

Application of Diabetes medical treatment combination in China

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Abstract:

With the progress of the times and the development of society, opportunities and challenges coexist in contemporary society. As one of the chronic diseases with the highest prevalence rate, diabetes has brought a huge crisis to people's daily life. Under the modern medical system, many difficult problems of diabetes patients seeking medical treatment can be solved through hierarchical diagnosis and treatment, and the pressure of outpatient service can be shared. At the same time, the use of many medical treatment combinations can make diabetes patients no longer need lifelong medication, but can replace "lifelong medication" with "lifelong management" through "diabetes reversal". As a leading country in the treatment and prevention of diabetes using the medical treatment combination model, China has created a unique reverse outpatient model under the concept of traditional Chinese medicine. The purpose of this paper is to explore the role of medical treatment combination in promoting the treatment of diabetes from the perspective of health economy and public management mechanism.

Keywords: Diabetes, Hierarchical diagnosis, Medical treatment combination, reversal clinic.

1. Introduction

Diabetes has become a major social problem in China, which now has the largest number of diabetics in

the world. Although diabetes affects all ages, older people are becoming a growing concern and pose a growing public health challenge. As of 2021, about 140 million people aged 20 to 79 in China have been

diagnosed with diabetes, with a national prevalence of about 12.8 percent.(Xinhuanet.com, 2020) This alarming statistic means that one in eight people have diabetes and there is an urgent need for effective health interventions. Therefore, the aim of this study was to explore community-level healthcare interventions to improve diabetes management, with a particular focus on older adults, and to assess how to access hypoglycemic drugs and potential applications of new technologies such as artificial intelligence.

1.1 Current situation of diabetes status in China

Surprisingly, diabetes is not a recent social, it started to affect people's healthy at least ten years before. In 1990, the overall average who has diabetes reached the 175 thousand, and around 9 thousand people died due to diabetes(Liang, 2023). Up to 2019, the diabetes number pumped up to 550 thousand people in female around age between 55 to 59, and the male died due to diabetes reached 350 thousand at the age of 85 to 89 years. Diabetes could affect health more than people can imagine. In 1990, the rate of death due to diabetes was 204.71% in total, and people who become disability resulted by diabetes around 456.46 in 1990, unfortunately, the number keeps increased to 494.76% in total.

The number of diabetes has kept increasing after 2019, there was a news published in 2023 presented has already over 140 million (Liu, 2023). Compared to type-1 diabetes, type-2 diabetes is much more common in the elderly population. Around 70% of people have type-2 diabetes, while only 10% of the population had type-1 diabetes(Dnurse, 2020). This is because type-2 diabetes is more easily affected by lifestyle, diet and the time of exercise. The age distribution of diabetes above 50 is 27%, the secondary largest number of populations are the age between 30 to 34 years old, which is only 6% lower than the age group above 50. There is still 5% population of young adults around the age of 18 to 24 years old. (Dnurse, 2020)

Location could also become an important factor for diabetes, it can deduce how many people may have the potential risk of diabetes. Through the data in 2022, the place in the Northwest in China has the largest number of people prevalent in diabetes (Liu and Chai, 1AD). The percentage who prevalent it is around 11.1 to 15.3%, which is 9% higher compared to the lowest place. The place which less people who got diabetes are on the southeast and southwest of China, they have the lowest values and outliers.

Diabetes could become a serious common social common problem which affects both living standards and the health not only because of the lifestyle, location and age, the education and knowledge of diabetes is also limited.

Around 77.14% of elderly people have awareness of diabetes, but only 18.8% of them would like to prevalence diabetes. (Yan et al., 2022)This can show clearly how lack of information provided around people, also can see in the most proportion of people do not realize the importance of prevalent diabetes. However, although awareness of diabetes around China is nearly 80%, only a half people be able to control it which is another situation China has facing now. The lack of medicine treatment. In China, lot of people are not able to get the condition to treat diabetes, as the good doctors and medicine are more appeared in the city like Beijing, Shanghai which has higher cost of live and better technology.

