launched the hierarchical medical system (X. W. Li, 2015). The core path is to implement the family doctor system. It is emphasized that each

district and county should have a third-level hospital (as the leading unit). Different methods, including technical support and trusteeship are used to expand the overall coverage of district and county hospitals and municipal hospitals. Several secondary general hospitals in the region have been transformed into rehabilitation hospitals to receive the patients from tertiary hospitals. Medical institutions at different levels in the medical alliance are closely contacted through contracts. More grassroots GPs are trained to take charge of health management and cost accounting, so as to play the role of gatekeepers in community construction.

At the same time, Jiangsu Province, as an economically developed province in China, has carried out the HMS by means of allocating high-quality medical resources to lower-tiered regions and playing the role of county-level public hospitals. The overall planning has been conducted among the personnel, finance, materials, equipment, information and management; the referral channels have been continuously improved. Besides, important county medical alliances have been formed. Meanwhile, resource integration has been promoted in cities, with tertiary hospitals playing a leading role in vertically integrating other medical institutions within their jurisdictions, exporting their brands, technologies, talents, and management, and promoting the construction of medical clusters. In the medical association, for patients referred from the grassroots level, high-level hospitals provide registration fee-free and limited treatment facilities, while lower-level medical departments provide post-rehabilitation treatment for patients referred from the higher-level institution.

Xiamen City is also actively carrying out innovation, and has launched the mode of “co-management by three specialist physicians”, which is an important way to monitor chronic diseases together by specialists, GPs, and administrators. The co-management mode has solved several difficulties, including “large hospitals’ incapacity of reaching lower-tiered regions, small hospitals’ incapacity of undertaking tasks, and patients’ incapacity of being referred smoothly”. Through a relatively sound network platform, the collaboration of supporting facilities in different fields has been realized, providing an important prerequisite for the development of the HMS in the future.

As for the construction of the regional medical alliance in other countries, the Singapore model has a great influence on the world. In Singapore’s medical service system, medical services of different types are provided, including grassroots medical services, hospital treatment, and medium- and long-term nursing services. These services are offered by centralized institutions, including private hospitals, public hospitals, and private organizations, which is known as PPP model. According to statistics, in Singapore, more than 80% of the domestic medical services are provided by private clinics, while only 20% are supplied by the

government's general clinics. The supply-side structure of secondary and tertiary medical services is on the contrary. For hospitalization services, about 80% are provided by public medical institutions and 20% by private hospitals. This reasonable “inversion” makes the effect of HMS in Singapore very significant. Singapore's national health service system is based on community health services, which is of greatest difference from that of China.

As for the United States, its construction of a medical alliance is called the “accountable care organization”. Its core is insurance, and the entire system directs patients to seek medical treatment through insurance reimbursement. Patients can only be reimbursed if they choose the medical institutions in the insurance-covered network, but once their choice is beyond the network, they must bear the high cost by themselves. In general, the medical service systems in most countries are tired and graded according to the disease spectrum. High-level medical institutions are responsible for the treatment of difficult, complicated, acute and critical diseases, while low-level institutions are responsible for health management and disease triage.

Considering the context described in previous sections, this thesis proposes to study a new model of cooperation based on resource sharing between universities, hospitals, and communities. In this model, the subject plays an important role and brings into play their respective strengths, contributing to the improvement of community health services and the optimization of medical diagnosis and treatment outcomes.

Chapter 2: Research Content and Technical Route

2.1 Research objectives and significance

Due to the current problems of human resources, materials, finance, and the long-lasting public habits of medical consultation, the hierarchical medical system (HMS) has had insignificant effects since its implementation. Most comprehensive hospitals, mainly those with large scale and influence, tend to have a very large number of patients coming to them for treatment, while primary medical institutions are visited by few patients.

In recent years, China has been promoting the construction of HMS, aiming to break the bottleneck, optimize and integrate medical resources, and adjust the treatment structure to guide patients to seek medical treatment, so that patients can gain excellent medical resources and save medical costs at the same time. However, after HMS is implemented in China, there has been little change in the habits of seeking medical treatment and patients are still accustomed to seeing doctors in large hospitals, even their conditions are trivial and minor. Although the central government has introduced many policies, especially in terms of government medical insurance, and used the price advantage to attract patients, the number of visits to primary medical institutions is still low and has not reached the expected effect, while the number of outpatients in large and medium-sized general hospitals remains high. It is still difficult to alleviate the current situation of “expensive and difficult to see a doctor”, which means that the implementation of the HMS is still facing many obstacles.

The first obstacle is that it is hard for medical institutions at different levels to fulfil their responsibilities. Tertiary hospitals are responsible for treating intractable, emergent, critical, and complex diseases. Secondary hospitals mainly undertake the rehabilitation of post-operative patients referred from tertiary hospitals and the treatment of patients from primary hospitals. Primary medical institutions mainly diagnose and treat chronic diseases, common diseases, and multiple diseases. However, although the document stipulates the work of each level, it is very manipulative, and patients and doctors are free to choose their own treatment institutions according to their preference, HMS is not established, and the related management and assessment system is not sound (Xiao & Yang, 2017).

The second obstacle is that primary medical institutions do not have a comparatively higher

level of quality medical services so it is hard for them to treat the patient well (Dai, 2016). GPs (GPs) are the core component of primary medical institutions, yet the number of GP is severely insufficient, coupled with incomplete facilities, outdated equipment, inaccurate test results, limited types and quantities of essential drugs. Therefore, in primary institutions, it is difficult to meet the requirements of patient consultation and treatment, as a result of which, patients are reluctant to consult in primary institutions, but prefer large hospitals with better facilities in all aspects (Xiao & Yang, 2017).

The third obstacle is the significant benefit conflicts among medical institutions. The HMS intends to enable patients to “seek medical treatment for critical illnesses in large hospitals and stay in community medical institutions for minor ones” and collaborate with institutions at all levels. However, the reality is that because the government does not compensate large hospitals enough, large hospitals need to rely on their own revenue to keep their normal operation, and if patients are referred to lower-level medical institutions, their revenue will drop, so they will not refer patients with minor or chronic diseases to primary care institutions strictly according to HMS, creating a situation of competition for patients and bed expansion (Dai, 2016).

The fourth obstacle is that the multisite practice system of physicians is impeded. In the HMS, patients can get the same medical service in the primary medical institutions as they can in the large ones, which requires a certain guarantee of the competence and quality of physicians. The multisite practice system of physicians is a good solution to allocate and extend quality medical resources to the grassroot level, but the effects are still unsatisfying. The main reason for this is mainly in the legal responsibility and management system. From a legal perspective, the multisite practice system is contrary to the laws of physician practice. Nowadays, the occupational system defines physicians from different perspectives, such as occupational scope and region, which indicates that their workplace is fixed and cannot be changed at will (Ren, 2014). In the case of multisite practice, once there is a medical dispute, it is difficult to find the responsible subject, and no one is responsible for the accident if a medical accident occurs. Then the consequences can only be borne by the physician. From the perspective of management, the multisite practice of doctors is not conducive to personnel management in hospitals.

The fifth obstacle is that it is hard to introduce and retain talent. For GPs who are the core of primary medical institutions, their workload in primary care is high, but the income is not proportional to the workload and remains at a lower level. In addition, for physicians in primary medical institutions, there is no clear path for their future career development. Not only do they feel their status is lower than that of physicians in large hospitals, but they also lack good career

prospects and room for upward mobility, coupled with the lower salaries in primary care institutions that cannot motivate physicians' work enthusiasm (Y. Hu, 2014) .

The sixth obstacle is that information sharing is weak. One example is that the health records of citizens are not synchronized. The target of HMS is that hospitals at all levels can cooperate to improve the integration of medical resources. However, a majority of citizens do not register their health records in the network of medical alliances so their information cannot be shared. Consequently, physicians have an incomplete understanding of the health conditions of their patients, leading to the fragmentation of health information (Y. Hu, 2014) .

The seventh obstacle is that the system does not reflect the differences in regions and demographic layout. Firstly, the basic public health services cost higher in central and western regions, with inadequate infrastructure or obsolete facilities that cannot provide accurate diagnosis and treatment. On the one hand, the coverage of primary medical institutions is relatively low because of the complex terrain, distinctive and diverse cultural characteristics, as well as varying accessibility and low population density in the central and western regions . Therefore, the setting up of primary health care institutions is more complicated and requires more consideration, and the costs are higher. On the other hand, the medical conditions in the central and western regions are not very good, the health infrastructure is not perfect, the equipment is old. More seriously, the facilities whose maintenance costs are relatively high are vulnerable to frequent natural disasters.

Moreover, there is insufficient financial support for primary medical institutions in regions with a larger migrant population. China's service standards for primary care institutions do not yet take into account the mobile population, which directly leads to insufficient funding for primary care institutions to provide health services to the mobile population. The central and local governments in China allocate subsidies to primary medical institutions based on the permanent residents' population without covering the migrant one. Moreover, subsidy standards vary from province to province due to their economic conditions, which directly demotivates primary medical institutions to serve the migrating population (Y. Hu, 2014).

Although the HMS has achieved some progress in China, there are still many problems that hinder the implementation of the system for various reasons.

Firstly, at the governmental level, relevant systems are inadequate (S. D. Sun, 2014). There is no corresponding incentive and commitment mechanism to promote HMS, which dampens the enthusiasm. Therefore, the effects of HMS are undesirable so far. Besides, publicity is insufficient, resulting in many patients not being aware of the situation related to graded treatment, let alone seeking treatment by level. Third, subsidies for primary care institutions are

too low, and the government's financial subsidies are not enough to make the institutions function properly. Fourth, health technicians are not work in the community. The lack of primary health personnel is due to reasons such as salary and career prospects coupled with the imperfect multiple site practice system for physicians in China (L. J. Bai et al., 2016).

Secondly, at the patient level, patients' health awareness in China is not high enough at present, which largely affects how patients seek medical treatment and their hospital choice. Together with patients' lack of understanding of HMS and high expectations for disease recovery, all make it difficult for the HMS to achieve the expected results (L. J. Bai et al., 2016).

Lastly, at the level of medical institutions, large hospitals have more advantages due to their abundant funds, strong medical personnel, and better hardware facilities compared to primary medical institutions which generally have poorer facilities, less qualified medical personnel, and fewer types and quantity of medicine. With the psychology of patients' desire for rapid treatment and recovery, large hospitals are much more attractive to patients than primary care institutions (L. J. Bai et al., 2016).

In summary, the current HMS has problems such as unclear responsibilities of medical institutions at all levels, unbalanced distribution of human resources and benefits, barriers to talent and information flow, and a lack of mature referral mechanism for incomplete basic information of patients. This selects the Seventh Affiliated Hospital of SMU as the research object and studies the university-hospital-community linkage mode to promote the development of the HMS at the national level, in order to achieve the win-win goal of the government, universities, hospitals, communities and patients.

2.2 Research contents and methods

2.2.1 Research contents

Chapter One: Introduction. It mainly introduces the research background, including the background of medical reform, cooperation with universities, government trusteeship and community reform; the geographical reform, population sociology, economic status, and medical status of Lishui Town, Nanhai District, Foshan; the disease spectrum in Lishui Town; definitions of relevant research concepts; and the latest research status in and outside China.

Chapter Two: Research Contents and Technical Route. The HMS aims to guide patients to seek medical treatment and control medical costs so that they can use quality resources at a lower cost, thus solving the problem of unaffordable medical services. The research methods

include data collection by adopting a questionnaire survey, quantitative data analysis, and a case study.

Chapter Three: Literature Review. Introduction of synergetic correlation, public goods, game theory and stakeholder theory. Introduction of medical resources allocation, medical and health resource allocation, hierarchical diagnosis and treatment system, two-way referral and patients' medical behaviour.

Chapter Four: Research Methods. This part includes the principles that construct the stationarity test, moving average model, and difference operation; application, test, and prediction of the model; and principles, application, test, and correction of the multivariate regression model.

Chapter Five: Empirical Analyses. Eviews10.0 was used to conduct a stationarity test and difference operation on the index of referrals. An ARIMA (1, 1, 1) model was established by the order determination based on a partial autocorrelogram. The stability of the model was measured by a residual test, with its stability and reversibility determined by the reciprocal of the model's characteristic root. The number of referrals was predicted to keep growing in the future based on this model. Stata16.0 was applied to sort out and analyze data on total medical revenue, the number of referrals, bed utilization rate, and emergency visits, and statistical description was made accordingly. The explanatory variables were determined to be total medical revenue, referrals, outpatient visits, emergency visits, and admissions. Regression models were created and the heteroskedasticity and multicollinearity were tested also.

Chapter Six: Case Study. Based on the development of the Seventh Affiliated Hospital of SMU, the function of the conceptual model was tested empirically.

Chapter Seven: Conclusion and Prospects.

2.2.2 Research methods

(1) Literature research

We searched the literature and conducted a review on the development status of the HMS, and its related concepts, connotations, related theories, and the development of clinical practices at home and abroad. Through checking and studying the information released authoritatively at home and abroad, the theoretical basis and conceptual models are deeply understood and mastered. Based on previous research, this thesis discovered blind spots and innovative areas that have not been studied. In combination with the latest development in theoretical research, this thesis lays a theoretical foundation for the theoretical framework of the hierarchical medical system, the analysis as well as the design of case studies.

(2) Expert consultation

Based on the analysis of traditional theories, we consulted experts in the fields of health policies, health economics, hospital administration, and hospital reform. The research design is validated from several perspectives: university, hospital, and community, with the analysis improved to guarantee that the research conclusions are science-based and rigorous.

(3) Case study

By studying the case of the Seventh Affiliated Hospital of SMU, the thesis focuses on the operation mechanism and reform measures of the hierarchical medical system.

(4) Statistical analysis

A database was built by statistical software to analyze the results.

2.2.3 Data sources and collection

(1) Data collection

The thesis collected and sorted out the relevant materials and data for analysis, and conducted interviews with key informants.

(2) Questionnaire survey

A questionnaire with 30 items was distributed to different groups of respondents, including hospitals, communities and patients, and the results were analyzed. Given the advice from the tutor and experts, the design of the questionnaire is guaranteed to be science-based and reliable.

2.3 Technical route

Figure 2.1 presents the map of the technical route of this study.

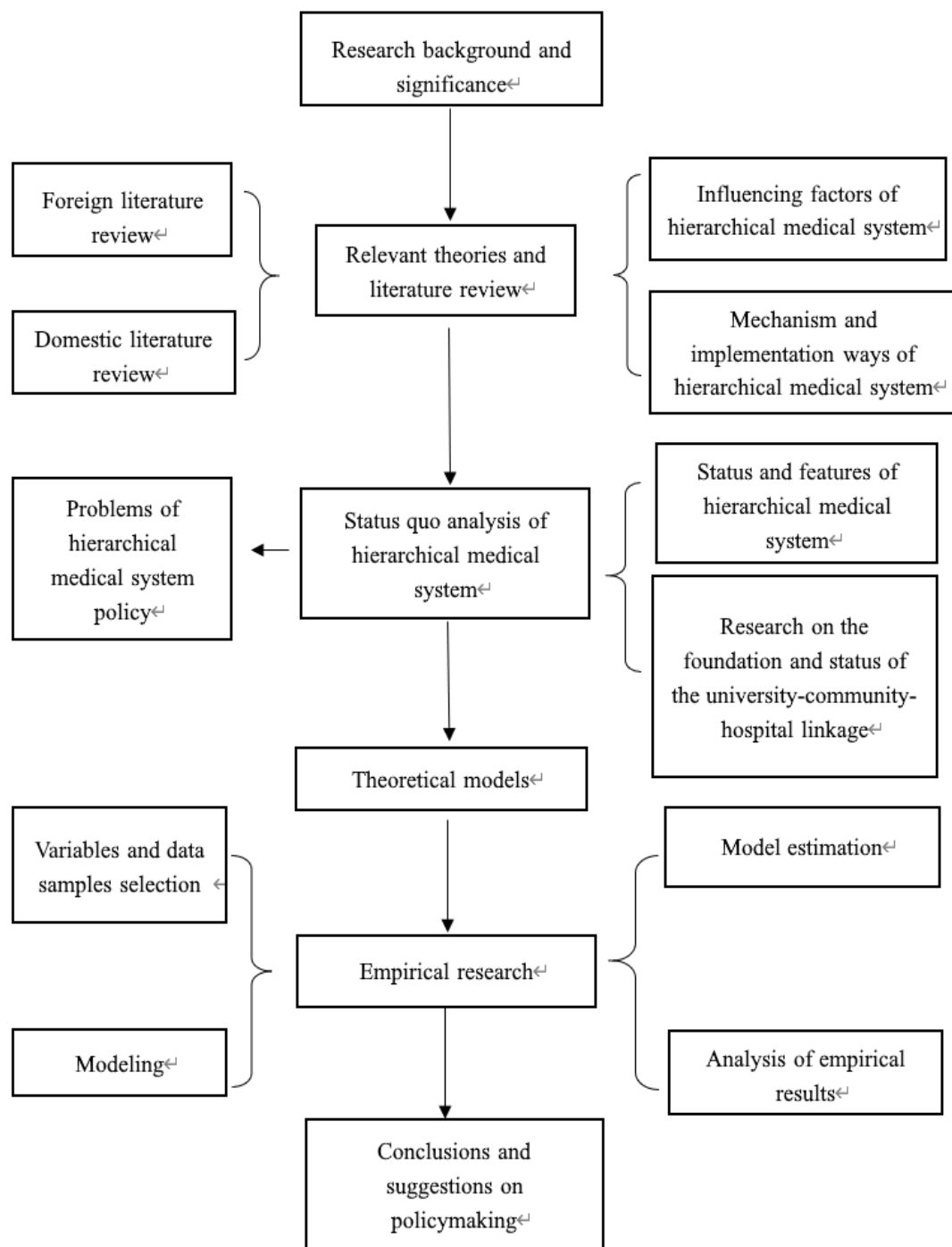


Figure 2.1 Map of the technical route

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Chapter 3: Literature Review

3.1 Relevant theories

3.1.1 A hospital management system with “dual cores, four dimensions, and two motivations”

In order to adapt to the new situation of China's medical reform, to play the role of bridgehead and cornerstone of hospital reform, expand the university's ability to serve society, and enhance its brand capability, Southern Medical University (SMU) established a hospital management company in 2014. Through years of successful practices and improvement, the company has formed a set of theoretical systems with a good reputation and strong applicability in the industry, and the hospital management system can be summarized by “dual cores, four dimensions, and two drivers” (hereafter referred to as the “242” system). The “242” system takes disciplines and channels as the twin cores of hospital management, and strategy, quality, performance and talent as the four dimensions of hospital management, supplemented by project innovation and information data as growth drivers, thus forming a virtuous cycle of hospital management and sustainable development.

The key to the university-hospital-community linkage in the promotion of HMS is the comprehensive involvement and support of the university. In the case of this thesis, the irreplaceable guiding role of the “242” system is reflected in the entire process, especially in the areas of organizational change, performance reform, production quality improvement, and project innovation.

3.1.2 Synergy theory

In a broad sense, synergy (or collaboration) theory indicates that elements in a system can interact with each other to create a completely holistic effect, resulting in a “chemical reaction” that produces a better effect than the simple addition to individual elements. In short, the synergy effect is like “ $1+1>2$ ”. The HMS is the best application of synergy theory to the medical and healthcare industry. This system divides the hospitals in the society into different levels, and hospitals at each level cooperate. Referral and initial diagnosis systems can maximize the use of excellent medical and healthcare resources, ease the tension between doctors and patients,

and reduce medical expenses for patients (L. H. Bai, 2007).

According to the basic theory of division of labor and cooperation as well as fair administration of medical services, the division of labor and cooperation in medical institutions should strictly follow the principle of non-duplication of collaboration, which is achieved by establishing a comprehensive medical and health management service system with various levels, i.e., using a hierarchical medical model.

From the international development level, the “gatekeeper” system is more common whose core and key are to seek the initial diagnosis at the primary level. Based on the latest theoretical research home and abroad as well as the analysis of authoritative cases, hospitals at all levels have distinct rescue and treatment responsibilities. Tertiary hospitals are responsible for the treatment of difficult and critical diseases. Secondary hospitals are in charge of the treatment of multiple and common diseases. Primary hospitals mainly treat common and first-grade chronic diseases. Most countries believe that the core of the hierarchical medical system is to classify diseases according to their severity. Patients with minor illnesses are treated in primary medical institutions while those with serious illnesses are in superior general hospitals. Reasonable distribution can ensure that the resources among medical institutions are utilized and coordinated effectively.

In 1971, German physicist Haken put forward the unified concept of synergy, which states that there are rational and disorderly situations in various events (Haken & Knyazeva, 2000). The rational situation is coordination, while the disorderly situation is chaos, but the two can be transformed into each other under certain environmental conditions (Bobrek & Sokovic, 2006). It can be said that synergy exists ubiquitously in all fields. In the process of overall development, various elements coordinate and cooperate to promote things to advance and develop together, which can strengthen the whole, benefits individuals, enhance the attribute connection between things and develop positively. The research on the synergy of things has formed the synergy theory. Synergy theory is applicable to any systematic material world that is objective and open. Synergistic capacity is the process or ability of two or more different resources or individuals to coordinate and cooperate to accomplish a specific goal together.

Ansoff (1965), an internationally renowned researcher on the theory of corporate collaboration, divided corporate collaboration into four categories: operational collaboration, management collaboration, capital cooperation and marketing collaboration. J. F. Zhou and Li (2003) established a four-zone, six-factor, seven-base synergy model covering strategy, resources, products, design and other factors for agile companies. The four zones are internal aspects of enterprises coordination, alliance coordination, cooperation coordination and

competition coordination, respectively; the 6-factors are the factor of allies, collaborators, suppliers, customers, competitors, and substitutes; and the seven basic synergies are timing coordination, bit and order coordination, number coordination, information and knowledge flow coordination, logistics coordination and value coordination.

Mao and Du (2006) studied the evaluation of enterprise synergistic capacity and built an evaluation model of enterprise synergistic capacity including five elements: knowledge synergy, system synergy, resource synergy, process synergy and relationship synergy.

Z. L. Luo (2014) analyzed the evaluation indexes of the synergistic capacity of public medical groups through an expert questionnaire on the elements of the synergistic capacity of public medical groups, and proposed ten major factors: strategy, system, information, resources and innovation synergy at macro, meso and micro levels. From the perspective of hospital business structure as a whole, it is an objective and open overall system, and various types of hospital departments complement and coordinate with each other around the goal of common development of the overall system, and its benign development also depends on the coordinating role of each level of hospital department.

From the perspective of the medical service system as a whole, the overall function and value of each medical unit can be significantly higher than the sum of the overall function and value of each member by coupling the resources and functions of each medical department, thus achieving the goal of optimizing the overall efficiency (Haken, 1983). From the internal point of view of medical service institutions, it can further enhance the advantages of the medical institution itself through effective coordination of resources and processes among various business units within the organization.

Synergy classification of medical service systems is similar to the internal collaboration of firms, which usually includes static collaboration, dynamic collaboration, internal collaboration, and external collaboration. The static coordination of the medical service system should be the coordination of resource allocation in management, operation, investment, and medical service marketing. Dynamic coordination of the medical service system is to effectively utilize all kinds of resources in the medical service system, such as talent, technology, assets, funds, and reasonably allocate the limited resources. The collaboration of the medical service system is not to change the competitive relationship existing in the original medical and healthcare service system, but to jointly form status of strategic synergy, make full use of the resources in the system, share medical technology among medical institutions, and improve the overall level of the medical service system.

In the 1990s, a collaborative structure of medical services began to emerge in the United

States. Different levels of medical and health institutions cooperated through alliances or other forms to provide patients with safe, high-quality, efficient, and seamlessly integrated health services, such as the American Information Management System and its regional medical systems of George Washington University School of Medicine and Utah University Medical Center. In addition, the NHS of the United Kingdom and the Strategic Health Information Network of Europe are also examples of implementing the coordination of medical service systems (Enthoven, 2005).

Concerning the research on the resource synergy theory of the medical service system, Leatt's (2002) research shows that society should establish a cooperative relationship between primary medical care, large medical care and social welfare institutions, so as to make the medical system efficient. Stender and Christensen (2013) have researched and established a synergistic medical service network, which can closely link and cooperate with each other to provide continuous medical services for patients, which not only meets the needs of patients, but also saves medical resources. Jack and Powers (2009) argued that the synergy of medical service resources refers to a way of eliminating the fragmentation and decoupling between medical services and building a coordinated, continuous, and integral management form of the medical service system.

The WHO pointed out that collaborative service organizations can manage the cost of health care services to create a level of health services that are easily and readily accessible to the public so that patients can enjoy the desired healthcare services at an affordable cost. The synergy of hospital service structure is to establish a common goal within the hospital business structure and consider the overall interests and individual interests as a whole. Through the division of labor, coordination and cooperation, the synergy of the hospital can also obtain various resources such as human resources, technology, and services, which can adapt to the development needs of the medical institution itself, but also complement the structural functions, through the process of integration, to achieve the maximum integration of synergy (R. Y. Zhu, 2014).

At present, many big cities in China have explored the synergy of the medical service system. For example, the medical institutions under the eight health bureaus in Chaoyang District of Beijing have built Beijing Chaoyang Hospital Group in a cooperative form. Ruijin Hospital Group and Nanjing Gulou Hospital Group in Shanghai form medical groups with hospitals or specialties (S. L. Hu, 2000). Tianjin has listed the establishment of "medical alliance" in 20 popular projects, and selected Heping and Hexi districts in Tianjin as pilot projects to set up 10 medical alliances, which are of great convenience for residents to seek

medical help nearby and reduce the pressure of overcrowded large hospitals.

With the opening of the medical market, various medical service institutions have gradually become market-oriented, and the corporation mechanism and market mechanism of self-management, self-financing and self-development of capital market are also gradually being introduced into hospitals. Therefore, the synergy of resources and processes is also applicable to hospitals. At present, some hospitals have begun to try to build a synergistic management environment.

In this study, we believe that the cooperation of resources and processes in hospital service structure includes two levels. The first level is to realize the union of different resources such as technology, functions, and operations among hospital infrastructures at different levels, including the effective implementation of processes such as referral process, labor scheduling and information sharing, to promote the partnership of connectivity, linkage and synergy among various hospital infrastructures, and to improve the management level of hospital service structure.

The other level is to use the individual medical service organization to adjust the internal pattern of the organization, improve the process, and reasonably dispatch various resources, so as to achieve the purpose of enhancing the strength of the medical service organization itself. The synergistic capacity of medical service system resources and processes is defined as: the coordination and cooperation between resources and processes such as information technology and business, the orderly and reasonable development of referrals between hospitals at all levels, and the joint development of medical institutions, the integration of hospital service structure and the competitiveness of hospital business organizations themselves are enhanced.

3.1.3 Public goods theory

Early in the 1970s, China has explored the public goods theory (James, 1972). However, since the theory was originated in Europe and the United States, there are still some differences in relevant issues and some Chinese situations, and it does not fully meet the development requirements of the relevant fields in China. Therefore, when China learns from this theory, it should not be applied rigidly, but flexibly and in accordance with the actual situation in China. After over 40 years of development in China, this theory helps solve many complicated problems, including balancing the interests of the nation and individuals and coordinating the relationship between the government and the market.

Public goods theory aims to provide a theoretical foundation for balancing the relationship between the government and the market as well as solving problems of market-oriented public

services (L. Yang, 2017). The object of public services is public goods, and in the process of using public goods, the phenomenon of “free-riding” easily occurs. The most direct consequence of this phenomenon is the serious waste of public resources (Wen, 2016).

Medical resources are public goods and health resources are scarce. To avoid the waste of medical resources, the government or health administrative departments should adopt an effective way to optimize the allocation of resources, so as to improve the utilization of resources and the quality of medical services. The HMS is now being promoted nationwide, so it is necessary to build a big data center for graded diagnosis and treatment, which can use advanced information processing technologies such as cloud computing technology and big data analysis to solve the problems of hospital resource allocation and mutual referral scientifically and efficiently among various medical institutions. In this way, public services can be equalized and rationalized (M. S. Chen et al., 2010).

To investigate the public product attributes of public hospitals, the origin of hospitals should be traced from the beginning of the development process. The word “hospital” originates in the west, which means “guest” in the Latin language. Before it was given with today’s medical implication, hospitals meant places to provide services or shelter for guests. From the development history of western hospitals, the originality of hospitals is closely related to the spread of Christianity. Christianity has a very special connection with western culture. Many people argued that Christian culture is a pillar of western culture. Its emphasis on “God creates all” and “natural human rights” all reflect the operational logic of western governments today.

It is precisely under these values that Christianity regards medicine as a positive act of doing good deeds, which can not only effectively improve the public’s health level, but also widely spread Christian doctrines through this materialized carrier.

According to the Christian Bible, in the process of missionary work in Jerusalem, Jesus began to lead his followers to establish medical facilities to help the poor and sick, which became the spiritual source of the Christian hospital. The first Christian hospitals were established not only to provide medical care but also to provide shelter for the homeless, resulting in what became known as “masonic homes” and “monasteries”, demonstrating the humanitarian spirit of Christianity. The earliest form of nursing also emerged from the founding of hospitals by Christians. In order to provide very effective care for the sick, Christian hospitals employed nuns, widows. to take on the heavy responsibility of caring for the sick. However, after entering the Middle Ages, Protestantism gradually gained the upper hand and imposed restrictions on Christian-founded hospitals, and church hospitals were heavily annexed or abandoned, while at the same time, a large number of secular hospitals were established by

Protestantism. Although secular hospitals were qualitatively better than the previous Christian hospitals in terms of medical standards and services, most poor patients were excluded from the hospitals because they could not afford the high cost of medicines.

In China, the earliest origin of hospitals can be traced back to the Han Dynasty. In the first two years of the Yuan Dynasty, the emperor of the Han Dynasty, to respond to the mass disease disaster caused by the flood of the Yellow River, established the first organized place with equipment in China, similar to a hospital. Later, in the fifth year of Yan Xi, in order to correspond to the plague in the army, the Han Dynasty officially established an institution named “Yan Lu”, which is the earliest field battle hospital in China that can be verified in history. After the Song Dynasty, there have been larger-scale government-run hospitals. However, in the face of high medical costs, such hospitals in the Northern Song Dynasty started to be “profit-seeking”, that is, they were required to seek profits and improve their income levels, then provided aid to the weak on the basis of sustainable financial support. In the Southern Song Dynasty, the previous tide was reversed, public hospitals started to be run for the public good again. After the historical evolution of “seeking profit” in the Northern Song Dynasty and “benefiting the public” in the Southern Song Dynasty, government-run hospitals generally preserved the characteristics of “benefiting the people”. In the Yuan Dynasty, hospitals were running on the basis of the government-run hospitals in the Song Dynasty, the policy of “free for the poor but charging the rich” was adopted by their customers, which is similar to today’s so-called “public welfare” characteristics.

