



# The effect of the integrated delivery system in rural areas of China

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**Background:** With the continuous development of modern society, the management of chronic diseases has become the focus of the medical community in China. In particular, diabetes is a chronic disease that cannot be ignored. China has built an integrated delivery system to deal with imminent health problems. The purpose of this study is to investigate the effects of integrated rural supply system in China.

**Methods:** We selected 1,061 patients with diabetes from the Zhili Town Health Center's hospital information system. We tracked and studied their outpatient and inpatient expenses, treatment behaviors, incidence of complications, and satisfaction over 5 years. We compared the data collected from 2014 to 2019 to determine the trends of these four factors and the effects of the integrated delivery system for patients with diabetes.

**Results:** We found that the average costs for diabetes patients in outpatient and inpatient departments were increasing slightly every year. The number of patients in tertiary hospitals has decreased significantly, while the number of patients in community hospitals (primary hospitals) has increased, and the number of patients in secondary hospitals has remained relatively unchanged. Meanwhile, the expenses per visit were also lower over this period in hospitals at all levels. Diabetes complications have been increasing marginally, and there is a relatively high degree of satisfaction among patients and doctors in primary hospitals, which is rising.

**Conclusions:** Considering the various needs of people in different stages of life, the integrated delivery system provides and manages continuous services such as health promotion, disease prevention, diagnosis, treatment, rehabilitation, and management through cooperation between institutions at different levels of the health system.

**Keywords:** Integrated delivery system; chronic diseases; diabetes

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## Introduction

Over the past 35 years, the number of diabetes patients has quadrupled, making diabetes the seventh leading cause of disability in the world (1). The overall prevalence of diabetes in adults is 9.1%, which means that approximately 415 million adults worldwide suffer from this disease (2). Diabetes has always been a persistent and common chronic disease, especially with the improvement of our national

economic level and quality of life. China's diabetes related medical expenses have soared from 2.2 billion yuan in 1993 to 200 billion yuan in 2007, and are expected to exceed 360 billion yuan by 2030 (3).

It is generally believed that in order to effectively deal with the most urgent challenges in the medical system, such as the aging population, the increase in chronic diseases, the increasing expenditure, and the lack of medical services in rural areas, it is necessary to integrate medical

services across all sectors (4). The aim of the people-oriented integrated medical and health service system is to develop complete system, clear division of labor, encourage close cooperation, provide high-quality medical service system, and offers continuously improving service quality and operational efficiency. This individual-centric and population-based service is the guiding principle of health service integration, and different integration dimensions play an indispensable role in the various levels of this system (5). This is an important change and development direction of the health system architecture, and is critically important for sustainable development and the promotion of comprehensive health coverage.

In 2016, the World Health Organization proposed the basic framework of an integrated health service as a global health strategy to achieve sustainable development goals. Integrated health service is a system that enables people to access disease prevention and continuous health promotion services, as well as diagnosis, treatment, disease management, rehabilitation, and palliative care services. It coordinates between the different levels of the health system and nursing locations both inside and outside of the health sector according to their needs (6). Primary health care is the foundation of the integrated delivery system. Only when the integrated medical and health service system focuses to the important role of primary health care, that is, the continuity of services and information, the needs of most non-emergency clinical services, and the promotion of integrated services, can better health outcomes be achieved at a lower cost.

In 2015, it was reported that the selection of the health service integration strategy should be based on the background and objectives of the health system, and fully consider the local background, as well as the value orientation and preferences (7). Most research regarding international health service integration is based on the health systems in developed countries. However, the integration model and specific strategies are not necessarily suitable for China's health system, and in particular, for China's rural health system. In 2016, the World Health Organization, the World Bank, and the Chinese government jointly published a report entitled "Deepening Health Reform in China". According to the report, China's healthcare should be strengthened through a hierarchical medical service system in accordance with the people-oriented integrated care model (8).

