Turning to Telemedicine:

How Technology can Mitigate the Type 2 Diabetes Mellitus Epidemic in China

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IAS3193: Environment and Disease Crises in China

May 12, 2019

Introduction

Technology plays a unique role in medicine. Although the synthesis of technology and medicine usually results in the development of special treatments that are often only available in wealthy, developed countries, technology can actually be used to help mitigate two problems global health. First, there is widespread incapacity to effectively provide primary health care for the vast global poor who are often economically, geographically, and politically isolated. Second, many actors are unable to conduct effective interventions for the escalating epidemic of chronic lifestyle diseases. Telemedicine, or "healthcare at a distance," is a mechanism that can work on both of these problems.

Type 2 diabetes is one of the greatest public health challenges facing China today. There are an estimated 109.6 million Chinese adults with diabetes, making China number one in the world.[1] Furthermore, type 2 diabetes is on the rise.[2] As a noncommunicable, lifelong disease, individuals who are diagnosed with type 2 diabetes will have to manage disease complications and pay for treatment for years. There is no doubt that China's healthcare system must find more effective ways of preventing, diagnosing, and managing type 2 diabetes across different geographical regions, socioeconomic statuses, minority populations, and age groups. China's healthcare system is already inundated with problems; urban patients queue for hours outside of city hospital centers to see specialists they choose based on self-diagnoses while rural patients suffer from the lack of training and resources rural healthcare professionals can provide. However, telemedicine is a unique and potentially powerful way to address the diabetes epidemic in China. China is tech-savvy, with broad adoptions of technological advances such as

[1] Hu Cheng and Jia Weiping, "Diabetes in China: Epidemiology and Genetic Risk Factors and Their Clinical Utility in Personalized Medication," 2018, 3.
[2] *Ibid.*

health-related mobile applications, even among rural and older populations. In addition, *hukou* and the government's tight control of citizens pose an advantage in the successful application of telemedicine through the integration of government institutions in the health sphere. Despite the lack of standardized practices and need for more research, telemedicine efforts to prevent, diagnose, and treat type 2 diabetes in China must be continued, with a focus on disease management, because China's population needs and is uniquely suitable for technology-based solutions.

Background

Overview of Diabetes Epidemic in China

In the past 30 years, the prevalence of diabetes in China has increased at an unprecedented rate, and affects the entirety of the population. Therefore, solutions that can effectively address multiple segments of the population are needed. 35.7% of the population had prediabetes in 2013, more than double that rate of 15.5% in 2008. Most of the population breakdown falls along predicted patterns: diabetes, as well as prediabetes, is more prevalent in seniors, males, and overweight and obese individuals.[3] Interestingly, diabetes is more prevalent in urban residents, while prediabetes is more prevalent in rural residents. In addition, the majority ethnic group, Chinese Han, had the highest rates of diabetes and prediabetes surveyed while Tibetan participants had the lowest rates.[4]

While the diabetes epidemic is affecting the asymmetrically large population of older Chinese, prediabetes is a major crisis in the younger population. In the span of five years, the prevalence of diabetes in 20 to 39-year-old increased almost 20%, going from 9.0% in 2008 to

[3] *Ibid.*
[4] *Ibid.*

28.8% in 2013.[5] This is a major problem, because studies have proven additional risks from an early diagnosis of type 2 diabetes. Young people who have diabetes are at a higher risk of chronic complications, a major cause of mortality and morbidity, as well higher cholesterol levels.[6] These are additional burdens on Chinese patients as well as the Chinese healthcare system.

