

## Controlling COVID-19 Transmission due to Contaminated Imported Frozen Food and Food Packaging

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### BACKGROUND

The emergence of the coronavirus disease 2019 (COVID-19) has been sharply increasing with more than eighty million confirmed cases worldwide (1). It has been contained in China through stringent non-pharmaceutical interventions (2). A combination of strict border control and quarantine measures have effectively prevented the spread of the virus from infected travelers, but the risk of resurgence caused by other routes of transmission (fomite transmission) has been identified in a number of localized outbreaks (3–7). Although the COVID-19 virus is highly unlikely to cause an epidemic through foodborne transmission, epidemiological investigation on the source of infection have found that all these outbreaks in different cities in China could be tracked to fomite transmission originating from workers at port cold storage, seafood processing facilities, and market sites related to imported cold-chain food (Table 1) (3–4). Furthermore, COVID-19 viral RNA has been detected on the surface of frozen food (salmon, white shrimp, lophiiformes, cod fillets, frozen hairtail, frozen beef, frozen pig elbow, frozen chicken wings, and frozen pork) and their packaging materials imported from countries with significant COVID-19 epidemics across 18 provincial level administrative divisions (PLADs) in China (Figure 1).

Additionally, several COVID-19 outbreaks have occurred in meat and poultry processing facilities abroad. COVID-19 was diagnosed in 18.2% workers in some states of the USA (8). Those who work in these cold, high humidity, and congregate locations are at high risk for both the acquisition and transmission

of respiratory infections. Thus, the food and food packaging materials are likely to become contaminated through droplets expelled from COVID-19 carriers by breathing, coughing, singing, sneezing, or even talking. Moreover, scientific studies have shown that COVID-19 virus remained highly stable under refrigeration (4 °C) and freezing conditions (–20 °C and –80 °C), on fish, chicken, and pork for 21 days (9). In the investigation of the COVID-19 outbreak in Qingdao, live COVID-19 virus was successfully isolated and cultured from samples taken from imported frozen seafood packaging (10). These findings indicated that COVID-19 virus could survive on cold-chain food and food packaging during long distance shipping and may cause human infection, in particular to high-risk people (such as dockworkers or stevedores). It was confirmed in these studies that COVID-19 outbreak could be caused by fomite transmission in the cold food chain, although the likelihood of this food-to-human transmission is considered lower when compared with other routes of transmission.

Keeping all workers in the whole food supply chains healthy and safe is vital for their personal wellbeing, for their families, and for ensuring that consumers' needs are met. This is also important for maintaining consumer trust and confidence in securing safe and sustainable food supply. In this regard, Chinese authorities have developed a series of guidance documents to protect food workers from contracting COVID-19, to prevent cross-contamination of COVID-19 virus across the whole food chain to avoid possible exposure of the virus to consumers, and to strengthen food hygiene and sanitation practices.

TABLE 1. Coronavirus disease 2019 outbreaks related with the cold-chain food and food packaging in 2020.

Date	City	Place	Zero patient	Cold-chain food contamination
June 11	Beijing	Wholesale market	Employee	Imported salmon
July 22	Dalian	Dock	Dockworker	Food packaging of imported fish
September 24	Qingdao	Dock	Dockworker	Food packaging of imported frozen cod
November 8	Tianjin	Cold storage	Stevedore	Food packaging of frozen pork

## GUIDANCE RELATED TO IMPORTED COLD-CHAIN PRODUCTS

The Joint Prevention and Control Mechanism of the State Council of the People’s Republic of China rapidly promulgated eight technical guidance documents at a national level for the prevention and control of COVID-19 transmission related to cold-chain food production according to the COVID-19 epidemic situation in China (Figure 2). More than 30 guiding documents were promulgated by municipal or provincial governments based on the State Council documents. These documents could be classified into four categories: guidance to prevent human infection,

guidance for detection methods, guidance for disinfection, and guidance for source tracing.

