

How to deal with the transmission of SARS-CoV-2 on the surface of Cold-chain foods to people: a review

G.-S. CHEN¹, S. HU¹, S.-L. ZHENG¹, C.-D. LIU¹, M. WANG²

¹Department of General Practice, Affiliated Hospital of Weifang Medical University, Weifang, Shandong, P.R. China

²Department of Emergency, Affiliated Hospital of Weifang Medical University, P.R. China

Abstract. – OBJECTIVE: The outbreak of SARS-CoV-2 in 2020 has become the world's largest public health event, causing global attention and concern. Despite national efforts to control this emerging infectious disease, it still cannot be contained. China, which reported the disease early, was able to control the outbreak quickly, but there is the problem of imported infections abroad. This review aims to summarize SARS-CoV-2 detected on the outer packaging of imported cold chain food and lead to the transmission of novel coronavirus.

MATERIALS AND METHODS: We reviewed information on SARS-CoV-2 detected on the outer packaging of imported cold chain food and relevant literature. We searched the following databases: PubMed, Web of Science, EMBASE and CNKI. search terms were "2019 nCoV", "SARS-CoV-2", "COVID-19", "cold-chain", "item surface", "spread", "people".

RESULTS: We found that SARS-CoV-2 survives on the surface of cold-chain food for a long period of time and these active viruses can be transmitted to humans.

CONCLUSIONS: We believe that while strictly preventing and controlling the importation of infected patients, we should strengthen the management of imported cold-chain food and its workers to prevent the transmission of SARS-CoV-2 to humans on the surface of cold-chain food objects.

Key Words:

COVID-19, SARS-CoV-2, Cold-chain food, Surface, Transmission.

which is highly contagious and spreads rapidly, quickly spreading around the world^{1,2}. Paradoxically, unlike other respiratory infections, Corona Virus Disease 2019 (COVID-19) also breaks out in hot summer weather, as it does in tropical countries³. Surprisingly countries with robust health care delivery systems and advanced medical technologies also experience outbreaks of COVID-19. SARS-CoV-2, in December 2019, began to be detected in Wuhan, China, and spread rapidly in a short period of time^{4,5}. China adopted an aggressive and effective strategy of rigorous prevention and control and brought the outbreak under control within a few months. As a result of outbreaks in many countries, China faced the difficult task of importing infected patients abroad for transmission. With China's strict prevention and control measures, imported cases were fully contained. However, in the second half of 2020, several cases of COVID-19 were detected on the outer packaging of imported cold-chain foods in China and resulted in the transmission of the disease⁶. To explore the presence and transmission of the virus on the surface of cold-chain foods, we searched relevant literature and departmental circulars and reviewed to propose countermeasures for the management of imported cold-chain cargo to eliminate the transmission of novel coronaviruses from the surface of articles to humans. Imported cases and the novel coronavirus on the surface of objects are detected and dealt with early, so that the virus can be fully controlled on a continuous basis.

Introduction

The outbreak of novel coronavirus pneumonia in 2020 was caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2),

Presence and Spread of SARS-CoV-2 on the Surface of Objects

In December 2019, several cases of unexplained pneumonia were reported in Wuhan, China, and

were soon found to be infectious. On January 7, 2020, experts from the Chinese CDC isolated the pathogen as a novel coronavirus. On January 12, 2020, the World Health Organization officially named this virus as SARS-CoV-2.

SARS-CoV-2 is highly contagious, and the population is generally susceptible. SARS-CoV-2 is transmitted mainly through respiratory droplets and close contact. COVID-19 patients emit the virus from their bodies into the air and surfaces of objects by talking, coughing and sneezing. The surfaces of objects in areas at high risk of respiratory infections such as hospital fever clinics, infectious disease clinics, respiratory clinics and emergency departments are where SARS-CoV-2 is most prevalent. The surfaces of objects in confined and crowded buses, airplane cabins, subways, supermarkets, restaurants, airports and train stations are also frequently exposed to SARS-CoV-2. People in these places are susceptible to infections when they are not well protected^{7,8}. Hospitals and aircraft cabins are the most common accelerators of SARS-CoV-2.

