



An emergency responding mechanism for cruise epidemic prevention—taking COVID-19 as an example

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ABSTRACT

COVID-19 has severely impacted the global cruise tourism industry. The increasing number of confirmed cases during the quarantine period of 'Diamond Princess' questioned the efficiency and science behind the Japanese government's emergency management of the outbreak and led to a debate on the responsibilities of the ship's country of registry and port country. In order to deal with the spread of virus on a cruise ship rationally, the present study analyses why cruise ships are more prone to an emergent epidemic and discusses requirements of international conventions and domestic laws on cruise ship sanitation and epidemic prevention. It also evaluates the rescue responsibility of Flag State and Port State, explores the legal lacunae of international conventions on the rescue obligation of cruise home port, and provides solutions for prevention and control of cruise ship epidemic with short-term response measures and long-term mechanism construction. In terms of a short-term response, it is vital to adopt the quarantine idea of a 'temporary cabin hospital' and a disposal procedure of 'circular disinfection-section repeat testing-batch transfer and quarantine-international collaborative medical treatment'. For a long-term mechanism construction, three aspects need to be considered: the risk emergency management mechanism of cruise lines, health and epidemic prevention supervision mechanisms, and international cooperation mechanisms of infectious disease prevention.

1. Introduction

The coronavirus COVID-19 infection has reached a critical situation on a global scale [1]. An outbreak occurring on international cruise ships is difficult to control effectively due to large passenger capacity, smaller internal spaces, and intensive personnel activities. Recently, COVID-19 infection was recorded in both the 'Diamond Princess', operated by the Japanese Branch of the America Carnival Corporation & PLC and 'World Dream', operated by Genting Hong Kong, triggering an alarm for all the marine and inland passenger transports. Of these two cruises, the 'Diamond Princess', where the number of confirmed cases continued to rise during the quarantine period, is of greater concern to the international community. Before the outbreak, the 'Diamond Princess' was scheduled to depart from the Port of Yokohama on January 20, 2020, halting at Kagoshima on 22nd January, Hong Kong on 25th January, Naha Port on 1st February, and return to Yokohama on 3rd February. On 25th January, a male passenger in his eighties disembarked at Hong Kong and was diagnosed with COVID-19 on 1st February [2]. As of 11th

February, the Japanese government had tested 439 of 3711 people on board, with 135 people testing positive, greater than the number confirmed in all of Japan, during the same period [3]. Additionally, 39 confirmed cases were seen on 12th February, including a quarantine officer [4]. The total number of confirmed cases on the 'Diamond Princess' reached 454 on 17th February [5]. After 14 days of quarantine, the Japanese government finally allowed passengers who tested negative for the virus and showed no symptoms to disembark from the 'Diamond Princess' on 19th February [6]. Up to 27th February, the cumulative number of confirmed cases reached 705, including six deaths. In accordance with Japan NHK report on 22nd March, the number of confirmed cases of 'Diamond Princess' was 715, among which eight died [7].

The example of rising number of confirmed COVID-19 cases in such a short period is of great concern on part of the Japanese government's emergency management. The epidemic began to negatively impact the cruise tourism industry following the 'Diamond Princess' public health emergency. Several large cruise ships, such as the 'MS Westerdam',

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'Grand Princess', and 'Costa Fortuna', were not permitted to halt at various ports. Hence, the 'Exclusion Order' issued by many countries increased the operational risk of cruise companies. On March 11, 2020, Dr Tedros Adhanom Ghebreyesus, Director-General of the World Health Organisation (WHO) briefed the media clarifying that COVID-19 could be identified as a pandemic [8]. The epidemic continues to have a negative impact on the cruise tourism industry, leading to a sharp drop in the share prices of cruise companies, as well as layoffs of several cruise companies. As of 14th March, more than 30 large cruise companies and river shipping companies worldwide would be suspended or partially suspended in the future [9]. By 22nd March, multiple COVID-19 confirmed cases were reported by 11 cruise ships, including the 'Grand Princess', 'Silver Shadow', 'Silver Explorer', 'MSC Meraviglia', 'Costa Luminosa', 'MS Braemar', and 'Ruby Princess'. Before the COVID-19 outbreak, public health emergencies have frequently been reported on cruise ships [10]. The US Centres for Disease Control and Prevention (CDC) paid more attention to Norovirus and Influenza A, with more relevant regulations or guidelines on Norovirus [11]. Owing to mass gatherings, in China, the 'Diamond Princess' and 'Azamara Quest' reported transmission of Norovirus at the Shanghai port successively from 2008 to 2009, while the 'Fujimaru' reported Influenza A infection in 2010 [12].

Severity of epidemic emergencies on cruise ships caused by mass gatherings has surpassed that of other places onshore. The reasons for increased susceptibility of cruise ships to outbreaks require in-depth research. Traditionally, prevention and treatment of epidemics was a medical issue. However, this issue, along with responses to public health emergencies were closely related to legal governance. Emergency response mechanisms were formulated under a legal framework as the concentrated embodiment of the relevant provisions of international and domestic laws. On 14th February, the Chinese President, Xi Jinping convened the 12th Central Comprehensively Deepening Reform Committee and emphasized, 'We need to improve major epidemic prevention and control system and national public health emergency management system' [13]. In order to improve the emergency mechanism for prevention and control of cruise gathering epidemic in a rational manner, the present study attempts to reason why cruise ships are more prone to gathering epidemic, discusses requirements of international conventions and domestic laws on cruise ship sanitation and epidemic prevention. The rescue responsibility of Flag State and Port State for cruise ship is the researching focus, and the legal lacunae of international conventions on the rescue obligation of cruise home port will be discussed. The present study provides solutions for prevention and control of cruise ship epidemic from short-term response measures and long-term mechanism construction. In terms of short-term response measures, it is suggested to use the successful experience of 'temporary cabin hospital' in Wuhan, China with reference to quarantine and treat confirmed, but mildly infected cases in view of the peculiarity of cruise epidemic infection so as to establish an idea of quarantine by employing 'temporary cabin hospital' approach. This would help in blocking the spread from multiple sources as the core, adopting the disposal process of 'circular disinfection - section repeat testing - batch transfer and quarantine - international collaborative medical treatment', and finally providing a response plan for this public health emergency.