China has been actively promoting the establishment of a people-oriented integrated health delivery service

system to meet the dual challenge of chronic diseases and an aging population, as well as broader public health needs. However, there are difficulties at the grass-roots level in expanding the reforms of the medical system; at the same time, the grass-roots present unique opportunities and may be the key to the success and vitality of these healthcare reforms. The establishment of county medical communities is an important exploration and potential breakthrough to solve the problems of China's basic medical system. China is exploring the establishment of a value-based and results-oriented service system to improve the accessibility of health services, especially the capabilities of grass-roots services, in order to improve the health status of more people. The introduction of the Luohu model has put forward an example for the formation of a people-oriented comprehensive medical service system in Chinese cities. Evidence has shown that the integrated delivery system employs a comprehensive strategy to strengthen the coordination of primary healthcare and nursing, improve the quality and efficiency of healthcare services, and promote the health of the population (9,10). Thereafter, more and more new medical teams have begun to coordinate the needs of medicine and patients in China.

This study evaluates the integrated delivery system's power to control and manage diabetes in rural areas of China by analyzing the actual compensation ratio, medical expenses, healthcare-seeking behaviors, and the degree of satisfaction of both doctors and patients in primary hospitals. We present the following article in accordance with the MDAR checklist (available at <http://dx.doi.org/10.21037/apm-20-2490>).

## Methods

### *Zbili model*

### Background

Huzhou No. 1 People's Hospital Medical and Healthcare Group was established in March 2019, led by the Huzhou No. 1 People's Hospital. Its member units include the Wuxing District People's Hospital and 22 health stations, thereby realizing the integration of first-line direct connection with coverage of the whole area and continuous service at the city, district and township levels of the integrated medical service system. Specifically, a "1 + 1 + 1" three-level urban medical community mode was developed, and included one municipal general hospital, one district general hospital, and one township health center

(comprising 22 stations). The township health centers (community health service centers) and village clinics (community health service stations) affiliated to Wuxing district are under the unified management of the group, forming an integrated management mode of city, district, township (street), and village (community). We should rationally plan and establish grass-roots medical and health institutions, implement the standardized construction of basic medical and health institutions, promote the equalization of basic public health services, and improve the fairness and accessibility of public health services. We have established an open and shared center for imaging, electrocardiography (ECG), pathological diagnosis, medical inspection, and disinfection. The common inspection items can be implemented at the grass-roots level and carried out in the form of higher-level diagnosis. Under the premise of ensuring medical safety, the examination results are mutually recognized. The outpatient, inpatient, and inspection resources of leading hospitals and district hospitals are open to medical institutions within the group. Patients can make appointments for registration and inspection at higher-level hospitals at the grassroots level. The inspection and diagnosis reports are transmitted to the primary medical and health institutions in real time, so as to facilitate medical treatment for the masses.

### *Organizational structure*

#### **Study design**

##### *Objectives*

On the 1<sup>st</sup> January 2014, 1,061 patients with diabetes were identified in the Zhili Town Health Center's hospital information system. Patients were eligible for inclusion based on the following criteria: (I) diagnosed with diabetes mellitus according to China's guidelines for the Prevention and Treatment of Type II Diabetes (2017 Edition) (11); (II) patients definitively diagnosed with type 2 diabetes mellitus by a doctor, and had received a medication course of 3 months or more and continuous use of medications for more than 1 month; (III) fasting blood glucose  $\geq 7.0$  mmol/L and/or 2-hour postprandial blood glucose  $\geq 11.1$  mmol/L; (IV) simple diabetes mellitus without complications; (V) aged between 30 and 75 years old; and (VI) willing to participate in the study, with strong compliance, cognition, and acceptance ability. Patients were excluded from this study based on the following criteria: (I) those with diabetes complications; (II) patients with other serious diseases, such

as advanced cancer and autoimmune deficiency syndrome (AIDS); (III) pregnant women, psychiatric patients, etc.; and (IV) patients that do not meet any of the inclusion criteria.

All procedures performed in this study involving human participants were in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by Zhili Health Center (No. 2019-02) and informed consent was taken from all the patients.

### *Data sources*

The hospital information system of the Zhili Town Health Center investigated and recorded the identification number of the research subject, and extracted the medical treatment data from 1<sup>st</sup> January 2014 to 31<sup>st</sup> December 2019 via the Huzhou Medical Security Bureau database (12). This included baseline information such as age, gender, medical insurance type, the insured unit of all the research subjects, as well as all the outpatient and inpatient information from 4 years of medical records, including hospital information, hospital level, and the successive medical expenses. The financing level information was obtained from relevant documents via the Huzhou Human Resources and Social Security Bureau (13) and the Huzhou Finance Bureau (14).