British political economists began to investigate the attributes of public goods in the 18th century, with Hume (1983) and Smith (1972) as the most typical representatives. Hume defined the concept of collective consumer goods along with the logic of the development of public affairs. Smith went further, making public works one of the three most important duties of the country. This is the earliest exploration of public goods in academic circles.

Nowadays, Samuelson’s (1954) exposition on public goods is generally accepted by the mass public. In his representative work *Pure Theory of Public Expenditure*, he defined pure public goods or services, as the consumption of any member of society, that will not affect the consumption of such products by others, especially will not reduce the consumption of others. Public goods have three obvious characteristics: indivisibility of utility, non-competitiveness of consumption and non-exclusiveness of benefit. Among them, the indivisibility of utility means that the utility of public goods is integral and cannot be divided. Once divided, public goods will no longer have their related functions. Non-competitiveness of consumption emphasizes that anyone’s consumption of public goods will not affect the quantity and quality of public

goods enjoyed by others at the same time. The non-exclusiveness of consumption indicates that anyone who consumes public goods does not exclude others from consumption.

Based on the embedding of public value theory in the reform of public hospitals in China and the first chapter of this thesis. Buchanan (1993) extended and developed the theory of public goods. The most important point is club theory, that is, from the perspective of inside and outside a club, it is found that there is no real boundary between private goods and public goods. Public goods should be a status of “club equilibrium”, which means that based on the production cost and consumption level, the best scale curve of clubs should be established, and the number of products and members and the best allocation should be formed. The theory of public goods provides a basic theoretical basis for us to define the attributes of public hospitals and their medical services and is also the main reference for the reform of public hospitals.

Reviewing the development process of Chinese and foreign hospitals, whether it was the Christian hospitals taking the dissemination of doctrines as their original intention or those from the Song Dynasty in China aiming to “benefit the people”, hospitals all have essentially embodied the ideal of public goods and the characteristics of quasi-public goods.

First of all, at the beginning of the establishment of the hospital, the founder wanted to pursue the idea of “non-exclusiveness”. Christianity establishes hospitals to do good, which does not exclude any members of society and does not allow anyone to enjoy services exclusively, otherwise, the Christian doctrines will be violated. Secondly, the hospital also reflects the founder’s considerations of being “non-competitive”. The Chinese government-run hospitals started to deal with natural disasters and treat the ill. The original intention was to build a benefit-sharing mechanism to help all. However, with the increasing number of patients, the investment cost of government departments began to surge, and all players felt “competition” because of others’ income, which eventually led to the bankruptcy of those who were “non-competitive”, and to the emergence of government-run hospitals “seeking profits” in the Song Dynasty.

According to the history above, we believe that from the perspective of the origin of hospitals, public hospitals or even all hospitals possess the ideal for the public good at the beginning, but due to the limited material conditions and the scarcity of hospital medical resources, congestion was bound to emerge, eventually causing hospitals giving up the pursuit of pure public goods but becoming quasi-public goods, which has influenced to this day.

In 2017, Premier Li Keqiang explicitly put forward “making the basic medical and healthcare system a public product for the whole country”, officially announcing that the national government once again regards protecting citizens’ right to health as one of the

important projects of national people's livelihood construction. For the general public, the most frequent physical manifestation of the health care system is the public hospital, and their experience in the public hospital directly determines their final evaluation of the national basic health care system.

Therefore, the role played by public hospitals is of the greatest concern to the world as to whether the basic health care system can be successfully realized as a public good. It can be said that how to set the institutional arrangement of public hospitals and its realization path directly reflects the degree of excellence of China's health system. Therefore, in order to achieve the great goal proposed by Premier Li Keqiang on the public productization of the medical and healthcare system, the public products attributes of public hospitals should be given priority.

It is true that from the perspective of the supply of public goods, any public products all need to be invested in the huge resource. For public hospitals, their main investment source is national finance. However, a country's investment in medical resources is limited after all, especially in a populous country like China. Only when social productivity and production efficiency reached a very high level, can public hospitals truly become a public product.

In the near future, public hospitals can only become quasi-public goods, but the problem is that even if "quasi-public good" is the goal of public hospital development, reasonable institutional arrangements are still needed. At present, with limited investment in public hospitals, the most basic equalization bottom line must be considered. The bottom line is to give all members of society the opportunity to enjoy the medical services provided by public hospitals on an equal footing. It should be noted that the equalization of medical opportunities in public hospitals must be realized within a reasonable limit in combination with the current productive forces of society, instead of talking about the so-called "equalitarianism" desperately.

Considering the current social and economic development, the main goal of equalization of medical opportunities in public hospitals is to provide general public medical opportunities for social members, improve the social coverage of public hospitals, and let public hospitals fulfil their natural social mission from the day of birth. Because of the differences in natural endowments and social resources, social members in every country and every historical stage will naturally be divided into several levels, and the basic needs of vulnerable groups at the bottom of society for public health should be met by the public hospitals. However, according to the actual status quo of public hospitals in China, there are still many obstacles to realising the bottom line of equalization of quasi-public goods.

According to the statistics of the China Health and Family Planning Statistical Yearbook

(NHFC, 2016), there were 12,708 public hospitals in China in 2016, with an average of 107,633 people who were not served by public hospitals, while there were 1,281 public hospitals in the United States, with an average of 241,019 people who were served by public hospitals. In contrast, the coverage of Public Hospitals in China seems to be very comprehensive. However, the severe uneven distribution of medical resources is the most important pain point in China's healthcare system arrangement. The insufficient number of public hospitals at the grassroots level and the low service quality directly affect the realization of the equalization bottom line.

According to the China Medical and Health Development Report (P. Q. Fang, 2016), the number of hospital visits increased from 2.972 billion in 2014 to 3.083 billion in 2015, but the number of primary medical institutions dropped from 4.364 billion to 4.342 billion at the same period. In the first half of 2016, the number of outpatients in hospitals increased by 6.1%, while the number of primary medical institutions decreased by 0.9.

After the founding of the People's Republic of China, the Party and the government have made remarkable achievements in the field of people's health. In addition to transforming the field hospitals established during the war and the military and church hospitals left by the National Government into public hospitals, the government has also built a large number of hospital institutions with the characteristics of public goods, forming a people's medical service system with the characteristics of socialist countries, which has also become a benchmark for many Latin American countries to learn.

After the 1980s, with the opening of the reform of the socialist market economic system, when the government put more energy into the construction of the market economic system, the investment in health and public hospitals gradually decreased. The proportion of health expenditure in the national fiscal expenditure has been declining, from 2.53% in the Seventh Five-Year Plan period to only 1.66% in the Tenth Five-Year Plan period (P. Q. Fang, 2016).

At this stage, the government blindly believes in the principle of marketization and pushed the development of medical services and public hospitals to the market. Under the background of an imperfect market economy and insufficient ability to allocate resources, the superposition effect of "government dereliction of duty" and "market failure" is formed, resulting in the weakening of the public goods attribute of public hospitals and the serious lack of accessibility of the services provided. No matter how to set the reform path of public hospitals in the future, the public's preference requirements for fairness and the attributes of public products in public hospitals must be responded to. Specifically, the following principles must be taken into consideration:

First, the principle of fairness is an important prerequisite for realizing the value of public

products in public hospitals. Human life is the most precious, and only with a healthy life can human beings carry out social activities. From a legal point of view, people's right to life and health is the basis for realizing all civil rights. Therefore, in any society and country, whether or not health can be guaranteed is a universal concern, and failure to achieve it will inevitably lead to great social unrest. In view of this situation, when public hospitals are allocated as the most important public health resources, fairness must be the first choice. This fairness is mainly reflected in the accessibility of medical products and services provided by public hospitals. Even as a quasi-public product, public hospitals should keep their consumption "non-exclusive" characteristics. The door of a hospital must be open to all people, regardless of their identity, social status, and class, and they can be assured to receive the most basic medical services in public hospitals. This is a prerequisite principle that public hospitals must adhere to and must not be broken through.

Second, the principle of government as the last line of defence is an important guarantee to realize the value of public products in public hospitals. In order to exert their value, public goods must ensure a certain amount of resources. Although in different historical stages, depending on the development level of productivity in human society, the total amount of government investment in public hospitals may be different, and the investment strategy will also change. Especially in recent decades, the governments of many countries and regions are trying to solve the financing problem of public hospitals by utilizing marketization, and providing inexhaustible resources for the normal operation of public hospitals by exerting the ability of renewable resources in the market. However, this practice should take the government as the last line of defence.

We believe that the reform of public hospitals and even medical reform is a worldwide problem, and there is no one-size-fits-all solution or universally applicable path. In the process of reform, governments of various countries and regions will try new reform programs and paths based on their own realities, which should be encouraged. However, in order to reduce the cost of trial and error, maintain the principle of fairness, and ensure that the attributes of public hospitals as public goods do not change in principle, the principle of government as the last line of defence should be clearly set in the reform. It is necessary to set the principle that the government should bear the responsibility of supporting the development of public hospitals in time regardless of the effectiveness of reform, so that the people's right to health can be guaranteed, the long-term stability of society can be maintained, and the most solid foundation can be laid for continuing reform.

Thirdly, the principle of proportionality is a strategic choice to enhance the value of public

products in public hospitals. The report of the 19th National Congress of the CPC pointed out that socialism with Chinese characteristics has entered a new era, and the main social contradictions in our country have been transformed into the contradiction between the people's growing needs for a better life and the unbalanced development.

Among them, unbalanced and inadequate development is the truest portrayal of China's social economy today. The development level of public hospitals directly reflects this imbalance and insufficiency. According to statistics, as of August 2016, there were 705 top-level hospitals in China, while there were 547 hospitals in eastern regions, accounting for more than 75%. From this statistic, a conclusion can be drawn that the level of economic development directly determines the investment of local governments in public hospitals, and determines the development level of public hospitals.

Therefore, the principle of proportionality is very essential in the development of public hospitals in China. Proportionality refers to two meanings. One is the proportionality of public hospitals providing services. As a public product, public hospitals can be enjoyed by all members of society. However, due to the lack of economic and financial levels, the services provided by public hospitals cannot fully meet the individual needs of all people. Therefore, in terms of service level, public hospitals should make different arrangements according to reality. Large and comprehensive medical services cannot be regarded as the foundation of public hospitals, and this irrational behaviour will result in the loss of the attributes of public goods. The other is the proportionality of public financial input, which must be done according to the ability on the premise of fairness. We support the return of public hospitals to the public good, but not irrational and costless investment, which in practice will cause the government to go bankrupt and lead to greater social.

3.1.4 Game theory

As game theory is a branch of the field of mathematics, the analysis and solution of game problems are usually expressed by a game model. In this thesis, game theory is mainly used to analyze the decision-making behavior of relevant stakeholders such as government managers, physicians, and patients.

First of all, there are certain preconditions for the occurrence of game phenomenon, i.e., some assumptions need to be established at the beginning of game model construction. As far as the game model is concerned, one of the most basic assumptions is that the participants in the game are rational, that is, the participants only care about the means to achieve the intended purpose, that is to say, they only consider how to choose in the game to maximize their own

utility, and interest-driven is the fundamental reason for the game participants to make choices. Secondly, due to the existence of the above assumptions, there will be inevitable competition among the participants in the game, and the relationship between the participants is interdependent and competitive. Finally, the participants in the game are concerned about the game result, because it is related to the choice they should make when maximizing their utility (Nash, 1950).

3.1.4.1 Overview of the development of game theory

Game theory thinking originated in China at the earliest. As early as more than 2,000 years ago, military and governing strategies based on game theory were recorded in Sun Tzu's *The Art of War* in the Spring and Autumn period of China described the management of the army and the strategy of governing the country using game theory thinking. In a broader sense, the conditions, methods, results and other issues involved in the process of transforming contradictions into unity and coordination belong to the category discussed by game theory and are also a theoretical method that can be applied to both quantitative and qualitative research (Rothschild & Stiglitz, 1976).

Neuman et al. from Germany published the classic book *Theory of Games and Economic Behavior*, which was the cornerstone in the history of game theory development. It described game theory in the form of a mathematical model for the first time, and also linked it with economic behavior for the first time (Holmstrom, 1979). However, as early as 1912, the theory of game theory was first explained in the form of mathematical models. Later, French mathematician Borel introduced the concept of "optimal strategy" for the first time in his research, pointing out that it is ubiquitous in the game phenomenon and verifying it. It was further verified by German mathematician Neuman in 1928 (Roger, 2001). Game theory has thus become a major branch of mathematics. Since then, the related theories and methods of game theory have not stagnated.

In the field of basic theoretical research, the original zero-sum-two-person game further developed into the non-zero-sum-n-person game (J. H. Chen et al., 2001). In recent years, the research on the latter has made rapid progress. As for the types of gambling theory, due to the deepening of related researches, there are various types of gambling theories according to different perspectives or different signs in the whole process, such as single-player, two-player and multi-player gambling theories according to the number of insiders. According to the interests of insiders, it can be divided into zero-sum games, basic and gambling theories or variable sum game theories. According to the behavior logic of insiders, it can be divided into cooperative gambling theory or non-cooperative game. Following the steps of gambling theory,

it can be divided into stillness, action, or repeated gambling theory. According to the form of the message composition of the gambling theory, it can be divided into the complete message gambling theory or the incomplete message gambling theory. Because game theory is a branch of mathematics, the classification and treatment of problems related to game theory are also often described using game theory models (Qian et al., 1999).

3.1.4.2 Application of game theory

In the game of patients' choice of medical institutions in the medical association, this thesis analyzes the choice of patients' treatment plan and puts forward that the condition for patients to choose primary hospitals first is that the advantages of primary hospitals are greater than those of large hospitals first, thus reducing the disadvantages of primary hospitals first. In this regard, some suggestions are put forward to strengthen the input of equipment and facilities in primary hospitals.

Y. W. Yang (2015) used game theory to analyze the game of interests of the parties in the medical association and the game of patients' interests in choosing medical institutions in the medical association. In the analysis of the game of interests of the parties in the consortium, it is argued that the actual services provided by tertiary hospitals and primary clinics are strictly homogeneous despite the great differences in hospital resources, and therefore the parties should abandon their own pursuit of revenue maximization and engage in win-win cooperation. Accordingly, suggestions are made to strengthen administrative leadership, explore compensation, encourage investment and reward and punishment systems. In the game of patients' choice of medical institutions, this study analyzes patients' choice of treatment methods, and concluded that the prerequisite for patients to choose primary health care institutions is that the advantages of choosing primary health care institutions are higher than those of choosing large hospitals, which reduces the disadvantages of choosing primary health care institutions. Based on it, this study proposes to increase the investment in equipment and facilities of primary health care institutions.

L. L. Chen et al. (2016) analyzed the game of public welfare choice between government departments and medical associations, the game of interests between patients and medical associations, the game of interests between core physicians and partnered clinics, as well as the game of cooperation and competition between non-member clinics and medical alliance. Establishing a sound incentive system and mechanism can help enhance the public service capacity of primary institutions. The study also advises on how to promote the healthy development of medical associations in terms of establishing a sound incentive system and

mechanism, enhancing the public service capacity of primary health care institutions, and achieving orderly competition among medical institutions within the jurisdiction.

D. R. Zhao and He (2016) used game theory to build a game model between government departments and private hospitals. By calculating the expected utility function of both sides, they analyzed the relationship between the two sides in the game and concluded that government departments should strengthen the top-level design and guide private hospitals to join the medical association.

3.1.5 Stakeholder theory

In 1963, Stanford Research Institute proposed the concept of stakeholder theory based on its long-term research results. The theory refers to individuals and groups that can affect or be affected by the process to achieve the goal of an organization. Stakeholder Theory is widely used in the field of health services (Y. Luo & Jiang, 2011).

In-depth research on the HMS reveals that there are usually three criteria, which are used to determine the different mentality of each beneficiary in the face of the tiered care mechanism, and then to trace the origin of the conflict, explore the path and the mystery of it, and balance their rights and interests to alleviate the conflicts between them (S. H. Tang et al., 2017).

The HMS mechanism is essentially an issue of benefit distribution, and the intention of setting up primary care institutions in China is to solve the phenomenon of “difficult access to seeing doctors” under the public’s demand for medical care. However, in fact, due to the weakness of primary care institutions themselves, it is impossible to generate healthy competition and mutual restraint with higher-level hospitals. If we want to use two-way referrals to help establish real cooperation and constraints among medical institutions, and then promote the formation of a closer medical association and build up the interests of all parties, we should explore in depth from the perspective of benefit distribution, such as the construction of cooperation mechanisms between medical insurance and medical institutions at all levels (W. M. Li et al., 2018).

The research objects usually include primary and secondary stakeholders that may influence the implementation of a tiered healthcare system. In this thesis, there are two general categories of research subjects, which are: secondary and primary stakeholders, combined with the level of influence on the implementation of HMS. This thesis adopts several perspectives for analysis, such as correlation degree, interest demands, policy influence, and role orientation, and analyzes the interest correlation among different stakeholders through information and data collection. This study classifies the stakeholders as follows: government agencies, medical

health authority (suppliers), SMU and its hospital management company (manager), health insurance sectors (fundraiser), hospitals and community health service centers (main implementer), doctors and nurses (supply-side and important variable X) and patients (demand side) (K. Hu et al., 2007). It is noteworthy that in this thesis considers government agencies as independent stakeholders and conducts a comprehensive analysis of the university-community-hospital linkage (D. Y. Zhao & Liang, 2009).

3.2 The medical system

3.2.1 Medical alliance

Medical alliance is a special medical and health organization. Building up a united medical alliance requires the integration of the structure of medical and health institutions at all levels so as to fully utilize their advantages, and thus healthcare resources available can be properly distributed and managed. Medical alliance is mainly comprised of hospitals, community healthcare centers and other grassroots medical institutions in the same region. A well-established mechanism to integrate medical institutions can centralize discrete medical resources for management. The integration of resources of these medical institutions can promote proper use of medical resources and solve issues such as the difficulty of receiving medical care. For example, patients with common diseases can seek treatment in grassroots medical institutions, while severely-ill patients receive medical care at tertiary hospitals or higher. Within the medical alliance, patients can enjoy services such as referrals between grassroots medical institutions and regional medical centers.

Government and other administrative departments think highly of the establishment and development of medical alliances and have developed relevant policies and rules. On Jan 23rd, 2017, the National Health and Family Planning Commission of the People's Republic of China (now National Health Commission [NHC] of the People's Republic of China) implemented Guidelines for Establishing Pilot Medical Alliances, which specified the requirements of the build-up and operation of the medical alliance. Each region should design its medical alliance considering local medical resource distribution and service capacity and build it based on the principle of proximity to ensure meeting the healthcare needs of different groups of people in the area.

The 2017 Report on the Work of the Government also expounded on the establishment of medical alliances and proposed that tertiary public hospitals need to take initiatives to direct the

set-up of the medical alliances. In the same year, Premier Li Keqiang presided over a State Council executive meeting, and specified the requirements for realizing medical alliance. He pointed out that the focus should be on lifting restrictions over medical insurance payment and administrative divisions, and voluntarily promoting work on the pilot medical alliance. The four patterns of the medical alliance, therefore, come into being.

Later on, more policies are released in China to stimulate the development of medical alliances. For example, Guidelines for Developing Medical Alliance clearly requested to work on a pilot medical alliance in 2017, gradually build up the overall rule framework, and expand the pilot medical alliance step by step. Medical institutions are encouraged to participate in the building of medical alliances, and public institutions should play a leading role in particular. Those documents published later stipulate the evaluation of work related to medical alliance development, proposing that performance evaluation and job promotion should be based on the evaluation results, which provides multiple support for the development of the medical alliance.

After the introduction of the medical alliance, there are increasing relevant studies and practices, gradually leading to various development characteristics. In terms of pattern, multiple patterns are developed such as county-level medical alliance. Since the implementation of these patterns is different, each region should choose the one that fits them best considering their actual needs. In terms of the degree of integration, there are three types. The first is loose-type, and a typical example is Nanjing Drum Tower Hospital; the second is tight-type, represented by Shenzhen Luohu Hospital Group; and the last one is mixed-type, like Shanghai Ruijin Hospital. The medical alliance used by this thesis for the case study, The Seventh Affiliated Hospital of SMU, is a mixed-type county-level medical alliance.

The above analyses clarify the definition of the medical alliance. It suits the development of the modern medical system, provides more comprehensive medical care services to patients, solves unequal distribution of medical resources, and makes full use of the advantages of medical institutions at all levels considering the building of the medical system. For example, higher-level hospitals can get access to grassroots medical institutions or communities, which enable them to play a leading role in the regional medical system; while grassroots medical institutions can improve their soft and hard strength, make up for their shortcomings, optimize healthcare patterns such as hierarchical medical system, and provide accessible medical care services for local people. However, many problems are still identified in the promotion of medical alliances, mainly shortage of medical resources, increasing medical costs, lack of information sharing between medical institutions, and bottleneck in human resource integration. Therefore, it is necessary to work on these problems (Q. H. Huang & Hu, 2015).

3.2.2 Medical resources allocation

Given the overall development of medical services in China, primary medical institutions are less developed than hospitals in terms of quantity or outpatient visits, with a prominent problem of inversion of medical services. Only when hospitals are prompted to improve their productivity can high-level medical resources be better allocated to primary medical institutions. Moreover, it is conducive to improving income, introducing referral incentives, and optimizing referral processes and criteria (S. R. Zhang et al., 2017).

From the perspective of resource allocation, it is believed that the supply of high-quality medical services in public hospitals in large and medium-sized cities has exceeded the demand, the trend of which is intensifying (Dong et al., 2009). The purpose of the HMS is to make full use of medical services in all respects and guide collaboration among medical institutions at different levels (Shen & Zhang, 2016). The establishment of HMS not only activates the unused medical resources at the grassroots level, but also greatly reduces the pressure on public hospitals, especially large public hospitals, and provides a more convenient and comfortable experience for the public (L. L. Chen et al., 2016).

Currently, the distribution of hospitals is like a pyramid while that of patients is an inverted pyramid against the backdrop of hospitals selected freely by patients. The insufficient medical resources cannot meet the increasing needs for medical treatment, which shows an obvious asymmetry between the allocation of medical resources and the demand for medical treatment. The hierarchical medical system can effectively change patients' medical preferences and choices of hospitals (H. Z. Sun & Liu, 2017).

Due to the historical reasons and comprehensive strength of tertiary hospitals, it is difficult to change patients' medical habits in a short period of time, so how to weaken the scale and technical advantages of tertiary hospitals by implementing the HMS, and at the same time improve the level of county hospitals, primary hospitals, and communities by introducing preferential policies, increasing the number of medical personnel, improving income, and expanding the number of beds, so as to promote patients in the process of free choice. In this way, we can promote the balance of patients' access to medical institutions at all levels in the process of free choice (Liang, 2015).

From the perspective of the functional structure of medical systems, the main reason for the imbalance in the number of patients among different hospitals is that medical institutions at all levels provide similar outpatient services. Therefore, the HMS is implemented to carry out differentiated reform in medical services, decreasing some outpatient services of hospitals while

improving those of communities. The superior hospitals should undertake the main responsibility of trusteeship for primary medical institutions within the jurisdiction. Firstly, daily medical treatment should be managed to improve the medical services of primary medical institutions, which can effectively tackle the problem of patients preferring tertiary hospitals. Besides, the tutorial system can be adopted in one-to-one discussions about the trusteeship of business and technology. This study also put forward that outpatient visits are the key to the success of the hierarchical medical system, and it is important to increase visits to primary medical institutions. Otherwise, it will lead to the Matthew Effect that patients have more distrusts primary medical institutions (H. R. Gao, 2017).

3.2.3 Hierarchical medical system

In 2015, China issued the Guidance on Promoting the Development of Hierarchical Medical System, in which the top-level design specifically determined the implementation of HMS according to the relevant requirements and targeted measures, greatly ensuring the smooth development of the HMS in China as shown in Figure 3.1.

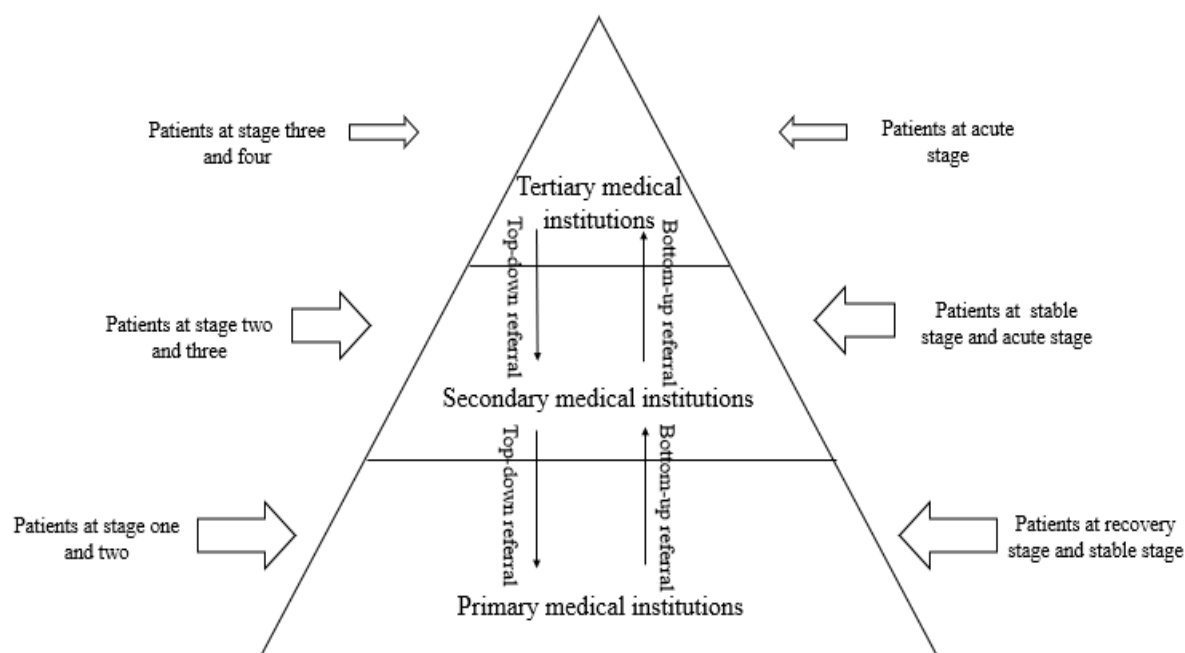


Figure 3.1 The diagram of the hierarchical medical system

Source: S. R. Zhang et al. (2017)

With the adjustment and improvement of national policies, governments and other relevant agencies have been exploring operation models of public medical and health institutions.

The research and exploration of the issues related to the operation model of the institution are mainly related to the following different aspects:

1. Medical group model. The hospital makes comprehensive use of capital, technology and

other different elements to effectively play the advantage of medical resources gathering and expand brand influence.

2. Medical alliance model. In different cities, two-way referral and chronic disease treatment are being promoted gradually. This is an important premise to achieve mutual benefits. Grassroots organizations and hospitals actively interact and build a good partnership, and actively promote the hospital to extend their own services to create the corresponding medical association.

3. Hospital trusteeship model. The primary medical institutions should entrust responsibilities such as personnel and administrative duties to other hospitals.

4. Assets restructuring model. Medical institutions carry out systematic and comprehensive mergers and acquisitions, improve the comprehensive level of management, and integrate wards and patients into medical departments with stronger operating standards.

5. Medical collaboration model. This model is also known as the cooperation model. Under this model, different entities form a partnership model in a loose state, and each entity also uses various models such as contracts and agreements to define the rights and obligations of hospitals in detail and promote the establishment of operational cooperation relationships.

6. Hospital-establishing and hospital-managing model. That is to give full play to the main role of public hospitals, through the creation of branches or to do a good job of controlling grass-roots health institutions, from the vertical level to build a medical group. Public hospitals have complete say in the latter's human resources, finance, and products.

Since the new medical reform in 2009, HMS has been a key indicator and initiative that is highly valued in China. Most of the provinces have also implemented HMS pilots, so that the public's medical needs can be effectively met. For example, Zhejiang and other provinces promulgated measures to introduce standardized policies for HMS. Shanghai implemented a system of GPs, focusing on strengthening the construction of medical associations and improving the system of medical services. Qinghai and other places integrated medical insurance payments and other methods to reasonably guide patients, under which two-way referrals were carried out.

Nowadays, the HMS has developed over the years and has shown very remarkable results, as follows:

In 2012, Zhejiang took measures targeted at the medical development at that time and initiated the GP service model. In 2013, a "two allocations and two improvements" project was implemented to allocate both medical personnel and resources to primary medical institutions and improve medical service capacity and efficiency at the primary level. Implementation Plan

for the Pilot Project of HMS in Zhejiang Province proposed in 2014 states that the mechanism of the hierarchical medical system should give top priority to the interests of patients so that the health gatekeeper system can be promoted, and the joint coordination mechanism can be formed. During the pilot, medical service prices and reimbursement rates of medical institutions were adjusted to widen the price gap of initial diagnosis in hospitals and guide patients to go to corresponding hospitals. The hierarchical medical system in Zhejiang has achieved significant results, but there are still some problems such as the less refined policies, unduly strict referral policies, and insufficient infrastructure.

Shanghai has contributed to exploring the same area and introducing residents to sign contracts with family doctors, further launching a contracted pilot “1+1+1”, which has gained positive effects. Under this scheme, higher-level hospitals provide information to support family and community doctors, while the latter promotes signing services and transfers patients in need to the former. The medical system in Shanghai has achieved interconnection between the health information system and the medical insurance system, which shares the medical information and prices for people to seek appropriate treatment.

Yichang, Hubei is the first to build a prefecture-level coordinated referral system for the hierarchical medical service, in which medical institutions and patients are closely related. On this platform, patients can have easier access to the appointment for medical services, two-way referrals, and online consultations. Medical services from more than a thousand public hospitals are integrated via the information system and the internet, which shortens the time for residents to seek medical services and for their referral to hospitals for treatment.

Qingdao, Shandong put into effect the plan of “initial diagnosis at primary levels, hierarchical diagnosis and treatment, and two-way referral”, to promote medical reform in the hierarchical medical system. It innovates in proposing the comprehensive prevention of cardio-cerebral apoplexy as the pilot of the hierarchical medical system and setting up a multi-disciplinary team for project cooperation. In 2016, Qingdao achieved a significant increase of 15% and 9% in the control of blood pressure and blood glucose.