Back to the effect that education helps to prevalent diabetes, compared to people's education level in elementary school, there is a 3% increase in the thought of prevalence between 17.7% to 21.4%.(Yan et al., 2022). They also got more people who control diabetes, about 47.36%, 10% higher than people who from elementary school. Furthermore, gender can be another factor affect the diabetes. In 2022, women have a higher value compared to men on all prevalence, awareness and control. The biggest difference is between awareness, woman's average is 12% higher than the awareness of men overall.

From all population who have diabetes above 50 years old, age around 75 to 79 have the highest number of both prevalence and awareness (Yan et al., 2022). About 19.72% people overall prevalence diabetes, nearly 2% higher than the lowest age group from 65 to 69. 77.78% people aware this disease, 0.46% higher than the second largest percentage of people in 70 to 74 years old. On control diabetes, the highest number of people are greater than 80 years old, 43.35%. Age group between 75 to 79 years old is still the second highest large number of people. It is only 2.55% lower than the age group higher than 80 years old.

Overall, type-2 diabetes is more common compared to type-1 diabetes in populations as it can be easily affects by the action and daily routine. The location, age, education and knowledge of diabetes also are important factors which caused the increase of the number of diabetes now day. The trend of future diabetes in China will still went up though the situation recent years, if government can not have solutions to improve this health problem, the situation will get worse. The treatment situation of diabetes is an important and necessary part we need to know to understand, develop and improve health conditions provided for people with diabetes now days.

1.2 Current situation of diabetes status in China

It can be seen that diabetes is becoming a growing public health problem in China, especially in the elderly popula-

tion over the age of 65. In addition to public health, this is a serious economic challenge. According to the annual report of the National Commission of Health (2018, as cited in Luo et al., 2019), the medical management of diabetes alone (excluding a range of complications) accounts for a staggering 8.5% of China's total national health expenditure.

However, one of the most significant challenges in managing diabetes among older adults in China is the low rate of diagnosis and awareness. Despite increasing efforts to promote diabetes screening programs in China over the past two decades, there are still many elderly people, especially those in rural areas, who are unaware of their condition, let alone get an exact diagnosis. This largely delays early intervention and treatment and increases the risk of serious complications such as cardiovascular disease and kidney failure (Luo et al., 2019). According to a national study, only about half of older people with diabetes are aware of their condition (Li et al., 2022), which is much lower than in other countries around the world where diabetes is prevalent, such as Australia, where about 72% of patients are diagnosed (Sainsbury et al., 2020).

The problem is more acute in rural areas, where the medical infrastructure is less developed and regular check-ups are rare. Taking Liaoning Province as an example, the awareness rate of diabetes among the elderly population in rural areas was significantly lower, and there was a significant gender difference in diagnosis rate. In contrast, awareness campaigns in urban centers such as Shenzhen have produced better results, but even there, issues such as limited understanding of diabetes symptoms persist (Shi et al., 2020). In addition, it is important to note that although studies such as the nationally representative cross-sectional survey (Wang et al., 2017) show that the prevalence of diabetes is generally higher in areas with higher average economic status, in rural areas, however, the disease is likely to go undetected due to poor overall health awareness, leading to an underestimation of the prevalence.

Access to medical resources, including outpatient care and essential medicines such as hypoglycemic drugs, is another key challenge in managing diabetes in the elderly. The China Country Assessment Report on Ageing and Health (World Health Organization, 2016) highlights disparities in healthcare service usage between affluent and less affluent elderly populations. This is especially true in the management of chronic diseases in the elderly, wealthier elderly individuals access outpatient services 1.6 times more frequently and inpatient services 3.8 times more frequently than their poorer counterparts. In terms of access to specialist treatment for diabetes, although inadequate regardless of economic status, older people in rural areas are twice as likely as urban residents to forgo long-term

treatment for chronic diseases because of poverty (Zeng et al., 2015)

In addition, the cost and availability of hypoglycemic drugs is another important barrier to the effective management of diabetes. A study of the accessibility of eight anti-diabetic drugs in Shaanxi Province in western China found that the accessibility of essential drugs in public health facilities was about 60-70% (Yang et al., 2019). However, the affordability of drugs varies significantly between patients. For example, the cost of a month's metformin supply is 1.36-2.04 days' salary for urban residents (measured by the minimum wage standard for public servants in Shaanxi Province), but it requires 2.75-4.13 days' income for rural residents, at least more than 10% of the monthly income.