### *Statistical analysis*

After obtaining the data, we performed statistical analysis using SPSS 22.0. Since the cost distribution was not normal, an intermediate value "m" (interquartile interval "q") was used to describe the cost.

## **Results**

### *General information*

In 2014, there were 99,982 residents under the jurisdiction of the Zhili Town Health Center in Wuxing District, Huzhou, China, and 1,061 of them were selected as the subjects for this follow-up cohort study. There were no differences in race, ethnicity, or type of insurance in the cohort. Of the 1,061 patients with diabetes, 456 (42.98%) were male and 605 (57.02%) were female; the ratio between males and females included in this study was balanced. The average course of disease in these patients was  $6.65 \pm 2.53$  years. The average age of the participants was  $56.83 \pm 10.74$  years. In the research period, one person died in 2015, one in 2016, one in 2017, two in 2018, and one in 2019.

**Table 1** Financing standard and outpatient reimbursement ratio of medical insurance for urban and rural residents in Huzhou City from 2014 to 2019 (¥/year)

Year	Financing level (¥)		Outpatient reimbursement ratio (%)		
	Personal	Government grant	Primary	Secondary	Tertiary
2014	230	485	55	30	20
2015	290	590	55	30	20
2016	290	590	55	30	20
2017	350	710	55	30	20
2018	450	940	55	30	20
2019	458	942	55	30	20

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### *Reimbursement ratio of different medical institutions*

Table 1 (15) shows the financing standard of basic medical insurance for urban and rural residents in Huzhou City from 2014 to 2019. The level of personal financing and public subsidies was improved every year. The reimbursement of basic medical insurance for urban and rural residents in public institutions remained essentially unchanged, with 55% for basic hospitals, 30% for secondary hospitals, and 20% for tertiary hospitals.

### *Medical expenses for patients with diabetes in outpatient departments*

The average total expenses, including inspection costs, drug costs, and other indirect costs (transportation, loss of wages, eating, etc.), are shown in Table 2. In this research, we only focused on the inspection and drug costs, which account for a large portion of the patients' entire expenditure. As for the outpatient department, diabetics faced increasing expenses for both inspection and drugs, which accounted for larger proportions compared to inspection. According to the comparison of the per capita expenses of drugs and inspection at different hospital levels, the gap between primary hospitals and tertiary hospitals in terms of traditional Chinese medicine was smaller compared to Western medicine. In recent years, the per capita cost of traditional Chinese medicine has increased significantly, especially in primary and secondary hospitals. This is mainly attributable to the good publicity and curative effect of traditional Chinese medicine, which has been gradually recognized by the majority of patients. The

biggest difference in expenses was the inspection costs. In 2019, the average inspection costs of patients with diabetes mellitus in tertiary hospitals was 32 times that of first-class hospitals, compared with 23 times in 2014. As for the actual reimbursement ratio, it rose in the outpatient department from 2014 to 2019, which reflects the effectiveness of our integrated delivery system in reducing the financial burden on patients.

### *Medical expenses for patients with diabetes in inpatient departments*

As for the expenses in inpatient departments, only tertiary hospitals provide inpatient services. From 2017 to 2019, the costs of hospitalization for diabetics decreased due to the effectiveness and practicability of the integrated delivery system (Table 3). In addition, the actual reimbursement ratio rose, which also reinforced the validity of our group.

### *Healthcare behaviors and numbers of visits*

Generally, the number of people who chose primary and tertiary hospitals increased every year, and the number of people who chose secondary hospitals decreased marginally, which was mainly related to the gradual recognition of grass-roots hospitals by the people, with an increasing number of patients with minor diseases choosing to visit grass-roots hospitals. At the same time, patients still believed in the experts at tertiary hospitals and chose to visit these hospitals. The integrated delivery system is hugely important in relieving the patient pressure in tertiary