Xiamen has promoted a medical service model in line with the local medical situation, that is, medical services are provided by a team consisting of GPs, dietetic technicians, and specialists from three tertiary hospitals. Specifically, experts concerned should regularly go to the community health center to provide medical services. Besides, three tertiary hospitals have adjusted their hospital structures, transferring some of their general outpatient clinics to the community health center. Since all community health centers in Xiamen are affiliated with the above-mentioned three hospitals, the “hospital-establishing and hospital-managing” model has

been fully underway.

In addition to the above-developed provinces in China, there are also some successful examples in less developed ones. For instance, Panzhihua in Sichuan province has reformed the hierarchical medical system by focusing on the diagnosis and treatment of disease entities. Critically ill patients can be directly transferred to tertiary hospitals while other patients with chronic or common diseases should be treated through gradual referral in line with the complexity and severity of their diseases. In Panzhihua, the medical service system of tertiary hospitals is effectively integrated, with the local general hospitals as leaders who manage secondary hospitals and primary medical institutions, so as to form an efficient regional medical alliance. These measures improve the service capacity of local primary medical institutions. Another example is Liangshan Yi Autonomous Prefecture with a weaker medical basis. In exploring the role of the hierarchical medical system in health poverty alleviation, the prefecture weighted resources for poor areas where ethnic minorities live and exploited modern technology to shorten the distance for people to seek medical consultation. Despite insufficient facilities, the prefecture made full use of models, such as alleviating poverty through experts and technology, long-distance medical teaching, medical cases sharing, mutual recognition of test results, and regular training of personnel, to enhance the service capacity of local medical institutions. The system of family doctors characterized by ethnic minorities was established, which was highly recognized by the public .

Different countries have different influencing factors for graded diagnosis and treatment, and foreign medical service systems are relatively mature. The research on influencing factors of HMS started early, and its content was comprehensive and in-depth. The research scope mainly focused on influencing factors of the medical and health service systems and referral.

Mac (2008) found that the influencing factors of the American health service system include the degree of specialization of physicians, the training mechanism of health personnel, the expansion and high-end development of hospitals caused by medical insurance, and the neglect of the development of basic medical services, which are the main reasons for the waste of American health service system.

Macinko (2001) adopted the health statistics of 18 OECD developed countries to study the correlation between health service systems and health and found that the perfection of health service system in the region was negatively correlated with the incidence of cardiovascular disease, mortality of residents and infant mortality.

Green et al.'s (2007) study show that with the increase in patients' self-pay ratio, the outpatient service cost decreased, which indicated that medical insurance played a positive role

in guiding patients' medical treatment behavior. Webb and Lloyd (1994) argued that the main factors affecting a physician referral are the referral cost and patients' wishes. Sobal et al. (1988) found that physician-patient interaction, physician's sense of responsibility, and physician's speciality are also factors to consider. Stephen and Anderson (1975) stated that physicians' payroll and institutional service are the main factors affecting physicians' referral.

Xin et al. (2016) conducted the study from the perspective of sociological characteristics, and findings show that in terms of age, the elderly is more willing to choose primary health care institutions than young people. Yuan et al. (2006) found that more women than men chose primary health care institutions. S. J. Chen and Li (2013) found that among urban residents, more women than men chose to go to non-primary health care institutions for the first visit. Xu and Wu (2016) stated that people with low educational background, and those without formal occupation and retired workers tend to choose more primary health care institutions. From the perspective of family characteristics, in terms of family income, the higher the family income, the less patients choose primary health care institutions (X. M. Zhang et al., 2013). Regarding the place of residence, the probability of urban residents going to high-grade hospitals for medical treatment is higher than that in rural areas.

However, Wang et al. (2018) proposed that from the perspective of health status, elderly patients with chronic diseases are more inclined to seek medical treatment in primary medical institutions, because the proportion of more serious chronic diseases among the elderly is the highest, requiring more convenient and reasonable care, so the dependence on community centers is also very high. X. Li (2015) believed that the level of medical service, medical service attitude, equipment, environmental conditions and the convenience of community centers are important factors affecting the medical service capacity of community centers. From the aspects of government supervision, it mainly affects patients' willingness to see a physician in community centers from the aspects of guarantee supervision system and implementation, reward and punishment system and implementation, referral system and implementation, and charging system and implementation.

Z. L. Yao (2016) found that expert support system is the key to improve the medical service level in community centers, which affects patients' willingness to visit the community centers. The maximum payment limit, reimbursement ratio and payment range of medical insurance support affect patients' willingness to visit the community centers. In the study of the mechanism of patients' willingness to visit the community centers, patient satisfaction is a very important intermediary variable, which has been mentioned in related studies. From the perspective of participating in medical insurance, whether it is urban and rural residents or rural

residents, those who participate in medical insurance or participate in supplementary insurance will be more inclined to choose primary medical care; Residents who can use medical insurance in their current residence are more inclined to go to primary medical institutions for the first visit than those who cannot use medical insurance in their current residence.

In the medical field, researchers have systematically analyzed the factors that influence physicians' willingness to accept patients in terms of ease of implementation of two-way referrals for graded care, the power of government supervision, the ability to manage medical capacity flexibly, the intensity of legal penalties, the pay and treatment of medical staff, and the degree of potential for medical disputes.

Y. H. Yang and Ni (2008) found that the implementation simplicity of two-way referral affects the referral efficiency of hospitals and community centers, thus affecting the willingness of patients in hospitals. Government supervision affects the willingness of patients in hospitals from three aspects: medical insurance system and its implementation, reward and punishment system and community first diagnosis system and its implementation. Hospital capacity flexibility includes four aspects: backup human resources, backup material resources, backup financial resources and logistics support system. It is an inherent ability of hospitals, which enables organizations to better allocate medical resources. There is a close relationship between capacity flexibility and performance, which affects the willingness of hospital patients. The punishment is to restrain the medical staff's behavior of failing to refer patients down according to their illness, thus affecting the willingness of hospital patients. Remuneration and welfare mainly affect the hospital medical staff's willingness to treat patients from three aspects: income level, welfare benefits and promotion opportunities.

In primary health care institutions, the researcher analyzed the factors influencing the willingness of accepting patients in community centers from the following aspects: the simplicity of two-way referral, the intensity of work, the working environment, the punishment and the remuneration and welfare of medical staff in community centers. Two-way referral is an important link of hierarchical diagnosis and treatment, and the key to enliven community health service.

K. Gao and Gan (2015) found that the two-way referral has a difficult situation of "easy to refer to higher level institutions but difficulty in referring to lower level ones", which is one of the main reasons that affects the progress of community health services. D. X. Li et al. (2013) thought that referral procedures, referral time, referral channels and referral standards were important factors affecting the implementation of two-way referral. Shen and Zhang (2016) found that the working intensity of medical staff in community centers affected the willingness

to accept patients in community centers from three aspects: physical labor, mental work and work stress. H. G. Ma and He (2010) suggested that the working environment of medical staff was the key factor to accept patients in community centers. Z. C. Zhang (2014) found that it affects the willingness of accepting patients in community centers. Remuneration and welfare mainly encourage the medical staff in community centers to accept patients from three aspects: income level, welfare treatment and promotion opportunities, which affects the willingness of accepting patients in community centers. The punishment is to restrain the medical staff in community centers from refusing to accept patients, thus affecting the willingness of accepting patients in community centers.

As shown in Figure 3.2, university is the central part of the model, while hospital and community are two powerful tools. University provides comprehensive guidance for hospital and community and coordinates the integration, cooperation and exchange between them; hospital conducts all-round reform of itself, including organization and performance reform, fully promotes discipline construction, intensifies talent introduction and education, provides advanced education and learning platforms for community doctors, and sends young GPs to communities to accumulate more experience; and community implements reform of medical insurance and drug system, improves service ability, provides initial treatment at the primary level and basic public health services as required, strengthens the two-way referral together with hospital, and finally works together with hospital to build regional medical communities so as to promote its brand.

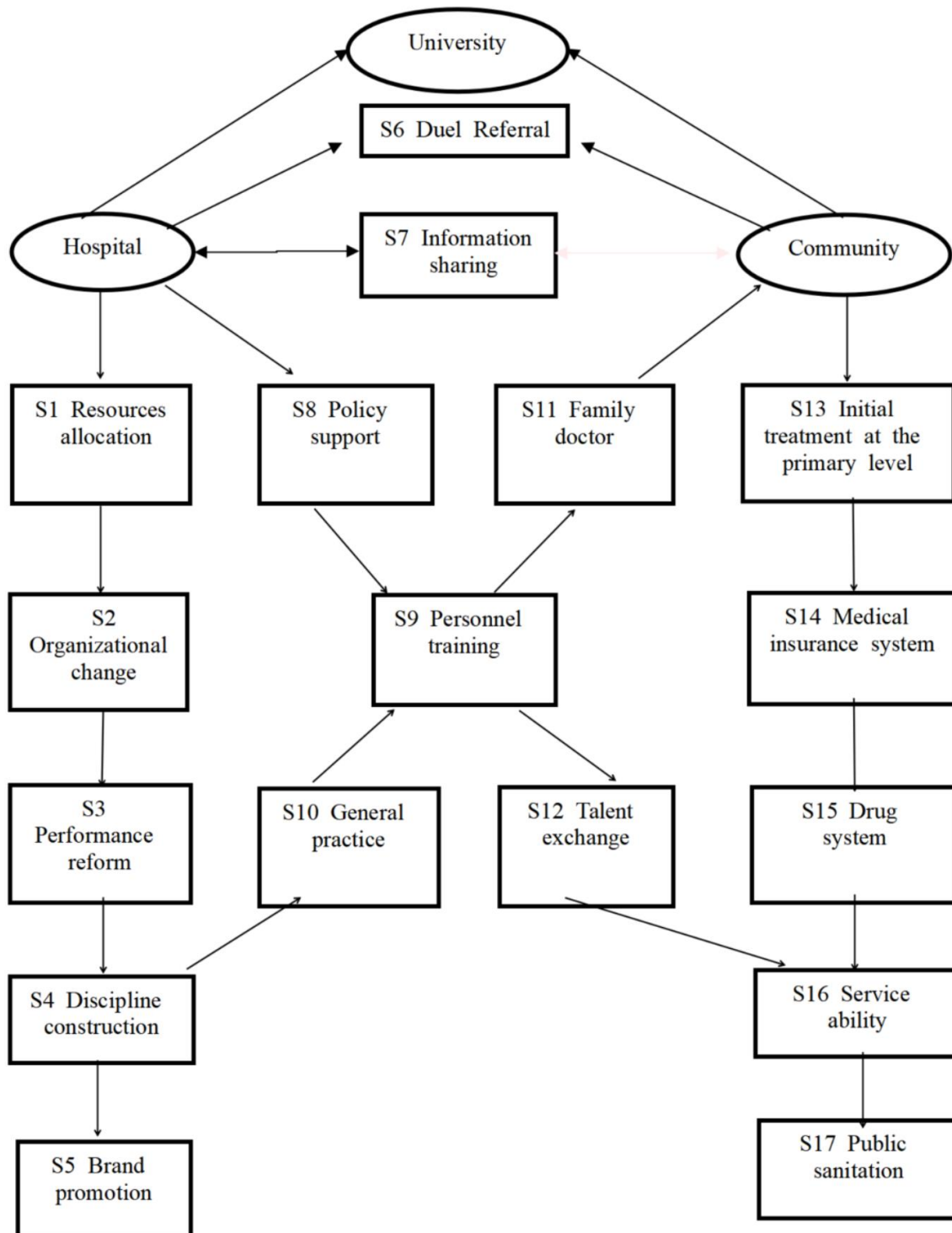


Figure 3.2 Topological graph of the model of the hierarchical medical system

3.2.4 Two-way referral

3.2.4.1 Domestic two-way referral status

The research on the theory of two-way referral in China can be roughly divided into three aspects:

(1) Clinical pathway research. Clinical pathway research mainly studies the specific referral model and institutional indicators of common chronic diseases such as hypertension, diabetes and coronary heart disease. Xun et al. (2011) explored the two-way referral model for cancer survivors. He (2013) compared the clinical pathway of two-way referral of hypertensive patients through the control group. Z. C. Zhang (2014) combined with the current situation of diabetes treatment with traditional Chinese medicine, discussed the medical mode of two-way referral of diabetes between traditional Chinese medicine hospitals and community medical institutions

(2) Studies on the behavioral characteristics and influencing factors of the subjects involved in the transfer of both parties. Most of the studies in this category used questionnaires to investigate the willingness, satisfaction, and influence of physician-patients on the transfer of both parties.

M. S. Chen et al. (2010) conducted a questionnaire survey on referral willingness and its influencing factors among 400 medical staff and 400 patients in 21 public hospitals in Songjiang District of Shanghai. D. X. Li et al. (2013) conducted a survey on the awareness and impact of two-way referral for patients in urban areas in distant suburban counties of Beijing. Song et al. (2013) conducted a survey on nine hundred and eighty-two patients who were socially referred to clinics after random selection in Zhuhai in order to analyze the influencing factors on patient satisfaction with the referral. Liang and Chang (2014) carried out a survey on the referral awareness of four hundred and thirty-three skeleton doctors from the People's Hospital of Henan Province.

Moreover, Y. W. Yang (2015) conducted a questionnaire survey on medical care and patients in Tianjin on the status of the two-way referral, and the results showed that all medical parties had a poor degree of recognition of two-way referral. The results of the patient's intention survey show that the main consideration of the referral procedure is complex and costly. The results of the medical care intention survey show that there are no specific referral norms and procedures, and there is a concern about medical risks.

We conclude that the main obstacle is that China's current social security policy measures are not sound. The medical insurance for urban residents, the medical insurance for urban citizens and the medical insurance for rural residents are handled by the health bureau and the labor security department respectively, and the corresponding rural medical relief and township medical relief is managed by the Civil Affairs Bureau. Different guarantee systems do not have the same payment standards, coverage scope, reimbursement ratios, medication lists. The departments are separated from each other, which seriously limits the overall use of medical

resources and is not conducive to the efficient development of two-way referral. In addition, the information system between medical insurance facilities is not smooth, and the procedures for sharing patient health record information are cumbersome and complex, which is also the main obstacle to the implementation of the two-way referral system.

K. Gao and Gan (2015) selected more than 30 hospitals in 12 provinces in China, conducted a questionnaire survey on more than 2,000 patients through medical students, and analyzed the influencing factors on patient referral decisions. These questionnaires analyze the current cognition of physicians and patients on two-way referral and the influencing factors on referral willingness.

(3) Study on the model of two-way referral. At present, there are six types of models for merging public hospitals and social primary care institutions nationwide: public hospital-led model, social firm-led model, public hospital-social integration model, disease management-based model, social capital integration-based model, and government administrative-driven model. According to the two-way transfer management models implemented by comprehensive public hospitals and social medical institutions, the following three types of management models are roughly included.

First, is the government-led mode. The ownership of the two-level hospitals belongs to the government, and the two sides sign a cooperation agreement to realize two-way referral. The second is the cooperation mode under the separation of management and administration. Primary medical institutions are owned by the government and managed by general hospitals. The third is the hospital management mode, which means that the two hospitals belong to the same medical group, so as to realize the internal referral system in the hospital.

H. Li and Gan (2011) applied the system dynamics model to analyze the restrictive factors of referral to lower-level institutions in the group hospital mode and studied the internal interaction mechanism of referral. Y. Yao et al. (2012) selected five hospitals in four cities, including Wuhan and Nanchang, to conduct a questionnaire survey, and analyzed the two-way referral situation of hospitals at the upper and lower levels under the three modes of cooperation, trusteeship, and medical group in upper and lower-level public hospitals. The results of the study showed that about 10.5% of physicians did not agree with the current referral status. However, the highest level of acceptance and better implementation of referrals was found in the hospital group management model. An important barrier is the lack of effective communication mechanisms. From the summary of the above research findings, it is clear that the main problems and influencing factors of two-way referral have been largely investigated. The main research methods include case studies and questionnaires. The research on measures

is mainly qualitative, and there is no analytical framework and ideological basis between problems and measures, and there is no research on the conditions of the proposed measures and the effectiveness of their implementation.

(4) Research on the policy and process of two-way referral. Such studies include comparative studies of home and abroad countries with referral policies, and relevant incentive system analysis. Some are based on the perspective of community hospitals, some on the perspective of patients, and some on the perspective of government.

Using the literature method and statistical data analysis method of regional health administrative management system, put forward a benefit distribution model of two-way referral related parties, which can achieve the effects of patient cost reduction, income increase of township hospitals and balance of the new rural cooperative medical fund (W. Li & Mei, 2013). Among them, the core is that township primary hospitals pay 5% of the hospitalization expenses incurred by patients to the transferring hospitals.

Lei (2013) established an incentive and restraint mechanism of two-way referral with medical insurance. Encourage and guide patients and restrain hospitals. The main measures include enlarging the reimbursement ratio of hospitals at different levels and reducing the deductible line for patients who are transferred to other hospitals. Will be transferred to the patient costs included in the hospital fund expenditure.

Gan et al. (2014) analyzed by establishing a three-stage dynamic game model that medical insurance reimbursement leads to an increase in the total social medical expenses, and poor reimbursement is higher in lower-level hospitals will promote patient diversion, but it will also be affected by the difference in medical service quality between higher and lower hospitals.

3.2.4.2 Foreign two-way referral status

(1) The United Kingdom case

The NHS in the United Kingdom was established in 1948, and the British community health service system is part of the overall NHS system. After nearly half a century of development, it is now regarded as one of the most comprehensive health care delivery systems in the world. The NHS system in the United Kingdom is arguably the most publicly funded health care organization in the world. As a country with an ancient tradition of GPs who are important providers of community health care services in the United Kingdom.

The United Kingdom is also one of the first developed countries in Western Europe to adopt the two-way referral mechanism and the most standardized implementation. At present, the basic medical and health public service system in England basically covers all public hospitals, various outpatient departments, social medical insurance centers, health hospitals and other

medical institutions in the United Kingdom. There are usually three service networks. The first level is the basic care facility, which is the largest part of the hospital service system in England, accounting for about 75% of its total cost in the hospital service system.

Primary medical and social care is provided primarily by a medical practitioner and a nurse practitioner. Patients are first treated in a primary care facility and then transferred to the appropriate higher-level hospital as the disease progresses. The second level is the regional hospital, which is the medical management center of the region. However, if there are several regional hospitals, they are generally managed by the same management. Primary care providers are responsible for receiving patients referred to them by local hospitals. The third level is the teaching hospital, where critical care and major medical problems are predominant. Primary care facilities can refer patients directly to teaching hospitals once they are deemed to be more complex, and regional clinics can also refer patients to teaching physicians.

Currently, there are approximately 40,000 GPs in the United Kingdom, with each GP serving an average of approximately 1,600 residents. The GPs not only provide primary health care services to the villagers in the community, but are also responsible for selecting the clinic, department, and specialist for the patients, and providing the most scientific, rational and efficient health consultation services to the patients, thus greatly improving the effectiveness of the treatment and greatly reducing the time spent by the patients due to the “confusion”.

According to NHS, British legal residents can seek medical treatment at the nearest community clinic, but they need to register at the community clinic in advance. Patients can go directly to community clinics to find GPs for treatment. Children can go directly to the community hospital to be seen by a GP. If the illness is urgent, GP will refer the child to a clinic for further diagnosis. Therefore, in the United Kingdom, clinics are usually emergency departments, not outpatient clinics.

Patients are sent directly to a teaching hospital only when there is a genuine emergency. If the GP feels that the patient's condition is beyond the scope of care provided in the community, but immediate emergency care is not necessary, the GP will contact the teaching hospital, an urban public hospital, or even a higher-level general practice department. The GP will make an appointment with the relevant physician before issuing a referral letter to the patient, including the date of the appointment and other relevant matters.

Patients can then go directly to the inpatient facility for medical treatment and receive free consultation services from the NHS. Once inpatient treatment is completed, the patient is returned from the hospital to the community for further recovery and consolidation. The community GP will then visit the patient and provide more specific care.

In addition to this, the fact that people in the United Kingdom do not go to the main clinic or go to the clinic less often is a very influential factor. That is because of the trust that the British public has in community GPs. The high status and trust of GPs in the UK is due to three main factors:

First, GPs have a high level of diagnosis and treatment, which is because GPs have a high professional entry threshold and perfect systematic on-the-job training.

Second, community clinic physicians do not rely on the patient to earn money, and it is not possible to make money by prescribing drugs, because the community clinic fees are all financed by the government. Patients cannot question the motives of physicians to serve the examination and prescribe drugs.

Third, the United Kingdom adopts the community contract mechanism, and the clients of GPs are relatively fixed. GPs and community residents have frequent contact, mutual trust and good interpersonal relationship. The hospitals in the United Kingdom are generally privately owned, and the GPs rarely move around. Many of them even work in a fixed community for their whole life. Although there is a choice between community residents and GPs, the process is complicated because community residents often choose to be treated close to home. Switching to a registered practitioner makes it more complicated to see a doctor. GPs in the UK have a large role in managing the mental health and chronic illnesses of people in the community from birth to death, in addition to their outpatient and clinic duties. After a few years of practice, a strong business relationship is established between the patient and the physician, and it is rare to change physicians.

(2) The American case

The medical and health service system in the United States is divided into two levels: family physicians and hospitals of various forms. Family physicians are responsible for the early diagnosis of patients, while other clinics provide primary care and advanced medical treatment for patients. The hospital system is highly market-oriented, with private clinics and private hospitals accounting for a major portion of the system. Patients should first find their family physician when they seek medical care. If the family doctor feels the need, the patient will be transferred to a local clinic for treatment; if the condition is serious, the patient will be transferred to a higher-level teaching clinic and then to a lower-level clinic or clinic when the condition is less severe.

The health care system is dominated by private hospitals and insurance companies. The private insurance market is now highly developed throughout the United States. Community GPs are also generally private practitioners. Therefore, the business mechanism of U.S.

hospitals is more diverse and market-oriented. Community health care for specific groups of people, including active military personnel, the elderly and the poor, is subsidized by the government. The majority of the population is covered by private health insurance purchased by employers. In contrast, national health insurance is mainly social insurance.

At the suggestion of a commercial insurer, community residents often select a community physician to serve as their family physician, a service relationship that is not mandatory but is based on trust and can be adjusted at their discretion. Although the structure is loose, the government still places great importance on the management of health care services. Usually, health care organizations and health care service providers work together to organize managed care construction. In other words, in order to achieve the rational creation and use of health care services, they use organizational measures and business incentives to induce improvements in the practices of both the supply and demand sides of hospitals, focus on regulating and supervising the behavior of hospitals, reasonably limiting hospital fees and improving the quality of hospital services.

As a result, the healthcare market is moderately competitive and highly regulated. The vertical medical group of family physicians and clinics in the United States has developed over a long period of time and has become very standardized. National primary care physicians and primary care providers have been given the role of "gatekeepers" to define access and guide physicians through the hierarchy of care. The hospital groups are usually centered on a large general hospital with a cluster of hospitals at various levels, with a great deal of complementarity between hospitals and between hospitals, and a standardized referral system.

There are three general forms of managed care insurance in the United States: the U.S. Government Preferred Provider Organization, the National Health Protection Agency, and the Point of Care. In addition, there are also Diagnostic and Treatment Service Group Plans that are popular in the American government. Health Maintenance Organizations implement quantitative subsidies for health care providers based on capitation costs. This approach evaluates hospitals on the basis of quality and also standardizes physician practices, addressing many of the drawbacks of paying for hospital services by line item. The Health Maintenance Organization, with its lower costs and access to quality medical consultation services, has seen a yearly increase in participation, reaching 50 million today. The Provider of Choice group was developed from the cornerstone of the Health Maintenance Organization. On the other hand, they have learned that national Health Maintenance Organizations are subsidized on a capitated basis, and on the other hand, they have no constraints on the quality of physician services they choose.

Patients pay relatively little money by themselves when they are treated by government-recommended physicians and clinics, but should pay a significant percentage of their own costs if they choose to see their own physicians outside the network. Since its inception in 1982, the Point-of-Service program has grown rapidly in both size and number of enrollees, increasing by 18.6 and 29.43 times in ten years respectively.

Medical treatment project team plan groups for inpatients with similar conditions according to their consumption level, and links hospital-specific diseases with their medical expenses for payment. Management-based health care controls the cost and utilization of medical services by adopting the appropriate payment method for the supplier's cost. Different payment methods have different incentive effects on the number of medical services provided by suppliers, and the control effects of medical expenses are also different. As a gatekeeper, GPs usually pay by the head, which fundamentally changes the economic incentives for physicians. Providing more medical services does not mean getting more income. Therefore, paying by head instead of paying by the number of services avoids the problem of over-provision of medical care. Of course, the headcount includes all the primary health care expenses of the insured. Physicians will withhold a certain percentage of funds every month. If there is still a surplus after the deficit is eliminated at the end of the year, these funds will be returned to physicians. Under this payment mode, physicians' behaviours of irrational drug use and prescribing large prescriptions can be basically eliminated, and patients can be referred from hospitals to community health service centers.

(3) The Australian case

Australia's medical security system is one of the most perfect medical systems in the world. The referral system in Australia's medical system is based on the "gatekeeper" role of GPs and the cost control mechanism. The main development direction of primary health care in Australia is to build community health service centers. There are more than 560 community health service centers and more than 200 auxiliary community health institutions in Australia. Community health service centers provide services including disease diagnosis, treatment, infectious disease prevention and monitoring, health consultation and medical care. Similar to GP in the United Kingdom, Australian GPs play the role of "gatekeeper" of health service. Under normal circumstances, about 80% of patients will stop medical services in community health service centers. Only about 20% of patients will be referred to hospitals.

Australia reasonably combines community primary health care with general hospitals and specialized services, which reflects the fairness and accessibility of health services. If a patient needs further medical examination or surgery, the GP will communicate with the patient.

Patients can also make their own requests and negotiate with the GP. After reaching a consensus through communication and consultation, the GP will issue a referral form or a referral letter to the specialist. After receiving the referral document, the specialist will arrange for the patient to check or contact the hospital, and make an appointment for the patient to arrange the operation. The specialist will write back to the GP who has made the referral, informing him of the results of the examination or the arrangement of hospitalization. When the specialist's diagnosis and treatment behavior or hospitalization behavior ends, the specialist or hospital will feedback the results to the GP again, and the results will be input into the electronic medical record of the GP. In the process of patient referral, there are restraint and incentive mechanisms for both GPs and specialists. On the one hand, the GP will not deliberately turn up based on the patient's safety considerations.

Moreover, the Royal Australian College of General Practitioners will evaluate the referral information and documents provided by GPs to patients as the basis for evaluating the quality of GPs' referral services. There are also some other institutions, including the Medical Insurance Welfare Advisory Committee, the Improvement Evaluation and Health Care Group and the Professional Service Appraisal Committee, which will also guide and supervise the two-way referral of physicians. At the same time, the learning content and professional focus of specialists are strictly distinguished from those of GPs, and there is no interest dispute between them. Obtaining "sorted" patients from GPs has become an efficient service mode, so they are willing to accept the referral system. There is no interesting relationship between GPs and hospitals, and generally, there will be no problem inducing patients to be hospitalized.

Unlike the United Kingdom, Australia does not require community residents to observe the "first consultation system" at the primary health care level, nor does it need to appoint a specific GP to register. Australian residents can freely choose to see a physician with a card, or even go directly to a general hospital or a specialist. However, this situation is rare. Residents do not "get together" to go to hospitals and "neglect" community physicians. There are many reasons for this.

First, there is no outpatient department in Australian general hospitals, and patients can only go through the emergency department, while physicians in the emergency department arrange the order according to the priority of illness, and patients generally have to endure a long waiting time to see a physician by themselves. Therefore, although patients enjoy full freedom of choice in seeking medical treatment, they usually choose their own community physicians for the first consultation. If the patient chooses to go directly to the specialist who opened the business, the specialist will decline politely due to professional restrictions, and ask the patient to go to the

GP first. The specialist is used to receiving patients referred by the GP.

At the same time, in general, the cost of specialist clinics is obviously higher than that of general clinics, so patients should consider paying for themselves. There are 20,500 specialists and 39,000 GPs in Australia. The number of GPs is almost twice that of specialists, and the accessibility of GPs is stronger. Therefore, the common community residents in Australia generally choose community physicians first. Although there is no institutional restriction, GPs still play the role of “gatekeeper” for community residents’ health. Australia has a universal medical insurance system.

Almost all Australian residents have a medical insurance card, which is marked with the card number, cardholder’s name and other information. Residents can get the services provided by the national medical insurance system when they go to the clinic for treatment or hospitalization. The government implements diagnosis related group (DRGs) to calculate the allocation for hospitals. DRG pays according to the classification of disease types, and pays for the case portfolio. Standardization of DRG payment can promote the horizontal comparison of costs in different clinical processes in different hospitals, promote the rationalization of disease treatment and disease cost management, and help improve the management level of hospital management, clinical management and patient treatment process. Australia’s universal health insurance tends to be relatively balanced. Because the cost of community treatment is far lower than the cost of hospitalization in general hospitals, and hospitals adopt the budget contracting system, in order to control costs, hospitals are more willing to improve the turnover rate of beds and pay more attention to the cooperative relationship with community GPs. A discharge administrator is responsible for the discharge of patients, and actively seeks to refer postoperative patients or confirmed patients to the community for further treatment to save costs.

(4) The French case

French medical institutions include public hospitals and private hospitals. Although there are fewer public hospitals than private hospitals, it still plays a leading role in the national medical service. Public hospitals in France include university medical centers, provincial central hospitals and local hospitals, as well as psychiatric hospitals and other specialized hospitals. The funds of public hospitals mainly come from government financial subsidies and social security funds. There are 29 national university medical centers in France with more than 40,000 beds, with modern medical equipment and advanced treatment methods, which mainly treat various intractable diseases. There are 99 provincial central hospitals located in major cities, which are responsible for the treatment of the most difficult and severe diseases, and also undertake the clinical training tasks for medical college graduates. There are 365 local hospitals

located in towns, which are small in scale and only have simple medical rescue facilities and equipment to undertake the prevention and treatment of general diseases.

France practices the principle of combining prevention, medical treatment and rehabilitation. Private hospitals undertake a great deal of health care services. These private medical institutions bear about one-third of the national health care services. They play an important role in community medical service.

France has implemented a strict grading diagnosis and treatment system in hospitals, hospitals at all levels are not allowed to expand the diagnosis and treatment programs without authorization, and a strict referral system has been implemented. Patients should be recommended by GPs before they can be treated by specialists. After the surgical operation, the central hospital usually transfers to the community rehabilitation center for treatment one week later.

