Research on Cold Chain Transport of Vaccines in Major Outbreaks

Gang Li¹, Gangyi Wang¹, Yuanbo Ma¹, Lulu Yue¹ and Wenting Zhao ¹
¹Logistics engineering, Shandong Jiaotong University, Jinan, Shandong Province, 250000, China

Abstract: In the face of the sudden outbreak of new type of coronavirus, the virus is spreading at a faster rate than expected, which seriously threatens people's life and health and national security. According to the World Organization, infectious diseases have been at a high incidence in the last two decades. How to transport kits and vaccines safely and efficiently to suspected cases and patients in a short period of time is related to the speed of national control of the epidemic. This paper first analyzes the scale of the pharmaceutical cold chain market in China, analyzes the policy of the pharmaceutical cold chain industry issued by the state, and analyzes the problems existing in the pharmaceutical cold chain industry; then it analyzes the influence of epidemic situation on cold chain transportation, and finally puts forward the safe and efficient transportation scheme of vaccine under epidemic situation.

1. Introduction

In recent years, China's logistics industry has been in the golden age of rapid development, cold chain logistics as an important branch of the logistics industry, also maintains the momentum of rapid development. According to the data of China Logistics and Purchasing Federation, the import volume of frozen refrigerated aquatic products and meat products rose to about 10 million tons in 2019, and the total output of fruits, vegetables, meat products, aquatic products and dairy products is expected to exceed 1.3 billion tons, and the cold chain market demand is huge. According to the calculation and analysis of the cold chain committee of China and material Federation, the total demand for food cold chain logistics in 2019 is expected to reach 235.2 million tons, an increase of 46.53 million tons over 2018, an increase of 24.65 percent over the same period last year. In 2019, the total amount of food cold chain logistics in China is estimated to be about 6.1 trillion yuan, an increase of 27.08% over the same period in 2018. The total scale of China's cold chain logistics market in 2019 will reach 339.12 billion yuan, an increase of 50.52 billion yuan over 2018, an increase of 17.60% over the same period last year, and is expected to reach 470 billion yuan in 2020.

2. Analysis of pharmaceutical cold chain logistics in china

2.1. Scale analysis of chinese pharmaceutical cold chain market

According to the China pharmaceutical industry research institute released "2018-2023 China's pharmaceutical logistics industry market prospects and investment opportunities research report "data: in 2017, the total amount of pharmaceutical logistics in China was 3.02 trillion yuan, an increase of 11.3% over the same period last year. According to the annual growth rate of 8%, it is estimated that by 2020, the total amount of medical logistics in China will reach 3.8 trillion yuan, while the scale of
drug market in cold chain transportation may reach 120 billion yuan. Among them, vaccine products, injections, tincture, oral medicine, external medicine, blood products and other pharmaceutical products as the main category. If based on the current circulation cost rate of 12.5% of China's pharmaceutical cold chain logistics costs, the scale of China's pharmaceutical cold chain market in 2020 is about 15 billion yuan. Visible, the next few years our country medicine cold chain market is promising.

2.2. Policy analysis of pharmaceutical cold chain industry
With the improvement of our national living standard and the vigorous development of the health service industry, the people's demand for medicine is becoming more and more vigorous, so it is urgent to inherit, develop and make good use of medicine, give full play to the role of medicine in deepening the reform of the medical and health system, and benefit human health. As an important way of medical transportation, the development of medical cold chain is very important. In recent years, the country has also issued a series of pharmaceutical cold chain industry policies. Since 2009, five national cold chain standards have been approved, such as "Medical Biological Cold chain Logistics Operation Standard" and "Medical Logistics Service Standard " . In 2011, the Ministry of Commerce issued the outline of "the National Drug Circulation Industry Development Plan (2011-2015) " , and the pharmaceutical cold chain logistics is booming.\[1\]