Viral stability and infectivity under environmental conditions are influenced by viral biology (type), environmental (temperature, light, relative humidity) and surface physicochemical properties, as well as local environmental factors, including vector fluid properties (saliva/mucus), virulence agents, pH, etc⁹. SARS-CoV-2 spike protein has a 10-to-20-fold increased affinity for the ACE2 receptor compared to SARS-CoV-1, which may contribute to efficient replication in the upper respiratory tract and allow for more efficient transmission in humans¹⁰. Chin et al¹¹ reported prolonged survival of SARS-CoV-2 on plastic surfaces, where it was released at room temperature and 65% relative humidity for 7 days. Fisher et al¹² found no decrease in the titer of infectious SARS-CoV-2 at low temperatures and was able to survive in inoculated chicken, pork and salmon fillets stored at -20°C for 3 weeks. This would suggest that SARS-CoV-2 may survive and spread on the surface of cold objects for extended periods of time.

Long-Term Presence of SARS-CoV-2 on the Surface of Cold-Chain Foods

Cold-chain food is at a specific low temperature throughout the entire process from processing, storage, transportation, distribution and retailing in order to maintain the quality of the food. The temperature of cold-chain items generally needs to be controlled at around -18°C. During this cold chain process, microorganisms such as viruses do

not freeze to death or grow and multiply and remain viable. Frozen seafood products are usually stored at low temperatures, the lower temperature of the environment, the longer the virus can survive, making it easy to find novel coronavirus viruses in frozen seafood products or on their packaging. Incubation periods of SARS-CoV-2 and asymptomatic infections can also spread the disease. In these areas with high levels of SARS-CoV-2, contamination can occur from latent and asymptomatic cases infected individuals participating in the processing, packaging, handling, and transportation of cold chain food.

Since July 2020, the presence of SARS-CoV-2 has been detected in imported cold-chain foods from South America and Europe in Xiamen, Dalian, Chongqing, Yantai, Qingdao and Shenzhen, China, and some have been transported to other locations for wholesale distribution¹³⁻²⁶ (Table I).

Interestingly, the samples that tested positive for the novel coronavirus were all from the outer packaging of frozen seafood products and were not detected within the frozen seafood food, suggesting that the chances of the food itself being contaminated with the virus are very small, which means that the chances of the virus being transmitted through food are relatively small. We consider that the reason for this may be related to the fact that masks must be worn in specific places when processing cold-chain foods. During transport of these cold-chain foods, latent and asymptomatic cases may not wear masks and could easily excrete SARS-CoV-2 or contaminate the outer packaging of cold-chain foods.

A shipment of frozen pork from Bremerhaven, Germany arrived at Tianjin port after a long journey on 19 October 2020. On November 4, the shipment was transported from the Pacific Ocean Terminal to the Hailian Cold Storage, and on November 5, the shipment was shipped in its entirety to Dezhou, Shandong Province. On November 7, a weakly positive test for SARS-CoV-2 was detected on the surface of the cold-chain pork package in Dezhou. The virus survived in the cold-chain for nearly 20 days from the time of entry to the time of detection²⁷. Cold-chain food products usually travel by sea and take more than 20 days to reach China from South American countries. The high detection of SARS-CoV-2 on the packaging surface of cold-chain seafood from Ecuador, South America also indicates that SARS-CoV-2 survives for at least 20 days on the packaging surface of cold-chain seafood.

As relevant government departments and the public pay attention to the problem of SARS-CoV-2

Table 1. Detection of imported cold-chain foods and their packaging surfaces.

