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Transport-related experiences in China in response to the Coronavirus (COVID-19)

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Abstract: In the year 2020, the Coronavirus (COVID-19) broke out in many countries of the world. In China, the Chinese government and people have adopted strong measures. After more than a month of fighting against the epidemic, the epidemic has been basically under control in China. However, in other countries of the world, such as South Korea, Japan, Iran, many countries in Europe, and the Americas, the epidemic is still developing rapidly and the situation is not optimistic. This paper summarizes the transport-related experience of China in the fight against the epidemic and hopes that it will be helpful to other countries in the fight against the epidemic.

Keywords: transport; experience; coronavirus; epidemic

1 Introduction

At the beginning of 2020, the new coronavirus was wreaking havoc in the world, and China, South Korea, Japan, Italy, Iran and other countries all suffered severe epidemics (Centor and Fisman, 2020; Murdoch et al., 2020; Rubin et al., 2020; Wu et al., 2020). Especially in China, so far, a total of more than 80,000 confirmed cases and more than 3,000 deaths have caused great harm to the national economy and national physical and mental health. After more than a month of arduous efforts to combat the epidemic, the new coronavirus pneumonia epidemic in China has been generally alleviated, but the epidemic situation in other countries of the world is still in the development stage, and the situation is not optimistic. Therefore, it is necessary to summarize China's anti-epidemic experience, to provide experiences for the fight against epidemic disease in the world in the later stage, and to provide solutions for similar infectious diseases in the future.

In China's efforts to combat the new coronavirus, transportation work has played an important role, and it has accumulated rich experience in both controlling the development of the epidemic and protecting people's lives (Fang et al., 2020). Moreover, the spread of new coronavirus is closely related to the flow of people (Chen et al., 2020). Through the analysis of the correlation between the development of the epidemic and the control of the movement of people in China, the effect of the control of the movement of people on the control of the epidemic was analyzed (Chinazzi et al., 2020), and the strategy for the control of movement of people in the epidemic was summarized. Herrera-Valdez et al. (2011) found that epidemic "waves" can be explained through the combination of transport patterns and changes in contact rates due to the use of explicit or scheduled social distancing measures. Ohkusa and Sugawara (2007) used real data
for transportation modes and locations in the Tokyo metropolitan area, and simulated the diffusion of an infectious disease into that real data through assuming that a certain percentage of those contacted would become infected and transmit the disease. However, there are no specific data to explain the impact of strict control of personnel movement and social distancing on epidemic control (especially no comparative studies), and there is no clear analysis of the mechanism of control of personnel movement for epidemic control. All these are issues to be elaborated in this paper. Moreover, this paper also introduces the methods and strategies of transporting key materials and personnel during the epidemic period in China.

The remainder of the paper is organized as follows. In Section 2, we introduce methods for data collection and analysis. Then, we present finding and policies in Section 3, where we analyze the control strategy of personnel flow and its impact on the development of the epidemic, the mechanism of restricting the flow of personnel to control the development of the epidemic and transportation guarantee for key personnel travel and material distribution. Conclusions are given in Section 4.

2 Methods

The data came from the real-time dynamics of China's national epidemic situation (https://news.ifeng.com/c/special/7tPIDSzDgVk, access date: 3/2020) and the global epidemic situation (https://news.ifeng.com/c/special/7uLj4F83Cqm, access date: 3/2020) that were released daily by Ifeng.com. The cumulative number of confirmed cases, the number of existing confirmed cases, the number of cured cases, the number of deaths, the number of newly confirmed cases and the number of new suspected cases in all countries and provinces of China were updated daily. These data were collected from authoritative statistical departments of various countries and epidemic statistics agencies in Chinese provinces to ensure the authenticity and validity of the data.

In the following Section 3.1, we analyze the variation of the number of cases over time in China and several other countries and then understand the importance of social distancing for controlling the spread of the epidemic. Then, in Section 3.2 we theoretically explain the mechanism of restricting the personnel flow to control the development of the epidemic and introduce the corresponding social distancing methods adopted by China in the fight against the epidemic to classify and isolate different sources of infection. Section 3.3 introduces a series of measures and strategies adopted by China in key personnel travel and material distribution during the epidemic in order to ensure social distancing.

