Mobile Device-aided Health Care: Administration of New Health Care in China

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As mobile Internet communication and the needs of medical services are booming, China has groping a mode of mobile health care to effectively solve the problem of limited unevenly distributed medical resources by integrating the lowest cost of investment, best medical staff and advanced management mode of the patients.

Being the country with the largest population, China has only 2.21 licensed /assistant physicians per thousand people. Another serious problem is uneven geographical distribution of medical resources. Less than 3% of general hospitals are responsible for more than 40% of medical service. Both limited medical resources and distribution imbalance lead to countless of trans-provincial medical behaviors, resulting in an increase of economic cost and time cost. Meanwhile, China's mobile Internet communication is booming. A new type of digital medical care has been developed rapidly in China. According to different stages of medical interventions, operation modes of digital medical services can be divided into different types. Major functions encompass reservation, payment and medical consultancy. 3% of applications involve the management of chronic diseases. Many mobile medical platforms rely on doctors from comprehensive hospitals. Patients could be managed and followed-up via the platform. This Internet management mode of chronic diseases currently attracts 389,407 specialists from comprehensive hospitals and 895,921 patients with chronic diseases. Recently, the National Health and Family Planning Commission (NHFPC) has released “Management of Diagnosis and Treatment in the Internet (trial) (draft)” and “Opinions on Promoting the Development of Internet Medical Services”. It is worthy of attention whether China's Internet healthcare can dance with shackles under existing policies and achieve steady and rapid development in future.

Limited health resources and uneven distribution in China

Although being the world's second largest economy entity (with annual gross domestic product of 74412.7 billion RMB), China has relatively limited health care resources which are geographically unevenly distributed. Till 2016, the total population of mainland China has reached 1.38 billion [1], while there are only 10.69 million medical and health practitioners nationwide, of which 3.04 million are practicing /assistant doctors [2]. Based on this estimation, there are only 2.21 licensed /assistant physicians per thousand people. Another serious problem is that geographical distribution of medical resources is uneven (Figure 1). Among the top 100 comprehensive hospitals [3], more than half are located in Beijing, Shanghai and Guangdong Province. On the contrary, the western region of China who enjoys 72% of territory and 29% of the whole population only account for 14% of the top hospitals (Figure 1A). Most of the outstanding physician resources are distributed in large cities such as Beijing, Shanghai, and Guangzhou, while the growth of primary care medical and health practitioners is relatively slow (Figure 1B). Because of the huge gap of human resources and clinical skills between general hospitals and primary medical institutions, 3.08 billion patients are accepted by a total of 28 thousand general hospitals annually, but only 4.34 billion patients choose to go to 921 thousand primary medical institutions. It means less than 3% of the medical institutions account for more than 40% of medical and health service [2].
Figure 1A the proportion of national top 100 hospitals in China. The top three cities/provinces were Beijing, Shanghai and Guangdong Province, accounting for 23%, 19% and 9% respectively. In 12 western provinces and autonomous regions, only Chongqing, Sichuan and Shanxi provinces have top 100 hospitals, accounting for 6%, 5% and 3%, respectively.

Figure 1B the growth of total medical and health practitioners and primary care medical and health practitioners in the past 20 years. During 1996 to 2015, the number of health practitioners in China rose by 58.6% from 6.74 million to 10.69 million. In contrast, primary care medical and health practitioners rose by 31.4%.
health practitioners decreased from 1.32 million to 1.03 million, accounting for less than 10% of national practitioners.

Mobile phone users and digital medical health
The limited medical and health resources and distribution imbalance lead to a large number of trans-provincial medical behaviors, resulting in an increase of economic cost and time cost. Meanwhile, China's mobile Internet communication is booming (Figure 2). At present the coverage of mobile broadband network has reached 57% [4]. By the end of 2015, statistical data from National Bureau of Statistics of the People’s Republic of China showed that the broadband network covered 94.5% of the total villages and 78% of poverty villages [1]. Mobile phone penetration rate has been increasing year by year. By the end of 2016, Ministry of Industry and Information Technology of the People's Republic of China statistics revealed that there were 1.32 billion mobile phone users, and mobile phone penetration rate reached 96.2% [4]. Based on these advantages, a new type of digital medical health based on mobile Internet platform has been developed rapidly in China. A large number of risk investment funds have flowed into Internet medical platforms, and Internet users of medical applications have been growing year by year (Figure 3) [5]. By the end of 2016, there were more than 2,000 mobile medical applications in China [6], involving hundreds of thousands of medical practitioners in the country [7-12].

![Figure 2A the penetration rate of the Internet in the recent 16 years](image-url)
Figure 2B the growth of China’s mobile phone users in the recent 21 years

Figure 2 Rapid development of mobile Internet market in China. Figure 2A the penetration rate of the Internet in the recent 16 years. By the end of 2016, the penetration rate of mobile broadband in China was 57%, 12 times the figure of 2002. Figure 2B the growth of China’s mobile phone users in the recent 21 years. By the end of 2016, there were 1.32 billion mobile phone users nationwide, 192 times the number of users in late 1996.

Figure 3A Investment of China mobile Internet capital
Figure 3B the number of registered doctor users of some of platform

Figure 3 Investment of China mobile Internet capital. Figure 3A Till 2016, China mobile medical market size reached 10.56 billion RMB with growth rate of 116.4% year on year. Figure 3B the number of registered doctor users of some of platform. There are more than 100,000 registered doctors on multiple platforms.