### Guidance to Prevent Human Infection

Transmission of the COVID-19 virus has been linked to close contact between individuals within closed settings. In addition, outbreaks have happened in port cold storage, meat/seafood processing facilities, and wholesale markets. Four documents were proposed including the following: “Guidance for normalizing prevention and control of COVID-19 outbreaks in key locations, key units, and key populations in low-risk areas in summer (revised edition)” Guidance [2020]-192 (Jun 17, 2020) (11), “Guidelines on prevention

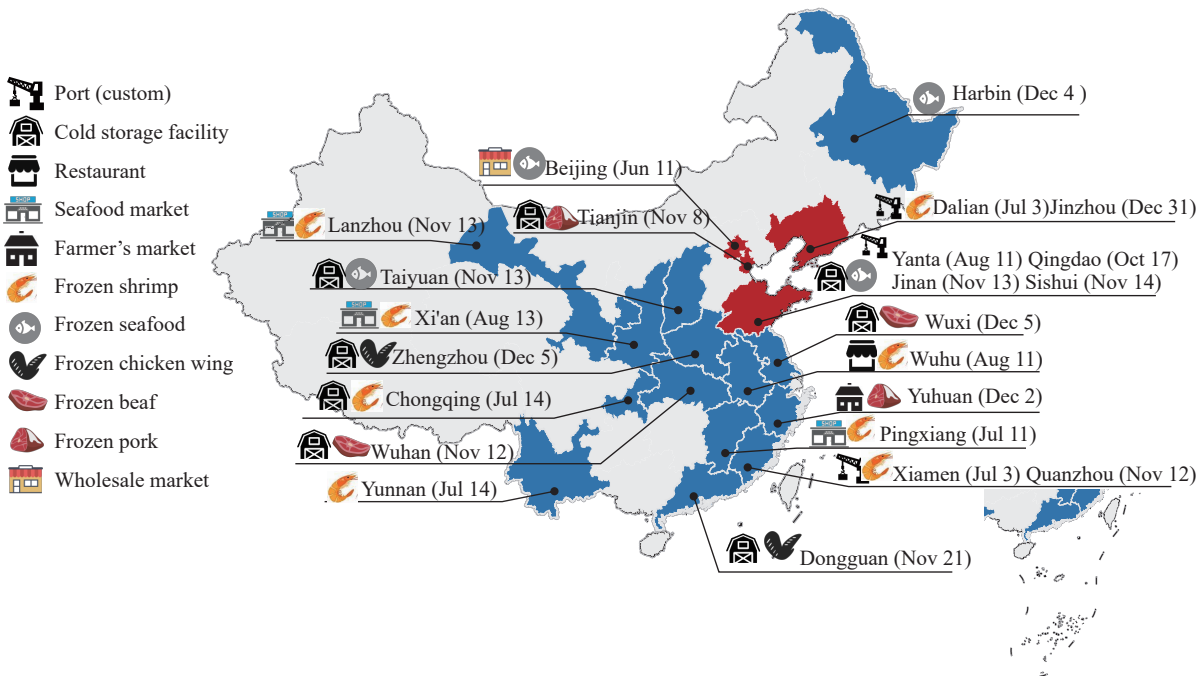


FIGURE 1. Detection of COVID-19 virus on imported frozen raw foods across China from early June 2020 to the end of December 2020. The blue regions represent areas where the viral RNA has been detected, while the red regions represent areas with both viral RNA having been detected and outbreaks having occurred.

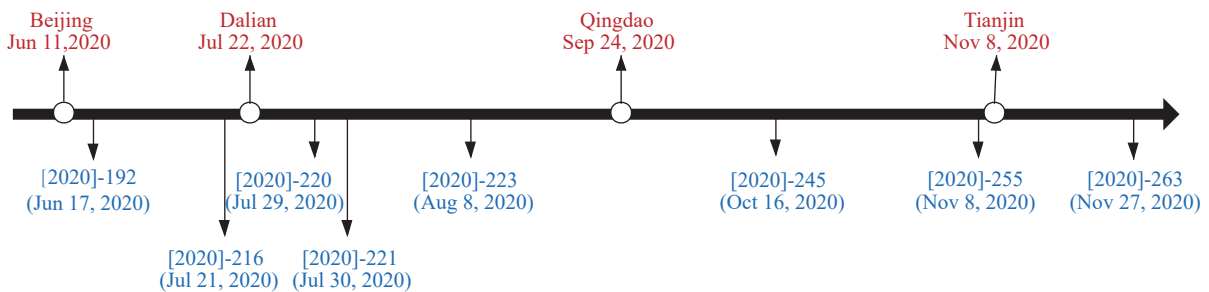


FIGURE 2. The timeline of the onset of coronavirus disease 2019 outbreak and the prevention and control technical guidance documents in 2020.

and control of COVID-19 for meat processing facilities” Guidance [2020]-216 (Jul 21, 2020) (12), “Technical guidance for COVID-19 prevention and control in farmers’ markets” Guidance [2020]-223 (Aug 8, 2020) (13), and “Technical guidance for prevention and control of COVID-19 in cold food production chain and technical guidance for disinfection in cold food production chain to prevent and control of COVID-19” Guidance [2020]-245 (Oct 16, 2020) (14). These guidance documents are intended for stakeholders to ensure compliance with measures to protect food workers and consumers from contracting COVID-19, to prevent exposure to the virus or transmission of it, and to strengthen food hygiene and sanitation practices.