**Table 2** Outpatient expenses and reimbursement rate of hospital at all levels in 2014–2019

Year	Institutions	Average drug expense				Average inspection expense	Growth rate of inspection expense (%)	Total expense	Year-on-year growth rate (%)	Actual reimbursement ratio (%)
		Traditional Chinese medicine	Western medicine	Total average drug expense	Growth rate of drug expense (%)					
2014	Primary	140.18	289.46	429.64	–	226.73	–	2,149.13	–	36.83
	Secondary	119.32	784.69	904.01	–	335.03	–			
	Tertiary	156.93	1,512.91	1,669.84	–	2,568.91	–			
2015	Primary	148.45	469.79	618.25	43.90	326.26	43.90	2,488.88	15.81	38.15
	Secondary	134.10	980.56	1,114.66	23.30	484.59	44.64			
	Tertiary	211.65	1,668.17	1,879.82	12.57	2,754.48	7.22			
2016	Primary	157.75	655.50	813.26	31.54	202.17	–38.03	3,002.95	20.65	41.07
	Secondary	156.58	1,300.41	1,456.99	30.71	772.88	59.49			
	Tertiary	292.14	1,734.55	2,026.70	7.81	2,811.53	2.07			
2017	Primary	135.10	775.15	910.25	11.93	373.18	84.59	3,372.25	12.30	41.06
	Secondary	174.47	1,520.24	1,694.71	16.32	1,312.26	69.79			
	Tertiary	342.14	2,620.19	2,962.34	46.17	4,072.89	44.86			
2018	Primary	175.38	1,131.53	1,306.90	13.58	128.54	–65.55	3,799.14	12.66	42.96
	Secondary	224.13	1,388.69	1,612.82	–4.83	1,445.25	10.13			
	Tertiary	320.23	2,436.63	2,756.86	–6.94	4,339.31	6.54			
2019	Primary	203.85	1,417.82	1,621.67	24.08	142.16	10.59	3,917.32	3.11	44.18
	Secondary	251.97	1,259.21	1,511.18	–6.30	1,502.58	3.97			
	Tertiary	311.72	2,198.63	2,510.35	–8.94	4,578.46	5.51			

**Table 3** Hospitalization expense and reimbursement rate of tertiary hospital in 2014–2019

Year	2014	2015	2016	2017	2018	2019
Average expense	9,814.58	10,931.33	13,658.04	16,189.50	15,673.96	15,934.59
Actual reimbursement ratio (%)	45.13	46.97	48.98	53.01	54.61	55.25
Year-on-year growth rate (%)	–	11.38	24.94	18.53	–3.18	1.66

hospitals and improving the construction and service of primary healthcare (*Table 4*).

### Complications of diabetes

The blood glucose standard [haemoglobin A1c (HbA1c) <7.0%] was based on the relevant standard in China's Guidelines for the Prevention and Treatment of Type II Diabetes (2017 Edition) (7) issued by the Diabetes Society

of the Chinese Medical Association (CDS). The rate of blood glucose reaching this standard was calculated according to the following equation: the number of patients whose HbA1c <7.0%/total number of patients × 100%. As shown in *Table 5*, the rate of blood glucose reaching the aforementioned standard rose from 45.33% to 59.14% between 2014 and 2019, and the rate of growth has also increased. This has demonstrated the positive effect of our integrated delivery system in controlling blood glucose and

**Table 4** Visit to hospital at all level in 2014–2019

	2014	2015	2016	2017	2018	2019
Primary	736	821	825	880	934	972
Secondary	713	739	698	723	701	719
Tertiary	441	478	512	515	553	571

**Table 5** Control rate of blood glucose and complication of diabetes for patients in 2014–2019

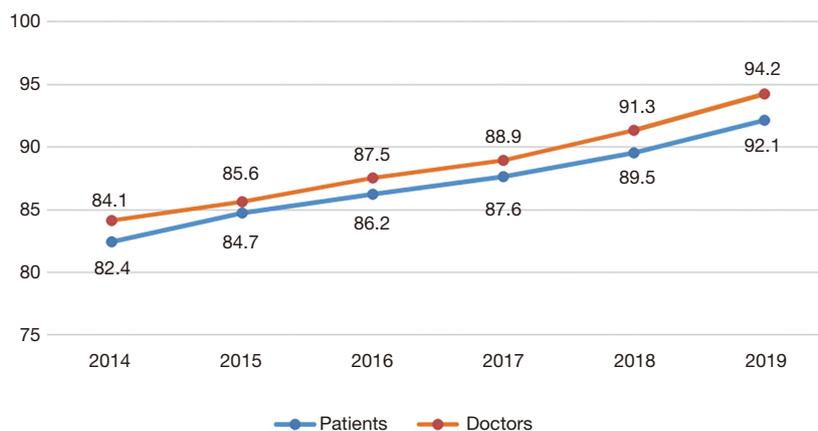
	2014	2015	2016	2017	2018	2019
The rate of blood glucose reaching standard (%)	45.33	45.96	49.61	53.28	56.83	59.14
Complications of diabetes	381	391	398	404	409	413
Hyperlipidemia	299	314	327	341	354	368
Diabetic nephropathy	279	293	304	319	331	341
Lower extremity angiopathy	217	225	229	235	238	243
Cerebrovascular disease	203	209	214	221	227	232
Coronary heart disease	59	63	66	71	73	76
Diabetic foot	6	8	11	12	12	13
Rate of complications (%)	43.00	48.00	54.00	58.00	60.00	63.00