Medical insurance in France is mainly divided into basic medical insurance and supplementary medical insurance. The current French law stipulates that residents living in the domestic territory must join the basic medical insurance. Basic medical insurance is divided into five different categories according to industries or classes, and their benefits are different. However, in general, basic medical insurance can reimburse two-thirds of the total income of individuals, and the rest needs to be taken care of by the patient himself, or by purchasing supplementary medical insurance.

The social insurance department has established strict scope and catalogue for medical service items and drugs, and certified prescribing physicians. For specific medical service items, it is also necessary to seek the opinions of supervisory consultants determined by the social insurance department in advance. The percentage of insurance for patients' diagnosis and treatment varies according to the method of diagnosis and treatment, the spectrum of diseases, and the function of medication. Usually, the percentage of self-paid expenses for hospitalization is less than the percentage of outpatient visits.

(5) Analysis and introduction of referral modes in other countries (e.g., German, Japan, Brazil, and Singapore)

In the health service system of Germany, family physicians have successfully played the role of “gatekeeper”. German health insurance law clearly stipulates that patients should seek a family physician. Only when the family physician issues a referral certificate can he be hospitalized in a large hospital. Germany has a compulsory social medical insurance system. Anyone who participates in legal medical insurance can enjoy a wide range of health care services. Japan divides the national medical system into more than 200 two-level medical

circles, and strictly regulates the number of beds provided by each medical circle to control medical expenses.

In 1992, the Japanese government began to implement the two-way referral system, requiring residents to choose community health service institutions for the first visit, and promoting exchanges and cooperation between general hospitals and community health service institutions, which changed the problem that it is easy to transfer from community health service institutions to general hospitals and avoided the vicious competition between community health service institutions and general hospitals.

Brazil adopts the principle of regional and hierarchical visits. Patients have a set of standardized medical procedures. Brazilian residents must go to the community health service institutions for the first visit, and there are referral offices in each city. When patients need to be transferred to a hospital for treatment, the community health service institutions will contact the referral offices, and the referral offices will contact and arrange hospitals. The referral office in Brazil understands the utilization of beds in various hospitals and is responsible for guiding the adjustment of the process of patient visits in our city. In order to alleviate the operational pressure of large hospitals, many doctors in large hospitals are practicing in small clinics or social medical service stations, so that social health resources have been fully and rationally used.

Singapore's medical and health service system includes two parts: the public medical system and the private medical system. Nearly 80% of primary health care services are undertaken by the private system. Public medical institutions form two major medical groups. The Singapore government gives high financial subsidies to public hospitals and clinics, and the annual changes in health needs and hospital types and different departments control the total income of subsidized hospitals. The design of Singapore's medical insurance system guides patients to seek medical treatment reasonably and make the two-way referral. First, patients who first visit the underlying medical institutions are given a 20% reduction in medical expenses. Second, inpatients need to pay part of their expenses according to the ward level.

By analyzing the mature models abroad, we can find that the relatively ideal two-way referral system must be based on a sound basic system. The above-mentioned medical and two-way referral systems in economically developed countries such as Britain, France, the United States, Australia and Japan have the following common characteristics:

(1) Hierarchical diagnosis and treatment system

Two-way referral refers to the collaboration of medical services between two or more medical institutions. If there is a crossover between hospitals, there is a conflict of interest, and

even if they belong to the same hospital enterprise, the conflict of interest will lead to poor referral. In developed countries around the world, the prerequisite for effective two-way referral is a clear division of labor between public hospitals and community health services at all levels of care. Community health service organizations are deeply involved in the community, focusing on managing, tracking and evaluating the health status of residents, providing the timely basic diagnosis of common and chronic diseases, identifying major problems and making appropriate referrals, so that patients can receive correct diagnosis in a timely manner. The senior public hospitals, on the other hand, are responsible for high-technology operations such as critical and difficult diseases.

(2) GP system

A major factor in the successful implementation of categorization and referral mechanisms in developed countries worldwide has been the introduction of general practitioners. Most of the community health services are staffed by general practitioners, who adapt to the outpatient needs of community residents, diagnose, and intervene in common and chronic diseases and other preventive and curative care. In contrast, general clinicians focus only on disease diagnosis and clinical research. Only by strictly implementing the registration system for general practitioners and specialists to regulate the scope of practice and change the management mode of physician training, and by practicing in different fields at the same time, can we promote a clearer division of labor in each clinic, and thus effectively promote the normal Attention to the construction of community medical service.

(3) Attention to the establishment of community basic medical service projects

Developed countries in the world attach importance to the capacity building of primary medical and health services, including not only medical and health services, but also family planning, Children's Home, homes for the elderly, rehabilitation centers for the mentally handicapped, and treatment centers for alcohol and drug addiction. Generally, community health service centers with perfect functions have been established through high financial input and subsidies, and a strict referral system has been established step by step. Community health services go deep into the residents' side, mainly providing services and help for the elderly rehabilitation, women's health care, children's growth, rehabilitation of the mentally handicapped and other projects that residents need.

(4) Control by large hospitals

Developed countries in the world have implemented strict control systems on the diagnosis and treatment scope and bed size of large hospitals. Some countries stipulate that only the inpatient department and emergency department should be set up in large hospitals, and the

total budget of large hospitals should be controlled, which urges large hospitals to reduce the hospitalization days as much as possible, and refer patients with the stable condition to the community for rehabilitation treatment as soon as possible, thus promoting the effective operation of the two-way referral downward, and avoiding the abuse and waste of medical resources caused by the provider induced service.

(5) Standardized system of residents' medical treatment

Developed countries in the world generally stipulate the path of patients' medical treatment, strictly limit the random choice of hospitals, and ensure patients go to primary medical service institutions for the first visit by means of reimbursement gap in medical insurance. Community residents are strictly prohibited or not allowed to go to large hospitals themselves in non-emergency situations. Singapore also implements a strict referral system, which requires residents to visit community health service centers first. Only when it is confirmed that a referral is needed, the community health service center will issue a certificate, and the patient will go to the general hospital with the certificate, otherwise, the expenses will not be reimbursed by medical insurance.

(6) Perfect social medical insurance system.

The social medical insurance system in developed countries is relatively holistic. Social medical insurance has a high coverage rate, which is supplemented by not only compulsory medical insurance but also various commercial medical insurance. Generally, the out-of-pocket medical expenses of patients are relatively small. By establishing the restraint and incentive mechanism of hierarchical reimbursement of medical insurance, and using economic leverage to guide patients to choose primary medical and health institutions for "first diagnosis", plays a strong role in promoting and guaranteeing hierarchical diagnosis and treatment and two-way referral.

(7) Stress on the construction of medical information.

In developed countries, community hospitals generally set up perfect residents' health records. Residents who have health problems can consult community physicians first by telephone or email. When community physicians confirm that patients need to be referred to a higher-level hospital for treatment or operation, they will provide detailed medical history records and all inspection reports of patients, without repeated examination and partial diagnosis. With the rapid development of information technology, electronic information management has been implemented in medical institutions at all levels in developed countries, such as registration of medical appointment information, residents' health management files and publication of various related information, which promotes the rational allocation and use

of medical resources.

The practical experience of medical and health services in developed countries shows that the government has introduced policies to regulate and guided by economic leverage, established a “gatekeeper” system of medical and health services at the grassroots level, and effectively establish a medical and health service system of community first diagnosis, hierarchical diagnosis and treatment, and two-way referral. Therefore, according to the national conditions, establishing a policy and legal system of two-way referral, giving full play to the economic leverage of hierarchical reimbursement of basic medical insurance, guiding residents to change their concept of medical treatment, seeking medical treatment rationally, and speeding up the standardization construction of primary medical and health service institutions will strongly promote the realization of two-way referral.

Consequently, there are still some defects in the medical service system in developed countries. For example, Britain’s all-inclusive financial payment system is embarrassing even if Britain is rich in financial resources. In the 1980s, Britain began to reform the medical field, separating management from management, and gradually introducing market mechanisms. By means of bidding, the government gradually transfers the management rights of various medical institutions to specialized hospital management companies and fund organizations, and then the government pays for services, so as to promote the reduction of medical expenses and management costs through the competition of various hospitals at all levels. Since 2014, the United States has also vigorously promoted the health care reform bill. President Obama pays more attention to vulnerable groups, requiring employers to provide insurance for employees, and the government pays all the money to help all Americans buy health insurance, otherwise, they will be fined. The health care reform bill covers more than 32 million uninsured people in the United States, thus achieving the goal of universal health care. However, the middle class and high-income class in the United States are worried that the level of medical insurance they enjoy will decline, and the medical reform will also increase the financial burden, thus affecting the economic recovery.

3.2.5 Patients’ medical treatment behavior

Most existing literature on health-seeking behaviors focused on classifying farmers and people with certain diseases to investigate the health-seeking situation of vulnerable groups.

(1) Rural residents

Y. Q. Ma et al. (2016) found through a questionnaire survey that rural poor people tend to seek higher outpatient care psychologically and expect to go to tertiary hospitals for medical

treatment. The factors that influence their actual outpatient behavior include their family status, economic income level, education level, and the convenience of visiting primary health care institutions.

(2) Patients with chronic diseases

The standard of living of the population has been greatly improved after the development of the market economy, and the number of chronic diseases is increasing. Chronic diseases are becoming an important risk to the health of the population, and there are many studies related to the medical consultation behavior of this group. Ning and Yu (2016) conducted an in-depth analysis of the behaviors of middle-aged and elderly patients with chronic diseases in rural areas based on the data from authoritative surveys, pointing out that their behaviors vary in the economic situation and family background.

(3) The elderly

Similar to Japan, there is a serious aging phenomenon in China. Access to medical care and health protection for the elderly has become an important part of achieving universal health. Z. C. Zhang (2014) investigated the factors influencing the health-seeking behaviors of the elderly through a survey, with a focus on introducing the behaviors of the aged population in rural areas.

The logistic regression model is one of the most common ways to study the influencing factors of medical behavior, and it has been used in many aspects, and it has played a positive role with good results. For example, Z. Y. Yao and Zhang (2013) took three cities in southern Jiangsu Province as objects of their study and introduced a logistic regression model to analyze the association between the new agricultural cooperative and rural residents' health care behavior based on their relevant data. Zheng and Liu (2014) further explored the relationship by using the multivariate logistic regression model and found that there is a significant correlation between government investment and individual willingness to see a doctor.

Concerning factors that influence health-seeking behaviors, scholars conducted research from different perspectives, but basically from the perspective of internal and external factors. L. J. Tang (2016) argued that factors such as the proximity of the medical institution, whether the type of medication is perfect, and the strength of medical and nursing standards largely influence the general public's choice of hospital. Xin et al. (2016) pointed out that the technical level of primary hospitals, the medical environment, and the condition of patients' diseases have a significant impact on patients' willingness to choose primary medical institutions.

Some scholars analyzed the influence of factors such as personal trust, personal quality, and individual understanding of policies on health-seeking behaviors. Cao (2010) believed that the key factor influencing residents' choice of medical care is trust, and people generally lack

sufficient trust and understanding of community health care and prefer to go to large general hospitals. S. L. Li et al. (2014) concluded that farmers' access to health care is more influenced by the government, especially their knowledge and understanding of the New Agricultural Cooperative System, their understanding of their own conditions and their understanding of the government's medical relationship directly determine their choice of health care through their survey and analysis.

From this body of knowledge, we use empirical research methods to answer the research questions. The research objective is to explore a new model of the hospital, university, and community collaboration by describing a specific medical case. This case may serve as a model and reference for other cases or subsequent studies.

Chapter 4: Research Methods

Regarding the main objective of the thesis, a variety of methods were used in our empirical study in an attempt to obtain data from a variety of different sources involving sources in the hospital and community.

Thus, we adopted a questionnaire survey and collected internal data from hospitals. The research-based on the actual data of the number of tiered referrals, bed utilization rate, number of diagnoses and visits and total medical income in the Seventh Affiliated Hospital of SMU and communities in Lishui Town, Foshan City.

In order to quantify the impact of the number of referrals on the total hospital revenue, a time series model was established based on the actual statistical data of hospitals and communities from 2016 to 2019. First, the impact of the increase in the number of referrals on the increase in total hospital revenue was analyzed, which could be used to predict future changes in the number of referrals and total hospital revenue.

This chapter will describe the procedures adopted in data collection and data analysis.

4.1 Data collection

4.1.1 Research objects and data description

There are mainly five categories of research objects involved in this research, namely, county-level public hospitals (the Seventh Affiliated Hospital of SMU and some tertiary hospitals), grass-roots community health service centers (also called social health service centers), hospital physicians, community doctors and patients. The hospitals and community health centers are observed over a long period of up to four years, and a trend is obtained by analyzing key data from each year, and this trend is then used to corroborate the hypotheses and models presented in this thesis. Through the university's leadership, the long-separated hospital and the primary community can support each other in a positive triangle structure, thus achieving an increase in the upward transfer of patients from the social health to the hospital and an increase in the downward transfer of patients from the hospital to the social health, ultimately leading to a better implementation of the hierarchical diagnosis and treatment system, and enhancing the economic and social benefits of the hospital and the community.

Hospital physicians and community physicians were interviewed, and their questions were collected to provide a basis for more in-depth research. Patients were surveyed by questionnaires to understand their medical needs and understanding of the HMS, and to demonstrate whether this approach has a significant positive effect on patients' medical choices and habits. In this thesis, time series modelling and linear regression models are also used to measure the changes in referral volume.

4.1.2 Sample description

All data in the thesis are taken from actual data, mainly provided by the Seventh Affiliated Hospital of SMU and Lishui Community Health Service Center. The data was in Nanhai District, Foshan City, which is located in the Pearl River Delta region, one of the regions with the best economic and social development status in China, and adjacent to Guangzhou. With sufficient medical resources and a reasonable population size structure, it can basically reflect the medical quality and service level of counties and districts in China. There are four interview samples in this thesis, one physician and one surgeon in the Seventh Affiliated Hospital of SMU. One GP and one staff member of the medical association infertile water Community Health Service Center. The questionnaire samples come from 80 patients, and the main collection scenes are the outpatient customer service center of the hospital and the inpatient ward.

4.1.3 Questionnaire analysis

This thesis conducted a questionnaire survey on the HMS at the community level in Lishui Town, Foshan City, targeting different groups of people, including those in the hospital and community, and patients. The design of the questionnaire is to seek advice from mentors and experts to guarantee that it is scientific and reliable.

In the case analysis, a questionnaire was developed specifically to better understand the overview of the local HMS and the medical needs of the public. The sample was selected by interviewing the same number of people at the hospital outpatient on four randomly selected days of the week between 9:00 a.m. to 11:00 a.m. For statistical purposes, the sample size was set at 20 patients per day, a total of 80 patients, to ensure adequate sample. There was no specificity in the selection of respondents, so patients were selected randomly as respondents to conduct the survey. The questionnaire is divided into four parts, which are centered on the experience of medical treatment, choice of medical institutions, hierarchical medical system, and personal information of the respondents. A total of 80 questionnaires were distributed, and 80 were actually collected.

(1) Items

At the beginning of the research, the two-way referral relationship between hospitals and communities existed, but it was not a close relationship. With the intervention of universities, the three parties have gradually formed a linkage, and the trend of patients' medical treatment has changed greatly through information technology and big data processing, which shows that the people's habit and their understanding of HMS changed. Therefore, when designing the questionnaire, it was hoped to infer the consistency of data and opinions through random sampling. 30 items were designed from four aspects of the questionnaire: visiting habits, visiting institutions, basic information and hierarchical diagnosis and treatment policies, with single choice and multiple choices. See Annex A for details.

(2) Demographics

A total of 80 people were randomly selected from the questionnaire, including 39 males and 41 females, with almost the same proportion in gender. The education level is reflected by the per capita income, and the monthly income of most interviewees is less than RMB 6,000, which indicates that the patients in hospitals and communities are mainly the elderly or people with relatively lower educational levels, which is also the reason why there are more, bigger and better medical institutions around the region, and the "outflow" of patients with higher education level and income level is more obvious. 60% of the interviewees are over 40 years old, most of whom are 40 to 49 years old, implying that the main medical patients are middle-aged and elderly.

(3) Survey process

The design of the questionnaire was finished in May, 2020, and the survey was conducted from 10th June to 17th. Questionnaire collection and results analysis were completed by the end of June.

4.1.4 Interview

(1) Interview questions

There are many differences and differences between hospitals and community health centers, which are mainly reflected in the service target audience, the scope and level of diagnosis and treatment. In order to better reflect the ideas of the medical staff in the communities and collect more accurate information, four different samples were selected. Interviewees were a surgeon in tertiary hospitals, an internal medicine physician (to reflect different professional departments), a GP in primary health centers, and a staff who works in medical alliance. The interviewees included both professional physicians and administrators,

and both hospital and community personnel. Common questions include demographics (age, entry time, speciality, population served, service time, feelings and changes since being led by universities, difficulties and problems encountered). Questions were focused on the characteristics of their respective work. Interview topics and transcripts are attached in Annex.

(2) Interview process

Through extensive and in-depth interviews, there was a frank and friendly interaction between the interviewer and interviewees and the interviewees spoke freely based on their own experiences. The interviewer obtained stable, reliable, and abundant real information, which greatly assisted in the subsequent research conducted and in the formation of a summary of the results. The interviews of this study were conducted from March to May, 2021, all in the form of face-to-face communication. Five interviews were conducted with four interviewees, one of whom was temporarily terminated in the middle of the interview due to the urgent task of receiving the COVID-19 prevention and control, and a second interview was arranged and conducted subsequently.

(3) Data collection

During the interview, all four interviewees thought that the university-hospital-community integration played a decisive and accelerated role in the formation of the close medical association in Nanhai District and Lishui Town, and the HMS was gradually improved. At the same time, three of the four people also put forward some shortcomings of the current model, which are due to the institutional mechanism and public perception and awareness.

4.1.5 Documental analysis: indicators and descriptive analysis

This study uses community referral quantity (referring to the number of patients transferring from the community to general hospitals) as the indicator of the popularity of the two-way referral policy, so as to measure the implementation of the policy in Lishui Town. A time series model was used to fit and predict the community referrals. As for the multiple linear regression model, the explanatory variable and predicted variable were determined first, which were the number of community referrals and the total medical revenue respectively. The former focuses on the impacts of the two-way referral policy on the comprehensive economic benefits of the hospital while the latter measures the comprehensive economic benefits of the hospital. In addition, bed utilization, outpatient and emergency visits, and admissions were also included in the model as explanatory variables. The indicators and data of the conceptual model are shown in Table 4.1.

Table 4.1 Model indicators and description

Indicator	Code	Description
Total medical income	TMI	Hospital's income from various types of service such as medical treatment and medicine (the unit is represented by M).
Community-to-hospital referrals	Times	Community-to-hospital referrals, indicating the popularity of the two-way referral policy (the unit is person-time).
Bed utilization	BU	Number of actual bed days occupied / Number of actual open bed days $\times 100\%$ (shown in the form of percentage).
Number of outpatient and emergency visits	NOE	Outpatient visits + emergency visits (the unit is person-time).
Admissions	Admissions	Number of inpatients (the unit is person-time)

4.2. Data analysis

The pre-processing, modelling, tests and prediction of the time series model ARIMA(p, q, d) in this study were performed by Eviews10.0, and the descriptive statistics section was performed by Stata 16.0.

The data ranges from March 2016 to October 2019 with a total of 44 indicators. Table 4.2 contains the indicator mean (Mean), standard deviation (Std. Dev), minimum (Min) and maximum (Max). Details are shown as follows.

Table 4.2 Descriptive statistics of indicators

Variable	Obs	Mean	Std.Dev.	Min	Max
TMI	44	114.002	27.52	62.718	172.613
Times	44	112.364	64.544	3	211
BU	44	76.511	13.218	42.158	102
NOE	44	54.007	10.851	39.181	82.27
Admissions	44	2.241	.545	1.256	3.502

4.3 SWOT analysis

In addition to interviews and questionnaires, the SWOT model was mainly used in this research to systematically analyze the internal and external environment of the university-hospital-community. SWOT analysis refers to strengths (s), weaknesses (w), opportunities (o) and threats (t). Through SWOT analysis, the internal and external environment of the organization can be harmonized to form a comprehensive, objective and more scientific evaluation result.

For the SWOT analysis of the hospital-grassroots facility medical alliance, the most important indicators are policy, economy, resource and technology. Therefore, the analysis mainly unfolds around these topics.

4.3.1 Advantages

(1) Policy advantages

Since the new medical reform, the Chinese government has always emphasized the importance of HMS, and thus issued many related policies. From the perspective of promoting the development of county medical associations, Shanghai, Jiangsu, Anhui, Fujian, Beijing and other provinces or cities have issued various pilot and exploratory documents, in which medical alliances are either “closed” or “loose” in the traditional sense. Some are in the form of medical groups and the others are in the form of specialized alliances. With the intervention and promotion of policies, these medical associations have gained the attention of governments at all levels, and also gained more resource support. The collaborative development model of the university-hospital-community in this thesis benefits from the preferential policies of provincial, municipal, district and town governments, which promotes the deepening of cooperation and the achievement of achievements.

(2) Social and economic advantages

In China’s developed regions, such as the Pearl River Delta region, where this study was conducted, the government has high fiscal revenue and the general public also has higher per capita income, so the government has the ability to invest more funds in the development and construction of medical services. People also have a higher demand for being healthy, which will also promote the government to invest more resources to meet the needs of the masses. In addition, the research and interviews also found that people are more and more confident in various aspects such as system or medical security.

(3) Resource cost advantage

Universities coordinate the development of hospitals and communities to become a close medical association, and different medical institutions can share resources with each other, including hardware facilities, physicians, nurses and other human resources. Excellent talents in hospitals can practice more or help the grassroots, advanced medical equipment in hospitals can be used together, and information such as hospital diagnosis results can also be shared together. Grass-roots units can provide the development space after the hospital is overcrowded. Whether it is rehabilitation treatment or chronic disease control, all these eventually contribute to the joint efforts of all units, save many expenses and avoid repeated waste of resources.

(4) Advantages of system and mechanism

The model discussed in this thesis is easier to be applied in the two-way referral between hospital and community. Referral can promote the optimal allocation of resources among medical institutions, divert a part of mild patients to community health service centers, alleviate

the overcrowding of hospitals, reduce unnecessary conflicts between doctors and patients, and improve the relationship between doctors and patients. Narrowing the gap between hospitals and communities will help patients change their concept of seeing a doctor, instead of getting together to see a doctor in a hospital, they will selectively go to primary medical institutions for the first visit.

(5) Technical advantages

With the support of universities, hospitals can have better management methods and theoretical systems. By sending hospital management talents and professional technicians to community health service centers, we can help grass-roots units improve their management and technical level. Correspondingly, physicians and administrators in the community can also go to the hospital to quickly improve their own level through training, study, further study, temporary training and other means, as well as outpatient examinations, ward rounds, surgery, so as to promote the construction of community talents.

4.3.2 Disadvantages

(1) Policy interference

Corresponding to the policy advantages, this model needs the strong support of the government and universities. Once more essential changes occur in the middle of the policy, such as the change of the distribution pattern of rights and interests of all parties, the unequal responsibilities, rights and benefits, or the change of the national policy on hierarchical diagnosis and treatment of medical associations, the results will be uncontrollable. In fact, the system of the university-hospital-community is unstable, which requires governments at all levels and stakeholders to keep their initial intentions and jointly implement the hierarchical diagnosis and treatment system.

(2) Concept difference

Many existing medical association models have no clear benefit distribution mechanism. The research model of this thesis is that medical university takes the lead in establishing a close medical association in the county. There must also be competing relationships among the parties, or there will be various differences because of their respective interests. For example, the development of hospitals will have siphon effects on the clients and talents in the community, and high-quality resources may be more concentrated in hospitals. Therefore, when we need to design the system, we should fully consider the differences between the two, and formulate cooperation modes and specifications that are beneficial to both sides.

(3) Management authority

There is a significant problem in most medical associations, that is the leaders and legal persons of all stakeholders are not unified, which directly undermines the power of administrative orders. The starting point of the hospital cannot be fully accepted by the community, and the idea the community is unwilling to be satisfied by the hospital. Human resources, finance, and products are relatively independent, and leaders lack management authority, so they can't allocate resources uniformly and make effective use of resources.

(4) Inadequate supporting resources

The hardware facilities of most primary medical institutions are not adequate, the service level is not high, and the patients' willingness to be referred to these medical institutions is not high. At the same time, the community health service center implements the National Essential Drugs Catalogue. Unlike hospitals, the Catalogue contains fewer kinds of drugs, and some drugs needed by patients with chronic diseases or those needed by special patients are not included. Even if patients are transferred down, the level of drugs and medical treatment cannot keep up as well.

4.3.3 Opportunities

(1) Government attention

The Chinese government strongly supports the HMS and the construction of a medical association. In recent years, several policies and regulations have been issued continuously (as mentioned in the literature review chapter). At the same time, with China's integration with the rest of the world, coordination is the core trend of the reform and development of the medical service system, and people's livelihood and welfare have become the issues that the government pays more attention to delivering better health services to ordinary people.

(2) Health care reform

In 2015, the General Office of the State Council issued Guiding Opinions on Promoting Hierarchical Diagnosis and Treatment System, which pointed out that it is necessary to improve the differentiated payment policy of medical insurance among different levels of medical institutions. Subsequently, relevant policies have been introduced in most parts of China, using medical insurance payment as a lever to promote the change in people's habits and the orderly flow of patients, forcing community health service centers to increase construction efforts, so as to be able to carry more and more complicated patients. From the trend point of view, the proportion of medical insurance reimbursement is further inclined to the grass-roots level, and the proportion of medical insurance payment in grass-roots medical institutions will be further increased, which also provides a good development opportunity for the rational division of labor

and coordinated development of medical associations.

(3) Increasing demand

With the substantial improvement of China's economic level and welfare support capability, China has officially entered the stage of an aging population: the number of elderly people has increased substantially, and there are still a large number of disabled or semi-disabled elderly people, which is far from being satisfied by the existing old-age care institutions or facilities. People's demand for medical services is increasingly urgent, especially for the treatment, nursing, and rehabilitation of the seriously ill and chronically ill elderly. Community health service centers have many advantages, such as more distribution points, convenient transportation, close distance, and low fees. The construction of community medical institutions or community hospitals for the aged, which focus on the care of the elderly, will be promising.

(4) Technical environment

Relevant departments actively formulate and issue more favorable policies to guide health technicians and college graduates to work at the grass-roots level, and at the same time strengthen the training of grass-roots medical personnel to improve the service level of grass-roots medical institutions. Some local governments also encourage the construction of characteristic departments at the grass-roots level, and provide support in medical insurance policies and funds, which is conducive to the better flow of patients among hospitals at all levels, and also lays a technical foundation for cooperation within the medical association and among hospitals at all levels.

4.3.4 Threats

(1) Political environment

Although China's new medical reform has clearly put forward the concept of establishing medical alliances early as 2009, it is still in the early stage of exploration because it has only recently been put into experiments around the country, so the relevant policies and measures and guidelines formulated by both the state and the provinces and municipalities are only of normative significance, and there are no systematic implementation cases to prove it. There is no clear solution to the problem of benefit attribution.

(2) Economic environment

In the current economic environment, primary hospitals are indeed supported by higher-level medical institutions and local government departments in terms of financial investment and physician. However, because of the wrong positioning of primary institutions in the new medical reform, they are characterized as public welfare institutions, which makes the

subjective motivation of practitioners low, and the business ability and quality cannot be improved, thus leading to the waste of invested medical resources. This leads to a waste of invested medical resources and a reduction in the content of medical services. The unclear definition of treatment and responsibility incentive mechanism for primary medical staff has hindered the improvement of management and quality of primary hospitals. It is not conducive to effective communication and sharing of resources between higher-level hospitals and primary units in various aspects such as talents.

(3) Social environment

Although the establishment of medical clusters has been completed and a number of pilot clusters have been formed across the country, patients still prefer to be seen in large public hospitals based on their health and the credibility of their core doctors due to traditional beliefs, and they still do not prefer to be seen in primary care units for serious conditions such as stroke and cardiovascular disease. The existence of these practices and traditions makes it difficult to establish a tiered system of care and is not conducive to a healthy, trusting relationship between primary care providers and patients.

(4) Technical environment

In the current pilots of the medical consortium, due to the varying levels of information technology construction in each hospital, it is difficult to share patient information with core physicians, and the procedures for transferring patients from primary care to large hospitals are complicated and not highly electronic, making it impossible to unify standards for sharing medical data and information resources at all levels. At the same time, for primary care workers, some of them do not have high quality information technology and or appropriate technical training, so they cannot follow the trend and trend of building public hospital Internet information technology, hindering the collaboration between public hospitals.

4.4 Time Series model

In this section, the application of the established time series model is described, and the reliability of the model is verified.

4.4.1 Time series

As shown in Figure 4.1, around 2016, the number of referrals fluctuated around 20 with no obvious trend. After the two-way referral policy was implemented in 2017, the number of referrals showed a clear trend, a relatively significant growth from 2017 to 2019.

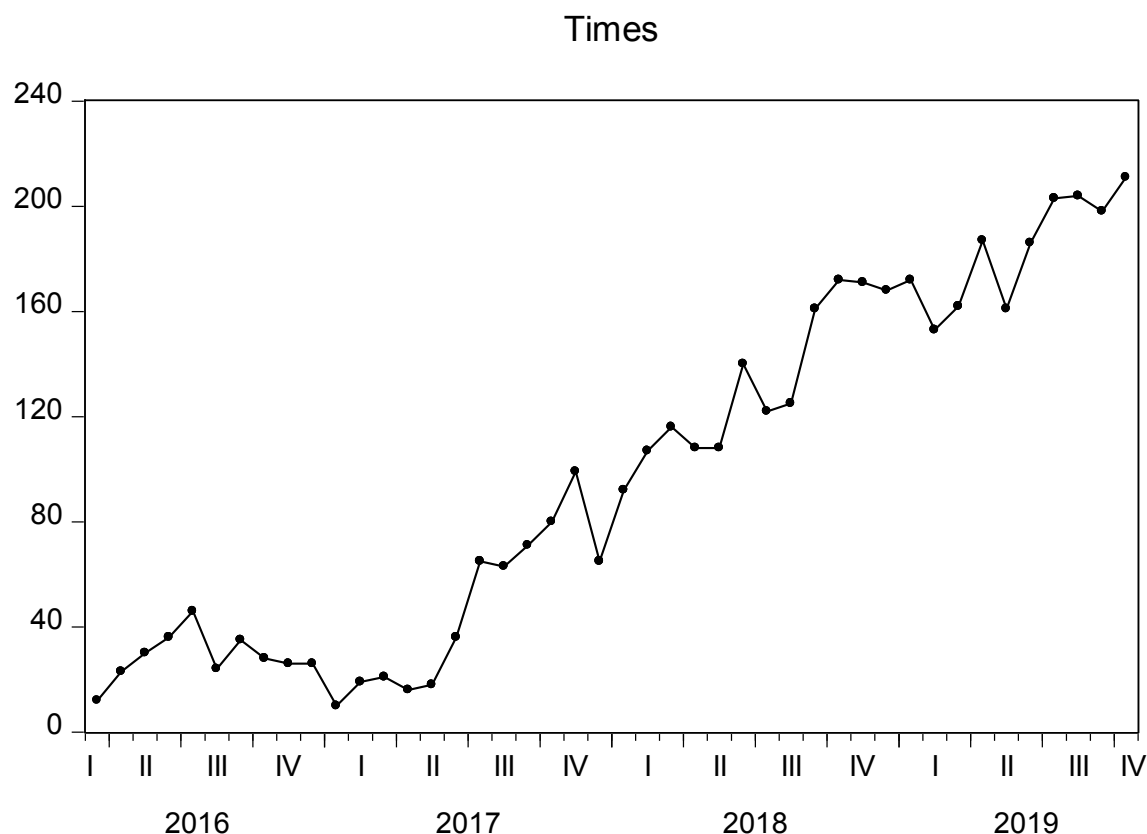


Figure 4.1 Trend of the number of referrals

Note: Statistical data of Lishui Town Community Health Service Center Office from 2017 to 2020

4.4.2 Stationarity test and difference operation

Augmented Dickey-Fuller (ADF) test is mainly based on the standard of time series. The method considers that the original hypothesis level has a unit root of not less than 1, while constant and trend terms are often present. These can be analyzed based on the time series diagram.