Immediate innovative solutions to the diabetes epidemic are crucial; the Chinese healthcare system has not been very successful in treating type 2 diabetes. Currently, only 27.6% of rural residents receive diabetes treatment while 41.8% of urban residents do.[7] This rural-urban disparity has many causes, from hukou to funding problems to staffing problems to the lack of trust and confidence in rural healthcare professionals, who are widely seen as incompetent and often act as pharmacists. On top of the different levels of treatment, a recent study found that only half of the patients who receive treatment have adequate control of their blood sugar, with a measly 5.6% of patients successfully controlling their blood sugar, blood pressure, and cholesterol.[8] Proper control of these factors through pharmaceuticals, as well as lifestyle changes, will improve the lives of millions prevent patient financial burdens, stress on China's community healthcare systems, and decreases life expectancy.[9] However, the most effective treatments plans are individual-based, and there are simply not enough healthcare professionals or resources.

Telemedicine as a Solution

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[5] *Ibid.*
[6] *Ibid.*
[7] *Ibid.*
[8] *Ibid.*
[9] Sun C et al, "Mobile Phone–Based Telemedicine Practice in Older Chinese Patients with Type 2 Diabetes Mellitus: Randomized Controlled Trial," 2019.

Telemedicine, a diverse and growing field within healthcare that involves patients and healthcare professionals exchanging information and services using "electronic information communication technologies" such as mobile applications, video conferencing, websites, and databases, is a solution to China's diabetes epidemic.[10] Telemedicine encompasses physician-to-patient interaction, physician-to-physician interaction, and patient-to-patient interaction.[11] All three of these are important to mitigating the rise of diabetes; they play in at different stages of the epidemic. Through telemedicine, health outcomes, especially chronic disease outcomes, can be improved because the medium of telecommunications can overcome geographic barriers to breach the gap between urban and rural care to reach underserved populations. In addition, the innovative and rapid development of technology means that telemedicine is growing, with new uses constantly being pioneered that can address prevention, diagnosis, and management.[12] Finally, effective telemedicine practices can lower healthcare costs, making complex and tailored pharmaceutical treatments accessible to more populations. Unfortunately, since telemedicine is a newer field, international standards and regulations for its implementation do not exist due to lack of research and often inclusive findings.[13] However, in the case of China and type 2 diabetes, telemedicine is worth pursuing.

Preventing Diabetes

While most telemedicine studies have been focused on diabetes management and treatment, diabetes prevention can also be accomplished through technological platforms.

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[10] Zhai YK, "Clinical- and Cost-effectiveness of Telemedicine in Type 2 Diabetes Mellitus: A Systematic Review and Meta-analysis," *Medicine* 93, no. 28 (2014)
[11] "What is mHealth? How Is It Different from Telehealth?" Population Health Insights, Care Innovations.
[12] Youfa Wang et al, "A Systematic Review of Application and Effectiveness of mHealth Interventions for Obesity and Diabetes Treatment and Self-Management," 2017.
[13] *Ibid.*

Addressing the root of the diabetes epidemic and discouraging behavioral/lifestyle risks that lead to prediabetes and diabetes is critical. Although East Asians have been found to have higher insulin sensitivity with lower insulin response than Europeans or Africans, type 2 diabetes in China is also being driven by lifestyle and diet changes that lead to obesity.[14] China's recent history of turmoil, such as the Great Famine of 1959–1962 under Mao Zedong, combined with current heavy, asymmetrical economic development and growth of middle class wealth, has created large changes in demand and diet that have contributed to the diabetes epidemic.[15] There is a pressing need in public health to raise awareness on the impact of childhood nutrition on diabetes risks, as well as education on better self-management upon receiving a diagnosis.

First and foremost, telemedicine can improve physician-to-patient interactions. Internet and mobile-based telemedicine not only increases access for rural populations, but also provides a qualified source of information on nutrition, diet, and and other risk factors.[16] In particular, telemedicine efforts run by public health organizations on social media have been successful in promoting diabetes awareness and education. In addition, telemedicine increases patient-to-patient as well as patient-to-pre patient interactions. Online chat-based groups on popular platforms have been successful in increasing dialogue on diabetes. For example, while most Chinese have shifted towards WeChat, QQ is still used by the youth for chatting purposes.[17] A year-long study conducted with 115 diabetes sufferers used QQ to provide health education; these patients learned from healthcare providers in the chat and passed on information to their

[14] Hu Cheng, "Diabetes in China," 2018.
[15] *Ibid.*
[16] Sun C et al, "Mobile Phone–Based Telemedicine," 2019.
[17] Arlene Zhang, WeChat message to author, 2019.

respective social circles.[18] Unfortunately, this was just one study. More prevention-focused telemedicine trials must be designed and implemented, and more research needs to be done, before a definitive answer can be given on the efficacy of preventative telemedicine to treat the diabetes epidemic.