3 Finding and Policies

3.1 Control strategy of personnel flow and its impact on the development of the epidemic

In the control of new coronavirus epidemic, China's efforts to control the flow of people have played an important role. The overall strategy for personnel flow control is "external control of output, internal control of proliferation". Starting at 10:00 on January 23, Wuhan (the place where the outbreak occurred in China, also capital of Hubei Province, China) city buses, subways, ferries, and long-distance passenger transport operations were suspended, and the airport and railway
station were temporarily closed, which basically prevented the epidemic from re-exporting to the outside world. Subsequently, across the country, including cities and rural areas, measures have been taken to restrict the movement of people, including: reducing flights, train number, and reducing the frequency of urban subways and buses; everyone must stay at home as much as possible, and reduce going out, they must wear a mask when going out, people must be more than 1.5 meters away from each other; access control was implemented in each residential area, the temperature of people entering and exiting was measured, and the foreigner access was prohibited; access of each city was controlled and the temperature of people entering and exiting was measured; access of each village in the rural area was also controlled; factories suspended work, schools suspended learning at school, to avoid crowds gathered, and so on.

The implementation of strict personnel control was very effective in controlling the epidemic, which can be said to be the key to China's anti-epidemic success. As shown in Fig. 1 (Figs. 1-8 data from https://news.ifeng.com/c/special/7tPIDSzDgVk, access date: 3/2020) for the national daily new-increasing trend of the epidemic, both confirmed cases or suspected cases peaked on February 3 and February 4 (at this time, more than 3,000 new confirmed cases were added daily). The longest incubation period of the new coronavirus is approximately 14 days, and the incidence is usually within 10 days. Therefore, as can be seen from Fig. 1, those infected before the migration restriction was adopted on 23 January were all diagnosed before 4 February, Since February 4, the number of newly confirmed and suspected cases has shown a downward trend every day. Here, the statistical coverage of confirmed cases changed on February 12, 13, and 14 in Hubei Province (the province where the outbreak was concentrated in China), and the conservative inclusion of clinically diagnosed cases led to a sharp increase in confirmed cases. After March 13, there were a few or a dozen new cases every day. Fig. 2 shows the cumulative trend of the national epidemic.

![Fig. 1 Daily new-increasing number of cases in China](image)
Fig. 2 Cumulative number of cases in China

Fig. 3 shows the daily new-increasing numbers (unit: person) of cases of Hubei province and outside Hubei in China. The trends of Hubei province and outside Hubei are similar. As the statistical caliber outside Hubei was consistent, the curve outside Hubei has been declining since February 4. This also proves that the restrictions on the movement of people in China are very effective.

Fig. 3 Daily new-increasing number of cases inside and outside Hubei (in China)

For comparison, we list several countries where the epidemic has been growing rapidly in recent days. The first is South Korea. From the end of February to early March, the lack of effective control of the movement of people, especially the large concentration of church personnel in the country, led to the rapid development of the epidemic and the number of infected people rose rapidly. After that, the government adopted strong and effective measures to control the movement of people, and the epidemic was quickly brought under control after March 8 (see Fig. 4). By comparison, in recent days, the number of infected people has been rising rapidly in Italy, Iran and Spain due to the lack of effective measures to control the movement of people (see Figs 5-7).
Fig. 4 Daily new-increasing number of cases in South Korea

Fig. 5 Daily new-increasing number of cases in Italy

Fig. 6 Daily new-increasing number of cases in Iran
Fig. 7 Daily new-increasing number of cases in Spain

Fig. 8 shows the distribution of the coronavirus epidemic in China, by province. The darker the color, the greater the number of infected people. The provinces surrounding the outbreak (Hubei), Henan, Hunan, Jiangxi, Anhui, and Chongqing were the most affected provinces. Secondly, Guangdong and Zhejiang, as the most economically developed provinces in China, have close ties with each other across the country, and have been greatly affected by the epidemic. Before Wuhan closed on January 23, about 5 million people left the city for the Chinese New Year, mainly going to other places of Hubei and neighboring Henan, Hunan, Jiangxi, Anhui, Chongqing, Guangdong, and Zhejiang. Therefore, it can also be seen from Fig. 8 that the movement of people is consistent with the development of the epidemic, which also proves that the movement of people exacerbated the development of the epidemic.