Time	Location	Category	Location of detection	Importing countries	Source/Link
Jul 3, 2020	Xiamen, Fujian	Frozen shrimp	Outer packaging	Ecuador	Bi, 2020 ¹³
Jul 3, 2020	Dalian, Liaoning	Frozen shrimp	Outer packaging, Container interiors	Ecuador	Bi, 2020 ¹³
Jul 14, 2020	Pingxiang, Jiangxi	South American White Shrimp	Container interiors and overpacks	Ecuador	Tang, 2020 ¹⁴
Jul 14, 2020	Shapingba, Chongqing	South American White Shrimp	Outer surface of the box	Ecuador	Wang, 2020 ¹⁵
Jul 16, 2020	Yunnan	South American White Shrimp	Outer surface of the box	Ecuador	Yunnan Provincial Health Committee, 2020 ¹⁶
Jul 23, 2020	Dalian, Liaoning	A variety of seafood	Cold storage food, processing workshop, dormitory, canteen, horse yard, communal toilets, administrative offices	N/A	Dalian Municipal Health Committee, 2020 ¹⁷
Aug 11, 2020	Yantai, Shandong	Frozen Seafood Products	Outer packaging	N/A	Zhou, 2020 ¹⁸
Aug 12, 2020	Longgang, Shenzhen	Frozen Chicken Wings	Frozen chicken wing surface	Brazil	Xuan, 2020 ¹⁹
Aug 12, 2020	Xian, Shanxi	Frozen white shrimp	Outer packaging	Ecuador	Shanxi Provincial Health and Wellness Committee, 2020 ²⁰
Oct 17, 2020	Qingdao, Shandong	Frozen Cod	Outer packaging	N/A	Chinese Centre for Disease Control and Prevention, 2020 ²¹
Oct 29, 2020	Rushan, Shandong	Frozen Pork	Outer packaging	Brazil	Zhang et al, 2020 ²²
Oct 30, 2020	Anqiu, Shandong	Frozen Pork	Outer packaging	Brazil	Zhang et al, 2020 ²²
Oct 30, 2020	Yantai, Shandong	Frozen Pork	Outer packaging	Brazil	Zhang et al, 2020 ²²
Oct 31, 2020	Weihai, Shandong	Frozen Pork	Outer packaging	Brazil	Zhang et al, 2020 ²²
Nov 07, 2020	Dezhou, Shandong	Frozen Pork Fore Knuckle	Outer packaging	Bremen, Germany	Cheng, 2020 ²³
Nov 07, 2020	Taiyuan, Shanxi	Frozen Scallops	Outer box	India	Taiyuan City New Coronavirus Pneumonia Epidemic Prevention and Control Leading Group Office, 2020 ²⁴
Nov 07, 2020	Tianjin	N/A	Outer packaging, Door handles	N/A	Tianjin Municipal Health and Wellness Commission, 2020 ²⁶
Nov 18, 2020	Fuzhou, Fujian	Frozen Pomfret	Outer packaging	India	Zhao, 2020 ²⁵

detection on the surface of imported cold-chain food, the detection of SARS-CoV-2 on the surface of imported cold chain food has increased, which has led to an increase in the detection of SARS-CoV-2 on the surface of cold-chain food. However, do not be overly concerned, as SARS-CoV-2 has been detected on the surface of imported cold-chain foods

at only 0.48 parts per million through sampling and monitoring to date²⁸. We should not only pay attention to the problem of SARS-CoV-2 detected on the surface of imported cold chain food, but also be rational and do a good job of initial disinfection and hygienic cleaning of the distribution chain to prevent the problem before it happens.

Transmission of SARS-COV-2 from Cold-Chain Food Surfaces to Humans

Earlier this year, it was reported that interpersonal transmission occurs mainly in households in China²⁹. This household transmission suggests that close contact transmission between individuals may be one of the most important modes of transmission³⁰. Family members infected with SARS-COV-2 readily emit SARS-COV-2 on the surfaces of room objects; however, direct research evidence of SARS-COV-2 transmission from the surfaces of these objects alone has not been seen.

Although the presence of SARS-COV-2 on the surface of cold-chain food products was detected in several cases from imported food, it is not clear how active SARS-COV-2 is on the surface of these objects and whether they transmit to humans. Previously, the viral nucleic acid load on the packaging surface of imported cold-chain foods was low and no live virus had been isolated.

On October 17 2020, China Center for Disease Control and Prevention issued an official release, confirming for the first time outside the laboratory that novel coronavirus could survive for a longer period of time on the outer packaging of items under special conditions of cold chain transport, suggesting that the novel coronavirus could infect people in contact with the items under specific conditions and circumstances, using cold-chain items as carriers. The cold-chain food has the potential to be used as a vehicle for cross-border importation of novel coronaviruses. Cold-chain foods have the potential to import SARS-COV-2 across borders over long distances²¹.