diabetes. Hyperlipidemia is the most common complication of diabetes, affecting more than 35% of diabetics. Diabetic nephropathy and diabetic peripheral neuropathy were the second and third most common diabetic complications, respectively, and similarly to hyperlipidemia, their incidence increased as the course of the disease increased. In fact, all of the complications exhibited an increasing incidence with the increased course of disease, especially diabetic nephropathy and diabetic peripheral neuropathy. Diabetics were also at an increased likelihood of suffering from lower extremity angiopathy and cerebrovascular disease. Diabetic foot was found to be a rare complication for diabetic patients. From 2014 to 2019, the rate of complications increased from 43% to 63%, however the growth rate slowed during this period. This further demonstrates the significant impact of Huzhou First People's Hospital medical care group, which established on the basis of the integrated delivery system, on preventing and controlling diabetes complications.

### *Patients' satisfaction*

We sent questionnaires to patients and doctors to directly understand how they felt about the integrated delivery system, and analyzed their responses. In our platform,

we aimed to not only to optimize the effectiveness of the entire system, but also to improve the medical security of the community health service center. Therefore, the ideas and suggestions of patients and doctors in community centers formed a part our evaluation criteria. Participant satisfaction was defined as the degree to which they were satisfied with their experience in the hospital (16). We sent 1,000 questionnaires to patients, and 300 questionnaires to doctors in primary hospitals (*Figure 1, Appendix 1*). We asked 20 questions in each questionnaire, and received responses from 731 patients and 194 doctors. Each question was assigned five points, up to a total of 100. In order to determine the effect of the integrated delivery system, we asked patients about the environment and facilities of our hospital, the service attitude of the medical staff, the process of diagnosis and treatment, the expenses, and the results after treatment. For doctors, we focused on the relationships with supervisors, colleagues, and other medical staff across different-level hospitals. Following establishment of the integrated delivery system and the medical and healthcare group management center, the average satisfaction of both patients and doctors in primary hospitals was higher. Based on the results of the questionnaire, our group has shown an initial achievement, with high levels of patient and doctor



**Figure 1** Satisfaction of patients and doctors in primary hospital.

satisfaction in primary hospitals.