2.3. Analysis of the problems in pharmaceutical cold chain industry
First, the construction of high-cost medical cold chain equipment including, low-temperature cold storage, ice freezer, ordinary cold storage, refrigerated trucks, transport vehicles, refrigerators, refrigerated boxes, refrigerated backpack. The cost of a standard refrigerated vehicle is 500,000 yuan, and the temperature control system and supporting operation management system of cold chain logistics are about between 300,000 and 500,000 yuan; The construction cost of medical cold storage is about 3,000 yuan / square meter, and the cost of high 10,000 square meters of cold storage needs 200,000 yuan per month. Nevertheless, According to CLSC statistics, by the end of 2018, the number of refrigerated vehicles in China was about 180,000, an increase of 40,000 units over the previous year, an increase of 28.6 percent over the same period last year, and the growth rate for five consecutive years remained above 20 percent. Second, the low level of information of cold chain logistics is the key factor for pharmaceutical circulation enterprises to reduce management costs and respond to customers more quickly. However, at present, most of the medical logistics operations do not have a special medical logistics information system, pharmaceutical cold chain logistics enterprises in the purchase and shipment, still use manual temperature measurement and recording, can not achieve the whole process of temperature measurement, even the phenomenon of broken chain occurs from time to time. Third, the standardization of pharmaceutical logistics is not perfect China's pharmaceutical production enterprises and commodity wholesale enterprises have not yet formed a unified drug standard coding and trace ability standards. The current cold chain standards GSP( product supply norms) and GMP( production quality management norms) are not uniform, and enterprises are not fully implemented in accordance with national regulations, and supervision is still not enough.\[2\]

3. Analysis on the impact of outbreak on cold chain transportation
3.1. Cold chain logistics is the mission of transporting living materials
During the Spring Festival this year, in the face of the sudden outbreak of the new type of coronary pneumonia virus, many citizens no longer go out to buy food or dinner, how to let citizens eat fresh vegetables at home every day, has become a big rigid demand. Many fresh e-commerce platforms respond quickly, increase the supply of vegetable baskets, for the public to send fresh vegetables home, responsible for fresh transportation and distribution of cold chain logistics in which played a vital role.\[3\]
3.2. Cold chain logistics carries the mission of transporting drugs to fight the epidemic

With the smooth progress of virus detection, vaccine development and other follow-up work, the application of virus detection kit will help to quickly distinguish common cold fever from new crown virus, which is of great significance to block transmission and reduce panic. It can be said that the development of cold chain logistics is closely related to people's daily life. Looking back on the development of cold chain logistics in China in 2019, although affected by the real economy and other aspects of the environment, many enterprises are affected by more significant market shocks.

3.3. Cold chain logistics service fresh e-commerce platform

In recent years, with the improvement of national living standards and the explosive growth of fresh e-commerce platform, people's demand for food is becoming more and more diversified, and imported fruits, organic vegetables and local meat products are placed on the people's table. According to relevant statistics, the import volume of frozen and refrigerated aquatic and meat products rose to about 10 million tons in 2019, and the total output of fruits, vegetables, meat products, aquatic products and dairy products is expected to exceed 1.3 billion tons in 2019; The total scale of the cold chain logistics market is expected to reach 339.12 billion yuan, an increase of 17.60% over the same period last year, and the demand for the cold chain market is huge.[4]

In the investigation, it was found that the cold chain transport volume of most enterprises decreased by the epidemic, 52.63% of enterprises indicated that the volume of transport decreased by more than 30%, and 15.79% of enterprises reduced the volume of transport by 10-20%, as shown in figure 1. In terms of freight rates, 52.63% of enterprises reflected no significant change in freight rates, and 21.05% of enterprises indicated that freight rates increased by 10-20%, as shown in figure 2.[4]

![Figure 1. Changes in cold chain volume](image1)

![Figure 2. Changes in cold chain rates](image2)
4. Safe and efficient transport programme for vaccines under epidemic conditions