On September 19, 2020, two workers from Qingdao Port Dagang Company loaded and unloaded this shipment of frozen seafood imported from abroad during the night shift. On September 24, 2020, during regular routine SARS-COV-2 testing of personnel in contact with the imported products, two stevedores were found to be infected with the novel coronavirus and were asymptomatic. As there were no novel coronavirus patients in Qingdao at that time, and they had no history of travel outside the city. Combining these epidemiological histories with the fact that both workers had a history of contact with cold-chain food overpacks, it was considered that SARS-COV-2 transmission from cold-chain food overpacks may have been the cause. 2 workers were sent to the sentinel hospital for treatment, and 1 patient later developed clinical symptoms and changes in the chest CT and was diagnosed with COVID-19 common type.

Meanwhile, 132 and 228 close contacts of the 2 patients were all put under intensive isolation. All 360 close contacts and 4341 general contacts were negative for SARS-COV-2³¹.

Coincidentally, the incident did not end there and involved a SARS-COV-2 sentinel hospital. The 2 patients with SARS-COV-2 who left the closed ward for examination in the CT room during isolation and observation at the designated hospital, were not properly protected, resulting in the CT room being contaminated with the virus, which in turn infected the TB inpatients and their companions who went to the same CT room for examination the following morning, and brought the virus into the TB ward, leading to the spread of this outbreak in the hospital.

This infection event successively involved 7 TB patients admitted to the hospital, 3 were daily companions of TB patients at the hospital and 2 were family members of patients or caregivers at the hospital. No health care workers were infected. The whole gene sequence sequencing and matching were carried out and confirmed that the infected individuals were highly homologous to the viral gene sequences of the specimens of the two loaders³². Fortunately, no community transmission occurred, and the outbreak of this SARS-COV-2 was quickly contained through the efforts of various departments.

What impressed the world was that, in response to this SARS-COV-2 transmission on the surface of objects, nucleic acid testing was conducted around the clock in Qingdao for a full 120 hours from November 12, 2020, and on October 17, nucleic acid testing was almost complete for the entire population of Qingdao, with the results of all 10899145 nucleic acid negative samples, except for the previously announced confirmed cases³³.

Later, on November 7, the outer packaging of a batch of German frozen pork samples imported through the Tianjin port was tested positive for SARS-COV-2, and in the early hours of 8 November, the first nucleic acid test results showed a positive test at the door handle of a cold storage at the site, while a handler from a frozen food company was also tested positive²⁶. Another asymptomatic infection was added to Tianjin on November 9 for a Binhai New Area Dongjiang port cold-chain handler. Although it is not certain that these patients are infected by cold-chain food surface SARS-COV-2, they have no history of exposure or epidemiological history of SARS-COV-2.

Strengthening the Management of SARS-COV-2 Transmission to People on the Surface of Cold-Chain Foods

SARS-CoV-2 is a respiratory virus and there is no evidence that SARS-CoV-2 poses a food safety risk. Although the probability of human transmission of SARS-CoV-2 from contaminated food packaging surfaces is small and concentrated in the outer packaging of food, we need to pay attention to it. This is because SARS-CoV-2 on the surface of cold-chain foods can be transported over long distances, allowing the spread of COVID-19 infection from areas of high prevalence to areas of low risk of COVID-19 or areas free of COVID-19 outbreaks.

Although different countries and regions implement their own food safety management systems during the preparation and packaging of cold chain items, they are all based on good hygiene practices. For example, hygienic practices such as wearing clean clothing, washing hands before handling, wearing hats and masks, etc. prevent any potential microbial contamination from spreading to the food³⁴.

It has been reported that approximately 90% of SARS-CoV-2 transmission is from symptomatic and asymptomatic patients, with the remaining 10% coming from the environment, including surfaces³⁵. Food contact surfaces include all areas that come into contact with food during preparation (e.g., cutting boards, tables, utensils), production, processing and packaging, and typically include stainless steel, plastic materials, wood, rubber, ceramics or glass³⁶⁻³⁸. These surfaces can be contaminated with pathogenic bacteria and viruses that can infect the food and/or the person handling it³⁹, so the greatest risk in the food environment remains human-to-human transfer. The wearing of masks, hats and gloves during cold-chain food processing greatly reduces contamination during cold-chain food processing. During the handling and transport of these cold chain foods, the environment in which they are handled and transported has low hygiene requirements, which can lead to contamination of the cold-chain food outer packaging.