China's medical insurance coverage of diabetes-related treatment has been improving year by year, but there are still significant differences between different regions and insurance types. Basic medical insurance for urban workers (UEBMI) and basic medical insurance for urban and rural residents (URBMI) are the most important types of medical insurance (World Health Organization, 2016). The coverage rate of medical insurance for urban workers is relatively high, and the reimbursement ratio can reach about 80%, especially in big cities. In contrast, the medical insurance coverage in rural areas is low, and although the new Rural Cooperative medical care system (NRCMS) has reduced the burden of rural patients to a certain extent, the reimbursement ratio is still limited and the out-of-pocket costs for diabetics are high (Zhang et al., 2014). A study from Tongxiang City near Shanghai (Wu et al., 2018) showed that in urban basic medical insurance, patients' out-of-pocket expenses accounted for 22.74% and 30.94% of the total inpatient and outpatient expenses, respectively. On the contrary, the out-of-pocket ratio of urban residents with basic medical insurance is higher, with the out-of-pocket ratio of inpatient expenses at 42.38% and outpatient expenses at 48.52%.

On the other hand, the price of diabetes drugs has decreased significantly through national policies such as centralized drug procurement. However, the coverage of high-priced diabetes drugs (such as GLP-1 receptor agonists) is low in the medical insurance for urban and rural residents, while the coverage of these drugs is wider in the medical insurance for urban workers (Lu, 2023). Therefore, patients with diabetes in both rural and urban areas still face greater pressure in terms of the financial burden of long-term treatment.

In conclusion, diabetes presents a significant public health and economic challenge in China, particularly among the elderly population. Despite efforts to improve diagnosis and management, substantial gaps remain, especially in

rural areas where access to healthcare services and essential medications is limited. The financial burden of diabetes treatment continues to be a barrier for many, as differences in insurance coverage and the affordability of medications persist. To address these issues, the key research question is: How can improvements in early diagnosis, healthcare access, and medical insurance coverage reduce the economic and health burden of diabetes among elderly populations in China, particularly in rural areas?

2. Causes for the challenge of diabetes management in China

2.1 High incidence of diabetes in China

In the Chinese context, there is a distinct familial aggregation of diabetes, with genetic elements playing a pivotal role in its etiology. Empirical research indicates that the presence of diabetic individuals within a family, particularly those with type 2 diabetes, markedly elevates the disease risk for other family members. The clinical data reveals that over half of the patients exhibit a family history of diabetes, and the concordance rate for the onset of the disease in monozygotic twins exceeds 90%. Moreover, the incidence of diabetes in individuals with a family history is triple that observed in the general population (Mou et al., 2019).

Consequently, the outcomes of pertinent genome-wide association investigations have elucidated that the genetic predisposition loci for diabetes mellitus vary across diverse ethnic groups. Notably, the rs3765467 locus of the GLP1R gene has been confirmed to be correlated with the susceptibility to T2DM specifically in the Han Chinese population of China (Zheng et al., 2021). All these indicators collectively underscore the heightened vulnerability of the Chinese populace to diabetes, serving as a pivotal determinant in the substantial prevalence of the disease within the country.