4.1. Requirements during vaccine transport
(1) The transport of vaccines must be carried in a freezer, The appropriate refrigeration equipment must be provided when receiving the vaccine.
(2) During the transportation of vaccines, the personnel who distribute, transport and receive the vaccines shall carry out temperature monitoring records.
(3) Cold chain equipment must be used exclusively for special purposes and shall not be diverted for other purposes.
(4) The cold chain equipment must build the file to build the card, establish and perfect the procedure of receiving and issuing and the registration system, make the account.
(5) Vaccine entry and exit must establish a special account, so that the account, vaccine match.
(6) The vaccine shall be kept in the cold chain system and shall be kept by a special person, OPV, MV the vaccine, etc. shall be stored in -20℃, BCG, HBV, DPT, DT etc. in 2℃-8.
(7) Temperature monitoring should be carried out during vaccine preservation, and vaccine temperature should be measured once a day after work and before work, and the results of monitoring should be recorded truthfully; Do a good record of power outages, downtime, failure maintenance, administrators can not go out for daily monitoring to do a good shift.
(8) The vaccines stored should be neatly arranged, and there should be a gap of 1-2 cm between the vaccine and the vaccine. The vaccines should be classified according to the name and expiry date.
(9) Cold chain equipment should be maintained regularly, always keep the refrigerator clean, so that no dust, no stains, refrigerator evaporator frosting temperature more than 4 hours to timely defrosting and defrosting, long-term stop when using, The inside and outside of the box should be cleaned and turned on for 2 hours a week. Refrigerators and reefer backpacks are used to wipe clean water traces to keep the box dry and clean.
(10) Any abnormal or malfunctioning cold chain equipment shall be reported in time, inspected and repaired by professional personnel, and shall not be disassembled casually by non-professional technical personnel.\[5\]

4.2. Design of refrigerated transport modes for vaccines
Because of its long holding time and high control ability, refrigerated truck becomes the main means of vaccine refrigerated transportation. There are many different types of refrigerated trucks developed today, including mechanical refrigeration, cold storage system refrigeration and cryogenic refrigerant refrigeration. For refrigeration accuracy, refrigerated trucks with mechanical refrigeration are commonly used for refrigerated transport tasks with temperature upper and lower limits.

The heat preservation box is a tool to achieve the temperature maintenance of the contents by reducing heat transfer through insulation materials. Since the main control temperature of the vaccine is between 2℃ and 8℃, most of the incubators used for vaccine transportation are also called cold storage boxes. The main reasons for the use of incubators for the transport of vaccines are air transport during emergencies, in some remote areas, hard-to-reach areas with refrigerated vehicles and areas where freight vehicles are banned in the city centre, the use of different time-sensitive incubators is a very flexible and effective solution.

Combined with two main modes of transport, the overall vaccine transport can be set as shown in Figure 3.\[3\]
5. Conclusion
According to the world health organization, new coronary pneumonia is growing rapidly and many patients are expecting the vaccine to be delivered to them as soon as possible. Now the high incidence of infectious diseases has surpassed any period in human history. At this time safe and efficient transport is an important guarantee to defeat the disease. Among the many human suffering, disease is one of the most dangerous. Safeguarding the safety of medical supplies is also the guardian of human life and health, helping doctors to join in the struggle to conquer disease and strive to return health and happiness to millions of patients and their families.

Reference
[1] Wang Qiaobo. Research on the Development of Cold-chain Logistics in Aviation Medicine in China GSP the Background [J]. National Circulation Economy ,2018(25).
[2] Xiong Yongjing, Yu Liying. Optimization of Pharmaceutical Cold Chain Logistics Distribution Based on New GSP Standard [Journal of J] Shanghai University ,2017(05).
[3] Enlightenment of Chen Ning's Foreign Modern Medicine Cold-chain Logistics Model to China [J.] Logistics Technology ,2014(11).
[4] Feng Weiying. on the scarcity of medical cold chain logistics talents in china [J] china pharmacoeconomics ,2013(02).
[5] Tang Jie. Practice and Reflections on Drug Cold Chain Management in Medical Institutions [J.] Huahai Medicine ,2012(30).