Introduction of Relevant Policies Based on the Detection of SARS-COV-2 on the Surface of Imported Cold-Chain Foods

With the increase in the detection of SARS-CoV-2 on the surface of imported cold-chain food and the occurrence of its transmission to people, the relevant departments in China attached great importance to it. A series of measures were introduced within a short period of time. On July 10,

2020, the General Administration of Customs announced the suspension of the registration of three Ecuadorian producers in China⁴⁰. On August 14, 2020, the General Administration of Customs announced the issuance of an announcement on the inspection and quarantine requirements for imported Ecuadorian frozen South American white shrimp⁴¹. On November 13, 2020, the Ministry of Transport issued the COVID-19 for (Imported Cold Chain Food Logistics by Road and Waterway Technical Guidelines on Prevention, Control and Disinfection of Viruses)⁴² and the [(Guidelines on Prevention and Control of Novel Crown Pneumonia Outbreak for Ports and their Frontline Personnel (Fourth Edition))]⁴³.

Strengthen the Management of Imported Cold-Chain Foods and Their Practitioners

Strengthen source control and strictly require imported cold-chain food companies to reduce or eliminate SARS-COV-2 contamination on the surface of imported cold-chain food during production and transportation. For companies with SARS-COV-2 contamination on the surface of cold-chain food, reduce or temporarily suspend their trading qualification.

Domestic personnel engaged in the importation of cold-chain food establish awareness of the risk of SARS-COV-2 infection, remember the importance of wearing appropriate personal protective equipment and practicing proper hand hygiene, and strictly implement national policies on cold-chain food prevention and control of the COVID-19. Loaders and unloaders should wear work clothes and hats, use disposable medical masks and gloves, etc., avoid goods close to their faces, touch their hands to their mouths and noses, and prevent contact with frozen aquatic products that may be contaminated with the Novel Coronavirus, etc. They do a good job of cleanliness and hygiene before leaving the cold-chain food workplace. Personnel working in the imported cold-chain food do a good health registration system and abnormal health reporting procedures and do SARS-COV-2 nucleic acid tests once a week^{42,43}.

Strengthening the Management of SARS-COV-2 Detection on the Surface of Imported Cold-Chain Food

During the transportation of imported cold-chain food, the carrier shall not open the container. If the test result is positive upon arrival, the cold-chain food operator shall promptly activate the

emergency plan of the unit, take timely emergency disposal of the relevant items and environment under the guidance of professionals according to local requirements, return the relevant items, temporarily seal them or dispose of them harmlessly, disinfect the work area, and carry out timely nucleic acid testing and health screening as well as isolation and observation measures for personnel who may come into contact with them. Personnel involved in the removal of relevant items should be properly protected personally and isolated for observation in the workplace. Even if the SARS-COV-2 test results for imported cold-chain food are negative, the customs department should organize guidance to urge the operators of the inspection sites or the importing enterprises to implement disinfection of the inside of the containers and the outer packaging of the goods for imported cold-chain food. Only timely detection and disposal of contamination by SARS-COV-2 can effectively stop the cold-chain from reaching the market. Consumers who purchase cold-chain food can avoid the risk of SARS-COV-2 infection by taking good personal precautions (avoiding direct contact with cold chain food with their hands).

Enhance Comprehensive Prevention and Control of SARS-COV-2 Transmission to Humans on the Surface of Imported Cold-Chain Food Products

When SARS-COV-2 is detected on the outer packaging of imported cold-chain food, all staff in contact with these items should be isolated and observed for their health status and SARS-COV-2 nucleic acid screening. Once they are positive for viral nucleic acid, they should be seen at a designated hospital regardless of whether they have symptoms such as fever, cough or fatigue. A survey of their movement trajectory is also conducted, and close contacts and general contacts are identified and placed under fixed-site isolation and home isolation observation for 2 weeks respectively. Early detection, diagnosis and treatment, combined with timely traceability, comprehensive contact investigation and integrated prevention and control, will maximize the possibility of controlling the SARS-COV-2 outbreak.

Conclusions

The transmission of SARS-COV-2 to humans from imported cold chain food surfaces is only an isolated occurrence. However, we also need to be

alert to this mode of long-range transmission and carry out early and comprehensive prevention and control to avoid large community spread.

Conflict of Interest

The Authors declare that they have no conflict of interests.