In this thesis, ADF tests were first performed on the series counts. Based on the series characteristics of the time series plot, the series is now set to trend and intercept terms.

Based on the ADF test results as shown in Table 4.3, it can be concluded that the series of the number of referrals is non-stationary. Then, a differential operation was performed, and an ADF test was conducted again to examine the stationarity of the series. The final results are shown in Table 4.4.

Table 4.3 ADF test model indicators and description

Original Hypothesis: TIMES has a unit root		
Exogenous: Constant, Linear Trend		
Lag Length: 1 (Automatic - based on SIC, maxlag =9)		
Augmented Dickey-Fuller test statistic	t-Statistic	Prob.
Test critical values:	1% level	-1.831182
	5% level	-3.520787

10% level	-3.191277
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Table 4.4 Second ADF test model indicators and description

Original Hypothesis: D(TIMES) has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag =9)			
Augmented Dickey-Fuller test statistic		t-Statistic	Prob.
Test critical values:	1% level	-3.162827	0.0295
	5% level	-2.933158	
	10% level	-2.604867	

Based on the results of this ADF test, we also firstly analyze the results by testing the “t” distribution. The t statistic is the left rejection region. It can be seen that the ADF test statistic is -3.2, yet the “t” value at the 5% level is -2.9, which is to the left of the 5% threshold. Therefore, the original hypothesis that there is a unit root is rejected, and the series is stationary. Secondly, the p value of the ADF test, namely the value of Prob. is 0.03, which is less than the critical value of 0.05. Therefore, the original hypothesis that there is a unit root is rejected, indicating again that the differential series of the number of referrals is stationary.

4.4.3 Autocorrelation and partial correlation functions

According to Figure 4.2, the autocorrelation function (ACF) decreases rapidly after the first order and is within twice the standard deviation, so the model parameter can be roughly determined: $q=1$. In the meantime, it can be seen that the partial autocorrelation function (PACF) also rapidly decays to within twice the standard deviation after the first order, so the model parameter can also be determined: $p=1$. Because the first order difference has been performed on the series, it can be determined that $d=1$. Based on the results above, it can be confirmed that the model is expressed as ARIMA (1, 1, 1).

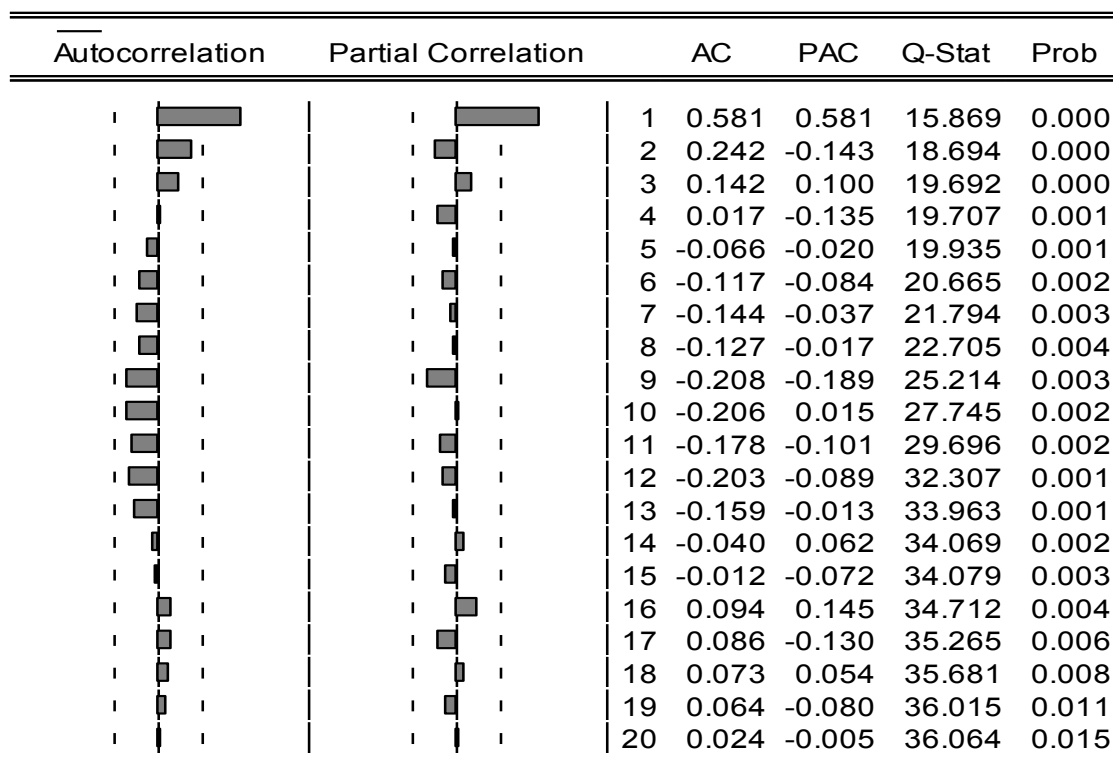


Figure 4.2 Autocorrelation and partial correlation functions

4.4.4 ARIMA (1, 1, 1) model

As shown in Table 4.5, it can be seen that in the autoregressive model, the reciprocal of the lag polynomial root is 0.34, and that of the moving average model is -0.37. In the AR model, the modulo of the reciprocal of the root is 0.34, while that of the moving average is 0.37, both of which are less than 1. Hence, it can be confirmed that the autoregressive model is stationary, and that the MA process is reversible.

Table 4.5 ARIMA (1, 1, 1) model indicators and data

Dependent Variable: DTIMES				
Method: ARMA Maximum Likelihood (OPG - BHHH)				
Sample: 2016M03 2019M10				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.769263	0.602780	7.912115	0.0000
AR(1)	0.342316	0.154748	2.212093	0.0327
MA(1)	0.367427	0.211268	1.739149	0.0897
SIGMASQ	2.274560	0.432392	5.260407	0.0000
R-squared	0.368757	Mean dependent var		4.818182
Adjusted R-squared	0.321414	S.D. dependent var		1.920183
S.E. of regression	1.581776	Akaike info criterion		3.852996
Sum squared resid	100.0807	Schwarz criterion		4.015195
Log likelihood	-80.76591	Hannan-Quinn criter.		3.913147
F-statistic	7.789025	Durbin-Watson stat		1.974135
Prob(F-statistic)	0.000327			
Modulus(Inverted AR Roots)			.34 (.34)	
Modulus(Inverted MA Roots)			.37 (-.37)	

4.4.5 Model residual analysis

By observing the upper part of Figure 4.3, we can find that the model fits well to Times, and that the residual part of the model fluctuates around 0. Then, the residual test is continued. The results are presented in Figure 4.4.

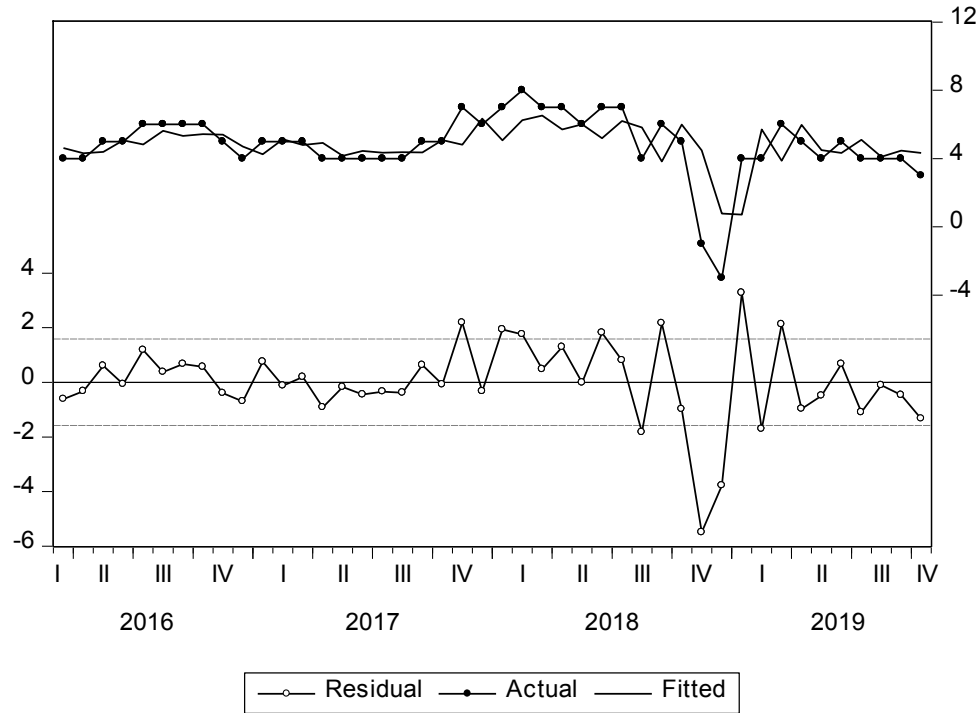


Figure 4.3 Fitting and residual plot of the model

Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob
		1 0.002	0.002	0.0002	0.989
		2 0.003	0.003	0.0006	1.000
		3 0.109	0.109	0.5867	0.899
		4 -0.020	-0.020	0.6062	0.962
		5 -0.045	-0.046	0.7118	0.982
		6 -0.023	-0.035	0.7403	0.994
		7 -0.107	-0.103	1.3610	0.987
		8 0.032	0.043	1.4203	0.994
		9 -0.132	-0.130	2.4318	0.983
		10 -0.124	-0.107	3.3400	0.972
		11 0.036	0.023	3.4203	0.984
		12 -0.063	-0.048	3.6724	0.989
		13 -0.136	-0.125	4.8753	0.978
		14 0.083	0.054	5.3404	0.980
		15 -0.099	-0.107	6.0229	0.979
		16 0.136	0.140	7.3623	0.966
		17 -0.019	-0.064	7.3883	0.978
		18 0.038	0.049	7.5013	0.985
		19 0.026	-0.052	7.5548	0.991
		20 0.008	-0.009	7.5606	0.994

Figure 4.4 Residual test for the model

The results of the P value of the Q statistic ($\text{Prob}>Q$) show that the autocorrelation coefficients of the 1st, 2nd, kth period of the original hypothesis series are all 0. When all p values are greater than 0.05, which is a significant level, the series can be regarded as a white noise series, that is, the correlation between the series values is not significant. It is found, by observing Figure 4.4, that the p value of the Q statistic is greater than 0.05 from lag (1) to lag (12), so the residual series is a pure random series. On this basis, it can be confirmed that this series does not have autocorrelation or partial correlation. The information of the series has been fully extracted by the ARIMA (1,1,1) model, and the model fits perfectly. Then, the stationarity is examined by the unit root test. The results are shown in Table 4.6.

Table 4.6 Residual series unit root test results

Original Hypothesis: RESID01 has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag=9)			
Augmented Dickey-Fuller test statistic		t-Statistic	Prob.*
Test critical values:	1% level	-6.344852	0.0000
	5% level	-2.931404	
	10% level	-2.603944	

As shown in Table 4.6, we also firstly analyzed the results by testing the “t” distribution. The “t” statistic is the left rejection region. It can be easily seen that the ADF test statistic is -6.3, but the “t” statistic at the 5% level is -2.9, which is to the left of the 5% threshold. Therefore, the original hypothesis that there is a unit root is rejected, and the series is stationary. Secondly, the p-value of the ADF test, namely the value of Prob. in the table, is 0.00, which is distinctly less than the critical value of 0.05, so the original hypothesis that there is a unit root is rejected, indicating that this residual series is stationary.

4.4.6 Model prediction

As shown in Table 4.7, in evaluating the prediction effect of the model, the mean absolute percentage error (MAPE) can be adopted in general. If the figure is less than 10, it is considered to represent high prediction precision, namely, the result prediction is more accurate. In this research, $\text{MAPE}=7.821693<10$, indicating that this model can satisfactorily predict the result. Furthermore, TIC equals 0.040653, which is between 0 and 1 and far less than 1. Hence, the accuracy of prediction results is relatively high. According to the predictions in Table 4.7, the number of referrals in the community is projected to grow in the next 5 months.

Table 4.7 Model prediction

Predicted value	2019 Nov	2019 Dec	2020 Jan	2019 Feb	2019 Mar
Predicted value	211.7	216.5	221.3	226.0	230.8

4.4.7 Model analysis

As for the trend, the number of two-way referrals is increasing. However, since the base of two-way referrals is small, in order to ensure the optimization of medical service patterns, promote the development and popularization of HMS, we should continue to push forward various infrastructure constructions, strengthen the education and training of medical personnel, and provide more drivers to improve the number of two-way referrals, so as to achieve an exponential increase in the number of two-way referrals, and expand the base of two-way referrals, making primary medical consultation system at community level a more common medical option.

4.5 Multiple linear regression model

4.5.1 Regression model under common standard error

In terms of the multiple linear regression model, the explanatory variable and predicted variable should be determined first, which are respectively the number of community referrals and the total medical income. The former focuses on the impact of the two-way referral policy on the comprehensive economic benefits of the hospital; the latter measures the comprehensive economic benefits of the hospital. Besides, bed utilization, outpatient and emergency visits, and admissions are also explanatory variables included in the model. The regression model under common standard error is shown in Table 4.8.

Table 4.8 Regression model under common standard error

	Coef.	St.Err.	t-value	p-value	95% Conf	Interval
TMI	0.449	0.029	15.35	0.000	0.390	0.508
Times	0.433	0.081	5.32	0.000	0.269	0.598
BU	0.423	0.165	2.56	0.014	0.089	0.757
NOE	-7.432	3.217	-2.31	0.026	-13.939	-0.925
Admissions	24.244	5.779	4.20	0.000	12.555	35.933
Constant						
Mean dependent var		114.002		SD dependent var		27.520
R-squared		0.925		Number of obs		44.000
F-test		385.870		Prob > F		0.000
Akaike crit. (AIC)		262.627		Bayesian crit. (BIC)		271.548
p<0.01, p<0.05, p<0.1						

As shown in Table 4.8, it can be seen that the number of referrals has a positive relationship with the total medical income, that is, the total medical income will increase as the number of referrals increases. Similarly, the bed utilization rate and the number of outpatient and emergency visits are also positively related to the total medical income. However, the number of hospital admissions and total medical income share a significant negative relationship, which

is inconsistent with the facts. Theoretically, the increase in the number of hospital admissions should have a positive relationship with the total medical income, and the medical income should increase as the number of admissions increases. Yet the negative relationship shown in Table 4.8 does not conform to the theory. Therefore, it may be considered that the model does not meet the model's hypothesis, and the model needs to be tested and corrected.

4.5.2 Multicollinearity test

As shown in Table 4.9, many scholars have done researches into multiple collinearity tests, and raised different test methods, many of which have been applied to practical production. Among them, the most commonly used one is the variance inflation factor (VIF) method. With the VIF figure taken into account, it can be judged whether there is apparent multicollinearity. If the maximum value of VIF is greater than 10, such characteristic is in existence, which will affect the estimation results of the model, making the results unreliable; if all values of VIF are less than 10, there is no multicollinearity in the model. Judging from the above results, we can see that the maximum VIF is 7.440, which is lower than 10. Therefore, the model does not have multicollinearity.

Table 4.9 VIF results of multiple collinearity test

Variable	VIF	1/VIF
Times	7.440	0.134
NOE	6.690	0.149
Admissions	6.420	0.156
BU	2.420	0.414
Mean VIF	5.740	

4.5.3 Heteroscedasticity test

If conditional heteroscedasticity exists in the model, it may result in a distinct deviation in the model's variance estimation. Under such a circumstance, the t-Test and F-Test are both invalid, and ordinary least squares (OLS) are not blue. At this time, it is necessary to select an appropriate method to complete the heteroscedasticity test. In most of these cases, White's heteroscedasticity test can be adopted.

Its original hypothesis is homoskedasticity, so it is considered that there is no heteroskedasticity when the obtained p-value satisfies the condition of being higher than 0.05. According to the final results obtained, it can be seen that the final $p=0.0416$ is obtained, which clearly satisfies the condition of being lower than 0.05, thus proving that heteroskedasticity does exist.

4.5.4 Autocorrelation test

As the variance of the OLS estimator is biased, the F-Test and t-Test are both invalid. In such a situation, the autocorrelation test can be employed. Firstly, we use an autocorrelation graph to determine whether the residuals have a serial correlation as well as the order k of serial correlation. Details are shown in Figure 4.5.

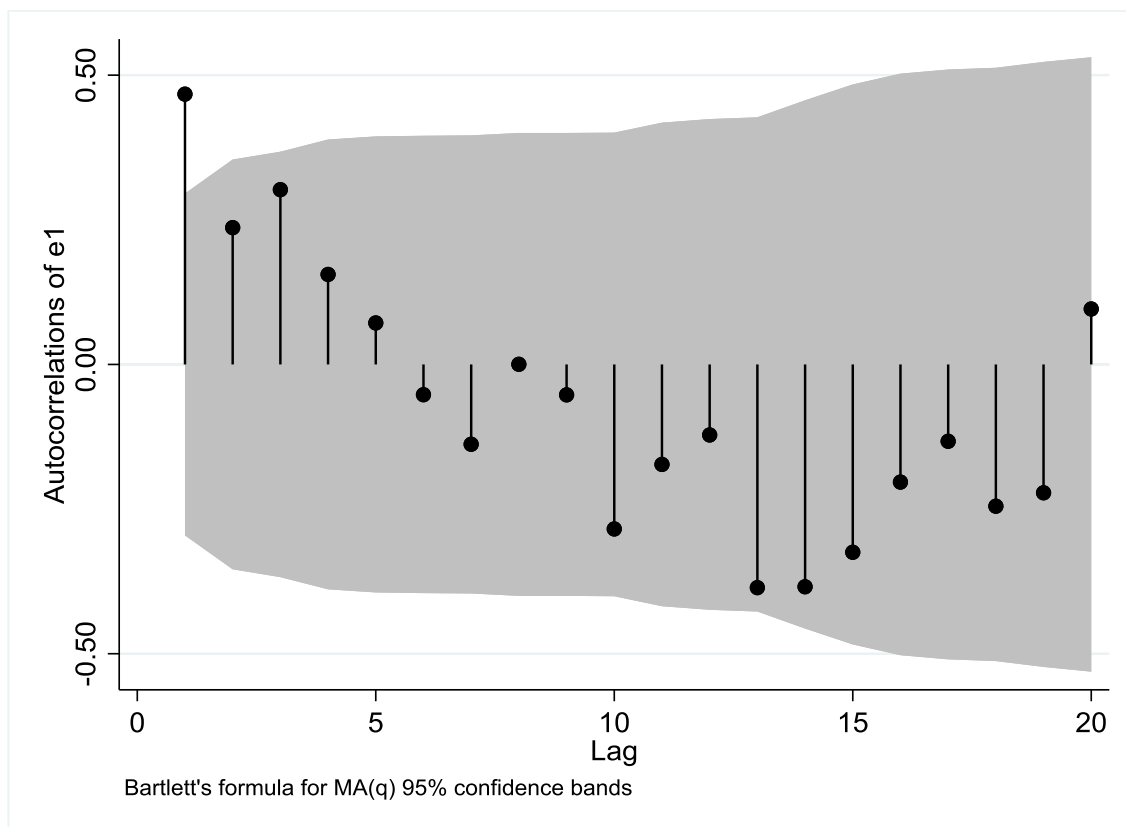


Figure 4.5 Residual autocorrelation

The results of the above figure show that the statistics of lag 1 are outside the 95% confidence interval, and that of lag 2 and after are within the 95% confidence interval. Therefore, the existence of first-order autocorrelation can be confirmed. Then a formal Breusch-Godfrey (BG) test was performed for autocorrelation, with the results in Figure 4.6. no serial correlation was obtained from the BG test.

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	11.333	1	0.0008

H_0 : no serial correlation

Figure 4.6 BG autocorrelation test

This thesis considers that when the p value is greater than 0.05, the original hypothesis will be accepted, that is there is no autocorrelation. Otherwise, there is autocorrelation in the model.

The results show that the p value equals 0.0008, which is distinctly lower than 0.05, indicating the existence of autocorrelation.

4.5.5 Regression model corrected by autocorrelation consistent standard error

As shown in Table 4.10, F-test is a joint test. Its original hypothesis is that all coefficients in the above equation are equal to 0. When the probability value of the F statistic is 0.000, which is lower than 0.001, the original hypothesis that all coefficients are equal to 0 is rejected, and at least one of the coefficients is not 0, that is, the fitting of the equation is valid.

Table 4.10 Regression model corrected by autocorrelation consistent standard error (HAC)

TMI	Coef.	Newey-West St.Err.	t-value	p-value	95% Conf	Interval
Times	0.449	0.028	16.31	0.000	0.393	0.504
BU	0.433	0.077	5.64	0.000	0.278	0.589
NOE	0.423	0.234	1.80	0.079	-0.051	0.897
Admissions	-7.432	4.755	-1.56	0.126	-17.049	2.185
Constant	24.244	8.077	3.00	0.005	7.908	40.580
Mean dependent var		114.002	SD dependent var			27.520
Number of obs		44.000	F-test			278.221
p<0.01, p<0.05, p<0.1						

According to the results, given that other variables are fixed, the p-value of the T-test for Times is $0.000 < 0.001$, so the coefficient is significant at the level of 0.1%. A coefficient of 0.449 represents the positive relationship between the number of referrals and the explained variable, namely the total medical income. For each unit increase in the number of referrals, the total medical income increases by 0.449 units. Given that the other variables are fixed, the p-value of the T-test for the bed utilization (BU) rate is $0.000 < 0.001$, so the coefficient is significant at the level of 0.1%. A coefficient of 0.433 represents the positive relationship between the BU rate and the explained variable, namely the total medical income. For each percentage increase in the BU rate, the total medical income increases by 0.433 units. After controlling other variables, the p-value of the T-test for the number of outpatient and emergency visits (NOE) is $0.079 < 0.10$, so the coefficient is significant at the level of 10%. A coefficient of 0.423 represents the positive relationship between NOE and the explained variable, namely the total medical income. For each unit increase in NOE, the total medical income increases by 0.423 units.

4.5.6 Model analysis

Based on the results of the multiple linear regression model, it is necessary to further implement the two-way referral policy and conduct more research on and design it. Meanwhile, we should

improve the management efficiency of the hospital, thus increasing the utilization rate of medical resources like beds, so as to solve the difficulty in obtaining medical services as much as possible. This will also help promote the economic benefits of hospitals, optimize strategic management of hospital brands and improve medical service quality, and increase the service coverage of the hospital and the number of outpatient and emergency visits, which will also promote hospital's economic benefits.

Chapter 5: Case Study

5.1 Background of the case study

In Guangdong, Foshan is one of the earliest cities to practice the co-construction of government and universities. As the best-known independent medical university in Guangdong and even Hunan, SMU has arranged layout in Foshan at early times, and has established its second campus in Shunde District, providing undergraduate education with features of collegiate universities. The capability of affiliated hospitals is an important factor to test the competence of medical colleges and universities. SMU has increased its investment in the construction of affiliated hospitals in order to reflect its development level. Statistics show that before 2016, the university has 6 directly affiliated hospitals, including Nanfang Hospital, the Third, Fifth, and Sixth Affiliated Hospital of SMU. In the past five years, SMU has continuously expanded the team of directly affiliated hospitals. At present, it has 13 directly affiliated hospitals, among which the Seventh Affiliated Hospital of SMU (Nanhai, Foshan) marks the cooperation of government and university the most. Aiming to establish a regional medical alliance, integrating advantageous resources from all sides, this case is a prime example of constructing an academic, high-level directly affiliated hospital facing the grassroots in the co-construction of government and universities.

(1) University-government collaboration and resource integration

On the basis of ensuring that state-owned assets are not lost and the main responsibility of the government to run medical institutions, a new mechanism has been gradually established from the perspective of supply-side reform: integrating the advantageous resources of local governments and SMU, facilitating the allocation of high-quality medical resources to weak areas, optimizing the regional allocation of medical resources, establishing a medical alliance with shared goals a unified development approach, promoting a high degree of unification and centralization of personnel, materials, finance and management, and increasing the management and professional talent training. The medical alliance with a unified goal and a unified development approach will promote a high degree of unification and centralization of personnel, materials, finance and management, increase the training of management and professional talents, and finally promote the comprehensive level of primary medical and health

institutions, the capacity of treatment and service and the quality of personnel to be improved.

(2) Combination of prevention, treatment, and recovery to realize overall management

In the national public health system, China unswervingly follows the path of integrating public health services with basic medical care, and takes health as the central task. China utilizes advantageous resources from universities and starts with leading hospitals to realize multiple primary-level medical treatments including disease diagnosis, health management and protection in regional primary medical institutions, thus realizing the incentive means of combining prevention and treatment to improve residents' health management ability. In 2018, Lishui Town proposed to establish the 0-to-100-year-old full-life-cycle medical and health service system the essence of which is exactly what this case describes: starting with universities and setting hospitals and communities as two basic points to facilitate the process.

(3) Integration of Chinese and Western medicine for coordinated development

Lishui Town is renowned for TCM in Guangdong Province. Situated in the town are many famous pharmaceutical corporations like E-fong Pharmaceutical and Double Crane Pharmaceutical Company Limited. Residents in Lishui have also paid special attention to TCM and regimen for a long time, creating a strong atmosphere of TCM.

In this case, the Seventh Affiliated Hospital of SMU has made full use of local characteristics and the professional strength of TCM of SMU, incorporating TCM services into the overall construction of the medical service system of the regional medical alliance to build a unified comprehensive TCM service platform. Meanwhile, it adopts modern health management and ideology, which plays a significant role in dealing with a public health emergencies, disease treatment, health management, rehabilitation, and disease prevention. At the same time, with the School of TCM, SMU as the base, it cultivates TCM physicians and GPs in the hospital and the community healthcare center, thus elevating the construction level of the primary traditional Chinese medicine system.

(4) Industry-academia-research integration and results transformation

Relying on a number of high-level clinical treatment bases of SMU to form a specialist alliance, take the road of health management, improve the quality of medical services and expand the capacity of quality medical consultation services. Vigorously build the College of Family Medicine, SUM, actively seek the integration and development of medical treatment, prevention and treatment, etc., and focus on the training of compound talents in Chinese and Western medicine and family medicine. Relying on the College of Family Medicine, SMU to set up research institutions, promote the implementation of research base construction in medical communities, and support the landing of major common key technology research and

product development and application.

(5) Integration of science, medicine and engineering to innovate technology

With people's health as the initial goal, we establish a horizontal cooperation mechanism for scientific research and teaching, set up theoretical research institutions such as the Academy of Chinese Medicine, create a deep cooperation relationship with well-known scientific research institutions such as the provincial and regional public health research institutes and Jihua Laboratory, and explore multidisciplinary integration and innovation mechanisms.

5.2 Mechanism and system

(1) Strengthen organizational leadership and build a responsible community

A national medical alliance committee composed of schools and social administration bodies will be established to conduct research and guide the management of the medical alliance, and coordinate medical treatment and basic public health operations nationwide. The governing body of the community should contract with the national health insurance agency on behalf of all members to improve the community's operational processes, procedures, and coordination mechanisms, thus opening up democratic participation mechanisms to invite all members to actively participate in the decision-making activities of the community. Finally, an evaluation center should be established by the government to evaluate the performance of health care providers, and could be included in the national health care system's evaluation of service performance, so that the results of the evaluation would be directly related to the performance of those responsible for the health care community and would increase the accountability of those in charge and the leaders involved.

(2) Optimize the management system and build a management community

At the management level, the university should take the lead, and the hospital and community should be highly unified, hence advancing the post allocation as well as the optimization of remuneration distribution, the assessment work, and the rewards and punishments. In the meantime, information, scientific research, and teaching should also be unified. Members of the medical alliance should unify their procurement, including drug consumables and medical equipment.

(3) Foster resource sharing and build a service community

According to the requirements of HMS in China, the medical alliance in this region has completed the separation of patients' first consultation, emergency visits, and chronic care, forming a goal of linking higher and lower level institutions. The establishment of the HMS

ensures the unified management of medical care quality in terms of service coverage and procedure. According to the layout of functional communities and living communities in the jurisdiction, the medical alliance realizes the allocation of the medical resources in the grassroots area. Under the overall planning of the university, member institutions of the medical alliance collaborate with each other, learn from the strong points of their counterparts and make up for the deficiencies, and strive for complementary development, forming a situation of orderly competition and comprehensive cooperation. The Seventh Affiliated Hospital of SMU takes the lead in establishing the health information sharing platform, which promotes the resource sharing of examination, test, and image reports, as well as the mutual recognition of result reports. The management departments of the government conduct overall arrangement of public health resources and medical resources in the medical alliance, realizing multi-directional medical and health services and establishing a full-life-cycle medical and health service system.

(4) Improve the distribution mechanism and build an community of shared interest

In the past, the Seventh Affiliated Hospital of Southern University and the Community Healthcare Center of Lishui Town were two different legal entities with no intersection in finance. The performance distribution of the two failed to link together, hindering their consensus in areas like a two-way referral. After the reform and collaboration, the Chinese government provides medical subsidies according to the actual situation of primary medical institutions and the subsidy rules of public hospitals, which is paid in full. The income of either medical institutions, like hospitals, or medical units in the community should be managed in accordance with unified management requirements.