2. Reasons for mass outbreaks of infection on cruise ships

Cruise ship has long been known as a 'marine mobile community' and such vessels are more likely to be the sites of outbreaks due to their large passenger capacity, high personnel density, constrained internal environment, relatively concentrated diet, and a generally comprehensive itinerary of visiting ports in comparison to onshore communities [14]. An 'onshore community' was taken as a control model to determine any correlation between the special structures and management strategies of cruise ships during the incidence and spread of mass infection, and to explore the reasons for international cruise ships to be

more prone to these outbreaks of mass infection.

2.1. Correlation between characteristics of cruise ships and the outbreak of mass infection

2.1.1. Special airtight structures can encourage the internal microclimate to stagnate

A cruise ship is a highly airtight place, with its internal cabins being divided into passenger accommodation and public spaces, in addition to the areas required for the various operations of the ship. The public spaces include restaurants, theatres, swimming pools, etc. The internal environment of a cruise ship is narrow with varying cabin spaces. Some cabins, even with large accommodating spaces have no windows for ventilation and have only natural light. Such cabins solely rely on air conditioning to maintain the air quality, which can lead to microclimate stagnation [15]. More public places tend to encourage personnel mobility. According to publicly available data, the 'Diamond Princess' has 1337 cabins and suites, of which only 748 have balconies, while the rest have no natural light [16].

As a result of the outbreak, the 3711 passengers and crew on board the 'Diamond Princess' were quarantined. Small cabins and the long gathering time in the dining and entertainment rooms led to a high probability of contact infection. Besides, inadequate cabin air replacement would increase the risk of spread by aerosol, so gathering epidemics of respiratory infections are more likely to occur on cruise ships [17].

2.1.2. An internal circulation system of central air-conditioning is not conducive to effective quarantine conditions

The internal ventilation of cruise cabins is mostly regulated by central air-conditioning. Important factors affecting the health of passengers and crew such as sanitation, ventilation, and humidity of central air-conditioning relate to the total numbers of crew and passengers affected [18]. The circulation of central air-conditioning is divided into an external circulation system and an internal circulation system. Internal circulation is used to adjust temperature. In accordance with an article published in the *China Shipping Gazette*, the air input from external circulation is fresh and clean but maintaining a constant temperature requires more energy consumption. An internal circulation system can be understood as being the air inlet of an air-conditioning system, which uses the original constant temperature air in cabins and the air from the air-conditioning is the air circulated throughout passenger accommodations [19]. Although air-conditioning has an air filter, it is ineffective in removing COVID-19; thus, the internal circulation system of central air-conditioning can neither guarantee the freshness or cleanliness of the air, nor effectively support any quarantine requirements.

2.1.3. A cruise ship's own epidemic prevention measures are inadequate

It can be seen that the epidemic prevention mechanisms installed by cruise companies is inadequate as shown by previous cases of gathering epidemic in recent years. In terms of food procurement, food and water are purchased, stored, prepared, and supplied according to strict procedures. Nonetheless, pathogenic microorganisms can be transmitted by 'faeces-hand-mouth' involvement [20]. In terms of routine infection prevention and disinfection, the implementation of self-quarantine on a ship can be lacking, including efforts regarding the effectiveness and pertinence of disinfection action. To combat the spread of infection, it would be necessary to increase the frequency and intensity of the disinfection of public places, and sites with poor ventilation would require additional attention. In terms of cooperation for infection prevention at any port within the line planning for confirmed and suspected cases on the ship, the personnel who have had close contact and general contact should be checked quickly and quarantined if necessary. Moreover, personnel testing and infection inhibition and site disinfection should be carried out in cooperation with the port health

department with the purpose of preventing internal cross-infections [21]. It is also necessary to have a sound evaluation and response plan to provide the medical treatment for infected tourists as well as suitable transfer and quarantine arrangements for the rest of the passengers.

Kentarou Iwata, Professor, Internal Medicine of Infectious Diseases at Kobe University, Japan, who boarded the 'Diamond Princess' on 18th February to carry out epidemic prevention, told local media after disembarking from the ship that he the 'red zone' (danger) and 'green zone' (safe) of the 'Diamond Princess' to be ambiguous and protective measures such as protection suits and gloves were meaningless. Iwata also pointed out that the ship's crew also lacked awareness regarding the protection and protective gear was not worn in real time and even the patients with temperature were seen walking to the infirmary on their own [22]. It fully showed lacunae in the cruise companies' epidemic response mechanism.

2.1.4. Defects found in a cruise ship's health provision system

In general, the passenger capacity of large luxury cruise ships is significantly higher than that of even the largest passenger-carrying aircrafts and the duration of most of the sea voyages is significantly longer. Since the large groups of passengers inhabit limited spaces, the density of personnel is extremely high. The biggest potential difference observed between a liner's personnel composition and that of an 'onshore community' is that cruise passengers are frequently middle-aged or elderly with a relatively higher vulnerability to common medical conditions and less resistance to diseases. Thus, they are more susceptible to epidemic induced afflictions. Although liners are equipped with medical facilities and medical personnel, there are limitations to the medical care which can be provided, implying that the capacity to deal with outbreaks is not that which would be expected ashore [23].

2.1.5. The current port management tactics for handling large outbreaks of infection seem inadequate

In the formulation of emergency plans, the screening of personnel information, preventive measures against different pathogens, infection route management, and quarantine measures of the ship—all require the cooperation of the ship and port epidemic prevention department. This, in turn, aids in forming a good technical reserve, developing targeted prevention plan as well as supporting policies including the large-scale personnel transfer plan of cruise home ports and port medical and health resources support plan.

However, there is no emergency plan for the prevention and control of infections in cruise ships. The United States occupies the core of international cruise tourism market and is the largest source of tourists. It has accumulated rich experience in the process of cruise operation and management. The cruise ship emergency response of the United States Coast Guard belongs to a part of mass rescue operation planning guidance-passenger vessel safety programme. When the ship encounters disasters such as fire, reef, and security threat, the United States Coast Guard launches corresponding cruise emergency rescue plans [24]. However, this mechanism does not have an emergency plan for the outbreak of infections and gathering-related epidemics. While the CDC focuses on the prevention and control of intestinal infections for passenger vessels, there is no targeted plan for respiratory infections. Furthermore, other countries with developed cruise tourism industry also have similar issues relating to epidemic management.