Operation modes of digital medical services

According to different stages of medical interventions, operation modes of digital medical services can be divided into different types. (1) Main business port refers to the appointment of doctors and communication of doctors and patients, such as "Micro-doctor (Registered Network)". (2) Consulting business is primary service, such as "Doctor Hao", "Doctor Chunyu", and "Doctor Xingren"; (3) Mobile medical platform relies on existing network users, such as "Doctor Pinganhao" and "Doctor Baidu"; (4) Mobile medical platform relies on doctors from general hospitals who have a large number of patients. Patients with definitive diagnosis and initial treatment, could be managed and followed-up via the platform, such as "Doctor 7LK". Other modes involve medical education, pharmaceutical equipment sales and other different operation types (Figure 4).
Figure 4 Functional classification of mobile Internet medical application

Major functions of medical applications encompass reservation, payment and medical consultancy, and the proportion is 31.3% and 30.3%, respectively. Only about 3% of applications involve the management of chronic diseases.

At present, the fourth mode best accords with clinical practice. Most cases with chronic diseases have visited their doctors before. The doctors understand the patients’ condition thoroughly and then set up electronic medical records for further follow-ups and remote consultancies. Take "Doctor 7LK" platform for example. It is aimed to facilitate second and subsequent follow-ups of patients with chronic diseases. It enables remote medical treatment, relying on the off-line primary medical and health institutions, clinical laboratories and medical image centers. The platform sets up a medical closed-loop of doctors, patients and medicine, and helps doctors to build up private clinics for better management of patients with chronic diseases (Figure 5). This Internet management mode of chronic diseases currently attracts 389,407 specialists from comprehensive hospitals and 895,921 patients with chronic diseases [12].
Figure 5 Management mode of chronic diseases via mobile Internet

Figure 5 Management mode of chronic diseases via mobile Internet. Offline doctors’ groups and online private clinics could be combined. On the one hand, the physicians can follow up the patients online for monitoring drug efficacy and adverse reactions and assessing chronic diseases. On the other hand, appointment supports of clinical laboratories, medical centers or surgical platform can be provided according to geographic information of the patients, thus reducing the number of visits in a different place. In addition, drug delivery and drug counseling can be realized through online pharmacies and logistics network.

Doctor users and patient users with Internet-based medical practices

The widespread existence of mobile Internet medical platform has weakened the uneven distribution of medical resources (Figure 6). Many doctors are more likely to accept Internet-based medical practices especially in poor areas, because it takes higher costs and has longer distances for patients seeing doctors. While the Internet can make it easier for doctors to connect with patients who are geographically distant, which is fundamental to the survival and development of these platforms. Nevertheless, in terms of the distribution of registered users, patients in the southeast have higher recognition of new Internet medical behaviors. One of the reasons is that it is relevantly economically
developed in this region, and the Gross Regional Domestic Product (GRDP) is related to higher medical input of the government. Moreover, the people in this area are highly educated, and they attach great importance to their own body and health. However, statistical bias may be caused by the differences among several Internet medical companies in different areas (Figure 7). The proportion of physicians and patients associated with chronic diseases is very large. All of the top 5 departments of registered users are related to chronic diseases (Figure 8). It correlates of the nature of the diseases and the need of follow-ups. However, the differences in the features of various diseases and uneven distribution of medical resources lead to the differences in the status and distribution of Internet medical resources.

Figure 6 Registered physicians of "Doctor 7LK" in several provinces and permanent resident population of these areas [1]. Although the number of registered doctors in the southeastern areas is absolutely higher, many doctors are more accepting of Internet-based medical practice in relatively poor western regions. As shown in Figure 6, take Gansu Province which is located in northwestern China as an example. The total population of Gansu Province is 26 million, while the registered number of physicians is 8480 on this platform, in equivalent of 3.26 online registered doctors per 10 million population. In contrast, only 2.08 registered doctors are shared by every 10 million population in Guangdong Province, in which is much more economically developed and has highest number of registered doctors.
Figure 7A

Figure 7B
Figure 7C the statistics of education of registered patients and economic levels in several provinces offered by “Doctor 7LK” platform

Figure 7C the statistics of education of registered patients and economic levels in several provinces offered by “Doctor 7LK” platform. The number of registered patients in the southeastern region is the largest, top of which is Guangdong province with 2.36 per thousand registered patients, far more than the central and western regions. This is related to high Gross Regional Domestic Product (7A), high local fiscal health expenditure (7B) and relatively high level of education (7C) in these areas.
Figure 8 Part of user distribution of the "Doctor 7LK" network platform.

Figure 8A In the departments of chronic diseases, the most registered department of the users is cardiovascular division, which is related to high incidence of cardiovascular diseases in the nation. Figure 8B in the aspect of the number of patients of each registered doctor, the rheumatologists correspond to largest number of patients, with an average number of 29.25 patients per rheumatologist, which reflects relative shortage of rheumatologists at present. Figure 8C Dermatology is the most interactive department and has the largest visit numbers per day, which is linked to special manifestations, diagnosis and treatment features of skin diseases.
Recently, the National Health and Family Planning Commission (NHFPC) has released “Management of Diagnosis and Treatment in the Internet (trial) (draft)” and “Opinions on Promoting the Development of Internet Medical Services”. It aims to standardize and restrict Internet medical services. It is worthy of attention whether China’s Internet healthcare can dance with shackles under existing policies and achieve steady and rapid development in future.

Contributions
LQ, JY and LZ designed the study. QJ, ZY and ZX searched relevant national and regional information. FL, TL and YM gathered data. LZ, ZM, GX and QM did the statistical analyses. LQ, JY, and QJ wrote the first draft of the paper, with revisions from LZ and GJ. All authors contributed to revisions and approved the final version.

Conflicts of interest
All authors declared that there was no conflict of interest.

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