Diagnosing Diabetes

Telemedicine is also useful for diagnosing diabetes: it refines data collection, especially in rural areas, and improves the quality and frequency of physician-to-physician interactions. Newer, easier to use data collection technology has helped healthcare providers to better track patient information between each visit. In addition, China has benefited from telemedicine networks that connect Chinese physicians with foreign physicians, with increasing consults between China and the United States.[19] Furthermore, China has seen an enormous growth of online, internet-based hospitals that provide phone or internet-based consultation, connecting physicians to patients. For example, "We Doctor Group," a digital healthcare provider, is linked to more than 1,900 major Chinese hospitals and 200,000 doctors.[20] "We Doctors" uses the internet to provide online consultations, diagnosis, and medication distribution to 110 million registered users.[21] These patients, who may have otherwise had to turn to the internet for personal research and pharmaceutical production, were able to connect to physicians from cities for personal consultations on their health problems. Telemedicine networks such as "We Doctor Group" not only benefit patients, but strengthen the diagnostic knowledge and tools of rural

[18] Richard Jones, "Diabetes and Telehealth in China: Diagnoses, Treatment and Intervention," Conference paper for 9th International Conference on Information Technology in Medicine and Education, 2018.
[19] Hu Cheng, "Diabetes in China," 2018.
[20] Richard Jones, "Diabetes and Telehealth in China," 2018.
[21] *Ibid.*

healthcare providers, because physicians on the network also chat to one another. Similarly to diabetes prevention, however, the benefits of using telemedicine to achieve better diagnoses are not as studied; most efforts in this area have been focused around international collaboration.

Treating and Managing Diabetes

The major focus of diabetes-related telemedicine efforts in China have been around treatment and management, as telemedicine supporters most often tout its ability to regulate noncommunicable disease. Recent telemedicine treatments of diabetes complications have been successful in areas such as tele-ophthalmology, while telemedicine management of diabetes has been successful in mobile health.[22] Efforts focused on treating diabetes-related complications as well as managing the disease through improved self-management of blood sugar, blood pressure, and cholesterol levels should be continued because they are the best fit for China's population, which is used to interacting daily with government monitoring as well as mobile technology.[23]

In terms of treating diabetes complications, tele-ophthalmology, or telemedicine-based treatment of diabetic retinopathy, should continue to be developed and implemented more widely across China. Diabetic retinopathy is a major long-term health complication, with the major root cause of blindness being caused diabetes related vascular complications. Of the 6 million blind people in China, 80% live in rural areas.[24] To address this issue, tele-ophthalmology networks have been established that link rural hospitals to urban as well as international hospitals. The increased collaboration between patients, Chinese healthcare providers, and foreign healthcare

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[22] *Ibid.*
[23] Youfa Wang et al, "A Systematic Review," 2017.
[24] Richard Jones, "Diabetes and Telehealth in China," 2018.

providers on health outcomes mean that expertise and knowledge have grown, resulting in better-informed decisions and lifestyles.