Although cruise lines and berthing ports are relatively fixed, different ports have different emergency response capabilities. The lack of international cruise emergency drill may also lead to failure in responding quickly and effectively during an emergency. China's major ports hold passenger vessel shore emergency drills every year, but emergency drills for cruise ships are few. On June 24, 2019, Shanghai Maritime Search and Rescue Centre held the '2019 International Cruise Large-scale Personnel Transfer Emergency Drill'. Thirty-one ships, three airplanes, and more than 190 volunteers attended the first large-scale drill conducted by China's search and rescue department for cruise

ships [25]. This cruise ship-shore emergency drill helped to improve the comprehensive emergency response capacity of cruise ships. China's disposal of the 'Costa Serena' and 'Costa Venezia' cruises fully reflected the importance of systematic cooperation between ships and ports in response to emergencies. At that time, a few people on both the ships have fever. With the cooperation of local government, customs, immigration, maritime, and other relevant departments, both incidents were handled scientifically and efficiently.

2.2. Reflection on the outbreak emergency response of the 'Diamond Princess'

2.2.1. The complexity of handling public health emergency with foreign factors

The handling of public health securely is a matter of the sovereignty of a state but since international cruise lines and ports are located in different states, cruise operators, crew members, and tourists all have different nationalities. This has the potential to create the conditions for the international spread of epidemics and increase the health risks accompanying various public health events. The existence of foreign factors would lead to a conflict between personal jurisdiction of the country of nationality of passengers and crew and the territorial jurisdiction of the port country when handling public health emergencies, which bears more political and diplomatic issues and increases the difficulty of solving public health emergencies. According to the owners of the 'Diamond Princess', about half of the passengers were Japanese, while the rest came from 56 different States and regions [26]. Based on Chinese verification, a total of 311 Chinese citizens were stranded on board. Before completing the testing of the remaining 3000 people, medical assistance and the cross-border transfer actions of States on behalf of their citizens were subject to the conditions of Japan's own health sovereignty. Since there were political and diplomatic implications, the States were unable to make their own health provisions as soon as they might have wished. Japan did not transfer passengers on the cruise ship to the shore in batches and quarantine them in hotels or other places that could accommodate thousands of people because it did not want the number of confirmed passengers on the cruise ship to be added to that of the locally confirmed people.

2.2.2. Limitations of port state emergency resources

The response to the gathering epidemic on the 'Diamond Princess' presents a challenge to every State. The Japanese Government took timely measures to transfer the confirmed patients to medical institutions in Kanagawa, Saitama, Chiba-ken, Shizuoka, and Tokyo for suitable treatment [27]. Japan's own capacity to test samples was 1500 per day and testing samples from the more than 3000 people on board the 'Diamond Princess' took too long, leading to a longer stay on board for confirmed cases and elevating the risk of cross-infection. For those who were confirmed as having the infection, the nearby port medical treatment capacity was limited and transfer of such cases increased the risk of cross infection. The public health authority of the cruise ship conducted a 'major test' on the relevant overall capacity of the port and it was obvious that both the medical treatment available and the personnel transfer capacity of the Port of Yokohama were insufficient to deal with the gathering epidemic of the cruise.

2.2.3. Prevalence of the means of COVID-19 transmission

With the joint efforts of medical staff and scientists, the 'spreading ways' of COVID-19 were scientifically verified [28]. Clinical and experimental results suggest that COVID-19 can be spread by droplets, contact, aerosol, and 'faeces-mouth' mode with an incubation period of up to 14 days [29]. COVID-19 virus spreads quickly. As the nucleic acid-detection mechanism is not being highly sensitive, it can be confirmed positive only after a number of tests. Moreover, transmission of COVID-19 is possible via asymptomatic individuals. The 'Diamond Princess' adopted traditional centralized quarantine measures but did

not design classified quarantine and batch transfer in response to the epidemic's spreading characteristics. Hence, there was a greater risk of potentially infecting people in a large airtight space accommodating 3800 people [30]. Besides, the testing methods adopted in Japan were relatively simple and there were no supplementary methods; thus, there was a likelihood of missed diagnosis. Moreover, it should also be considered that those passengers and crew who left the ship after 14 days of quarantine might still be asymptomatic potential carriers. Hence, it was possibly more challenging for the 'Diamond Princess' to deal with a mass infection-incident than what might have been the case with any other cruise-related public health adversity.

3. International and domestic legal provisions on epidemic prevention and the control of cruise ships

A major public health event may prove to be a test of the traditional legal system and give an opportunity to re-examine whether the relevant provisions are sound. The 'Titanic' sinking in 1912 resulted in the formulation of *The Convention on the Safety of Life at Sea* in 1914. However, over 100 years later, there are still difficulties in effectively dealing with major public transport emergencies, emphasizing the need to fully reflect on problems in current legal systems and defects in any response mechanisms. In the legal sense, a cruise ship is not a single vessel but a large-scale luxury passenger ship gradually shifting from the role of a passenger transport to a 'vehicle' for tourism. Unlike inland river cruises and traditional passenger ships, more than 60% of the cruise ships all over the world are labelled with flags of convenience in order to facilitate voyage management [31]: the affected 'Diamond Princess' is from the United Kingdom; the 'World Dream' from the State of Bahamas; and the 'Westerdam' from the Netherlands. Cruise ships and other international shipping ventures encompass different States, with international crews and tourists, potentially causing cross-jurisdictional problems in international cruise management which can further complicate public health events. A comprehensive analysis of international and domestic laws on risk prevention in cruise ships is, therefore, needed to examine any inadequacies of the legal systems.

3.1. Provisions of international law

International conventions play an increasingly imperative role in the prevention and control of infectious diseases. With the dynamic flow of trans-national personnel and business contacts, infectious diseases have become an international issue and international law in line with the concept of justice, is one of the more effective responses to the crisis of international public health events. International conventions do not impose special provisions for cruise risk prevention, rather emphasize the reference to provisions for ordinary ships. With regard to the provisions on cruise risk prevention, this assessment deals with the most relevant conventions developed by the WHO and the International Maritime Organisation (IMO). Furthermore, in response to specific infectious disease outbreaks, relevant international organisations have provided recommendations and proposals for ships such as the guidelines and standards developed by the Baltic and International Maritime Council (BIMCO) in response to the Ebola virus.