In consonance with the incessant evolution and advancement of the era, China has witnessed a marked enhancement in its economic stature, transitioning from a state of mere subsistence in the rigorous clime of the 20th century to an era of relative affluence with adequate sustenance and amenities in the 21st century. Concomitantly, as the standard of living has escalated, the dietary composition of the Chinese populace has experienced substantial metamorphosis. In bygone eras, the primary sources of caloric intake, protein, and fat in the diet were predominantly of plant origin. However, in contemporary times, there is a discernible shift towards an increasing reliance on animal-based sources, accompanied by an excess of total

caloric consumption. It is now common for individuals to indulge in foods that are high in sugar, fat, and calories. This alteration in dietary composition has precipitated a rise in obesity prevalence and has heightened the risk of diabetes.

Furthermore, the heightened pace of urbanization and modernization has catalyzed a shift in the lifestyle patterns of individuals, marked by a notable decrease in everyday physical activities such as walking and cycling, and the advent of sedentary occupations and lifestyles. This diminished engagement in physical activity results in inadequate energy expenditure, thereby exacerbating the incidence of obesity. All these unhealthy lifestyles contribute to the important risk factor for diabetes - obesity, most of which is manifested in the accumulation of abdominal fat, which may cause insulin resistance in the liver and muscle tissue, leading to hyperinsulinemia, and is directly related to the risk of diabetes through various pathways (Tabata et al., 2009).

In recent years, China has faced a serious aging population problem, and the incidence of diabetes has continued to rise. According to the 2023 Statistical Bulletin on Civil Affairs Development, by the end of 2023, the number of people aged 60 or above in China had reached 297 million, accounting for 21.1% of the total population, showing a trend of rapid aging. At the same time, according to data from the International Diabetes Federation (IDF), the number of diabetes patients in China has exceeded 140 million, with a prevalence rate of 12.8%. As people age, their metabolic ability gradually declines, the function of the pancreas weakens, the level of insulin secretion decreases, and the sensitivity of the corresponding receptors also decreases, so the ability to regulate blood sugar also decreases accordingly. According to research, the incidence of diabetes among people over 60 is significantly higher than that of other age groups. The incidence of diabetes among China's population aged 60 or above is close to 20%, far higher than that of the age groups of 40-59 and 20-39. This indicates that as the proportion of the elderly population increases, the number of diabetes patients will also rise.

2.2 Lack of health care equity in diabetes

The healthcare for diabetes management in China is lacking in fairness, with unequal distribution of medical resources between urban and rural areas, and varying efficiency in accessing treatment and medication for residents in different regions. The following two aspects are particularly evident:

The first is the unevenly distribution of high-quality resources. Most of the resources are concentrated in large

medical institutions in developed areas, including human resources, material resources, financial resources, technical resources and information resources(Li, 2021). While the primary medical institutions, which are the first treatment for most diabetes patients, are scarce in terms of various resources.

The second issue concerns drug-related challenges, including the difficulty in procuring certain medications. It is particularly arduous to obtain specialized drugs, as the prescription of insulin and hypoglycemic agents is typically not available at primary-level health and medical facilities. To access these medications, residents must obtain a referral from the community health service center and then visit a higher-level hospital. For economically disadvantaged families, the long-term use of these drugs can impose a significant financial burden.

2.3 Underdeveloped social support framework

Diabetes is an incurable disease, and diabetic patients need to manage themselves for life to control their blood sugar levels. Therefore, a social support system that helps patients manage themselves is very important. The effectiveness of patients' self-management is affected by various shortcomings, such as insufficient popularization of health education leading to information blockage and lack of knowledge. From the relationship between diabetes knowledge and self-management behavior, some studies have found that diabetes knowledge is positively related to patients' self-management behavior(Yao, 2020). Some patients may have difficulty obtaining scientific diabetes management knowledge, which may cause them to be blind and arbitrary in their treatment, affecting the treatment effect. Insufficient family support may lead to a decline in patients' compliance, and a lack of support from the family and society may make patients easily become complacent during treatment, leading to a decline in treatment compliance and poor blood sugar control. An imperfect medical insurance system may limit diabetic patients' utilization of primary medical services, thereby reducing their sense of social support, which is not conducive to their self-management.