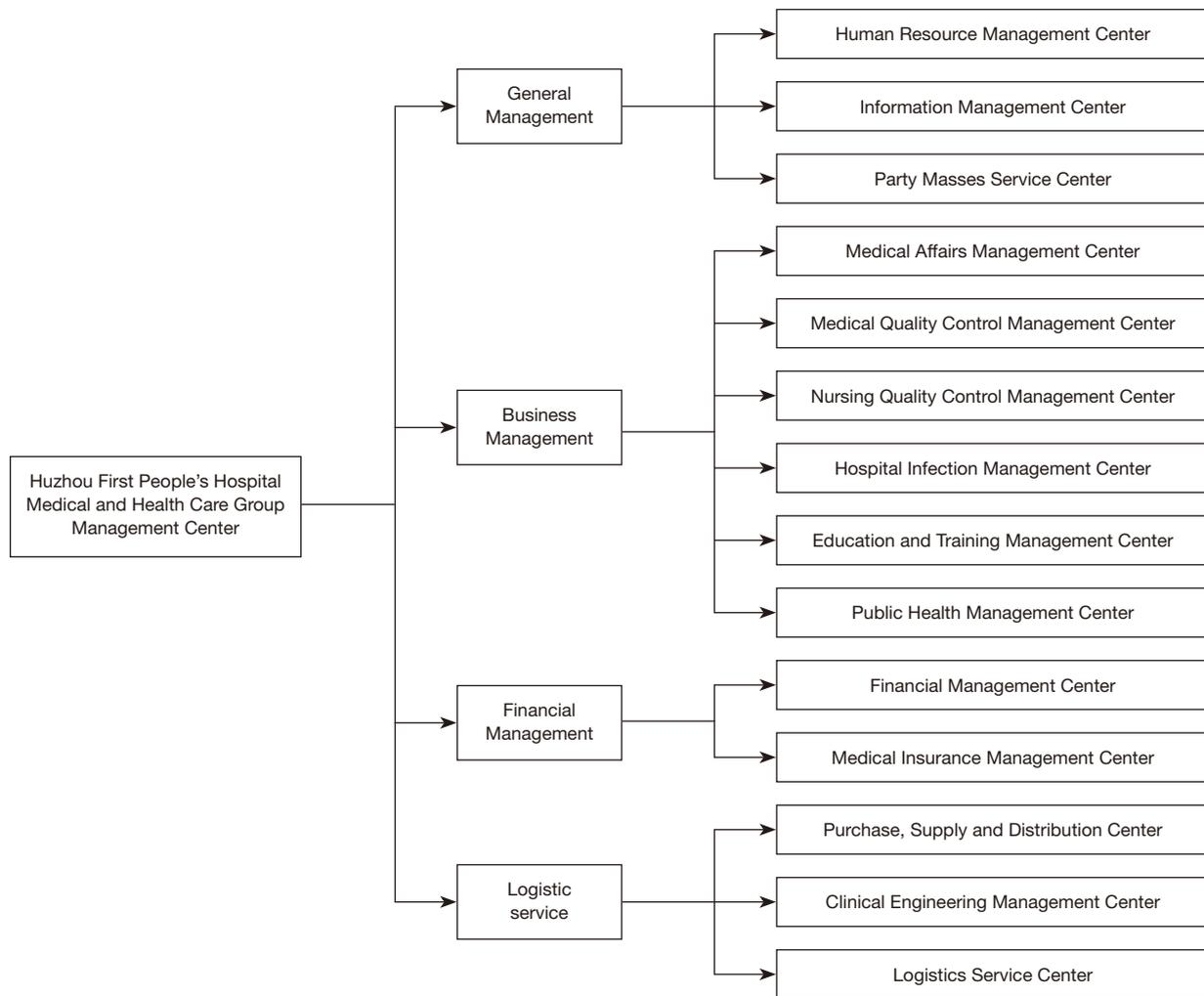
## Discussion

At present, China's aging population is growing, as is the number of common and chronic diseases, which has led to an increased demand for basic level resources. This necessitates an integrated and continuous medical services system. The increasing trend of chronic diseases has been extended to all aspects of China's social and economic environment. In the future, the economically active labor force will ultimately be responsible for more than half of the burden of chronic diseases, which will greatly weaken the quality of human capital (17). Diabetes is a chronic disease that requires continuous medical care as well as patient self-management training and support to prevent acute complications and reduce the risk of long-term complications (18). Evidence shows that diabetes is associated with substantial additional health service use and costs, with hospital admissions accounting for more than two-thirds of the cost burden (19). In view of the COVID-19 outbreak in 2020, the prevalence of diabetes may further increase, which will result in a huge burden to the healthcare system (20).

The Huzhou First People's Hospital medical and healthcare group was established on the basis of the integrated delivery system, and combines the medical institutions of the city, county, and township together (Figure 2). This article aimed to evaluate the work of our group and the effectiveness of the integrated delivery system.

For the outpatient department, the results indicate that the per capita expenses decreased in comparison with the

previous year. Also, the declining rate of drug inspection in 2018 is more obvious than before. Owing to the policy of controlling the drug ratio and other policies, the per capita cost of Western Medicine and Chinese patent medicine in secondary and tertiary hospitals began to decline. Meanwhile, the cost of examination and treatment in primary hospitals decreased significantly, which may be in line with the acceptance of patients with chronic diseases after diagnosis and treatment. At the same time, by signing a contract with a family doctor, patients can receive free blood pressure testing, blood sugar testing, and free physical examinations, which greatly reduces the examination expenses of patients in primary hospitals. From this point of view, the medical expenses of patients from our group have increased reasonably, and basically achieved the goal of benign operation of medical institutions, sustainable development of medical insurance funds, and no increase in the overall burden of patients. The increasing actual reimbursement ratio clearly demonstrates the positive effect of the integrated delivery system in reducing the burden of patients with diabetes. The inpatient department also exhibited similar results, with steadily increasing expenses and compensation ratios. On the other hand, the costs of inspection in tertiary hospitals were significantly higher than those in primary hospitals. In addition to the impact caused by a large number of examinations in tertiary hospitals, the primary hospitals are only equipped with simple auxiliary examination methods such as routine blood test, ECG, and B-ultrasound, and the lack of auxiliary examination equipment present in outpatient departments, which is another confounding factor. It is therefore necessary to take measures to convince patients about the proficiency of