3.1.1. The WHO related conventions

During the 58th World Health Assembly held at Geneva, Switzerland, in 2005, the newly amended 'International Health Regulations' (IHR) was formally adopted. Compared to the 1951 edition, the scope of IHR has been extended from the national health quarantine of plague, yellow fever, and cholera to a coordinated global response to public health emergencies. Procedures for the assessment and reporting of public health emergencies which justify international concern require Member States to assess the public health emergencies in a timely manner and inform the WHO accordingly. In coherence with the national legislation and the need to respond to public health emergencies,

Member States may take health measures other than those provided in the 2005 IHR, provided that relevant information be offered at the request of the WHO and that the implementation of these measures be considered for termination, at the request of the WHO [32]. On January 30, 2020, the WHO declared the outbreak of COVID-19 to be a public health emergency of international concern, also conveying that there is no present need to limit international travel and trade [33].

The WHO has also developed, *The Ship Health Guidelines*, which serves as a supplementary technical guidance system and *The Ship Inspection and Ship Health Certificate Issuing Manual*, as a part of the 2005 IHR, which provides guidance regarding the prevention and control of known public health risks. These guidelines are intended to draw the attention and response of vehicle operators to public health incidents and to provide at least two annual routine ship health inspections. The manual applies to all public health risks during international voyages and is designed to take into account the suitability of vessels and passenger ships, as well as requiring the inspection items and controls to be comprehensively conducted. The sanitary conditions of a cruise ship differ significantly from those of freighters; thus, the specifications of the manual are considered minimal for an international cruise ship.

The significance of the 2005 IHR for global control regarding communicable disease lays in the legalization of international cooperation mode and emphasizes on the collaboration between States Parties and the WHO, in identifying and assessing incidents and responding to public health risks and emergencies [34]. However, compared to other international organisations such as the United Nations and the IMO, the WHO is, in general, inhibited by limited legislative and enforcement powers to check State Parties. Consequently, the relevant provisions offer more of a guiding norm than those guaranteed by sanctions.

3.1.2. The IMO related conventions

The IMO's Conventions on the prevention and control of marine health-related outbreaks includes two major parts: *The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers* (hereafter referred as the *STCW Convention*) and *The International Maritime Labour Convention* (hereafter referred as the *MLC Convention*). Section A-VI/4, of the *STCW Convention* imposes mandatory minimum requirements for medical first aid and care by detailing the eligibility criteria for seafarers who provide medical first aid on board ships and seafarers designated to stay vigilant on board ships. This is designed with regard to assessing the efforts to minimise risks to others as well as themselves; to adequately and effectively prevent transmission and the spread of disease, cope with changing diseases, and follow procedures for seeking radio medical advice in accordance with established practices and recommendations.¹ The provisions of the *MLC Convention* on sanitation and hygiene cover three main aspects: crews, ships, and mechanisms. These encompass involve health and safety protection and accident prevention, ventilation, infirmary provision, on-board and onshore medical care, provision of medical care and medical statements. The biggest relevance to a disease outbreak is the *B3.1.2 Ventilation Order*²: 'Ventilation systems in bedrooms and restaurants shall be controlled to ensure satisfactory air conditions and adequate air circulation in any season and climate. Air conditioning systems, whether central or single, shall be designed to: (a) maintain appropriate temperature and relative humidity of indoor air in accordance with outdoor atmospheric conditions, and ensure adequate air exchange and ventilation where it is completely needed, accounting for the characteristics of offshore operations to avoid excessive noise or vibration; (b) to facilitate cleaning and sterilisation to prevent or control the spread of disease'.³ The provisions of the *IMO Convention* are principled and instrumental as per minimum requirements but no special provisions are

¹ Refer to STCWA-VI/4.

² Refer to MLC4.3, MLCB3.1.2, MLCB3.1.8, MLCB3.1.8, MLCB4.1.

³ Refer to MLCB3.1.2.

made for special construction and operation mechanisms of international cruise ships. In practice, the passengers of a cruise ship represent a higher aged group, who can tend to be more susceptible to contracting infections not least because of an often lower immunity. Therefore, this issue demands a high standard for the ship's treatment facilities and drug supplies, as well as general sanitary conditions. Unfortunately, the desirable high standards are not always met, and the provisions of the *IMO Convention* concerning cruise ship's preparedness to deal with a large-scale outbreak, may be lacking. As the most authoritative international organisation for global shipping, the IMO responded quickly to the outbreak. On 31st January, the IMO issued *Circular Letter No. 4203* and *Circular Letter No.4204*, designed to reduce the risk of COVID-19 infection. On 12th February, the IMO issued *Circular Letter No. 4203-Add.1*, a supplement to *Circular Letter No. 4203*, providing further information and guidance on infection control and prevention [35].

3.2. Provisions of Chinese domestic law

As cruise ships are cross-jurisdictional by nature, States apply international law directly or transpose relevant international conventions into domestic law, in accordance with international cruise operating practices and domestic situations [36]. The more developed countries involved in the global cruise industry are mainly concentrated in Europe and North America. In the field of cruise anti-epidemic preparations, the CDC designated *The Vessel Sanitation Programme Operations Manual* (VSP) with detailed and strict regulations on vessel sanitation [37]. Canada has also developed a working manual on the health inspection of international cruise ships, with reference to the United States VSP [38]. The *European Manual for Hygiene Standards and Communicable Diseases Surveillance on Passenger Ships* has been published with the support of the European Union SHIPSAN TRAINET Project and is dedicated to the health management and surveillance on cruise ships [39]. The manual, based on the EU regulations, focuses on health standards for navigation in European waters, with an aim to guarantee hygiene on cruise ships sailing or berthing within the jurisdiction of the EU, as well as the health of cruise passengers and crew, food and water safety, and an overall healthy environment. Since the cruise tourism industry is emerging in China, the above States and regions limited to cruise anti-epidemic provisions provide great reference to China, which has a relatively complete system of epidemic prevention laws and regulations on the prevention and control of infectious diseases, emergency response, and ship safety supervision, though it imposes less specific regulations on cruise ships.

3.2.1. Prevention and control of infectious diseases

The relevant domestic laws in China on the prevention and control of infectious diseases include *The Frontier Health and Quarantine Law of the People's Republic of China* and its implementing rules and regulations, *The Law of the People's Republic of China on Prevention and Control of Infectious Diseases* and other relevant normative documents. In accordance with Article 15 of the implementing rules and regulations of the *Frontier Health and Quarantine Law of the People's Republic of China*, 'When quarantine infectious diseases and suspected infectious diseases requiring quarantine are found at frontier ports and berthing vessels, or a death is confirmed and the cause of death is not known due to accidental injury, the relevant units at frontier ports and the vessel captain shall immediately report to the health and quarantine organ'.⁴ The laws and regulations governing the prevention and control of infectious diseases are of principle and the special provisions relating to vessels deal with emergency responses and ship safety supervision.