5.3 Build a “general practice +” medical alliance

(1) The development logic and connotation of “general practice +”

The construction of medical alliance in China starts with general practice from the perspective of clinical specialty. With the “1+5+X” discipline strategy as the blueprint, it matches the correlated population and various special diseases in general practice, and provides multi-channel clinical treatment plans, thus significantly improving people’s satisfaction and sense of achievement in medical services, and ensuring the long-term service of general practice in the treatment of systemic diseases and quality medical resources collectors. Patients’ health care ability can also be enhanced.

The construction of medical alliance sets the construction of general practice as the basis,

integrates medical theories relevant to clinical medicine, and combines medical disciplines like Public Health, Traditional Chinese Medicine, and Pharmacy, forming a cross-discipline linkage. The platform combining general practice and related clinical medicine around the six types of medical services, including public health care service and scientific research is established to form a multi-disciplinary medical system and a new health care service pattern that combines treatment and prevention. Therefore, it enriches the content of health care service, expands the service coverage and realizes the goal of optimizing health care service.

After the above two stages of development and management, a joint discipline system integrating general practice, philosophy, humanities and other social studies is built up, realizing the synergy of industry, economy, society, and culture to make contributions in various directions. It exerts influence on other social studies through the resources of general practice and related veterinary medicine, accomplishing the purpose of cross-border integration. Meanwhile, the development of general practice has opened up a new conduit for China's strategic development, realizing the popularization of medical care, enhancing the quality of health care services for residents, ameliorating domestic medical environment, and exploring a new path of reform that is feasible, replicable, and sustainable for the strategic goal of developing health care industry.

(2) The basic operational principles of “general practice +” medical alliance

“Four communities” of medical alliance namely community of shared services, community of shared interests, community of shared responsibility, and community of shared management is built on the principle of “Five Unification”.

Centralized working objectives. Centering on Lishui people's needs, the medical alliance aims to provide quality medical services from high-level affiliated hospitals of SMU.

Administration that is organized in a centralized way and a clear legal representative. The Seventh Affiliated Hospital of SMU, which is located in this region, has successfully integrated its management with that of the primary medical organizations in the Lishui communities, and has specified a legal representative, thus realizing the unified management of management mode, development vision, human resources, financial system, quality control, procurement management, and logistics support.

Centralized information system of medical alliance. In the building of medical alliance information platform, a unified medical information platform has been built, which utilizes electronic health documents and cases to record the diagnosis information of different institutions, realizing information sharing, ensuring the smooth transmission of medical information, and significantly boosting resources utilization and service efficiency.

Centralized service team. Focusing on general practice, a health care service team consists of GPs in Lishui Town, professionals in public health, and health management personnel has formed. Talents from the three divisions co-manage the team. Besides, professional medical teams in the hospital as well as public health teams and family doctors in communities also provide multi-dimensional, comprehensive, and high-quality services to residents.

Centralized payroll scheme. Prioritizing the public welfare of medical institutions, the medical alliance implements a set of unified performance assessment standards and remuneration distribution system to reflect the labor value of personnel with reasonable and relatively fair salary, thus stimulating personnel's work enthusiasm.

5.4 Measures and practices

(1) Joint construction of university and government to promote the allocation of medical resources to lower tiered cities

Relying on the high-quality medical and healthcare resources of the SMU, the Seventh Affiliated Hospital of SMU has jointly established specialized hospitals alliances including orthopedics, pharmacy, clinical medical center, obstetrics, dermatology center, together with Zhujiang Hospital of SMU and the dermatology hospital. It has greatly enhanced the strength of the hospital's specialties, given play to the leading role of the medical alliance, and provided its residents with safe and effective medical protection.

(2) Implement the integration of medical treatment and prevention to promote the construction of a full-life-circle health management system for residents in the region

The hospital has established an innovation base for "medical treatment and prevention combination" with Guangdong Provincial Institute of Public Health to instruct the public healthcare services and disease prevention at the grassroots, and promote the construction of the combination of medical treatment and prevention. The occupational disease prevention and control division has been set up to serve 140,000 industrial workers in the region. It has also set up TCM departments in community health service centers to meet its residents' needs for TCM medical services. The Nanhai mode of early cancer screening has been put forward initially by the hospital, which helps to win the title of "Annual Outstanding Member Unit of the National Early Gastrointestinal-Cancer Prevention and Treatment Center Alliance" in 2019. And an innovation base for "medical treatment-prevention-healthcare integration" has been established in the Heshun campus of the hospital, which has obtained the approval to carry out the pilot project of integrating medical and nursing services for the elderly and build the service platform

for remote cooperation.

(3) Enhance the coordination of medical services and education to improve the training model of GPs

Taking the university's construction of the general practice department as the opportunity and the construction of the education system after graduation as the key point, the university aims to establish a unique training system for GPs. The training system is based on the "3C" (cohort, clinical, community), focusing on the cultivation of GPs' ability to diagnose and treat clinical patients with critical disease and their response to public health emergencies, as well as the scientific research capabilities.

Focus on the construction of a defence system and basic public medical services

The general practice center jointly constructed by the Seventh Affiliated Hospital of SMU and the Guangdong Provincial Institute of Public Health is aimed to provide scientific methods and standardized procedures for disease prevention and control in the region. The staff selected from the obstetrics department of the hospital establishes the maternal health department, and the staff from the pediatric department of the hospital establishes the prevention and vaccination department and the child health department, which can further clarify the main body of responsibility for the corresponding parts of basic public health services, and effectively mobilize the hospital's resources to provide targeted healthcare services to specific populations in the region.

(5) Establish the medical alliance featuring the integration of medical and nursing services for the elderly and "GP +"

Construct two wards for the common diseases in the elderly (featured by the prevention and treatment of multiple chronic diseases) and hospice care (featured by chronic wound treatment), which radiate multiple specialities. The hospital coordinates with the community to promote the construction of a rehabilitation specialized hospital in Heshun District. Meanwhile, 40 teams of GPs will be organized to give multi-level and full-coverage medical services and "Internet plus nursing" service platform in 19 community health service centers.

(6) Set up a high-quality platform for chronic disease management

Relying on the platform provided by the university, the Seventh Affiliated Hospital of SMU and the medical alliance cooperate with the Nursing Department of the university to participate in the "key technology application of community residents' chronic disease monitoring and smart management system" project. This national, multi-center and interdisciplinary project led by Peking University is aimed to construct an evaluation and early warning system for the health status of patients with chronic diseases through the collection and modelling of the

indicators of their health behavior. The Department of Laboratory Medicine of the hospital was listed as the “Foshan City’s Key Technology and Engineering Research Center for Health Monitoring and Risk Early Warning” by the Foshan Science and Technology Bureau to build a monitoring and early warning platform for chronic diseases and geriatric diseases.

5.5 Medical alliance plays a key role in fighting against COVID-19

At the beginning of 2020, COVID-19 broke out and spread all over the world. Facing this unprecedented public health emergency, all regions are actively exploring the most scientific and effective way of pandemic prevention and control. And Lishui Town, Nanhai District has achieved outstanding results in epidemic prevention and control based on university--hospital-community coordination. As the first line of defence, joint prevention and control play an unprecedentedly important role in fighting against COVID-19, which has demonstrated the selfless, dedicated, and courageous spirit of the people. In the face of a sudden public health emergency, the grassroots communities bear the brunt of joint prevention and control. Different organizations and departments have been fully mobilized and reorganized to temporarily form a strong prevention and control team with close contact and clear division of labor, thus using joint prevention and control to curb the spread of the epidemic.

Community epidemic prevention, as the basic epidemic prevention work at the grassroots level, is responsible for the large-scale investigation of suspected cases and the initial screening of suspected COVID-19 cases at the grassroots level. On the one hand, it promotes an increase in the diagnosis rate of suspected cases, thereby reducing the risk of cases being misdiagnosed and neglected. On the other hand, it can help to locate the source of infection and the path of transmission quickly based on the experience of basic inspection, which greatly reduces the harm caused by the infected cases. Therefore, community epidemic prevention is an indispensable part of the prevention and control of major public health emergencies.

(1) Adopt grid-based management and thorough investigation in the community

After the community has adopted closed-off management, all the organizations, companies and community staff have carried out thorough investigations in areas with targeted tasks that they are assigned. They need to sort out and keep records of the epidemiological history, body temperature and COVID-19’s typical symptoms of all the residents in the community to carry out grid-based management. The grid-based community workers are required to collect the residents’ information related to COVID-19 every day at a regular time. The grid-based management plays a role in improving governance efficiency in community epidemic

prevention and accelerating the modernization of rural community governance. Facing such a large amount of complex work, the grid-based community workers have worked hard with the active participation and cooperation of the residents in the community. Also, with the help of science and modern technology, including the advantages of information circulation on social networking platforms such as WeChat and QQ, the grid-based management has completed internal investigations efficiently and thoroughly to ensure the effective prevention and control of the epidemic.

(2) Set up pre-test places at points of entry and exit to carry out strict preventive

Pre-test places are set up at important paths in the community: the entry and exit points of the community, organizations, rural residential areas and commercial residential areas. It had also taken measures to ensure that the residents are tested as appropriate. And accurate records of the personal information of the people who enter or exit the place are kept based on the temperature check and comprehensive consultation of their epidemiological history. And at the major entry and exit points, people who travel from areas severely affected by COVID-19 are required to take a 14-day self-isolation at designated places, and a 14-day self-quarantine at home after receiving a negative result of the COVID-19 test. Strict measures are taken by the whole community to ensure all infected cases can be sorted out. The pre-test points are the first defence line of community epidemic control as well as the fight against COVID-19, based on which people infected can be sorted out as early as possible, and the treatment can be done after scientific referral as early as possible to improve the rate of cure and reduce the risk of inbound transmission.

(3) Rally medical teams to provide medical assistance to severely-affected areas

Resources within the medical alliance are coordinated. Led by the Seventh Affiliated Hospital of SMU and in cooperation with the community health service centers of Lishui Town, 2 teams of altogether 13 outstanding medical workers have been rallied to provide medical assistance in Wuhan and Jingzhou, Hubei province. The SMU had conducted unified management and technical training for the two medical teams to ensure the safety of the team members and the smooth process of diagnosis and treatment at the front line. In fact, during the epidemic, the SMU had organized more than 10 teams of 286 medical workers to assist Hubei. The university is an independent medical college with the largest number of medical workers sent out for medical assistance in the country. And these team members are all from directly affiliated hospitals of the university such as the Seventh Affiliated Hospital of SMU. It can be said that the university has given the hospital the best guidance, and the hospital has given back the strongest support to the university.

5.6 Highlights

Since 2018, the resources of the top public health institutions at the provincial level, the community health service centers (station) of Lishui Town, and the medical institutions in the functional communities have been integrated to establish a regional medical alliance led by the Seventh Affiliated Hospital of SMU. After nearly three years of operation, preliminary results have been achieved.

(1) Strengthen grassroots-level forces and advance the reform of the hierarchical diagnosis and treatment system

a) Promote the sinking of high-quality medical resources.

As of November 2018, a total of 85 medical workers of the hospital have been dispatched to the community health service centers to provide medical services, which has effectively solved the shortage of health technicians in the community. At present, there are 148 GPs (of qualifications) in the region, which has reached the 2020 staffing requirements of GPs in Nanhai District.

b) “Double-increase” in the number of medical visits at the grassroots level and the number of two-way referrals.

As of November 2018, the number of outpatient visits at community health service centers (stations) has increased compared to last year. Community medical institutions and hospitals have opened the flow channel for patients, and the number of two-way referrals (especially the number of downward referrals) has increased significantly compared with last year.

c) Effective improvement of the TCM services at the grassroots level.

A TCM management department was established to fully manage the training of the TCM talents, and vigorously promote the TCM medical technologies which ushered in a golden period of development for the TCM industry. The community health service station of the Mashe community has built a distinctive demonstration site for the TCM department.

d) Strengthen medical and health protection for the children of the floating population

The paediatrics department, general practice center’s vaccination department and child health department were directly opened in the community health service centers. And an independent area of these departments was established to meet the medical and health needs of the children of nearly 150,000 migrants in the community, and initially form a medical and health service coverage in which the medical services can be reached in 20 minutes.

e) Implement contracted services of family doctors.

Taking the Ganglian community health service station as a demonstration site, the team-

based health service model of “co-management of three divisions” was implemented on a trial basis to implement contracted services provided by family doctors and improve the quality of their medical services.

f) Improve health services of functional communities.

Medical cooperation has been carried out with functional communities such as schools, factories, and government agencies through self-construction, trusteeship to move the front of “medical and prevention integration” to functional communities. As of November 2018, more than 60 medical staff have been dispatched to functional communities, which has significantly improved the health services of clinics in schools, companies and communities.

(2) Strengthen the construction of public health and the integration of medical treatment and prevention

Relying on the cooperation between the Seventh Affiliated Hospital of SMU and the Guangdong Provincial Institute of Public Health, a general practice center was built, focusing on regional public health services, scientific research, and talent training. Through the mechanism of “medical services drive public health, individuals drive families, and households drive the community”, it can comprehensively promote public health management, vaccination, child health, maternal health, mental health, disease prevention and control, and strengthens the construction of public health.

(3) Stimulate internal vitality

a) Rely on the general practice center to train and export GPs to achieve the function of self-hematopoietic.

The Seventh Affiliated Hospital of the SMU has become a center for training GPs. In order to improve the training level of GPs, the hospital has established a training system, which provides complete career planning for the future development of GPs. It further enhances the social status of GPs and enhances their sense of personal honor. In 2018, the first batch of 80 GPs has been recruited. It is planned to recruit 100 GPs per year from 2018 to 2020, and a total of 300 GPs will be recruited and trained to be high-quality GPs to serve the region and the whole province.

b) Establish and improve the organizational structure of the general practice center.

Efforts have been made to optimize the organizational environment, select and appoint young grassroots talents who are skilled in their own business and daring to reform as the managers of the community health service centers or functional departments to inject new impetus into the management ability and service quality of the community health service centers.

c) Relying on the construction of the medical alliance, efforts have been made to increase the enthusiasm of GPs, establish the incentive system, and improve their labor compensation and social status. The incentive measures will greatly improve the popularity of GP and fully stimulate internal vitality.

d) Promote the construction of resource sharing.

In order to build community health service centers, the Seventh Affiliated Hospital invested a lot of construction funds to improve the infrastructure and related equipment, realize the coverage of the information network, and improve the resource of the hospital from the perspective of hardware and software. In-depth promotion of medical resources such as clinical examination, clinical imaging consultation, disinfection supply, remote ultrasound diagnosis, remote video consultation, pharmaceutical services, appointment services in the medical alliance, and the construction of a shared system with management resources such as network foundation, video monitoring, and transportation have also been made. These will improve the precision of management, standardize the operation of related processes, improve the hardware level and software service level of medical services, improve the treatment atmosphere for residents, enhance their experience of medical services, and meet and facilitate the needs of people for medical services.

e) Unified information platform.

The construction of the medical alliance requires sufficient information support. For this reason, medical institutions in various regions have built a unified information system to realize unified medical services, health services, and administrative management, and an information platform to realize information sharing. Residents' medical files and medical records have been digitized and opened for access to achieve the unity of information.

f) Initially establish a 0-100 full-life-cycle health service system.

The government authorities of Lishui Town issued a commission request to the Seventh Affiliated Hospital. The request was launched in 2017 and aimed to build a regional medical health information management platform and health management system (including chronic disease prevention management system, maternal health management system, mental disorder patient management system) and four demonstration bases (including family doctor services demonstration area, community TCM services demonstration area) in three years, which can help to form a full-life-cycle residential information health service framework in Lishui Town.

Chapter 6: Results and Discussion

6.1 Results from case study

(1) Significant improvement in the professional titles and academic qualifications of the medical workers

As shown in Table 6.1 and Figure 6.1, in 2017, the hospital had about 600 employees, 210 of whom had intermediate and senior titles, accounting for 35%. And there were about 90 employees with postgraduate and above degrees, accounting for only 15%. With the improvement of the hospital's brand and strength, and the preferential policies for talent introduction published by the university and the government, outstanding talents from home and abroad have been gathered here. As of 2020, the total number of hospital workers has exceeded 1,100, with nearly 500 personnel with intermediate and senior titles, accounting for nearly 45%, and personnel with a postgraduate degree and above accounting for 33%. At the same time, thanks to the co-construction model of universities and the government, outstanding talents in the community also have more opportunities for further study and training, and continuously improve their professional titles and academic qualifications. At present, the overall status of talents in the Seventh Affiliated Hospital of SMU has risen to the top two in Nanhai District.

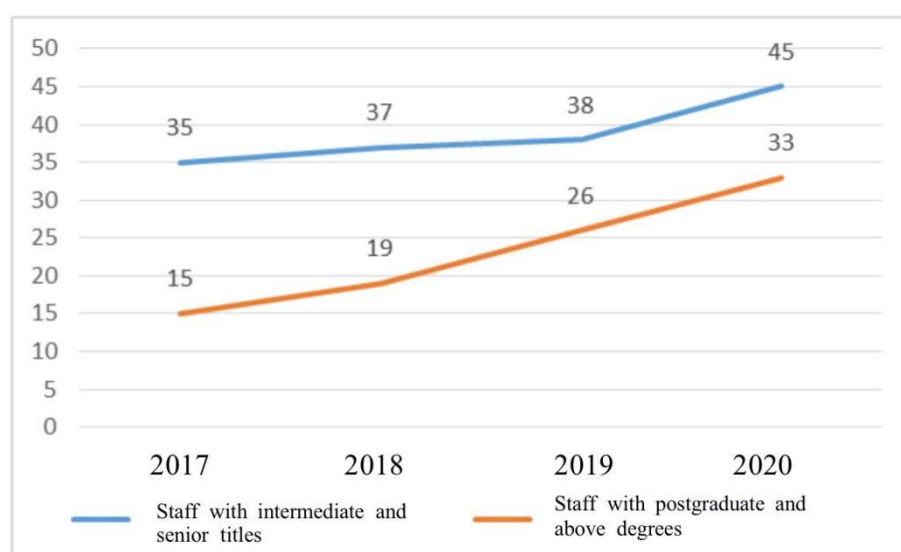


Figure 6.1 Professional titles and educational backgrounds of hospital staff

Note: Statistical data of the personnel department of the Seventh Affiliated Hospital of SMU from 2017 to 2020

Table 6.1 Professional titles and educational backgrounds of hospital staff

Proportion (%)	2017	2018	2019	2020
Staff with intermediate and senior titles	35	37	38	45
Staff with postgraduate and above degrees	15	19	26	33

Note: Statistical data of the personnel department of the Seventh Affiliated Hospital of SMU from 2017 to 2020

(2) Leap-forward improvement in scientific research

As shown in Table 6.2 and Figure 6.2, in the past, hospitals and community health service centers in Lishui Town remained at the grassroots level. And the main functions of these institutions were basic medical care and public healthcare. With the development in the past few years, the hospital has already achieved the scale and level of a Grade-A tertiary hospital, of which the most obvious indicator is the leap-forward improvement in scientific research. In 2017, the hospital did not have any project supported by the National Nature Science Foundation of China, or Provincial Nature Science Foundation, staff in the hospital did not publish any SCI articles, and there were no chief or deputy committee members of national or provincial associations. From the perspective of scientific research and academics, the hospital at that time was at a medium level in Nanhai District, and far behind an affiliated hospital of a high-level university. The university-community-hospital linkage has promoted the development of the medical alliance. The growth and optimization of its talent team have led to a leap in the hospital's soft power. In 2018, the hospital published 13 SCI articles; in 2019, the hospital completed 2 national or provincial nature science projects; in 2020, the hospital has achieved even more fruitful results, with a total of 4 national or provincial nature science projects, 41 SCI articles, and 5 persons elected as the chief (deputy) committee members of the national or provincial associations.

Table 6.2 Research status of the hospital

Indicator	2017	2018	2019	2020
National or provincial nature science projects	0	0	2	4
SCI articles	0	13	35	41
Chief (deputy) committee members of national or provincial associations	0	1	2	5

Note: Statistical data of the education department of the Seventh Affiliated Hospital of SMU from 2017 to 2020

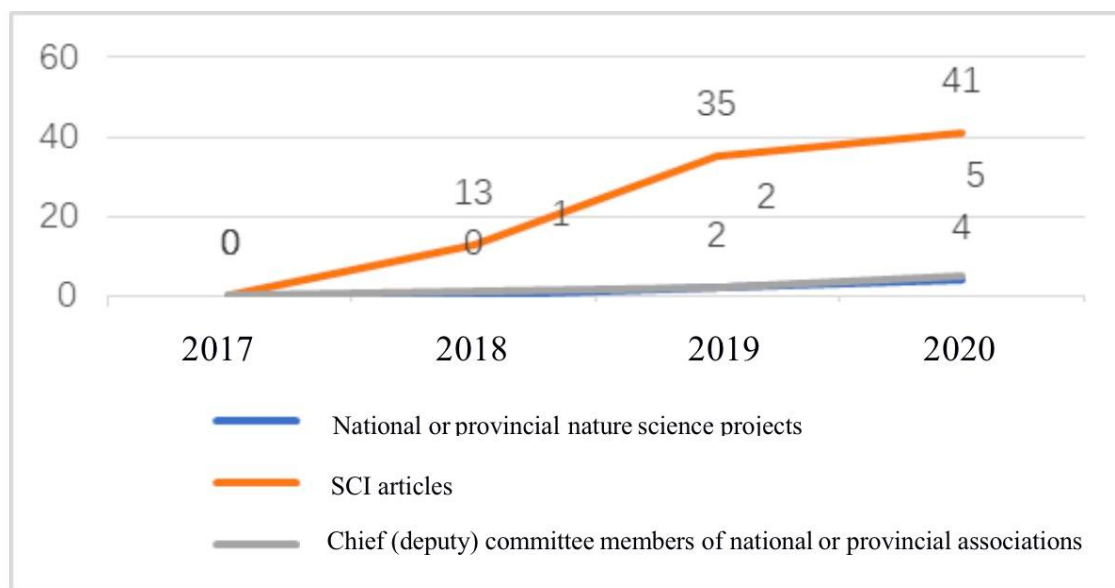


Figure 6.2 Research status of the hospital

Note: Statistical data of the education department of the Seventh Affiliated Hospital of SMU from 2017 to 2020

(3) Steady growth in business income

As shown in Table 6.3, Figure 6.3 and Figure 6.4, in 2017, the hospital just moved to the new campus, and the joint construction of the government and the university just started. In that year, the hospital realized RMB 280 million of business income, RMB 70 million of community health service center's business income, and RMB 350 million of total income, ranking in the lower middle among the public hospitals in Nanhai District; in 2018, the hospital achieved leap-forward development, with business revenue exceeding RMB 400 million; in 2020, under the influence of COVID-19, the hospital still achieved steady growth, with annual business revenue exceeding RMB 500 million, and total income of the medical alliance exceeding RMB 600 million including the income of the community health service centers.

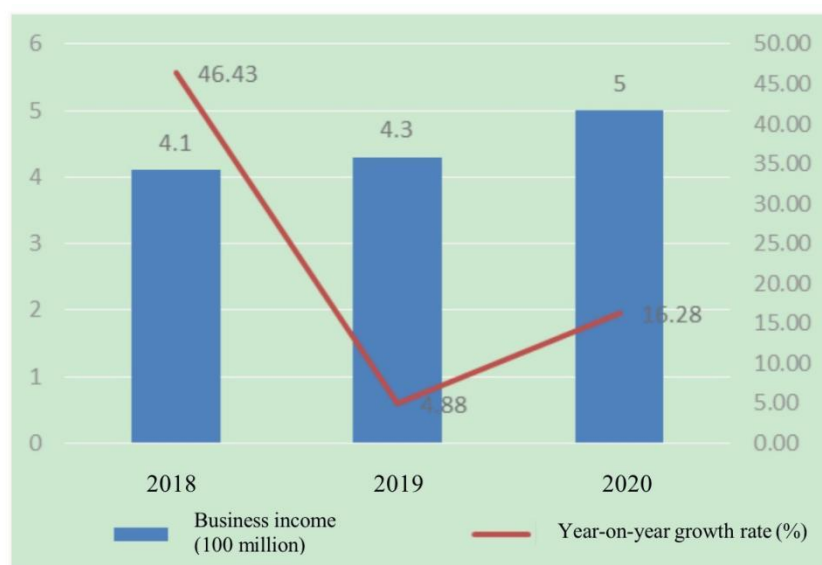


Figure 6.3 Business income of the hospital

Note: Statistical data of the finance department of the Seventh Affiliated Hospital of SMU from 2017 to 2020

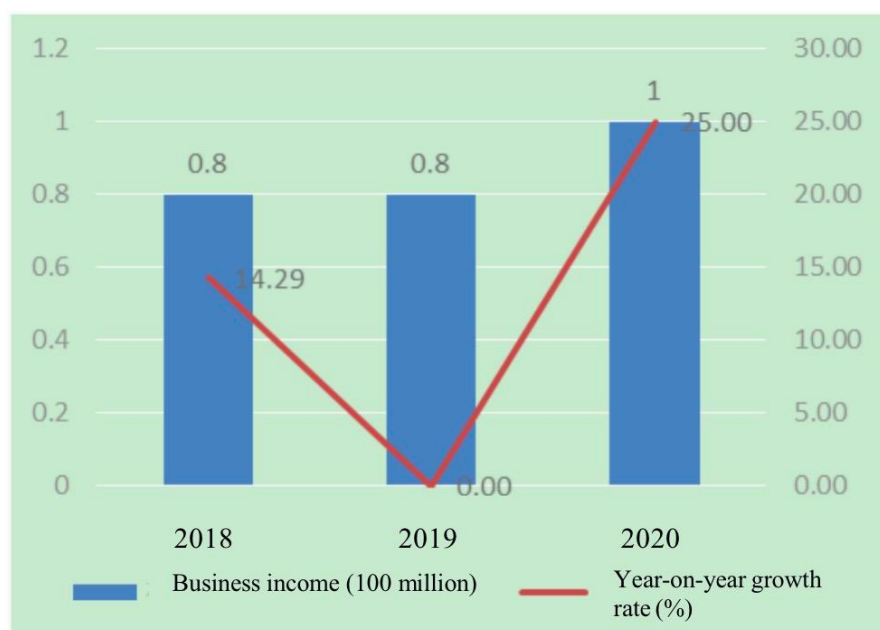


Figure 6.4 Business income of community health service centers

Note: Statistical data of the finance department of the Seventh Affiliated Hospital of SMU from 2017 to 2020

Table 6.3 Business income of the hospital and community health service centers

Indicator	2017	2018	2019	2020
The hospital (100 million)	2.8	4.1	4.3	5
Community health service centers (100 million)	0.7	0.8	0.8	1

Note: Statistical data of the finance department of the Seventh Affiliated Hospital of SMU from 2017 to 2020

(4) All-round growth of business indicators

a) Outpatient visits

As shown in Table 6.4, Figure 6.5 and Figure 6.6, in the past few years, significant growth has been achieved in the overall strength of the hospital, but the number of outpatients has remained almost stable. This is because Lishui has actively implemented the hierarchical diagnosis and treatment system which provides medical services for the most common diseases and senile diseases in the community and other grassroots-level medical institutions; at the same time, physical examinations for all its residents have been actively carried out, including physical examinations for the elderly and adolescents, to achieve early detection and prevention of diseases; early cancer screening has also been carried out with its focus on gastric cancer screening, to improve early diagnosis of major diseases. As of 2020, the number of outpatient visits in hospitals was 1 million (times), and 420,000 (times) in community health service centers. Significant growth has also been achieved in the number of hospital inpatients, from 23,000 (times) in 2017 to 32,000 in 2020.