References

- 1) Lu HZ, Stratton CW, Tang YW. Outbreak of Pneumonia of Unknown Etiology in Wuhan China: the Mystery and the Miracle. *J Med Virol* 2020; 92: 401-402.
- 2) Wu F, Zhao S, Yu B, Chen YM, Wang W, Song ZG, Hu Y, Tao ZW, Tian JH, Pei YY, Yuan ML, Zhang YL, Dai FH, Liu Y, Wang QM, Zheng JJ, Xu L, Holmes EC, Zhang YZ. A new coronavirus associated with human respiratory disease in China. *Nature* 2020; 579: 265-269.
- 3) Wong JEL, Leo YS, Tan CC. COVID-19 in Singapore-Current Experience: Critical Global Issues That Require Attention and Action. *JAMA* 2020; 323: 1243-1244.
- 4) Hui DS, Azhar EI, Madani TA, Ntoumi F, Kock R, Dar O, Ippolito G, Mchugh TD, Memish ZA, Drosten C, Zumla A, Petersen E. The continuing 2019-nCoV epidemic threat of novel coronaviruses to global health - The latest 2019 novel coronavirus outbreak in Wuhan, China. *Int J Infect Dis* 2020; 91: 264-266.
- 5) Zhu N, Zhang DY, Wang WL, Li XW, Yang B, Song JD, Zhao X, Huang BY, Shi WF, Lu RJ, Niu PH, Zhan FX, Ma XJ, Wang DY, Xu WB, Wu GZ, Gao GF, Tan WJ, China Novel Coronavirus Investigating and Research Team. A Novel Coronavirus from Patients with Pneumonia in China, 2019. *N Engl J Med* 2020; 382: 727-733.
- 6) Yuan Q, Kou ZQ, Jiang FC, Li ZJ, Zhang LJ, Liu HH, Zhao X, Kang DM, Gao RQ, Lei J. A Nosocomial COVID-19 Outbreak Initiated by an Infected Dockworker at Qingdao City Port — Shandong Province, China, October, 2020. *China CDC Weekly* 2020; 2: 838-840.
- 7) Jiang YF, Wang HF, Chen YK, He JX, Chen LG, Liu Y, Hu XY, Li A, Liu SW, Zhang P, Zou HY, Hua SC. Clinical Data on Hospital Environmental Hygiene Monitoring and Medical Staff Protection during the Coronavirus Disease 2019 Outbreak. *medRxiv* [Preprint].
- 8) Ikonen N, Savolainen-Kopra C, Enstone JE, Kulmala I, Pasanen P, Salmela A, Salo S, Nguyen-Van-Tam JS, Ruutu P, PANDHUB consortium. Deposition of respiratory virus pathogens on frequently touched surfaces at airports. *BMC Infect Dis* 2018; 18: 437.
- 9) Xue X, Ball JK, Alexander C, Alexander MR. All Surfaces Are Not Equal in Contact Transmission of SARS-CoV-2. *Matter* 2020; 3: 1433-1441.
- 10) Lamers MM, Beumer J, van der Vaart J, Knoops K, Puschhof J, Breugem TI, Ravelli RBG, Paul van Schayck J, Mykityn AZ, Duimel HQ, van Donse-