2.4 New ideas for treating diabetes in China

In order to alleviate the urgent problems caused by the social background of China and the disadvantages of diabetes itself, the Chinese government has embarked on an unprecedented path and devoted itself to it.

This new program developed by the Chinese government is committed to using the power of hierarchical diagnosis and treatment to radiate more people in diabetes prevention and treatment, and at the same time, it uses the form

of medical treatment combination to develop a new model of diabetes treatment, reduce the prevalence of diabetes in China and improve the level of diabetes treatment.

In order to encourage the promotion of hierarchical diagnosis and treatment and the construction of medical treatment combination, the Chinese government issued a notice (2016) on promoting the pilot of hierarchical diagnosis and treatment, promoting the implementation of hierarchical medical care on a small scale nationwide. In the same year, the Medical Administration Department also issued policies emphasizing the importance of establishing urban-rural medical consortia. Then the Chinese government announced the pilot construction of urban medical consortia (Xue, 2019). On December 29, 2023, the Chinese government announced the comprehensive promotion of the construction of close county-level medical and health communities and provided guidance (Zhu, 2023). For many years, the Chinese government has been committed to leveraging the enormous potential of tiered diagnosis and treatment and medical consortia in the treatment of chronic diseases, and providing policy and financial support to hospitals. Today, in many cities in China, the hierarchical diagnosis and treatment and medical treatment combination model has taken shape, especially in the treatment of diabetes.

In China, the medical treatment combination specializing in the treatment of diabetes is called the reversal clinic, and "reversal" means to "reverse" the dilemma of lifelong medication for diabetic patients into lifelong management. It helps diabetics, especially type 2 diabetics, achieve the goal of controlling blood sugar through the combination of traditional Chinese medicine and western medicine. There are two special cases that show the reversal clinic in China.

One of the reversal clinics is called The Jinshan Community Reversal Clinic which located in Fuzhou, the capital of Fujian Province (Tencent, 2023). The Jinshan Community Reversal Clinic in is the first medical treatment combination located in a community service center that has been reported in China. It is jointly constructed by a large Chinese medicine hospital and Jinshan Community Service Center, and has developed a human capsule instrument combining Chinese medicine diagnosis for diabetes detection. And the biggest feature of this reversal clinic is the "three teacher co management" treatment model, where the chief physician, nutritionist, and traditional Chinese medicine practitioner jointly diagnose and develop a private blood sugar control plan for the patient. It greatly improves the convenience of residents' medical treatment and has significant therapeutic effects.

The other of reversal clinics located in Jiangsu Provincial Hospital of Integrated Traditional Chinese and Western

Medicine, is the earliest known diabetes medical treatment combination in China (Medical, 2024). There are experts and authors, and a continuous stream of patients. Different from Jinshan Reversal Clinic, Nanjing Reversal Clinic did not sink to grass-roots communities or rural areas, but formed an independent department within the hospital to accept diabetic patients with chronic disease. Although this method cannot well reflect the convenience of patients' medical treatment, as the earliest reverse clinic, Nanjing Reverse Clinic still shows its great function of sharing the hospital's diabetes treatment.

At present, the hierarchical diagnosis and treatment system and the medical consortium model are not yet mature, and many deficiencies can still be found from their pilot implementation process. For example, hierarchical diagnosis and treatment require efficient operation methods, the enthusiasm of grassroots medical personnel still needs to be mobilized, and the formation of medical consortia requires strong medical resources and government finances as support. But we can still see its enormous superiority in sharing the enormous pressure of medical treatment in hospitals, improving the convenience of medical treatment for the public, and promoting the health of the lower-class people. With the development of the times and technology, the popularization of medical consortia is imperative, which is a huge dividend for people.