⁴ Refer to Article 15 of the Implementing Rules and Regulations of the Frontier Health and Quarantine Law of the People's Republic of China.

3.2.2. Emergency response

The *Constitution of the People's Republic of China* renders the most universally applicable provisions on responses to maritime emergencies, although it does not explicitly refer to maritime safety and emergency measures. The provisions of Articles 67 and 89 on 'State of emergency' recognise the existence of emergency administrative power and provide the basis for the initiation of the emergency administrative power of the government in case of maritime emergencies.⁵ The relevant laws and regulations concerning emergency response are mainly—'The Regulations of the People's Republic of China on Emergency Response to Public Health Emergencies', 'The Regulations on Emergency Response to Entry-Exit Inspection and Quarantine of Public Health Emergencies at Frontier Ports of the People's Republic of China', and 'The Regulations on Traffic Emergency Response to Public Health Emergencies of the People's Republic of China'. In accordance with Article 26 of the 'Traffic Emergency Provisions on Sudden Public Health Events of the People's Republic of China', the vessel captain shall take temporary measures to alert the docking point quickly and report to the owner, operator, or manager of the vessel and the port of origin. Furthermore, the captain must implement emergency health treatment and temporary isolation and quarantine people with infectious diseases, quickly sail to the designated port, follow the related arrangements of government departments, effectively protect the personnel on board, and provide sanitary treatment for the vessel, including contaminated locations.⁶ For an emergency response to the prevention and control of mass disease on a cruise ship, the State Administration of Quality Supervision, Inspection, and Quarantine (in the capacity of administration of entry-exit inspection and quarantine assigned to the General Administration of Customs in 2018) also formulated 'The Technical Plan for Emergency Treatment of Mass Disease Outbreaks in International Cruise Lines', where the requirements of emergency disposal, on-the-spot investigation on suspected cases, sample collection and delivery, epidemiological investigation, hygiene inspection, health control and incident report, declaration and evaluation were proposed to guide emergency disposal.

3.2.3. Ship safety supervision

As a special law on ship safety supervision, *The Maritime Traffic Safety Law of the People's Republic of China* does not directly stipulate the content of ship epidemic prevention. Nonetheless, China is a Class 'A' Member State of the IMO following the regulation of ship safety supervision, acknowledging the advantages of the provisions of IMO provisions, *STCW Convention* and the *MLC Convention*, and the IMO Circular Letters applicable to domestic ship epidemic prevention. In order to better guide the prevention and control of the epidemic situation of ships, the Secretariat of the Crew Sub-committee of the International Maritime Research Committee affiliated to the Maritime Bureau of the Ministry of Transport as the shipping authority in charge issued 'The Guidelines for the Prevention and Control of the COVID-19 on Vessels'. These principles, published on February 8, 2020, follow the guidelines adopted by COSCO Shipping Energy Transportation Co., Ltd and the protection methods taken by shipping companies during SARS outbreak. It is applicable to all types of shipping and can provide experience and guidance for the emergency risk control of cruise ships [40]. On March 18, 2020, the IMO issued *Circular letter No. 4221- 'The Guidelines for the Prevention and Control of the COVID-19 on Vessels and crews'* which was put forward by the Chinese government. The guidelines were proposed systematically from seven aspects: the establishment of the shipping company's prevention and control system, implementation of the ship's control measures, strengthening of personal protection for the crew, discovery of suspected cases, report of suspected patients, adjustment of crew's mental health, and the

⁵ Refer to Articles 67 and 68 of the Constitution of the People's Republic of China.

⁶ Refer to Article 26 of the Traffic Emergency Provisions on Sudden Public Health Events of the People's Republic of China.

information inquiry of the epidemic [41].

3.3. Legal analysis on rescue responsibilities of the ship's registry country and port country

With the successive emergence of cruise ships succumbing to epidemic, emergency response has become the prime international focus. The Japanese government's response to the 'Diamond Princess' public health emergency was widely criticised, which led to a debate on subject of rescue responsibility. On February 26, 2020, China Maritime Arbitration Commission, Maritime Legal Research Centre of Chinese Academy of Social Sciences, together with China Maritime Law Association, and China Shipowners' Association held an online seminar on Legal Issues Related to Cruise Epidemic⁷ [42]. At the seminar, several maritime legal experts discussed the responsibilities of the ship's registry country, port country, the country where the ship's operating company was located, and the country of nationality of passengers and crew. The scope of this study encompasses emergency disposal of infections based on which the responsibilities of only two subjects at the level of public international law, namely the ship's registry country and port country, have been discussed.

3.3.1. Flag State's responsibility and 'flag of convenience'

Clause 1, Article 94, 1982 United Nations Convention on the Law of the Sea (UNCLOS) states that 'Each country shall effectively exercise its jurisdiction and control over administrative, technical and social matters over ships flying its flag'.⁷ The Flag State has exclusive jurisdiction over its ships sailing on the international waters. The *International Convention for Safety of Life at Sea (SOLAS)* requires Flag States to provide qualified crew members for ships based on their own minimum personnel allocation. Besides, the 2006 *Maritime Labour Convention* also includes many provisions related to Flag State responsibilities which reflect that in the international maritime conventions, the Flag State has always occupied the central position in the jurisdiction of its ships.

The main reason why 'Flag State centralism' begins to deviate in international maritime jurisdiction is the prevalence of flag of convenience [43]. In order to reduce the operating cost, most ship owners in large shipping countries tend to register in countries of flag of convenience. Since there is no 'real connection' between countries of flag of convenience and ships under the UNCLOS, Flag States are unable to effectively supervise the ownership, safety management system, and crew quality of ships, resulting in an inefficiency in the regulation of flags of convenience. Flag States often fail to take effective measures in time after accidents. In accordance with the Article 24 (3), IHR, 2005, 'Contracting party shall take all feasible measures consistent with these Regulations to ensure that vehicle operators are always responsible for keeping vehicles free of infection sources, including vectors and hosts. In case of evidence of infection or contamination, appropriate control measures shall be taken.'⁸ Britain, the Flag State of the 'Diamond Princess' did not respond to the public health emergency. In a similar situation, 'MS Braemar' of Olsen Cruise Lines in Britain was refused entry by its registry country, Bahamas, because five people onboard had been confirmed with COVID-19 on March 10, 2020 [44]. The epidemic has highlighted the negative impacts of 'flag of convenience' on the shipping industry.