- laar E, Riesebosch S, Kuijpers HJH, Schipper D, van de Wetering WJ, de Graaf M, Koopmans M, Cuppen E, Peters PJ, Haagmans BL, Clevers H. SARS-CoV-2 productively infects human gut enterocytes. *Science* 2020; 369: 50-54.
- 11) Chin AWH, Chu JTS, Perera MRA, Hui KPY, Yen HL, Chan MCW, Peiris M, Poon LLM. Stability of SARS-CoV-2 in different environmental conditions. *Lancet Microbe* 2020; 1: e10.
- 12) Fisher D, Reilly A, Zheng A, Cook A, Anderson D. (2020). Seeding of outbreaks of COVID-19 by contaminated fresh and frozen food. *bioRxiv* [Preprint]. 2020.
- 13) Bi KX. (2020, July 10). Joint prevention and control mechanism of the State Council holds a briefing on information related to preventing the risk of importing epidemics and strengthening the supervision of the cold chain of imported food. <http://fangtan.customs.gov.cn/tabid/1071/Default.aspx>.
- 14) Zhan J. (2020, July 15). Frozen South American white shrimp products from Pingxiang, Jiangxi, tested positive for nucleic acid in their outer packaging. http://www.xinhuanet.com/politics/2020-07/15/c_1126239771.htm.
- 15) Wang D. (2020, July 15). Frozen South American white shrimp imported into Chongqing were found positive for nucleic acid of the new coronavirus in some of the outer packaging samples. http://www.xinhuanet.com/politics/2020-07/15/c_1126242315.htm.
- 16) Yunnan Provincial Health Committee/Office of the Leading Group of Yunnan Province for the Response to the Epidemic. (2020, July 16). Information on the disposal of frozen South American white shrimp in Ecuador. <http://ynswsjkw.yn.gov.cn/web/doc/UU159486581758166169>.
- 17) Dalian Municipal Health Committee. (2020, July 23). The eighteenth centralized press conference on the prevention and control of the SARS-COV-2 epidemic. https://hcod.dl.gov.cn/art/2020/7/23/art_1844_464218.html.
- 18) Zhou CQ. (2020, August 11). Samples of imported frozen seafood products from three enterprises in Yantai, Shandong Province, were found to be positive for nucleic acid of the new coronavirus. http://www.xinhuanet.com/politics/2020-08/11/c_1126353585.htm.
- 19) Xuan LL, Li Z, Liu ZY, Shenzhen government online. (2020, August 16). Press conference on the prevention and control of the epidemic in Shenzhen. <http://www.sz.gov.cn/cn/xxgk/xwfy/wqhg/20200816/>.
- 20) Shanxi Provincial Health and Wellness Commission. (2020, August 14). Circular on the investigation and disposal of frozen raw South American white shrimp in Ecuador. http://sxwjw.shaanxi.gov.cn/ywgz/wsyj/gzdt_897/202008/t20200814_1805397.html.
- 21) Chinese Centre for Disease Control and Prevention. (2020, October 17). New live coronavirus isolated from cold chain food outer packaging. http://www.chinacdc.cn/jkzt/crb/zl/szkb_11803/jszl_2275/202010/t20201017_222144.html.
- 22) Zhang QS, Shandong issued a number of notices. (2020, November 01). Pork with positive nucleic acid test in outer packaging. http://www.xinhuanet.com/local/2020-11/01/c_1126682854.htm.
- 23) Cheng L. (2020, November 12). Why imported cold-chain food has repeatedly become a risk point for epidemics? http://www.xinhuanet.com/politics/2020-11/12/c_1126732884.htm.
- 24) Taiyuan City New Coronavirus Pneumonia Epidemic Prevention and Control Leading Group Office. (2020, November 09). One positive test was detected on the outer packaging of imported frozen scallop products in the city: Effective control of persons and goods has been achieved. <http://wjw.taiyuan.gov.cn/doc/2020/11/09/1027897.shtm>.
- 25) Zhao WH. (2020, November 18). Positive nucleic acid test for New Coronavirus found in the outer packaging of imported frozen pomfret in Fuzhou. http://www.xinhuanet.com/politics/2020-11/18/c_1126754255.htm.
- 26) Tianjin Municipal Health and Wellness Commission. (2020, November 08). A cold storage loader in Tianjin tested positive for nucleic acid and the related investigation is underway intensely. http://wsjk.tj.gov.cn/ZTZL1/ZTZL750/YQFKZL9424/FK-DT1207/202011/t20201108_4046021.html.
- 27) Mei YX, Wang JY, Tencent. (2020, November 13). Be alert! Imported frozen pork virus survived for nearly 20 days in the cold chain state. <https://new.qq.com/omn/20201109/20201109A04E6U00.html>.
- 28) Li N. (2020 November 25). The joint prevention and control mechanism of the State Council held a press conference at 15:00 on November 25 in the press conference room of the Xizhimen Office of the National Health and Health Commission to introduce the cold chain food and food safety in autumn and winter, and to answer questions from reporters. <http://www.gov.cn/xinwen/gwylfkjz138/index.htm>.
- 29) Li Q, Guan XH, Wu P, Wang XY, Zhou L, Tong YQ, Ren RQ, Leung KSM, Lau EHY, Wong JY, Xing XS, Xiang NJ, Wu Y, Li C, Chen Q, Li D, Liu T, Zhao J, Liu M, Tu WX, Chen CD, Jin LM, Yang R, Wang Q, Zhou SH, Wang R, Liu H, Luo YB, Liu Y, Shao G, Li H, Tao ZF, Yang Y, Deng ZQ, Liu BX, Ma ZT, Zhang YP, Shi GQ, Lam TTY, Wu JT, Gao GF, Cowling BJ, Yang B, Leung GM, Feng ZJ. Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus-Infected Pneumonia. *N Engl J Med* 2020; 382: 1199-1207.
- 30) Chan JF, Yuan SF, Kok KH, To KK, Chu H, Yang J, Xing FF, Liu JL, Yip CC, Poon RW, Tsoi HW, Lo SK, Chan KH, Poon VK, Chan WM, Ip JD, Cai JP, Cheng VC, Chen HL, Hui CK, Yuen KY. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. *Lancet* 2020; 395: 514-523.
- 31) Qingdao Municipal Health and Wellness Commission. (2020, September 24). The city found 2 cases of asymptomatic infection of novel coronavirus pneumonia in Qingdao Port Dagang Company during regular routine testing. <http://wsjkw.qingdao.gov.cn/n28356065/n32569200/n32569201/200924235953927462.html>.