In terms of managing diabetes, telemedicine initiatives have been successfully implemented through mobile health innovations. Since diabetes mellitus is so complex, with lifestyle changes needed in diet, exercise, and pharmaceuticals/medicinal use, conventional self-management techniques focused around in-person checkups have not been as successful.[25] However, by applying telemedicine, self-management can be improved through new forms of reporting, education and awareness campaigns, and support from health professionals. Older populations have benefited from these innovative practices as well, as China's seniors are more adaptable than other countries' to new mobile applications due to China's technological leapfrogging.[26]

Mobile health, or mHealth, is similar to telemedicine, but is focused on self-care and self-management through mobile and wireless devices.[27] mHealth and type 2 diabetes in China includes apps that help users track and interpret their own medical data, as well as such as scheduled text messages that prompt regular self-checks of blood glucose levels. mHealth can easily be universally adopted, as 94.5% of Chinese had phones in 2014 and cellular signals covered almost all urban and rural residential areas, and already use their phones for economic, logistic, and social interactions through apps such as WeChat.[28] In fact, mHealth apps are already widely used throughout China. In 2015, when researchers conducted the first systematic evaluation of healthcare apps in China, they found diabetes-related apps to be the most common,

[25] Hu Cheng, "Diabetes in China," 2018.
[26] Sun C et al, "Mobile Phone–Based Telemedicine," 2019.
[27] "What is mHealth? How Is It Different from Telehealth?" *Population Health Insights,* Care Innovations.
[28] Richard Jones, "Diabetes and Telehealth in China," 2018.

with almost all focused on monitoring and recording data such as glucose levels.[29] Outside of diabetes-specific mobile applications, social media is powerful tool in managing diabetes. For example, QQ has been used for social monitoring as well as a mobile-based follow up for patients, such as rural residents, who face economic and logistical barriers which prevent regular hospital visits.[30] There are hospital-managed QQ groups included in diabetes management programs, allowing patients to converse with one another, access shared group information, and post questions to healthcare professionals that others may read and learn from as well.[31] Because healthcare professionals are intrinsically part of such telemedicine efforts, the risk of false information is significantly decreased. In addition, hospital participants and group members can send each other messages and reminders to take medication, make appointments, and follow dietary and exercise recommendations.

Concerns About Telemedicine

While there are many potential benefits to implementing telemedicine to address the diabetes epidemic, the nature of telemedicine means that valid concerns must also be raised. Some concerns about the effective use of telemedicine are the consequences of technological malfunctions and its susceptibility to hacking. For example, what would happen if implanted insulin pumps began operating on inaccurate data?[32] In addition, the Chinese government also poses a risk to those diagnosed with type 2 diabetes and prediabetes. In light of the incoming universal social credit system, many have questioned the security and equality of ratings and benefits, as those who are privileged may collect more and more benefits from the system, such

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[29] *Ibid.*
[30] *Ibid.*
[31] *Ibid.*
[32] Russ Prince, "How Telemedicine Can Kill You," *Forbes,* 2015.

as access to better medicine and treatment, while those who are already marginalized may be further hurt.[33] These questions about telemedicine in China are important to consider; healthcare efforts to resolve the diabetes epidemic should be undertaken for the benefit of all who are diagnosed with diabetes and prediabetes. Careful consideration when planning new studies and efforts are integral to ensuring fair and equitable practices of telemedicine-based prevention, diagnosis, treatment, and management.

Conclusion

As global actors continue to face the challenges posed by providing healthcare for diverse and in-need populations and treatments for chronic diseases, telemedicine must be realized as a viable avenue for problem-solving today's public health challenges, especially in China. In the end, the potential benefits of telemedicine in addressing the diabetes epidemic in China outweigh concerns over security costs. Telemedicine can help by educating individuals about lifestyle and genetic factors, improving rates of diagnosis, and leading innovative and cost-effective programs that successfully promote self-management and treatment of disease. Although Chinese telemedicine programs have already seen some success, there is still much to be improved. Public health efforts must advocate for the increased use of health apps on smart devices in order to further cut healthcare costs, increase patient engagement with their health, and improve health outcomes.

[33] Charlie Campbell, "How China Is Using "Social Credit Scores" to Reward and Punish Its Citizens," *Time,* 2019.

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