Fig. 8 Distribution of the coronavirus epidemic in China by province (on March 13)

3.2 Mechanism of restricting the personnel flow to control the development of the epidemic

The population is divided into four categories: A, B, C, and D (https://www.sohu.com/a/371179781_120055917, access date: 2/2020;
https://www.thepaper.cn/newsDetail_forward_5783010, access date: 2/2020). A is the persons who have been diagnosed with the epidemic, as shown in red in Fig. 9. Before A is diagnosed and admitted (but especially after having symptoms), A meet B in a public place that he never know, as shown in Fig. 9b). A does not know the existence of B, and B does not know the existence of A. When A arrives at his destination, he touches C. No matter how many C he touches, these C are easy to be found and isolated. D is the persons who stay at home and do not go out. The biggest hidden danger now is B, who can't be found at all. No one knows who B is, and B themselves don't know that they are B. As long as D goes out, he has the possibility of meeting B, and he is the new B (2B), as shown in Fig. 9c). Therefore, the purpose of everyone's isolation from each other now is to screen out B with time. The incubation period of the coronavirus is two weeks. Within two weeks, B has become ill and the result is out. The epidemic will not end until all B have been identified and isolated for treatment. All the isolation measures being taken (to control the flow of people) are to reduce the generation of new B (2B).

![Mechanism of epidemic transmission](image)

For **fig. 9 Mechanism of epidemic transmission**

A must be found and isolated as soon as possible to cut off the source of infection. This is an important experience in China's fight against COVID-19. But if there are too many A, such as in Wuhan, two new thousand-bed hospitals have been built. However, there was still a serious shortage of beds, and then the square cabin hospitals (Wuhan square cabin hospital, as shown in Fig. 10) were greatly expanded by using the gymnasium, school, international exhibition center, international expo center, etc.) to divert mild patients. Severe patients (severe A) were admitted in the designated hospitals, the mild patients (mild A) were admitted in the relatively simple cabin hospitals, and the suspected cases and close contacts (such as C) were isolated in the hotels or home. In this way, medical facilities can be greatly utilized, all patients can be treated, they did not become a source of infection in social activities, and cross infection was avoided.
In addition, to enter any public place (such as a station, hospital, shopping mall, supermarket, etc.), he/she must register, wear a mask, and take a temperature measurement. Employees of all units checked in every day to fill in their health status and travel history for the day. If there is a “red zone” travel history (especially the travel history in Hubei), they will be quarantined at home for 14 days. Some places, especially in Hubei province, have also developed personal health codes (as shown in Fig. 11), in which each person's real-time health information was stored (identifying himself or herself by his or her mobile phone number), which can be scanned in any public place with his or her mobile phone, combined with a real-time temperature test, to rule out suspected infections.

The e-health code displays the name, ID number and mobile phone number. **The red code** indicates that you have had close contact with the COVID-19 patient in the past 14 days. Please contact your local community health service center or CDC as soon as possible for concentrated quarantine and medical observation. **The yellow code** means that in the past 14 days, you may have been exposed to the environment contaminated by the Coronavirus. Please contact your local community health service center or CDC as soon as possible. Try not to go out in the near future, keep a certain distance with your family, and measure temperature twice a day. Once any discomfort such as fever, fatigue, cough, diarrhea, conjunctivitis occurs, put on a mask and go to the nearby medical institution for treatment immediately, and actively tell the doctor about the possible exposure history. **The green code** means that you have not been exposed to the environment contaminated by the Coronavirus before the date. It is recommended that you wear a mask when leaving home, change your clothes and wash your hands when you return.
For any newly confirmed case, his/her latest travel trajectory will be published on the Internet, and those with overlapped travel paths will be isolated and observed by themselves and must contact with the local disease control and prevention center. The health department will assign professional personnel to conduct epidemiological investigation and guide prevention and control of the epidemic. In addition, through high-tech information means and big data technology, a query system has been developed (as shown in Fig. 12). Anyone can easily query the epidemic situation of their surrounding communities on the network, so as to focus on prevention when traveling. As shown in Fig. 12, the green dot indicates the location of the inquirer, and the red dots indicate the communities with the epidemic. All these measures were taken to identify all possible sources of infection and to cut off the transmission routes and chains.

Fig. 12 Epidemic information inquiry system

3.3 Transportation guarantee for key personnel travel and material distribution

During the epidemic period in China, travel was reduced as much as possible. Necessary individual travel was mainly carried out by private cars to reduce the chance of infection. Travel guarantee of medical workers was particularly important. Some medical staff returned home from work, but there were also some key medical staff living in hotels to avoid family transmission. During the epidemic, most buses were suspended and to prevent infection, special vehicles were arranged for point-to-point transport of medical staff. In addition, “Didi Travel” organized a "medical care support team" to maintain communication with major hospitals in Wuhan. Meanwhile, Didi's technical engineer team urgently developed an online car-calling service for medical staff only.