- 32) Li ZJ. (2020, October 19). What has the CDC expert done since arriving in Qingdao? <http://fbh.qtv.com.cn/system/2020/10/19/015662233.shtml>.
- 33) Zhao GL. (2020, October 18). Press conference on the prevention and control of the epidemic in Qingdao. <http://fbh.qtv.com.cn/system/2020/10/18/015662053.shtml>.
- 34) Deng LZ, Mujumdar AS, Pan Z, Vidyarthi SK, Xu J, Zielinska M, Xiao HW. Emerging chemical and physical disinfection technologies of fruits and vegetables: a comprehensive review. *Crit Rev Food Sci Nutr* 2020; 60: 2481-2508.
- 35) Van Doremalen N, Bushmaker T, Munster VJ. Stability of Middle East respiratory syndrome coronavirus (MERS-CoV) under different environmental conditions. *Euro Surveill* 2013; 18: 20590.
- 36) Pressman Peter, Naidu A. S, Clemens R. COVID-19 and Food Safety: Risk Management and Future Considerations. *Nutrition Today* 2020; 55: 125-128.
- 37) Warnes SL, Little ZR, Keevil CW. Human Coronavirus 229E Remains Infectious on Common Touch Surface Materials. *mBio* 2015; 6: e01697-15.
- 38) Ren SY, Wang WB, Hao YG, Zhang HR, Wang ZC, Chen YL, Gao RD. Stability and infectivity of coronaviruses in inanimate environments. *World J Clin Cases* 2020; 8: 1391-1399.
- 39) De Rose DU, Reposi MP, Amadio P, Auriti C, Dall'Oglio I, Corsetti T, Dotta A, Salvatori G. Use of Disinfectant Wipes to Sanitize Milk's Containers of Human Milk Bank During COVID-19 Pandemic. *J Hum Lact* 2020; 36: 547-549.
- 40) General Administration of Customs Notice No.93. (2020, August 14). Announcement on Inspection and Quarantine Requirements for Imported Frozen South American White Shrimp from Ecuador. <http://www.customs.gov.cn/customs/302249/2480148/3242354/index.html>.
- 41) Jiaoyun Mingdian[2020]No.241. (2020, August 26). Ministry of Transport Ministry of Transport Notice on Further Strengthening the Prevention and Control of New Crown Pneumonia Epidemic in Cold Chain Logistics. http://www.gov.cn/zhengce/zhengceku/2020-08/29/content_5538336.htm.
- 42) Jiaoyun Mingdian[2020]No.292. (2020, November 13). Ministry of Transport Ministry of Transport Notice on the Issuance of Technical Guidelines on Prevention, Control and Disinfection of New Coronavirus in Imported Cold Chain Food Logistics by Road and Waterway. http://www.gov.cn/zhengce/zhengceku/2020-11/14/content_5561444.htm.
- 43) Jiaoshui Mingdian[2020]No.294. (2020, November 13). Circular of the Ministry of Transport on the Issuance of the Guidelines for the Prevention and Control of the New Coronary Pneumonia Epidemic in Ports and Their Frontline Personnel (Fourth Edition). http://www.gov.cn/zhengce/zhengceku/2020-11/14/content_5561445.htm.