3.3.2. Port State's responsibility and cruise home port's additional responsibility

The jurisdiction of the Flag State is not completely exclusive. After the 'Diamond Princess' entered the Japanese territorial sea and stopped at Yokohama port, Japan had the right to exercise territorial jurisdiction over it. In practice, port countries usually exercise jurisdiction only

when their own interests are involved. For internal affairs of the ship, port countries often choose to respect the jurisdiction of Flag States and exercise jurisdiction only at the request of the Captain. Obviously, the epidemic affected Japan's own interests; so, Japan had the right to exercise jurisdiction over the cruise ship and take quarantine measures for all passengers and crew. However, Japan's inappropriate response to the emergency still shows the impact of different 'jurisdictions' on rescue responsibility. The registry country of the 'Diamond Princess' was Britain while the ship was operated by Carnival Cruise Lines with Yokohama, Japan as its home port. According to the UNCLOS, 'The Flag State shall bear the primary responsibility as a 'floating land' after an outbreak.' However, as the home port of cruise ship, Japan also needed to accept the berthing of the ship and perform relevant obligations. A series of cases represented by the 'Diamond Princess' exposed a blank or fuzzy area in international law.

International law does not clearly stipulate the obligations of cruise home port. According to the IHR, the WHO carries out 'international health ports' assessment on all the ports. IHR specifies the requirements for health airports (ports) to 'Core capacity requirements for designated airports, ports and ground crossings' in Annex 1B.⁹ This part not only puts forward the requirements of the capacity that should be possessed at any time and in case of public health emergencies, but also highlights the requirements of risk assessment and interdepartmental cooperation. If the port of call is an international health port, it should have the corresponding health facilities and a defined emergency mechanism. Even if it is unable to fully respond to the gathering epidemic on cruise ships, it is still possible to transfer personnel to the place set up at the wharf or hotel for preliminary quarantine. Theoretically, all the home ports of large-scale cruise ships should have this capacity.

In the context of globalisation, infection control can no longer be simply understood as the unique obligation of a country. The fluidity of viral pathogens, people, and commodities reflect public health as the public interest of human society, requiring international consultation and cooperation among contracting countries. In accordance with Article 44 of IHR concerning 'collaboration and rescue', Clause 1 states that: '1. States Parties shall undertake to collaborate with each other to the extent possible, in: (a) the detection and assessment of, and response to, events as provided under these Regulations; (b) the provision or facilitation of technical cooperation and logistical support, particularly in the development, strengthening and maintenance of the public health capacities required under these Regulations; (c) the mobilisation of financial resources to facilitate implementation of their obligations under these Regulations; and (d) the formulation of proposed laws and other legal and administrative provisions for the implementation of these Regulations.'¹⁰ From this perspective, the authors believe that both Flag State and Port country actually assume a common but differentiated responsibility for the international control of infections. To be specific, although the Flag State has the primary rescue obligation for 'Diamond Princess', the home port of 'Diamond Princess' - Yokohama, Japan, had a corresponding rescue obligation after receiving cruise ships with suspected outbreak.

4. Suggestions on COVID-19 prevention and control on cruise ships

COVID-19 spreads quickly and possesses diverse means of spreading, necessitating timely intervention regarding the implementation of emergency mechanisms for epidemic prevention in accordance with the special structure of cruise ships, management mechanisms, and correlation between epidemic incidence and spreading [45]. The 'Diamond Princess' outbreak has provided the international community with a sample of what large-scale public transport means in terms of emergency

⁷ Refer to Article 91(1) of the UNCLOS.

⁸ Refer to Article 24 (3) of the IHR.

⁹ Refer to Annex 1B of the IHR.

¹⁰ Refer to Article 44(1) of the IHR.

response to the public health events. Combined with China's experience in fighting COVID-19, suggestions should be put forward for epidemic prevention and control from the perspective of short-term response measures, medium-term, as well as long-term mechanism improvement.

4.1. Short-term response measures

The core of short-term response measures is to block cross infection from multiple infectious sources. Based on the effectiveness of centralized quarantine and difficulty of personnel transfer, the response idea of 'temporary cabin hospital' has been adopted. 'Temporary cabin hospital' is a quarantine concept; quarantine can be in designated zones on the cruise ship, or at broad places such as wharves and gyms that can accommodate more people. In cases where there are few confirmed cases, specific quarantine zones on cruise ships can play a vital role. However, in case of a gathering outbreak, quarantine on a cruise ship does not effectively control the spread of COVID-19. It is further suggested to adopt the disposal process of 'circular disinfection-section repeat testing-batch transfer and quarantine-international collaborative medical treatment' to improve emergency response mechanisms in an episode of a cruise-related mass outbreak. Based on international conventions and relevant domestic laws, the following solutions are designed and proposed.

4.1.1. Mechanisms for circular disinfection

Although the cruise ship lacks effective medical support and security onshore, it has unique advantages hidden in its construction. Exhaust system of the cruise ship toilets can drain the indoor air into the atmosphere. Since the air inlet and outlet of central air-conditioning are separated, the fan outlet of supply line can be sterilised and positive pressure can be maintained. This facilitates to increase the mechanical ventilation volume of air-conditioning, especially new air volume, increase the circulation of internal and external air, maximize the air cleanliness of each room, and reduce the risk of infection [46]. In addition, temperature also affects the spread of the virus and higher temperatures will probably slow down the spread of the virus [47]. Therefore, high temperature disinfection is also an effective method.

As for the method of circular disinfection, suggestions proposed by the Chinese government on the safety of ship ventilation described in 'The Guidelines for the Prevention and Control of the COVID-19 on Vessels' can be adopted: (1) Maintenance of air-conditioning and ventilation system should be strengthened to ensure good air conditions in living areas. (2) Ships arriving at Chinese ports or epidemic areas should pay attention to air-conditioning and ventilation control, primary air (fresh air) on board accounts for 10%–20%, and secondary air (re-circulating air) accounts for 80%–90%. Each ship shall adjust air ratio according to its actual conditions until the secondary air is closed. The air in the living areas on board shall be kept as fresh as possible in principle. (3) Spaces used for quarantine on board shall be ventilated independently or the return air of the entire ship shall be closed to reduce air circulation within the living area.¹¹ For international cruises that have yet not experienced a mass epidemic, it is suggested to establish a port epidemic emergency team composed of local maritime departments and professional epidemic prevention departments to professionally test and quarantine suspected cases and disinfect the entire ship. At ports where conditions permit, the scope of testing and disinfection can be expanded and all ships arriving at the ports can be disinfected in order to discourage the epidemic spread.