During the epidemic, community workers were the core force of grass-roots epidemic prevention work, and transportation services for community workers were particularly important. In addition to the community's own work vehicles, in Wuhan, Didi’s "Community Security Convoy" organized more than 1,000 drivers to receive unified dispatch from the prevention and control command department to serve community travel. At the same time, during the peak of the epidemic, many volunteers appeared in the society. They volunteered to provide transportation services for hospitals and communities, and transported personnel and materials.

Anyone who had symptoms such as fever and cough went to the nearest designated hospital for treatment in time. No one was allowed to go to other medical institutions for treatment without
permission, nor did he/she take public transport without permission. In case of symptoms, he/she can also call the community or hospital, and special workers will come to test for him/her to send him/her to a designated hospital for testing. In Wuhan, due to the excessive increase of cases for a period of time, buses were hired temporarily to carry out case shipment, while bus drivers took strict protective measures.

During the epidemic, many residential communities in the city implemented strict management. In order to reduce the chance of infection, residents did not go out as far as possible, and the food and daily necessities were mostly purchased online. The specific method was: Residents choose any a supermarket or shop through an online platform (such as Meituan, Alibaba, etc.), order their needed goods and agree on the delivery time; then the platform sends its own courier to the supermarket store to pick up the goods and then deliver it to the gate of their community. Since the community was closed, the couriers cannot enter the community, and the goods can only be placed on the shelves at the gate of the community (as shown in Fig. 13). There was a list of their purchases and their names with the goods, and then the courier called customers to pick them up. Supermarkets or merchants will pay fees to the platform based on services, and the platform will then pay salaries to courier staff.

Fig.13 Shelves at the gate of the community

By March, coronavirus epidemic has been basically controlled in China, and the number of new confirmed cases per day was below ten digits. The next important task was to resume work and production while ensuring that the epidemic will not repeat. Provinces and cities across the country implemented hierarchical control, that is, dividing high-risk, medium-risk, and low-risk areas. For high-risk areas, travel was still strictly controlled and the resumption of work delayed. For low-risk areas and medium-risk areas, self-driving travel and point-to-point car chartering were encouraged. Self-driving travel was encouraged for those who had the driving qualification and had a vehicle. Self-driving vehicles can pass safely and orderly based on the health code and temperature measurement. Point-to-point charter was encouraged. Persons who were not qualified to drive or did not have their own vehicles, as well as those of moderate size and concentrated
inflows, can rent qualified social vehicles by the employer or organizer based on the health code to provide point-to-point one-stop service.

4 Discussion and Conclusions

By comparing the control of social distance in different countries, this paper analyzed the role of social distancing in disease transmission. This is consistent with previous research conclusions: Controlling social distance can significantly control the spread of infectious diseases (Chen et al., 2020; Chinazzi et al., 2020; Herrera-Valdez et al., 2011; Ohkusa and Sugawara, 2007). Based on China’s anti-epidemic experience this time, the population was divided into four categories (A, B, C and D), and the transmission rules and control strategies of infectious diseases were analyzed. Different isolation methods and isolation places were adopted for A, B, and C to cut off the source of infection and maximize the utilization and exploration of existing anti-epidemic resources. These are China's effective experience in fighting COVID-19. Through big data technology (such as e-health code), the travel trajectory of cases and close contacts were tracked, which is also a beneficial experience for countries such as South Korea to effectively control the epidemic (Lee and Lee, 2020). Moreover, this paper also introduced China's methods and strategies for the transportation of key materials and personnel during the epidemic period. In addition to encouraging private car travel as much as possible, special vehicles (such as the special car service of Didi company) or volunteer vehicles were provided for the transportation of key materials and personnel. However, how to maximize the transport service function of public transport vehicles while avoiding close contact of people is an issue that needs to be discussed in the future. Moreover, during the epidemic in China, community contactless logistics service is a good experience, which fully demonstrates the role of the Internet in logistics and distribution during the epidemic.

This paper introduced China's experience in the control of coronavirus epidemic. At present, the epidemic situation in China has been well controlled, and the epidemic situation in other countries of the world, especially in Asia, Europe and the Americas, is in the outbreak stage. We hope this paper's summary of China's experience will be helpful to other countries in fighting the epidemic. However, different countries in the world have different national conditions, and the methods used may be different. This paper only provides the experience of China for reference.

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Author contributions

Qun Chen: Conceptualization, Methodology, Writing – review & editing; Shuangli Pan: Investigation, Formal analysis, Writing- Original draft.
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Highlights:

- The article summarizes transport-related efforts to control Coronavirus spread in China;
- The article analyzes the mechanisms for restricting flow of people to control the epidemic;
- Transportation guarantee for key personnel and material distribution, a key strategy, is summarized.