Table 6.4 Business volume of the hospital and community health service centers

Indicator	2017	2018	2019	2020
Hospital's outpatient visits (10000)	90	90	100	100
Hospital inpatients (10000)	2.3	2.6	2.7	3.2

Outpatient visits in community health service centers
(10000) 35 38 40 42

Note: Statistical data of Lishui Town Community Health Service Center Office from 2017 to 2020

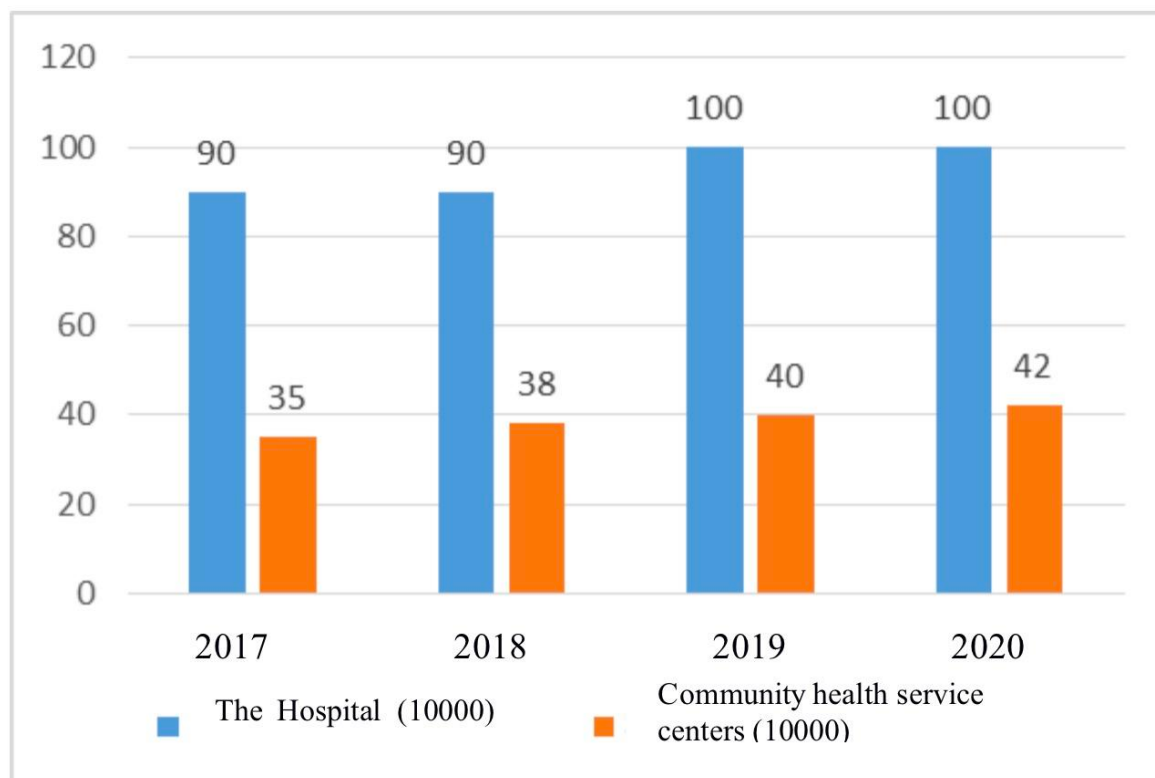


Figure 6.5 Outpatient visits to the hospital and community health service centers

Note: Statistical data of the finance department of the Seventh Affiliated Hospital of SMU and the Lishui Town Community Health Service Center Office from 2017 to 2020

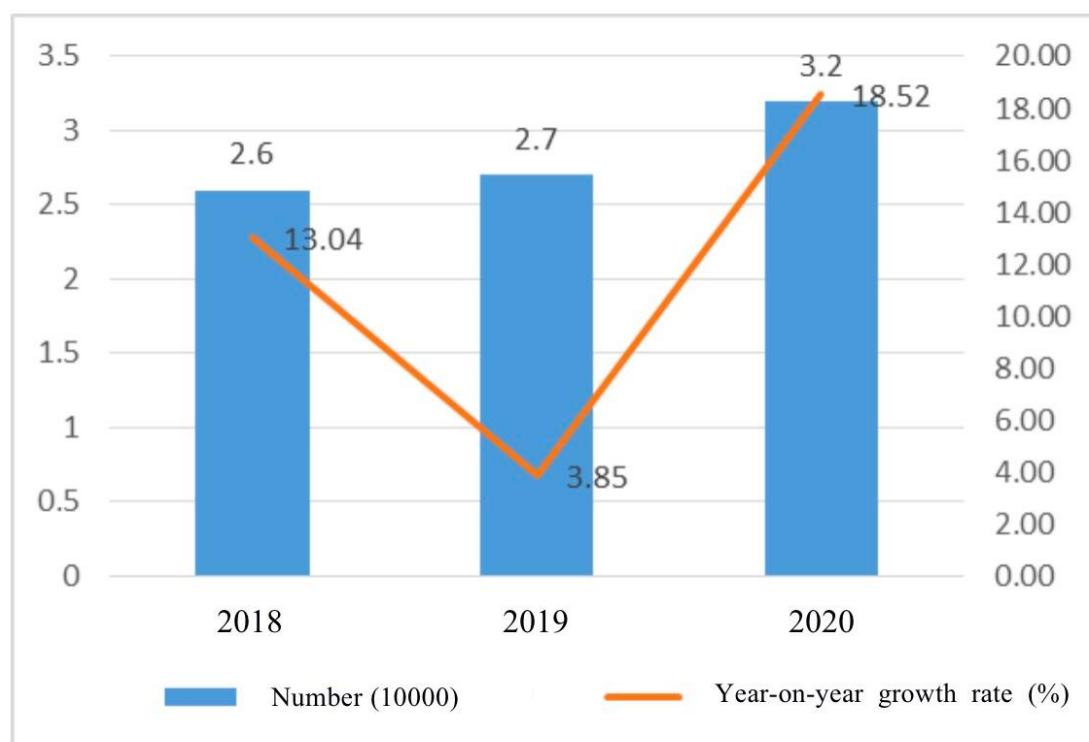


Figure 6.6 Status of hospital inpatients

Note: Statistical data of the finance department of the Seventh Affiliated Hospital of SMU from 2017 to 2020

b) Number of operations

As shown in Figure 6.7, with a small increase in the number of outpatients and inpatients, the number of operations in the hospital has achieved a significant increase due to the substantial improvement in its own strength and people's trust. In 2017, the hospital performed about 4,000 operations throughout the year, with an average of only more than 10 operations per day. In 2018, 2019, and 2020, the number of the hospital's operations increased to 5,000, 8,000 and 10,000 respectively. A more convincing indicator is that not only the number of operations has increased significantly, but the proportion of four-level operations has increased exponentially. Now the hospital's level of surgery is in the leading position among all the public hospitals in Nanhai District.

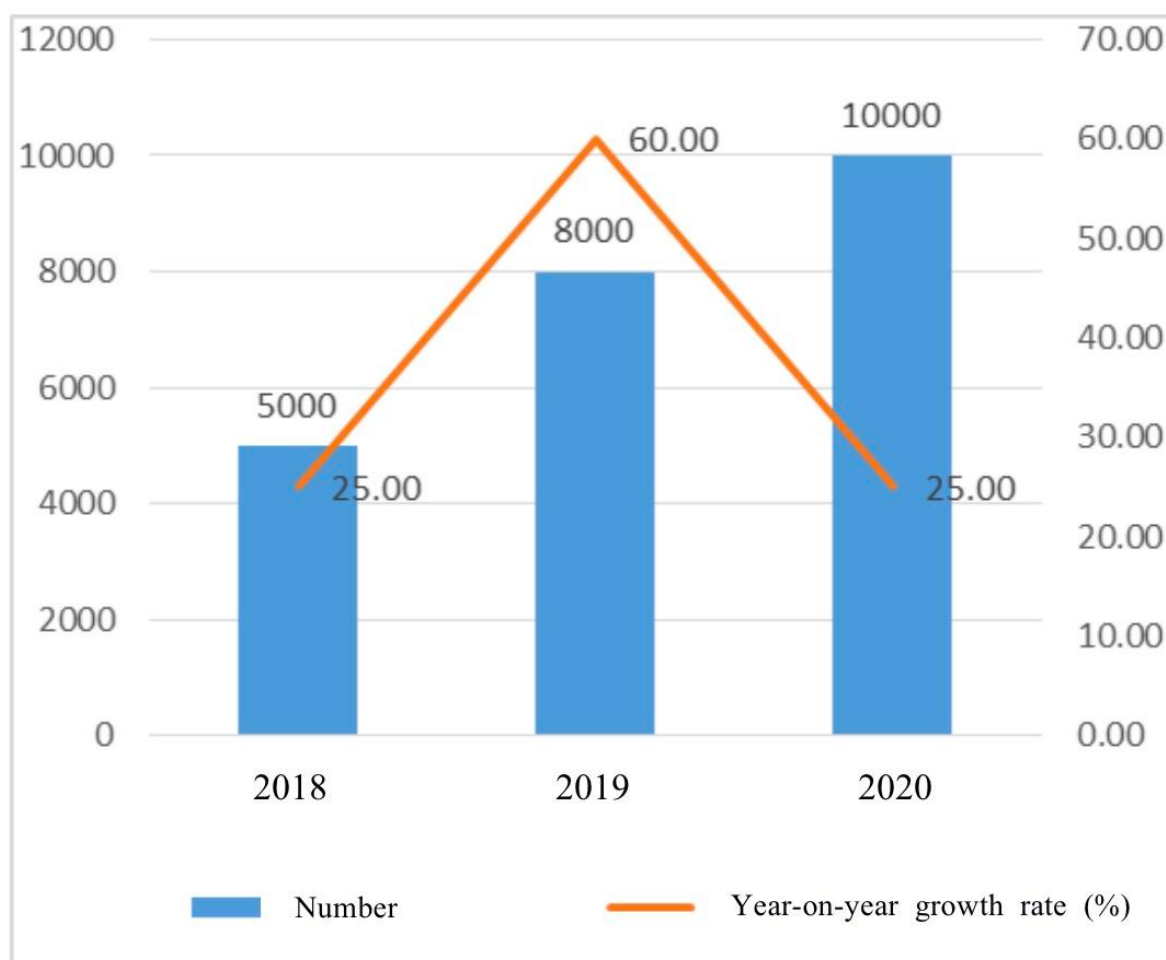


Figure 6.7 Status of operations in the hospital

Note: Statistical data of the finance department of the Seventh Affiliated Hospital of SMU from 2017 to 2020

(5) Development of various work of community health service centers

As shown in Table b.1, Table b.2, Table b.3 and Table b.4, Table b.5, Figure b.1, Figure b.2, Figure b.3, Figure b.4, Figure b.5 and Figure b.6, in the closed-loop of university-hospital-community linkage, the university is the engine, the hospital is the main body, and the

community is the foundation. Thanks to the common development of the medical alliance and the continuous advancement of the hierarchical medical system, considerable progress has been achieved in various tasks of the community, including the proportion of residents establishing medical files, the proportion of family doctors signing contracts, or the health condition of patients with hypertension and the elderly, and the management of chronic diseases. Lishui's basic public health services have also risen from the middle position of the Nanhai District to one of the best.

6.2 Results from the questionnaire survey

6.2.1 Experience with medical treatment

(1) Convenience of medical treatment. Thirty-six respondents were satisfied and 18 were very satisfied, accounting for 67.5% of the total together. Only 10% of the surveyed were dissatisfied, indicating that the locals recognize the establishment of medical institutions and medical processes.

(2) Travel distance to get medical treatment. Thirty-eight people (about 50%) said that the community health service centers or their station sites are nearest to them, and clinics, specialized hospitals and other medical institutions do not account for a high proportion. It shows that the local hierarchical medical system is thoroughly implemented, and “treating minor ailments in the community” can be realized concerning geographical regions. The average distance of the nearest community health service center was about 1km, while that of the nearest hospital was about 4km. Most people can quickly reach medical institutions for treatment.

(3) The degree of comfort in seeking medical treatment. Nearly 50% of the public were most dissatisfied with the experience of queuing and waiting, especially the long waiting time for registration, payment, taking medicine, and diagnosis. Medical resources, equipment, and skills are relatively recognized.

(4) Per capita medical expenses. The span of medical expenses is wide, and the distribution of each grade is relatively even. In general, the per capita medical expenses are mostly RMB 500-3000.

6.2.2 Choice of treatment

(1) Choice of first medical visit. Fifty-two people (65%) selected hospitals as their first choice for treatment, which is also consistent with the status quo reflected in various surveys conducted in China (Y. Li & Xin, 2020). Chinese people still regard hospitals, especially secondary and tertiary general ones, as their first choice for medical treatment, and the proportion of choosing community health service centers or clinics is relatively low. This also indicates that the implementation of “first contact care at the grassroots level”, the most critical part of HMS, is not as expected, which is also the focus of reform.

(2) Key factors for medical treatment. Fifty-seven respondents (71%) prioritized the professional level of doctors, signifying that the level and quality of medical care are still the major influencing factor for the public. The convenience of transportation, brand awareness, equipment sophistication, and medical insurance reimbursement ratio are also factors that people are more concerned about.

(3) Medical experience in community medical institutions. Fifty-six people (70%) have been to a community medical institution for treatment, and 30% have no relevant experience. There is a certain gap between this and China’s goal that the vast majority of people will be diagnosed at the grassroots level for the first time.

(4) Expectations of visiting community medical institutions. Nearly 70% of the surveyed hoped that community medical institutions can provide routine medical examinations and treatments. Half of the respondents wished that vaccinations, acupuncture and physiotherapy, health care, and rehabilitation can be provided. Meanwhile, some people hoped that the said institutions can also offer consultations, follow-ups for chronic diseases, physical examinations of pregnancy and other services. The community medical institution selected in this case can provide most of the above-mentioned services.

(5) Habits of seeking medical treatment. Sixty-nine people (86%) tend to choose regular doctors for treatment, and only a few people do not care whether they are regular doctors or not, showing that there is a deeply-rooted phenomenon of “acquaintance” in the mindset of the public and that people prefer seeing doctors they know. This has also caused some people with minor ailments and pains to register for a familiar doctor regardless of their actual situation.

(6) Comparison of medical treatment. As many as 73 people (91%) of the surveyed believed that there was a significant gap between community health service centers and secondary and tertiary hospitals, which also fully demonstrates the distrust of people in primary medical institutions, causing most people to go to hospitals instead of community medical treatments.

(7) The quality of doctors. 93% of the surveyed people cared about the professional skills of doctors, and 62% cared about the quality of service. On the contrary, age and job title are not the quality of doctors that are valued most.

6.2.3 Hierarchical medical system findings

(1) The degree of system mastery. 54% of the surveyed said they knew the hierarchical medical system, and 46% say they did not, fully showing that the hierarchical medical system is still relatively unfamiliar to the public. People did not understand the services that primary medical institutions can provide, which makes it difficult to alleviate the rush to secondary and tertiary public hospitals. It is also the most important goal of the reform that more people are willing to go to the grassroots level medical institutions for medical treatment, while enjoying the same diagnosis and treatment and services as the secondary and tertiary public hospitals offer.

(2) Main factors of visiting community medical institutions. 78% of the surveyed go to community medical institutions for medical treatment because of the convenience of transportation, 43% thought that they do not need to go to the hospital for medical treatment with mild symptoms, 38% thought that it is cheaper to go to community medical institutions, and only 3% were because of the habits of seeking medical treatment. It can be seen that if the layout of community medical institutions is sensible, the transportation is convenient, the price is reasonable, and the publicity is put in place, the proportion of first contact care at the grassroots level may gradually increase.

(3) Referral experience. Only 18% of the respondents have had a referral experience, and 82% have never experienced any referral. From the perspective of referral willingness, only 40% are willing to accept referrals, and most people said they are unwilling to take it or do not understand it. The result shows that there is still a gap in the current referral situation, and the referral hospital needs to be improved.

(4) Willingness to be referred to lower-level medical institutions. From the analysis of the statistical results, the reasons that can promote the downward transfer of the public are the distance (60%), price (40%), service attitude (31%), and medical insurance reimbursement (31%); the main reasons for unwillingness to transfer downwards is because the referral process is cumbersome (43%), the level of primary medical technology is low (41%), and there is a sense of distrust (38%). It shows that the willingness to refer is related to subjective and objective factors.

6.2.4 Basic personal information

(1) Physical condition. The proportion of people with good health and very good health was 60%, the proportion of people with poor health and very bad health was 4%, and about 74% had no significant chronic disease history.

(2) Physical examination. Fifty-eight percent of the respondents had the habit of regular physical examinations. Most people chose to go to a secondary or tertiary hospital for physical examination, and a small number of them choose to go to a professional physical examination center. The proportion of the respondents who are willing to go to the community health service center for physical examination is small, which once again shows that the public has insufficient confidence in the professional and technical level of primary medical institutions.

(3) Medical insurance. Twenty-four people said that they have purchased commercial medical insurance, accounting for only 30% of the total number of the survey. Those who did not purchase commercial medical insurance occupied 70%. On the contrary, those who had social medical insurance accounted for as high as 91%, indicating that governmental medical insurance is relatively mature in China and commercial insurance has not yet become mainstream.

Based on the results of the satisfaction survey of hospitals, community health centers and patients' perceptions, we can intuitively see the relationship between patients' preference of choosing medical treatment in regional medical associations, and patients have gradually changed their long-standing medical treatment habits under symmetrical information.

Considering the game theory applied in this research, besides the patients, the subjects involved in the multi-party doctor-patient game are subdivided from the perspective of the medical association, including tertiary hospitals and community health service centers. Because of the unequal medical resources and management levels of the two kinds of medical institutions, they are inherently different and are competitors to some extent. Therefore, it is necessary to distinguish them and discuss the multi-game problem between them and patients, and the explanation is as follows:

From the perspective of tertiary hospitals, compared with community health centers, tertiary hospitals have richer medical resources, stronger technical support and obvious advantages in talents. They own complete infrastructure facilities brought by government investment and rapid development for a long time, and often have an excellent operation and management team. Obviously, tertiary hospitals have a great attraction for patients, which makes patients more willing to seek medical treatment in tertiary hospitals, so tertiary hospitals

are in an absolutely dominant position in this game model of the medical association.

From the point of view of health centers, compared with tertiary hospitals, the community health center has clear shortcomings, such as relative lacking medical resources, imperfect construction of disciplines and specialties, mostly insufficient talent reserve and an unreliable customer base. In many places, the infrastructure of community health centers is outdated, aging and improvement-needed, and the centers also lack scientific and standardized management. Therefore, patients usually don't choose to go to the community health centers for treatment, especially when they are suffering from severe diseases, and they are sceptical about the medical service ability and quality of those centers, so the community health center is in an obvious inferior position in the game model.

Thus, it can be seen that the difference in overall strength between tertiary hospital hospitals and community health service centers has been causing patients to lose their trust in the quality of health care services in community health service centers and prefer tertiary hospitals for consultation. It was not until the introduction of the graded diagnosis and treatment model, especially the university-hospital-community linkage model used in this study, that the barrier between hospitals at all levels was gradually broken within the medical association, and the patient cognitive inertia shifted to a certain extent, making the proportion of first visits to community health service centers increase, and the congestion at tertiary hospitals has been reduced.

The game does not mean confrontation, nor is it zero-sum. Among the three game subjects: tertiary hospitals, social health centers and patients, the variability of patients are the highest, and the perception of patients is also the highest; the openness of tertiary hospitals is the highest, and the ability of tertiary hospitals to obtain resources is the highest; the coverage of social health centers is the widest, and the development potential of social health centers is the highest. We can confirm this from the various achievements and data in the development of hospitals and social health centers in the past five years.

Therefore, with the leadership and intervention of the university, the process of operating the medical association, the patient visits, the parties of the game can work as a whole, remove the barriers between each other, embrace the new environment, the new model, and inevitably produce new results.

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Chapter 7: Conclusions and Prospects

In this chapter, we will summarize the findings and achievements of our research, we will explore the theoretical and practical implications, we will also analyze the shortcomings and limitations of the research, and put forward new questions and prospects.

7.1 Summary of research results

7.1.1 Cognition of the government and the public on the linkage among universities, hospitals and the community to promote the development of HMS

(1) The government's cognition

The local government has an intuitive sense of the university-led and regionally constructed medical community model with a focus on general medicine. With the active organization and assistance of the university, the medical-community cooperation has built a new bridge linking a number of medical specialties from modern clinical and primary medical care, public health and preventive medicine, TCM, integrated Chinese and Western medicine, pharmacy, Chinese herbal medicine, and dentistry. Using six aspects of medical care, public health consultation services, health information management consultation services, scientific research, education and training, and information management and operation, we are actively integrating with clinical medicine and other specialized medical disciplines, and with the integration of medicine and defence as the core. We are also constantly innovating health services, enriching the content of health services, expanding the scope of health services, and optimizing the local health service model in a practical sense.

At the same time, the hospital's efficiency has increased year by year. The amount of operating losses that the government needs to support has been significantly reduced. The hospital has developed and the local health care industry has gradually clustered, and research and new technologies have been developed with the support of the university. The government's input-output ratio has increased significantly, which has attracted governments from other regions to learn from the model. The study of this thesis has some significance for the summary and promotion of this model.

(2) Cognition of the public

This research focuses on patients' experiences and satisfaction. Through interviews and document analysis, it is found that the general public has the following perceptions: a). There are obvious differences between university-affiliated hospitals and general hospitals, and the most important thing lies in the brand effect, which directly reflects the reliability and confidence; b). It's more convenient to see a doctor than before, all major illnesses and minor illnesses needed to be treated in big hospitals. Now it's possible to get better medical experience, diagnosis and treatment levels at social health centers supported by universities and hospitals. c). The medical treatment is more orderly, and the implementation of the hierarchical diagnosis and treatment system is directly reflected in the division of medical groups in hospitals and communities, with major illnesses seeing the specialist, minor illnesses seeing general practice, major illnesses directed to hospitals and minor illness directed to communities; d). The difference between hospitals and communities is smaller, since hospitals' physicians visit social health centers regularly (every week or every month), and social health centers' doctors can also get professional training and more opportunities for further research. e). It's cheaper to see a doctor. If the first consultation is in the social health center and then higher-level hospitals, patients can enjoy a higher percentage of reimbursement by governmental medical insurance. The contradiction between doctors and patients has decreased, doctors are no longer tired of dealing with patients, the public is more recognized for doctors' professionalism, and the relationship between them is more harmonious; f). The government's investment in hospitals is greater so the hospital is able to provide more resources to purchase better equipment. With hardware upgrades, diseases that could only be treated in Guangzhou can be treated locally.

7.1.2 Provide a new reform path for China's medical reform

After five years of development and operation, and after continuous investigation and analysis, universities now are taking the lead, hospitals and community health centers are encouraged to develop harmoniously, and with general medicine as the leader, the connection between medicine and other social disciplines such as engineering, management, humanities and social sciences will be established, which will make contributions and influence in the industry, economy, cultural construction and social influence. In concrete, the utilization of GP to promote the integration of medical resources, promote the cross-border integration of medical resources and other social disciplines, open a door for the implementation of the strategy of healthy China, and explore a new reform path that can be implemented, replicated and sustainable to achieve the strategic goals of popularizing healthy living, optimizing health services, improving health security, building a healthy environment and developing health

industry.

7.2 Research's implications

(1) Theoretical implications

In China, it is the first time to put forward theoretical research and case analysis from the perspective of university-hospital-community linkage to promote HMS, and innovatively put forward that universities should invest in high-quality resources such as brands, technologies, and talents, and sink to the county from the perspective of “supply-side”. This study has tried to innovatively summarize the connotation between general practice and medical alliance, exploring and analyzing it through cases. In fact, there is little research on this topic in China, especially the research based on data and trends. Furthermore, we also put forward and summarize the “dual-core, four-dimensional and two-drive” hospital management system and its connotation, exploring several important measures to achieve results, including “co-construction of government and school”, “integration of medical care and prevention”, “collaboration between medical care and education”, “public health system”, “combination of medical care and health preservation” and “chronic disease management”.

(2) Practical implications

According to the data analysis, after four or five years of practice and operation, the data from hospitals and community health centers have increased greatly, and the satisfaction of employees and the masses has also improved. This model has achieved great success in China, and can be applied and extended to similar areas. In fact, in the Pearl River Delta region, the government generally has abundant fiscal revenue, and there are many higher medical universities in the region, such as SMU, Guangzhou Medical University, Guangdong Medical University, Guangzhou University of Traditional Chinese Medicine. The model of co-construction between government and schools is possible to replicate. The cases considered in this research have outstanding representativeness and no obvious interference factors, which can be used for reference in other places with certain conditions, in the region or in other parts of China.

7.3 Suggestions for the construction of a pandemic prevention and control system

Different from the traditional government-led mode of epidemic prevention and control, this

research puts forward some suggestions on epidemic prevention and control with general practice and medical alliance as the main carrier. a). Strengthening the construction of the GP system and graded diagnosis and treatment system is the core. b). Strengthening the training of prevention and control of normalized infectious diseases and drills of public health emergencies for grass-roots medical staff is the key point; c). Strengthening the construction and application of grass-roots informatization is the guarantee; d). Promoting the construction of medical alliance is the connotation; e). Enriching patriotic health work is the means.

7.4 Limitations of research

Considering the period and sampling, this research was conducted during a long-time span, with a wide range of data sources, and it is not easy to carry out stage analysis in a short period of time, so it lacks timeliness. Because of the limitations, the questionnaire survey method was adopted in this research and only 80 questionnaires were collected. The sample may not be common enough. Only four interviews were conducted in this research, which did not involve nurses and logistics support personnel, nor interviews with government personnel, and the completeness was insufficient. This research is based on the case analysis of counties in the Pearl River Delta region which is one of the developed regions. Cases from other parts of Guangdong Province are absent, so its representativeness may be a limitation.

This research analyzes the promotion effect of university-hospital-community linkage on hierarchical diagnosis and treatment at the county level, but due to the lack of sufficient samples, only relatively shallow research was conducted in statistical analysis, and no more variables could be set for detailed analysis and elaboration.

We focused on analyzing the results of the past four or five years, but our research does not make a scientific and detailed forecast for the future, such as whether this growth will continue or will have a breakthrough soon. If there is an opportunity in the future, we will try to explore more in-depth these topics, departing from this research, in order to verify the research questions and

This study builds an ARIMA (1, 1, 1) model based on the referral indicators to predict the number of referrals. It confirms that the number of referrals will continue to increase in the future. As for the trend, the number of two-way referrals is increasing. However, since the base of two-way referrals is small, efforts should be made to promote the advancement of the hierarchical diagnosis and treatment system, the medical service system featuring up-and-down linkage, the medical service mode of primary consultation at the grass root level, and various

infrastructure constructions. It is also important to strengthen the education and training of medical personnel, provide more drivers to improve the number of two-way referrals, so as to achieve an exponential increase in the number of two-way referrals and expand the base of two-way referrals, making primary medical consultation system at community level a more common option.

Descriptive statistics are made based on total medical income, referrals, bed utilization, outpatient and emergency visits, and inpatients. The total medical income is used as the explained variable. Referrals, bed utilization, outpatient and emergency visits, and inpatients are used as explanatory variables. A multiple linear regression model is built and corrected through the consistent operation of the model. As we stressed, the results show a positive significant correlation between the total medical income and the number of referrals and the bed utilization rate. The total medical income is also positively related to the number of outpatient and emergency visits. Considering these results, we concluded that the county-level two-way referral policy has a promoting effect on medical economic benefits.

Currently, the reform is underway, and the effectiveness needs to be verified by actual results and data. Policies also need to be continuously summarized and innovated. With the gradual implementation of the hierarchical diagnosis and treatment system, the number of referrals has continued to increase, and will maintain the upward trend in the future, which has perfectly demonstrated the effect of the hierarchical system. Meanwhile, the policy has not only promoted the development of primary medical institutions, but also exerted a positive impact on the economic benefits of large local hospitals. Therefore, it is necessary to deepen the implementation of the two-way referral policy and strengthen the management efficiency of the hospital. Increasing the utilization rate of medical resources has an important role in promoting social-economic benefits. At the same time, such measures as strengthening the strategic management of hospital brands, improving the quality of medical services, increasing the service coverage of hospitals and the number of outpatient and emergency visits, will also play an important role in promoting the economic benefits of the hospital.

7.5 Future research direction

1. Further in-depth case study

Based on historical data research from the past few years, it is crucial to expand the scope of research, for example, whether there is the feasibility of implementation in the area next door or whether there is the same correlation and trend in other affiliated hospitals of the university.

Thus, it will be of great importance to conduct more in-depth interviews and investigations involving the administrators of universities, hospitals and social health centers, master their latest initiatives and more comprehensive ideas, put forward new research questions, establish new research paths and build more optimized theoretical models.

2. More detailed classification of patients and key variables of referral are put forward.

The barriers between tertiary and primary care institutions still exist, and there is a need to find the “human” connection beyond the policy side, use a scientific scoring system to categorize patients accurately, to propose the best way for each type of patient to seek care, and to help them establish a smooth referral pathway between various types of medical institutions. For example, the demands of patients in the acute, stable, and recovery phases are different, and future research should identify the most critical factors affecting them, and thus analyze the most critical variables affecting referrals.

3. Comparative study among different regions

China has a vast territory, and the economic, social and cultural conditions vary widely in different places. It is impossible to replicate one model for the whole of China, but it is still the focus and significance of the study to build a model that is relatively suitable for all regions, or to propose a template that can be used as an alternative and reference. Therefore, in future research, we need to strengthen the comparative links between different regions, conduct in-depth research in a few representative places, and extrapolate and optimize our research results and conceptual model.