¹¹ Refer to *The Guidelines for the Prevention and Control of the COVID-19 on Vessels* prepared by the Secretariat of the Crew Sub-committee of the International Maritime Research Committee affiliated to the Maritime Bureau of the Ministry of Transport.

4.1.2. Mechanism of section repeats testing

Based on China's experience in epidemic prevention, the viral nucleic acid testing may be applied multiple times attributing to asymptomatic infected persons and those with a relatively long incubation period, increasing the complexity of epidemic prevention [48]. The Ministry of Health, Labour, and Welfare in Japan stated that only two persons had been in close contact with the confirmed cases from Hong Kong when they disembarked at the end of January, but the number of confirmed cases, as of 10th February, suggests the possibility of two or even three infections from multiple sources [49]. The result is that the sampling of passengers and crew members cannot be confirmed by one or more tests during the 14-day quarantine, the presence of subsequently infected persons may affect the quarantine efficiency. Thus, it is necessary to screen out suspected cases, in accordance with rapid viral nucleic acid testing and multiple testing methods.¹²

4.1.3. Mechanism of batch transfer and quarantine

Both the science-based input and effectiveness of centralized quarantine measures of the 'Diamond Princess' have been questioned. Cruise companies need to adjust their cooperation with ports in case of emergency. Normally, close contacts and general contacts should primarily be classified first after the initial screening of suspected cases of respiratory epidemics on a cruise ship. Under the premise of relevant protective measures, suspected cases and close contacts ought to be transferred to quarantine observation rooms for detailed investigation to prevent cross-infection. Nonetheless, COVID-19 has various means of transmission and is highly infectious. Since cruise passengers are often elderly having a low resistance to infection, batch transfer and quarantine should be conducted in accordance with their health and the 14-day quarantine period needs to be reconsidered. After the nucleic acid test proves negative and they are ready to leave the cruise ship, rescue boats or aircraft should be used to transfer them to a specific site for the second 14-day quarantine period. According to media reports, the U.S. Government arranged a chartered aircraft for 300 Americans stranded on the 'Diamond Princess' to return home, while more than 40 confirmed American cases stayed in Japan for medical treatment [50].

Building cabin hospitals was an important measure of 'epidemic' in Wuhan, China. 'Temporary cabin hospitals' in Wuhan were used for quarantine and treatment of mild patients. In Wuhan, beds were laid in large indoor spaces and clapboards were installed for bed zoning. Cabin hospitals were located at Wuhan Hongshan Gymnasium, Wuhan Living Room Exhibition Centre, and Wuhan International Exhibition Centre. Among them, Wuhan International Exhibition Centre provided 1000 beds, China Optics Valley Convention and Exhibition Centre in Wuhan provided 1000 beds, Wuhan Living Room Exhibition Centre provided 2000 beds, and Wuhan Hongshan Gymnasium provided 800 beds. In total, there were 16 cabin hospitals with tens of thousands of beds [51]. As of 10th March, all of the 16 cabin hospitals in Wuhan were closed and the measure of 'temporary cabin hospitals' to quarantine and treat patients with milder symptoms proved to be effective.

4.1.4. Mechanisms for international collaborative medical treatment

Infectious outbreaks in large cruise ships may display a shoot in the number of cases over a short period; hence, it is necessary to transfer and treat a large number of patients while trying to prevent the spreading of the epidemic. Management of critically ill patients and serious outbreaks depends on the port's State government and considerable port transfer and treatment facilities are required for the gradually increasing number of confirmed cases. Moreover, it is also necessary to ensure sanitary conditions, micro-climatic and environmental regulations, as well as food and medicine supply to all places on board during quarantine. Besides, the disposal of non-medical and medical wastes must be conducted suitably following the given guidelines [52]. The large number of

¹² Refer to the 'COVID-19' *Diagnosis and Treatment Scheme (Trial Version 5)*.

people quarantined on a cruise ship poses a significant challenge to the port's local medical reception capacity, while a sharp rise in the daily number of confirmed cases suggests that centralized quarantine can cause cross-contamination within the ship. Hence, an alternative quarantine provision must be made available. In view of the complexity of handling international public disasters like this, it is proposed to adopt the model of a 'temporary cabin hospital' as used by the Chinese Government to treat minor cases, which had adopted two quarantine strategies. Firstly, to build a 'cabin hospital' at Daikoku Port in Yokohama and transfer the remaining passengers on board to the port for quarantine. Secondly, to find a temporary port on the islands near the Japanese mainland and build a 'temporary cabin hospital' in areas convenient for transport. The first method has the advantage of taking lesser time to be constructed and thus, to confine passengers on the ship as well as having the potential disadvantage of spreading the disease in Japan. The second method is of value as the temporary cabin hospital can be located away from the Japanese mainland with lesser impact on the Tokyo Bay urban agglomeration proximal to Yokohama, along with reducing the risk of affected passengers and crew spreading the infection ashore. Besides, it facilitates the use of rescue ships and aircrafts to transfer passengers. The concept, however, has its limitations because it takes a longer time and makes greater demand on medical supplies transport subsequently [53]. In the process of patient transfer and quarantine treatment, international organisations such as the WHO and IMO are suggested to be coordinating and organising, providing scientific guidance and professional medical support for epidemic control and benefitting the humanitarian relief.

4.2. Long-term mechanism construction

The control of infectious diseases cannot be distinct from laws and regulations. The latest COVID-19 international public health pandemic provides an opportunity to examine the shortcomings of the cruise ship emergency mechanisms and regulation. There also have been two other cruise-related public health incidents in China. On January 24, 2020, the 'Costa Serena' docked at Tianjin International Cruise Home Port with 4806 people on board. On January 26, 2020, the 'Costa Venezia' docked at Shenzhen Shekou Cruise Home Port with 6222 people on board. People with high temperature were found on both ships at that time. With the cooperation of local government, customs, maritime safety administration, and other relevant departments, these two incidents were dealt with promptly and efficiently [54]. Combined with China's experience in response to the cruise epidemic and the lessons learnt from COVID-19 prevention, it is suggested to promote the construction of infections emergency mechanism from three aspects: the risk emergency management mechanism of cruise lines, the health and epidemic prevention supervision mechanism, and the international cooperation mechanism of infectious disease prevention.