3. Limitation of Medical Treatment Combination

While the policy of Medical Treatment Combination could be promising, there are a few limitations that need to be noted during policy implementation. To begin with, as all hospitals involved in this combination are nationalized and public, the concern of inefficiency in the public market would persist. The reason behind this is that healthcare workers need to spend more time handling affairs brought by more regulations than private hospitals. Moreover, this inefficiency may be exacerbated when hospitals from different backgrounds work together. At the beginning

of the combining process, the problem of lagging policy unity would emerge. Later, not only would it be hard for hospitals to develop a new set of standards, but also health service workers may find it hard to understand those new differences.

Additionally, the appearance of medical treatment combinations may break the traditional hierarchy in healthcare. Hierarchy shapes the delivery of care, what is prioritized, and who receives care (Essex et al., 2023). In other words, patients with more complicated illnesses (e.g. cancer) tend to go to big hospitals in the city and receive proper treatment from doctors with higher expertise. However, after the implementation of the medical treatment combination, healthcare workers with higher expertise are assigned additional tasks. While in this way patients going to smaller hospitals could receive better treatment, patients who need doctors with higher expertise more desperately may need to wait.

Last but not least, when most hospitals in a specific area (e.g. province) work as a unity, the state monopoly appears. This could lead to two main concerns. Firstly, X-inefficiency (as shown by the Figure.1, the actual cost is higher than the potential cost) may arise. One main reason behind this inefficiency is the lack of competition from other hospitals, and the monopolist has no incentives to cut down costs. Although this increasing cost may not directly result in a big increase in healthcare prices as those hospitals are public, additional costs could indirectly result in higher tax rates to cover additional costs. In addition, state monopoly incurs a deadweight loss. As shown by the Figure.2, the state monopoly price would be lower than the traditional profit-maximizing point (point X) as public hospitals are not built to maximize profit, but instead built with the purpose of public welfare. At the same time, the state monopoly price would be a little bit higher than the socially optimal price (point Y) as a result of X-inefficiency. In this sense, the deadweight loss (shown by the red area on Figure.2) persists for medical treatment combinations, though less than the traditional monopoly market.