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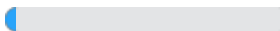
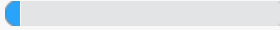
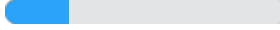
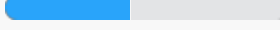
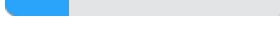
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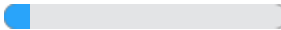
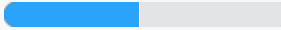
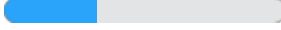
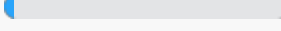
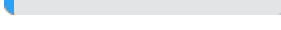
Annex A: Resident Questionnaire and Its Results for Hierarchical Medical Service (80 Valid Questionnaires)

Part I Preferences for Medical Institutions

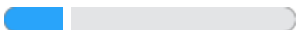
1. Please rate the level of convenience for your current medical treatment (please consider such items as queue registration, waiting for examinations, laboratory tests, receiving inspection reports, payment, collecting medicines) [Single-choice]

Option	Subtotal	Proportion
Very dissatisfied	3	 3.75%
Dissatisfied	5	 6.25%
General	18	 22.5%
Satisfied	36	 45%
Very satisfied	18	 22.5%

2. The nearest medical institution to your home is [Single-choice]

Option	Subtotal	Proportion
Private clinic	8	 10%
Community health service	38	 47.5%
General hospital	27	 33.75%
Specialty hospital	3	 3.75%
Chinese Medicine hospital	4	 5%

3. In the course of your medical treatment, in which areas do you feel inconvenient or dissatisfied? [Multiple-choice]

Option	Subtotal	Proportion
The hospital does not offer effective explanation for the procedures	17	 21.25%
Long queue time for registration, payment, medicine collection.	39	 48.75%

Long waiting time	38	47.5%
Short consultation time	15	18.75%
Poor service attitude of doctors makes patients feel disrespected	10	12.5%
Poor medical skills of doctors	9	11.25%
Doctors' unclear explanation of the condition	16	20%
The hospital lacks medical equipment, so I have to go to a higher-level hospital	5	6.25%
Insufficient medical resources such as beds, crowded medical space	6	7.5%

4. The distance from the nearest community health service center (station) to your home is [Single-choice]

Option	Subtotal	Proportion
Within 1 km	45	56.25%
1 km away	35	43.75%

5. The distance from the nearest tertiary grade-A hospital to your home is [Single-choice]

Option	Subtotal	Proportion
Within 1 km	10	12.5%
1 km~3 km	18	22.5%
3 km away	52	65%

6. The medical expense per capita of your family last year was (yuan) [Single-choice]

Option	Subtotal	Proportion
Less than 500	12	15%
501~999	23	28.75%
1000~2999	22	27.5%

3000~5999	11	13.75%
6000 or more	12	15%

Part II Preferences for Medical Institutions

7. When you need to see a doctor, you usually firstly choose [Single-choice]

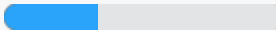
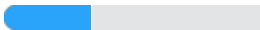
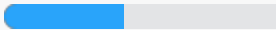
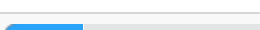
Option	Subtotal	Proportion
Individual clinic or pharmacy	8	10%
Community health service station (center)	20	25%
Secondary and tertiary hospitals	52	65%

8. What factors will you give priority to when choosing a medical institution? [Multiple-choice]

Option	Subtotal	Proportion
Waiting time	10	12.5%
Distance and convenient transportation	35	43.75%
Doctor's professional skills and service attitude	57	71.25%
Whether there is a familiar doctor	19	23.75%
Medical equipment	22	27.5%
Medical expenses	12	15%
Whether it is a designated medical insurance institution	25	31.25%
Whether there is a well-known expert	12	15%
Popularity of the hospital	25	31.25%

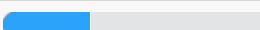
9. What services do you most want from community medical institutions? [Multiple-choice]

Option	Subtotal	Proportion
Routine medical examination and treatment	55	68.75%

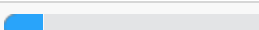
Consulting	27	 33.75%
Follow-up of chronic diseases	24	 30%
Acupuncture physiotherapy	34	 42.5%
Vaccination	42	 52.5%
Rehabilitation	36	 45%
Health care	38	 47.5%
Prenatal examination	22	 27.5%

10. Do you have any medical experience at a community health service station (center)?

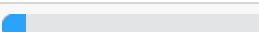
[Single-choice]

Option	Subtotal	Proportion
Yes	56	 70%
No	24	 30%

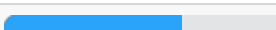
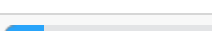
11. Do you tend to choose a regular doctor during your visit? [Single-choice]

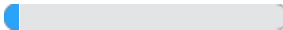
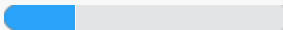
Option	Subtotal	Proportion
Yes	69	 86.25%
No	11	 13.75%

12. Do you think there is a difference between the community health service center and the secondary and tertiary hospitals? [Single-choice]

Option	Subtotal	Proportion
Yes	73	 91.25%
No	7	 8.75%

13. When choosing a doctor, which of the following qualities do you think is the most important? [Multiple-choice]

Option	Subtotal	Proportion
Medical skills	74	 92.5%
Service attitude	50	 62.5%
Communication skills	38	 47.5%
Professional title	12	 15%

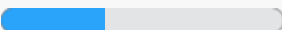
Age	5	 6.25%
Popularity	20	 25%

Part III Hierarchical Medical Service

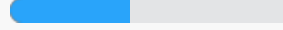
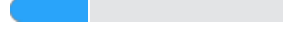
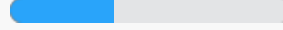
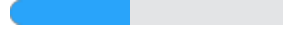
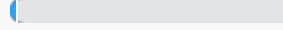
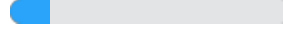
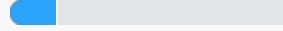
14. Do you know about the hierarchical diagnosis and treatment system? [Single-choice]

Option	Subtotal	Proportion
Yes	43	 53.75%
No	37	 46.25%

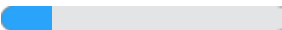
15. Would you like to choose a community medical institution for the first consultation?
[Single-choice]

Option	Subtotal	Proportion
Yes	50	 62.5%
No	30	 37.5%

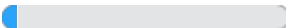
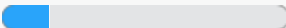
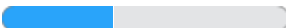
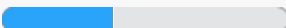
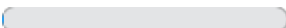
16. What factors will make you choose to have the first consultation in the community?
[Multiple-choice]

Option	Subtotal	Proportion
Nearby and convenient	62	 77.5%
The doctor is familiar with the patient's condition	34	 42.5%
Good service attitude	22	 27.5%
Not expensive	30	 37.5%
Mild condition	34	 42.5%
I'm used to community medical institutions	2	 2.5%
Adequate medical resources	12	 15%
High level of medical skills	13	 16.25%

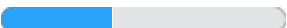
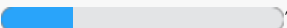
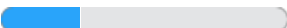
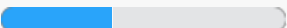
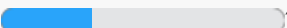
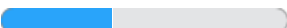
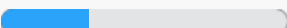
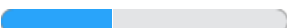
17. Have you ever had a referral? [Single-choice]

Option	Subtotal	Proportion
Yes	14	 17.5%
No	66	 82.5%

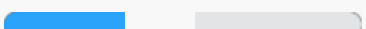
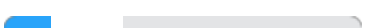
18. Are you willing to receive referral? [Single-choice]

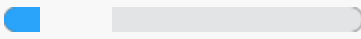
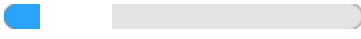
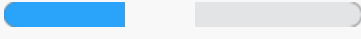
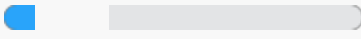
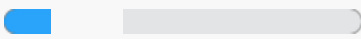
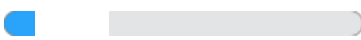
Option	Subtotal	Proportion
Very unwilling	4	 5%
Unwilling	13	 16.25%
General	31	 38.75%
Willing	31	 38.75%
Very willing	1	 1.25%

19. Which of the following factors do you think will make you willing to accept a referral (from a large hospital to a community health service institution)? [Multiple-choice]

Option	Subtotal	Proportion
High medical insurance reimbursement ratio	31	 38.75%
I have a family doctor	21	 26.25%
Doctors in the big hospital can still guide the treatment after referral	22	 27.5%
Reasonable price	32	 40%
Close to home	48	 60%
Relatively less patients and shorter waiting time	26	 32.5%
Good service attitude	31	 38.75%
Adequate medical equipment	25	 31.25%
High level of medical skills	31	 38.75%

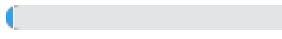
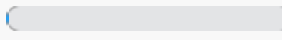
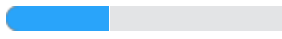
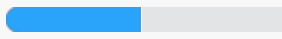
20. Which of the following factors do you think will make you unwilling to accept a referral (from a large hospital to a community health service institution)? [Multiple-choice]

Option	Subtotal	Proportion
Do not trust the quality of community medical service	30	 37.5%
Cumbersome procedures during the referral	34	 42.5%
Small difference in the reimbursement for	13	 16.25%

medical insurance		16.25%
The community does not carry out family bed services	10	 12.5%
I believe that the condition does not require further professional treatment and can be cured naturally	10	 12.5%
Insufficient conventional equipment	34	 42.5%
Low level of medical skills	33	 41.25%
The attitude of medical staff is not good enough	9	 11.25%
Backward management methods, low work efficiency, and sluggish work style	23	 28.75%
Lack of funds to carry out health services other than diagnosis and treatment	13	 16.25%
Not people-oriented, and the special requirements of patients are ignored	9	 11.25%

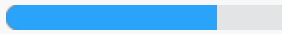
Part IV Basic Information of Residents

21. Please rate your physical condition [Single-choice]

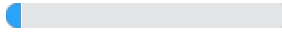
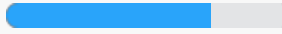
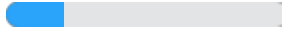
Option	Subtotal	Proportion
Very bad	2	 2.5%
Bad	1	 1.25%
General	29	 36.25%
Good	38	 47.5%
Very good	10	 12.5%

22. Do you have a chronic medical history (such as cirrhosis, diabetes, rheumatoid arthritis, hypertension, hyperlipidemia, hyperglycemia, chronic renal failure, anemia, chronic heart failure, peptic ulcer, cerebral hemorrhage (brain obstruction), coronary and heart disease)? [Single-choice]

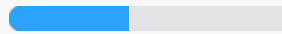
Option	Subtotal	Proportion
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Yes	21	 26.25%
No	59	 73.75%

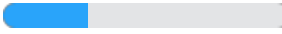
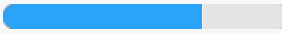
23. When you have a physical examination, which one do you usually choose? [Single-choice]

Option	Subtotal	Proportion
Community health service center	5	 6.25%
Secondary and tertiary hospitals	58	 72.5%
Professional physical examination center	17	 21.25%

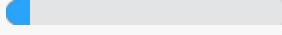
24. Do you have the habit of regular physical examinations? [Single-choice]

Option	Subtotal	Proportion
Yes	46	 57.5%
No	34	 42.5%

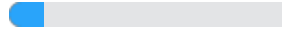
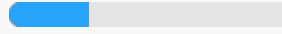
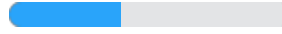
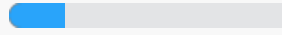
25. Do you have commercial medical insurance? [Single-choice]

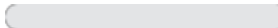
Option	Subtotal	Proportion
Yes	24	 30%
No	56	 70%

26. Do you have social health insurance [Single-choice]

Option	Subtotal	Proportion
Yes	73	 91.25%
No	7	 8.75%

27. Your age [Single-choice]

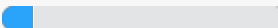
Option	Subtotal	Proportion
18~29 years old	10	 12.5%
30~39years old	22	 27.5%
40~49years old	32	 40%
50~59years old	16	 20%

>=60 years old	0	 0%
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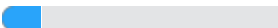
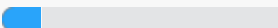
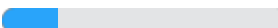
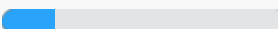
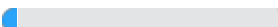
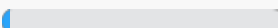
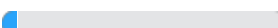
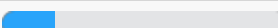
28. Your gender [Single-choice]

Option	Subtotal	Proportion
Male	39	 48.75%
Female	41	 51.25%

29. Your marital status [Single-choice]

Option	Subtotal	Proportion
Married	69	 86.25%
Unmarried	11	 13.75%

30. Your family's monthly per capita income (yuan) [Single-choice]

Option	Subtotal	Proportion
Less than 3000	11	 13.75%
3000~3999	11	 13.75%
4000~4999	16	 20%
5000~5999	15	 18.75%
6000~6999	4	 5%
7000~7999	3	 3.75%
7000~10000	5	 6.25%
10000 or more	15	 18.75%

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Annex B: Supplementary Tables and Figures

Table b.1 Status of public health work of the community health service centers

Indicator	2017	2018	2019	2020
Residents establishing medical files (%)	76	85	81	95
Family doctors signing contracts (10000)	55	60	87	95
Health management for the elderly (10000)	0.7	0.9	1.3	1.6
Health management for patients with hypertension and diabetes (%)	83	87	87	96
Health management of chronic diseases (%)	100	100	100	100

Note: Statistics of Lishui Town Community Health Service Center Office from 2017 to 2020

Table b.2 Status of available beds in the hospital

Indicator	2017	2018	2019	2020
Hospital beds opened	600	700	800	800
Year-on-year growth rate (%)	-	16.67	14.29	0.00

Note: Statistics of Department of Finance, Seventh Affiliated Hospital of SMU from 2017 to 2020

Table b.3 Status of the community health service centers established

Indicator	2017	2018	2019	2020
Number of community health service centers	16	17	18	20
Year-on-year growth rate (%)	-	6.25	5.88	11.11

Note: Statistics of Lishui Town Community Health Service Center Office from 2017 to 2020

Table b.4 Ranking of the comprehensive strength of the hospital

Indicator	2017	2018	2019	2020
Ranking of comprehensive strength (Nanhai District)	7	5	4	4

Note: Statistics of Nanhai District Health Bureau from 2017 to 2020

Table b.5 Status of referrals from community health service centers

Indicator	2017	2018	2019	2020
Number of referrals	125	805	1045	1098
Year-on-year growth rate (%)	-	544.00	29.81	5.07

Note: Statistics of Lishui Town Community Health Service Center Office from 2017 to 2020

Table b.6 Status of operations in the hospital

Indicator	2017	2018	2019	2020
Number of operations	4000	5000	8000	10000
Year-on-year growth rate (%)	0.7	0.8	0.8	1

Note: Statistics of Lishui Town Community Health Service Center Office from 2017 to 2020

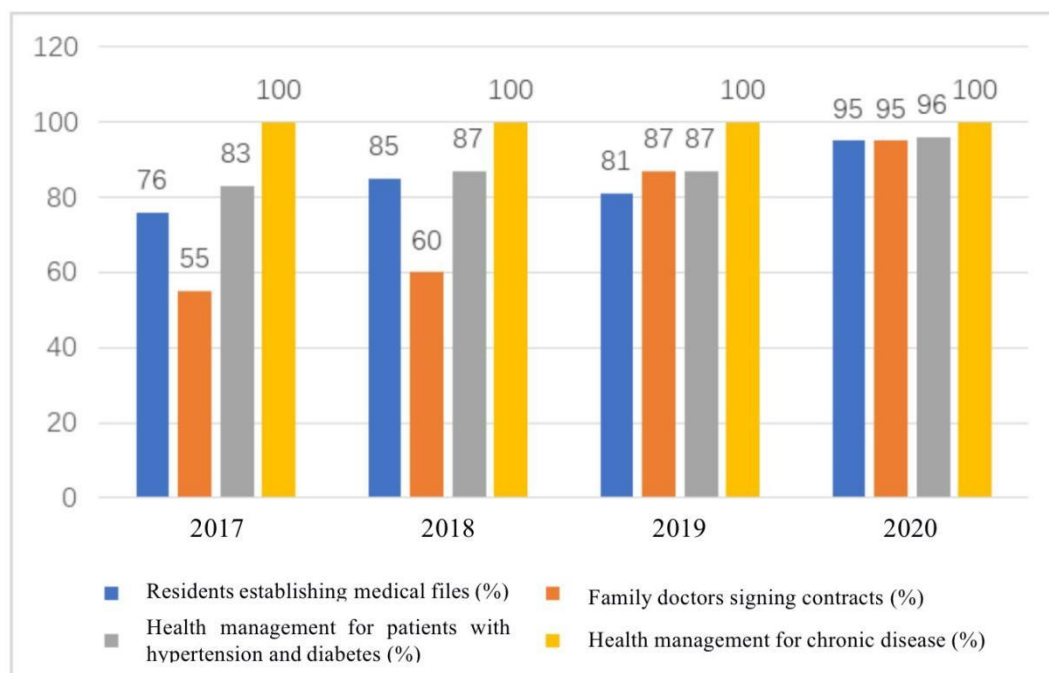


Figure b.1 Status of public health work of the community health service centers

Note: Statistics of Lishui Town Community Health Service Center Office from 2017 to 2020

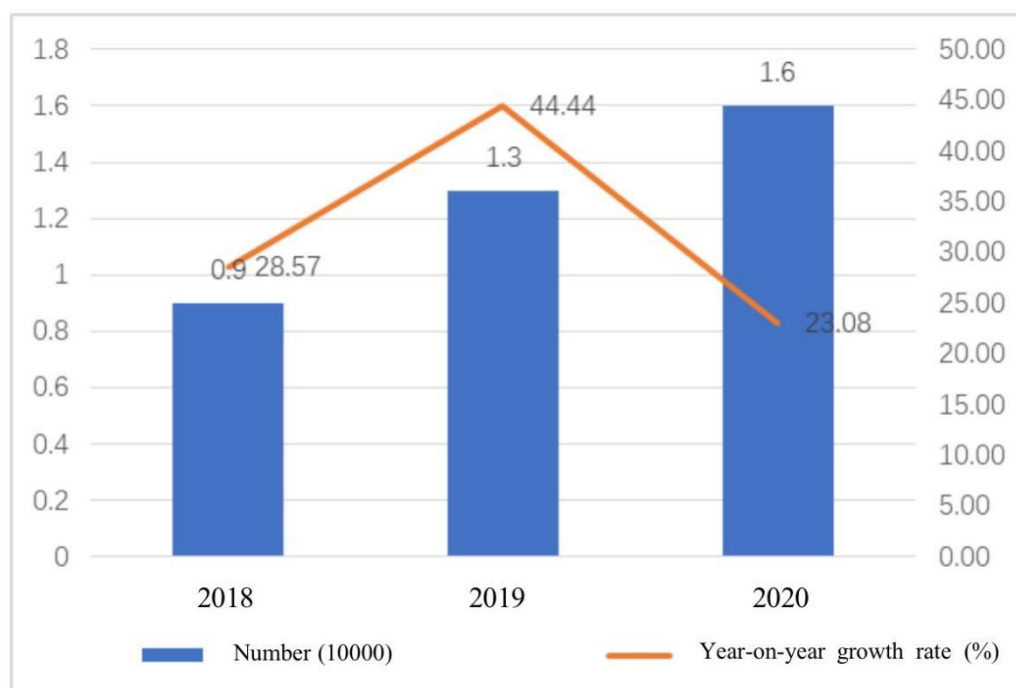


Figure b.2 Statues of health management for the elderly

Note: Statistics of Department of Finance, Seventh Affiliated Hospital of SMU from 2017 to 2020

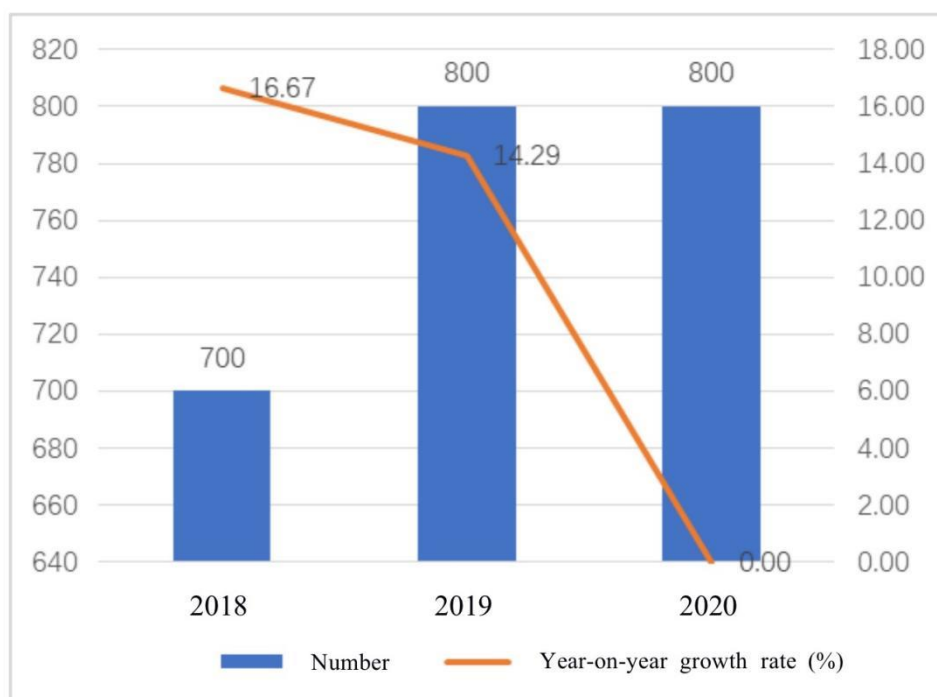


Figure b.3 Status of available beds in the hospital

Note: Statistics of Lishui Town Community Health Service Center Office from 2017 to 2020

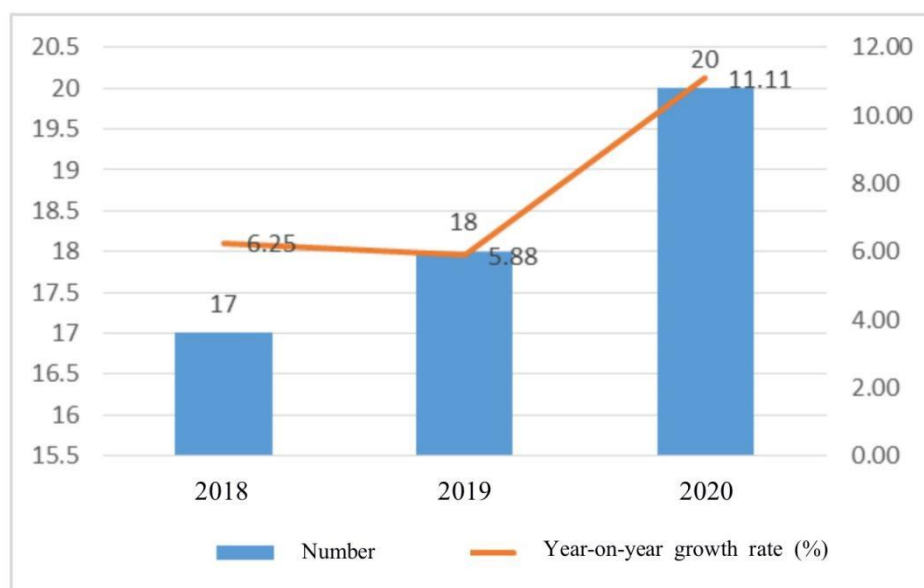


Figure b.4 Status of the community health service centers established

Note: Statistics of Nanhai District Health Bureau from 2017 to 2020

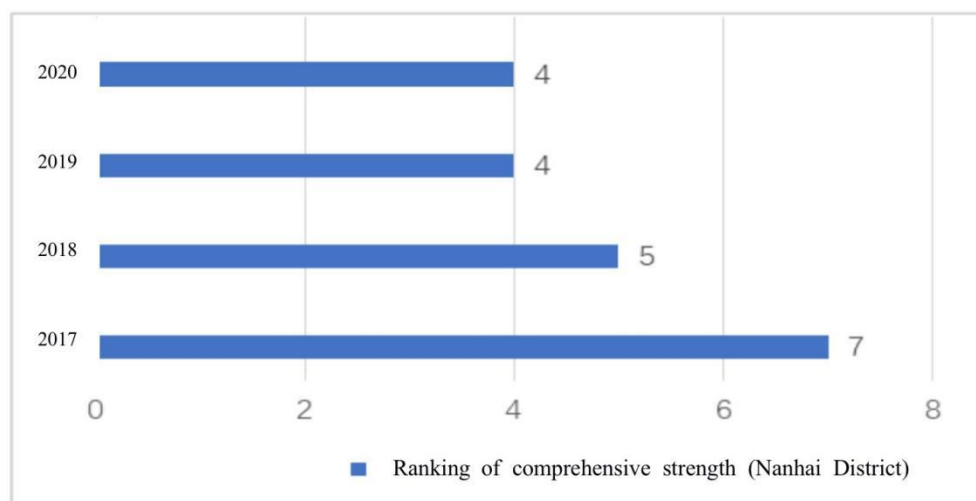


Figure b.5 Ranking of the comprehensive strength of the hospital

Note: Statistics of Lishui Town Community Health Service Center Office from 2017 to 2020

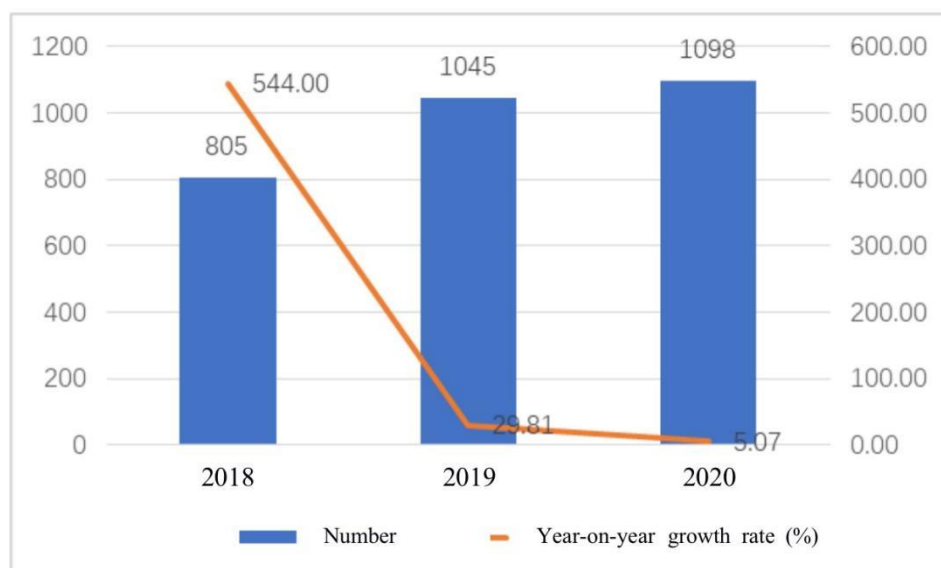


Figure b.6 Status of referrals from community health service centers

Note: Statistics of Lishui Town Community Health Service Center Office from 2017 to 2020

Annex C: Interview Forms of Medical Alliance

Interviewees	Surgeon, tertiary care hospital
Interview Location	Department Office
Interview time	
Interviewer	
Interview Content	
Question 1: Your basic personal information and professional expertise	
Basic information: Graduated from a key medical university with a PhD and worked in a gastroenterology department in a tertiary hospital in a big city, accumulating rich clinical experience, and joined the Seventh Affiliated Hospital of SMU in 2019. Specialties: specializes in endoscopic minimally invasive diagnosis and treatment of early gastrointestinal tumors and clinical management of fatty liver. He is proficient in the operation of ESD, ERCP, EUS and other endoscopic.	
Question 2: Work carried out (after the formation of the medical community) and highlights	
The university-hospital-community linkage has laid a good foundation for the gastroenterology early cancer screening program. On the one hand, it provides strong technical support for the gastroenterology department through the support of the university's science, education and research and other affiliated hospitals; on the other hand, through the linkage with the community, it is more convenient to carry out activities such as volunteer consultation and screening at the grassroots level. Through the "Nanhai model" of early gastric cancer screening explored by the Seventh Affiliated Hospital of Southern Medical University in Lishui Town, Nanhai District, Foshan City, based on the platform of general medicine + medical community and the "Li's" gastric function score, the "Nanhai model" has been applied in five demonstration villages (communities). On the one hand, it conducts epidemiological research in the community, and on the other hand, it solves the problems faced by primary care units in carrying out early gastric cancer screening, such as low prevalence of screening, low endoscopic response rate and detection rate, high lost visit rate, and low participation and compliance of general practitioners.	
Issue 3: Access and enhancement	
On the one hand, we continue to improve our personal expertise, and on the other hand, we gain a sense of accomplishment by further improving cancer screening, early diagnosis and treatment, and standardized treatment in the grassroots community of Lishui, curbing cancer morbidity and mortality, reducing patients' disease burden, and improving the health of residents in the region.	
Issue 4: Difficulties and challenges	
Residents are not sufficiently health conscious and do not recognize the great significance of early	

disease screening. There is a certain resistance to blood sampling and testing, etc. and insufficient motivation.

Interviewees	General Practitioner at Social Health Station
Interview Location	Social Health Station Doctor's Office
Interview time	
Interviewer	
Interview Content	
Question 1: Your basic personal information and professional expertise	
Basic situation: graduated from a medical school with a bachelor's degree, worked in a second-rate hospital in his home county after graduation, and then transferred to a grassroots community health service center to work due to many shifts and ill health. Speciality: diagnosis and treatment of common and multiple diseases of the population.	
Question 2: Work carried out (after the formation of the medical community) and highlights	
After the Southern Medical University and Nanhai District Government and Lishui Town Government opened the school-government cooperation and built Lishui Town close medical association, the two sides established a relatively smooth two-way referral mechanism. The hospital can provide remote ECG diagnosis and other services for the social health site to improve the level of individual diagnosis and treatment work, at the same time, when encountering patients with acute and critical illnesses, the hospital can be contacted to send an ambulance for timely referral to save patients to the maximum extent, while also reducing the risk of treatment by primary care doctors.	
Issue 3: Access and enhancement	
With the establishment of a close medical community, individuals can get more opportunities for study and further training through the platform of the hospital, get in touch with more high-level experts and learn the most cutting-edge medical knowledge, which will greatly promote the development of their professional level. They can also cooperate with relevant experts and carry out research on topics that can be of great help to the promotion of their titles, etc.	
Issue 4: Difficulties and challenges	
Part of the system is not perfect, the grassroots sites are understaffed, and study rotations to higher-level hospitals lead to insufficient site staff. Experts from higher-level hospitals sit at the grassroots level and so on are not fixed, making it difficult to form a greater impact and	

limited in their role.

Interviewees	Medical alliance staff
Interview Location	Meeting Room
Interview time	
Interviewer	
Interview Content	
Question 1: Your basic personal information and professional expertise	
Basic situation: Graduated from a medical school with a clinical major, and after graduation, he was engaged in teaching in the hospital affiliated to the school, then transferred to the Seventh Affiliated Hospital of Southern Medical University to engage in research and teaching, and now transferred to the management of the Medical Community. Professional specialization: Administration.	
Question 2: Work carried out (after the formation of the medical community) and highlights	
After the establishment of a tightly-knit medical community through university-government cooperation, a graded diagnosis and treatment pattern of "primary care, two-way referral, acute and slow treatment, and upward and downward linkage" has been gradually established between the leading hospital and the basic social health center. Through the construction of "five unified" medical community, it effectively promotes the sinking of high-quality medical resources and enhances the capability of primary medical services.	
Issue 3: Access and enhancement	
In the process of construction of medical community, individuals have to effectively study the national, provincial and municipal medical community construction programs, further grasp the national medical reform and medical community construction development direction, understand the construction of medical community in different regions, and improve their own policy learning and research ability. At the same time, the communication and coordination with different departments such as hospitals, social health centers, government departments at all levels, and grassroots community village committees further improved their own communication and coordination skills.	
Issue 4: Difficulties and challenges	
There are difficulties on the one hand in the policy mechanism, such as health insurance payment mechanism reform, the region and even the city to take the lead in promoting, it is	

difficult to carry out effectively at the level of the Medical Community; on the other hand, it is difficult to change the habits of the masses to seek medical care overnight, distrust of primary health care institutions, major and minor diseases are treated in large hospitals, which is not conducive to the construction of hierarchical diagnosis and treatment pattern.

Interviewees	Surgeon
Interview Location	Department Doctor's Office
Interview time	
Interviewer	
Interview Content	
Question 1: Your basic personal information and professional expertise	
Basic situation: Graduated from a medical school with a master's degree, worked in a hospital affiliated to a mainland university after graduation, then sought job opportunities in coastal areas and transferred to the Seventh Affiliated Hospital of Southern Medical University. Specialties: Long-term clinical and research work on osteoarthritis, with unique insights into the diagnosis and treatment of osteoarthritis. He is skilled in periarticular fracture revision and fixation, hip and knee joint replacement, arthroscopic anterior and posterior cruciate ligament reconstruction, meniscus injury and common bone tumor surgical treatment and other orthopedic surgeries.	
Question 2: Work carried out (after the formation of the medical community) and highlights	
The orthopedics department of the hospital is a key specialty at the municipal level, and has a profound foundation in specialty development and talent construction. After the university-government cooperation, the hospital has strengthened cooperation with the university-affiliated orthopedic specialty hospital to further improve the overall level of orthopedics, invited provincial-level or above experts to sit for a long time, and carried out various difficult and major surgeries under the collaboration of experts. Through the construction of medical association, the hospital will strengthen cooperation with communities, schools and enterprises to establish a green channel for emergency trauma and further broaden the development channels of the department.	
Issue 3: Access and enhancement	
After the school-government cooperation, individuals can rely on a larger development platform to effectively improve professional and technical level, scientific research and	

academic level, etc. Through two-way referral, remote consultation, remote film reading, regional electrocardiography, testing and other cooperation within the medical association, can effectively drive the primary medical and health services to improve the capacity, and gradually realize the integration of the leading hospital, grassroots social health center medical treatment, vertical integration of medical resources in the region, and gradually realize that patients do not leave the village to treat minor diseases, and do not leave the town to treat major disease.

Issue 4: Difficulties and challenges

Compared to Guangzhou and Foshan large tertiary hospitals, the hospital itself is not well-known enough, coupled with Lishui is located at the junction of Guangzhou and Foshan, convenient transportation, resulting in the outflow of patients, the region to improve access to there are certain difficulties.