4.2.1. Risk prevention and emergency management mechanisms of cruise companies

Characterised by large passenger capacity, high density seating, long crowd flow, compact environment, intimate contact while eating and numerous port destinations, a cruise ship is highly vulnerable to infectious outbreak episodes. Prevention and control of epidemics are, thus, very important for any large international cruise company. International cruise liners are subject to controlled port visitation and are in close contact with many port authorities facilitating effective and smooth communication including incidents of dealing with an infectious outbreak. Owing to reputable connections, effective management of an infectious disease should be offered by establishing a common route for risk management system and emergency disposal mechanism. This would help scientifically analyse various risks associated with the route and take possible measures for ensuring comprehensive and dynamic health risk assessment [55].

4.2.2. Supervision mechanism for epidemic prevention on cruise ships

On a voyage, cruise ships cover different jurisdictions with inconsistent enforcement. The ships labelled with flags of convenience have no 'real link' with the Flag State, making it difficult for the Flag State to perform its substantive supervisory functions in terms of security regulation and undermining the actual effectiveness of cruise control. Port State Control (PSC) is the main approach to effective regulation of ships involved in an international voyage and it is the most powerful supervision mechanism of IMO. It is suggested that for the maritime department, an epidemic situation should be used as an index to evaluate ship safety and cruise ships operating globally, especially in Asia, should be carefully scrutinized. Each international cruise ship should be checked regularly to evaluate its emergency response mechanisms, establish the anti-epidemic file evaluation mechanism, and strengthen the dynamic and static information management. For the port epidemic prevention department, the main risks of various infectious diseases and other related health accidents of international cruise ships should call for a careful study to maximize risk control and establish optimal epidemic prevention and control systems. In practice, it is necessary to resort to multi-sector joint defence and control, perform large-scale personnel transfer rescue drills, and improve the port management capacity to cope with the incidence of risk. In addition, reflecting on the incident of the 'Diamond Princess', the environmental ecology, health, emission control, and storage capacity of medical supplies to the port area are the paramount issues surfacing during the construction of any port. In light of the special conditions regarding development of China's cruise industry, it is suggested that the standards of vessels should be unified at national level through sound laws and regulations. A beneficial integrated information technology, promotion of intelligent application of high-tech supervision, establishment of a coordinated and unified integrated management system of cruising, joint law enforcement mechanisms as well as creation of a modern and appropriate ocean governance system and capabilities are also necessary.

4.2.3. Mechanisms for international cooperation in the prevention and treatment of infectious diseases

Cruise ships and other international shipping operations encompass different States with international crews and passengers resulting in significant mobility which can, unfortunately, encourage cross-border transmission of such as virus infections. In this era of frequent and indispensable international trade and communication, single-handed efforts without the collaboration of States in the field of public health have proved fruitless in curbing the epidemic. The Chinese President, Xi Jinping has proposed the concept of building 'The Maritime Community with a Shared Future', which would provide the 'Chinese Programme' and 'Chinese Wisdom' for all mankind in exchange for cooperation, joint governance, and the sharing of marine resources. States should actively promote bilateral and multilateral cooperation and concerted efforts among international organisations in response to international public health incidents while exploring regional cooperation and defence mechanisms for combating epidemics. In addition, it is necessary to develop a mode of support among international organisations utilizing the role of managers, coordinators, and decision-makers from different international organisations to cope with international issues using well-developed technical advantages. This would direct the organisations to construct a smooth and well-functioning cooperation mechanism with clear responsibilities and obligations.

5. Conclusions

As international shipping vessels route across different States and utilise different ports, the cruise operators, crew members, and tourists have different nationalities which can exacerbate the likelihood of creating conditions for the international spread of infectious diseases and increase the risk of public health incidents. The sudden mass infectious outbreak on the 'Diamond Princess' poses a great challenge to

both the Japanese Government and the global cruise tourism. Due to the epidemic more and more cruise ships will find progress challenging, at least in the near future.

In combating infectious diseases, there is an urgent need for a new global response concept and practical programme. 'The Maritime Community with a Shared Future', proposed by the Chinese President, Xi Jinping, embodies the common value pursuit of all mankind, upholding the interests of individuals and countries, transcending their boundaries, looking at the development prospect of opening up, innovation, inclusiveness, reciprocity and realising the overall interests of mankind [56]. Epidemic prevention calls for the mobilisation throughout China with action regarding the uniform distribution of scarce materials, a list of designated hospitals, orders compulsorily containing cities or communities, which should provide guidance for the management in case of an epidemic. Based on China's experience in combating the COVID-19 epidemic, it is suggested to build a response mechanism for sudden mass epidemics on cruise ships from two aspects: short-term response measures and long-term improvement. The former is aimed at building 'temporary cabin hospitals', for effective separation from multiple sources of infection, using the 'circular disinfection-section repeat testing-batch transfer and quarantine-international collaborative medical treatment' protocol in order to reduce potential contamination and deterioration of port public health security. In addition, the long-term response mechanism should also be gradually improved. For example, cruise operators should establish a risk management system and emergency disposal mechanism for common routes to scientifically analyse the risks that might be faced and make any possible preparations for emergency action as well as to establish a sound and dynamic marine health risk assessment mechanism. For the port epidemic prevention department, the main risks of various infectious diseases and other related accidents of international cruise ship should call for careful study to maximize risk control and establish a set of perfect epidemic prevention and control systems. The environmental ecology, health, emission control, and storage capacity of medical supplies in a cruise port are paramount issues during the construction of the port. The legal provisions and regulatory standards should be progressively improved to establish a coordinated and integrated management system for cruise ships and a joint law enforcement mechanism. In response to international public health events, there is a need to judiciously exploit the functions of managers, coordinators, and decision-makers from different international organisations to cope with international affairs using technical advantages and construct a smooth cooperation mechanism with clear responsibilities and obligations.

Declaration of competing interest

This is a short statement to confirm that there is no conflict of interest for this piece of work. All authors agree with the terms and the name order that places in the paper.

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