**Figure 2** Huzhou First People's Hospital Medical and Health Care Group Management Center.

medical staff in primary hospitals.

Also, the number of visits to tertiary hospitals has slightly increased, while those in primary hospitals have significantly increased from 2014. This signifies that the dependence of diabetic patients on tertiary hospitals is reducing and their trust in community health centers is increasing, which demonstrates that the integrated medical service system can relieve the pressure on tertiary hospitals and improve the quality of medical services. The secondary hospital is the intermediary connecting first- and third-level hospitals. They are responsible for the establishment of patient files, timely understanding of the patient's situation, matching the patient to the appropriate hospital, and supervising medical staff. Thus, the visits and costs in secondary hospitals can tend to be more stable than other hospitals.

The rate of blood glucose reaching the above standard has been steadily rising from 2014, which demonstrates the positive effect of controlling and treating diabetes. The complications listed in *Table 5* are common complications in diabetes. Among the participants, hyperlipidemia was the most common complication, followed by diabetic nephropathy and diabetic peripheral neuropathy. All of the complications listed in the table had exhibited a marginal increase, and thus, we conclude that the integrated delivery system had a good effect on controlling the occurrence of diabetes complications. Lower extremity angiopathy, cerebrovascular disease, and coronary heart disease did not increase significantly, as they are significantly affected by age.

We also investigated the degree of satisfaction among patients and doctors in primary hospitals. Patient

satisfaction with diabetes care is not only affected by the interaction between patients and medical staff or their views on medical facilities, but also by various treatment options, the participation of patients in their own disease management, satisfaction with drug and information requirements, and the availability of doctors (21). These results demonstrate that the integrated delivery system has a positive effect on increasing the satisfaction of patients in primary hospitals and improving the job satisfaction of doctors.

The integrated medical service system can improve the overall efficiency of medical services, provide residents with complete, continuous, economical, and high-quality healthcare services, and ensure the health of residents in an all-round and full cycle state. Developing the capacity of primary health services is crucial in improving the primary medical service system. The limited service ability is the primary reason for the low acceptance and trust of residents of primary medical institutions. A clean and tidy medical environment, skilled medical staff, and reliable medical equipment and inspection results are key conditions to improving the guarantee of medical services and enhance the quality of medical services. We should further promote the construction of primary medical institutions, and improve the infrastructure and medical environment through targeted policies. We should also further strengthen the formation of grass-roots health personnel teams, build a talent system focusing on general practitioners, and constantly enhance the appeal of primary medical and health institutions. Moreover, it is important to further strengthen the development of general practice service teams and improve the theoretical quality and professionalism of these teams, thereby ultimately enhancing the success of primary health services.

This study has some limitations that should be noted. Zhili is a small district with a relatively high proportion of the floating population, so it is difficult to collect complete information of all diabetes patients. Also, when calculating the costs, we only used the direct costs, including drug and inspection costs. However there are some indirect costs that we did not include, such as loss of wages, transportation, eating, etc. Moreover, the diabetes complications listed in the *Table 5* are complications that appeared in our hospital, yet are not exhaustive of all complications that may arise. Some complications are not contained in the regular inspection, and thus they are difficult to identify. Precise assessment of hypertension complications requires additional clinical information.

## Conclusions

Our research demonstrates that the implementation and development of an integrated medical and health service system can provide significant benefits to people's health and healthcare, such as reducing the cost of medical treatment, minimizing economic pressure, improving the job satisfaction of health workers, and improving service efficiency. The development of a people-oriented integrated delivery system is essential for the health system to cope with emerging health challenges, including the burden of urbanization, an aging population, multiple chronic diseases, as well as infectious and non-infectious diseases.

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## Footnote

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*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study involving human participants were in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by Zhili Health Center (No. 2019-02) and informed consent was taken from all the patients.

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