### Guidance for Detection Methods

COVID-19 viral RNA has been detected on frozen food and food packaging and the contaminated cold-chain food and food packaging might lead to a systematic risk for COVID-19 virus transmission. In order to implement the “four early” (early detection, early report, early isolation, and early treatment) prevention and control strategy and strengthen epidemic prevention and control, it is required to strengthen the epidemic risk surveillance to prevent potential additional risks. The most important factor is to strengthen the testing of food, its environment, and the workforce. As a result, “Guidance on strengthening the detection of COVID-19 virus in the cold-food chain” Guidance [2020]-220 (Jul 29, 2020) (15) and “Technical guidance of environmental monitoring of COVID-19 virus in farmers’ markets” Guidance [2020]-221 (Jul 30, 2020) (16) were proposed. COVID-19 virus laboratory testing technical methods as well as a sampling plan and laboratory biosafety is included.

### Guidance for Disinfection

Environmental surfaces are more likely to be contaminated with the COVID-19 virus in manufacturing chain where outbreaks have taken place. Therefore, “Technical guidance for prevention and control of COVID-19 in cold food production chain and technical guidance for disinfection in cold food production chain to prevent and control of COVID-19” Guidance [2020]-245 (Oct 16, 2020) (14) and “Work plan for preventive and comprehensive disinfection of imported cold-chain food” Guidance

[2020]-255 (Nov 8, 2020) (17) were proposed. The purpose of these documents is to provide guidance on the cleaning and disinfection of environmental surfaces (disinfection of internal and external packaging of loading and transportation tools and products) in the context of COVID-19.

### Guidance for Source Tracing

Rapid cold-chain food tracking provided strong support for the prevention and control of COVID-19 outbreaks in Dalian, Qingdao, and Tianjin. As a result, the “Notice on further improving tracking management of cold-chain food” Guidance [2020]-263 (Nov 27, 2020) (18) was proposed. In accordance with this guidance document, the national tracking platform was built for imported cold-chain food and has been connected to more than 9 provincial tracking systems (including Beijing, Zhejiang, and Guangdong, etc.) in real time of the production chains.

## SHORT-TERM RESULTS AFTER IMPLEMENT

In accordance with the requirements of the Joint Prevention and Control Mechanism of the State Council of the People’s Republic of China (Guidance [2020]-220), sampling and testing of cold-chain food and food packaging in the market and the environment were conducted at the national level. The positive rate of COVID-19 testing in the imported cold-chain food was relatively higher than before. By November 30, 2020, COVID-19 viral RNA was detected in food or food packaging samples collected nationwide, with an overall positive rate of 0.048‰ (19). As COVID-19 continues to spread around the world, relevant departments should strengthen the inspection of inbound cold-chain goods from foreign countries, especially those countries or regions with serious outbreaks.

Furthermore, workers needed to be protected as the main route of COVID-19 virus transfer to food and food packaging is assumed to be via cross contamination from infected individuals. Workers who have frequent contact with cold-chain food have a high possibility to be contaminated by COVID-19 virus without effective protection. It is suggested to enhance the awareness of protection and take preventive measures for food workers, especially the high-risk employees.

## CONCLUSION

Since June, several COVID-19 outbreaks in China have been linked to the cold-chain food and food packaging. With increasingly reported evidence, food and food packaging contaminated by COVID-19 virus may pose a risk of spreading the virus under certain conditions. According to a range of different situations, the government has issued a series of guidance documents to prevent both human-transmission and fomite-transmission, which has become a widely adopted practice of epidemic prevention and control. Moreover, technical guidances for cold-chain food tracking are also necessary. So far, the epidemic of COVID-19 has been contained in China through stringent non-pharmaceutical interventions and the integrity of the food chain has been maintained and adequate supplies of safe food is available for all consumers.

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