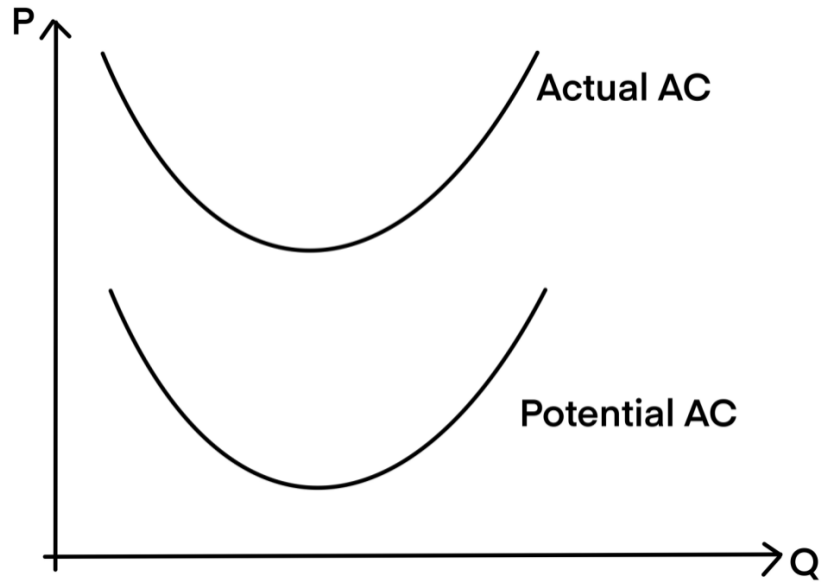


Figure. 1 X-Inefficiency

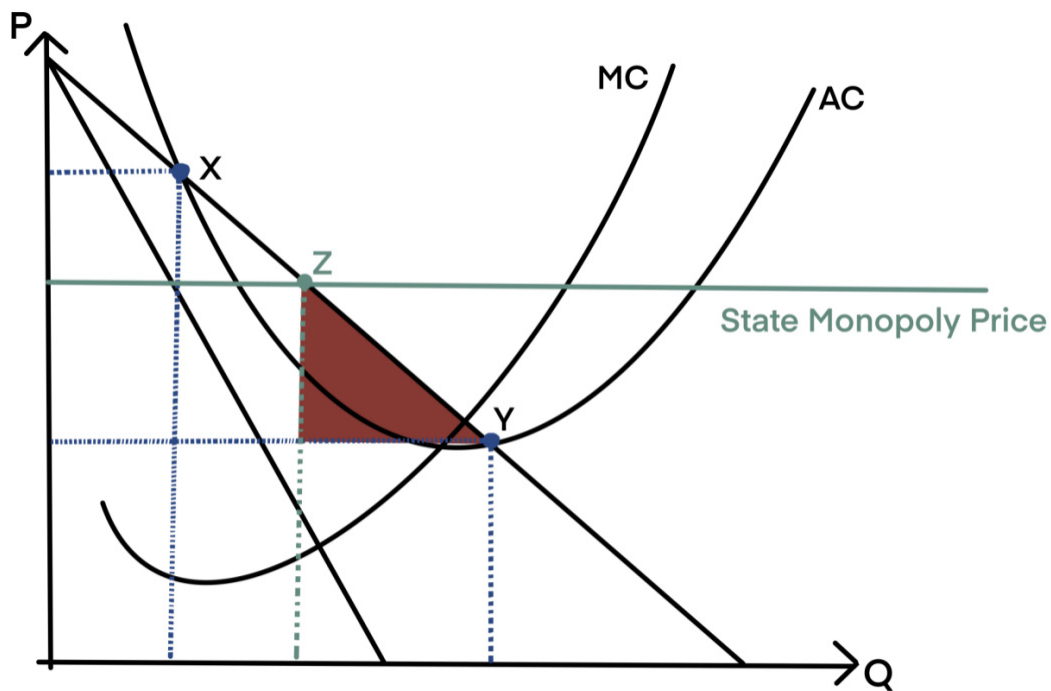


Figure. 2 Point X is profit-maximizing point, Point Z is state monopoly equilibrium point, Point Y is socially optimal point

4. Possible New Solutions

4.1 Telehealth technology

With technology proven to be an effective tool during pandemics, perhaps more attention should be paid to

telehealth technology once again. Numerous studies have shown telehealth technology could be an effective solution. A study focusing on web-based training for diabetes primary healthcare providers in China by Wei et al. (2019), suggests remote training is especially effective for village

doctors than township doctors. As medical treatment combination also focuses on patients from remote rural areas, improving the quality of treatment in rural areas could be potentially better as it addresses the root cause of the problem. At the same time, a study conducted by Ciemins et al. (2018), suggests telehealth technology could be also effective as an auxiliary tool for patients. In this study, the telehealth program helps rural diabetes patients to lose weight. Although two rural groups lose less body weight than the urban group, the body weight rural patients lose is not negligible.

4.2 Medicine Vending Machine

It has been brought to our attention that there have been considerable amounts of patents issued for medicine vending machines in China within the last two years. Some latest updates for intelligent medicine machines include setting up an illness database that applies to different hospitals, building a medicine matching and verification system(State Intellectual Property Office of China, 2023b), constructing a medicine storage and replenishing system(State Intellectual Property Office of China, 2023c), and other inventive systems such as a system to maintain proper humidity(State Intellectual Property Office of China, 2023a). Under the context of diabetes patients, their main difficulty is fetching drugs. Under current policy, diabetes patients need to go to big hospitals(usually in cities) to fetch prescriptions and then the right dose of drugs. In this sense, what diabetes patients truly need is not doctors with higher expertise, but easier access to a sustainable supply of drugs. Thus, once well-established medicine vending machines are put into use in remote areas, the issue of lack of access to medicine should be alleviated.

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the existing solution and proposed alternative approaches, supplementing her analysis with graphs she created herself. Therefore Yuki, Bella, Christie, Gloria and Alice contributed equally to this work and should be considered co-first authors.

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