

Challenges of COVID-19 outbreak on the cruise ship Diamond Princess docked at Yokohama, Japan: a real-world story

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Abstract: The event of the Diamond Princess, with a total of 712 (as of 17 March 2020) persons infected on the cruise ship, attracted global attention as the largest disease cluster outside China for the period 7 to 24 February 2020. Representing the Ministry of Health, Labour and Welfare, the authors were heavily engaged in the quarantine operation on the cruise ship ourselves. During the quarantine period from 5 to 23 February 2020, when the last group of the quarantined passengers left the ship, a series of measures have been conducted under the principles of *i*) zero deaths among all on board, *ii*) rapid establishment and thorough implementation of an infection control system, and *iii*) maintenance of health conditions and relief of anxieties among passengers and crew members. The case of Diamond Princess has implications of more than a cruise ship but deserves full scientific analysis to learn lessons from this operation as well as to study the characteristics, particularly the transmission of COVID-19.

Keywords: COVID-19, cruise ship, Diamond Princess, quarantine

Introduction

The coronavirus disease (COVID-19) outbreak has developed to a global pandemic as declared by the World Health Organisation on 12 March 2020. At the early stage of COVID-19 outbreak, Japan faced triple challenges: domestic cases apparently infected through overseas travels or contact with incoming travellers; evacuation of Japanese nationals from Wuhan, China; and an outbreak on a cruise ship, Diamond Princess, docked at Yokohama with 3,711 persons, consisting of 2,666 passengers (average age 66.0 years) and 1,045 crew members (average age 36.6 years) on board.

The event of the Diamond Princess, with a total of 712 (as of 17 March) persons infected on the cruise ship, attracted global attention as the largest disease cluster outside China for the period 7 to 24 February 2020 (*1*). Naturally, such attention invited both encouragement and criticism. Representing the Ministry of Health, Labour and Welfare, the authors were heavily engaged in the quarantine operation on the cruise ship ourselves. This article mainly describes the events during the quarantine period from 5 to 23 February 2020, when the last group of the quarantined passengers left the ship, with aims to clarify some points to avoid misunderstanding and unfounded criticism.

Anchorage quarantine approach

The Diamond Princess is a British-registered cruise ship (P&O Steam Navigation Co.) operated by an American company (Princess Cruise Lines, Ltd.). The ship left Yokohama, Japan on 20 January 2020, and was scheduled to return to Yokohama after calling at Kagoshima (Japan), Hong Kong, Chan May (Vietnam), Cai Lan (Vietnam), Keelung (Taiwan), and Okinawa (Japan).

A passenger who had been coughing during this voyage disembarked at Hong Kong on 25 January and was confirmed positive for COVID-19 on 1 February. This information was notified *via* International Health Regulation channel to Japanese Government on 2 February, after the ship left the last call port, Okinawa, on 1 February. When the vessel reached Yokohama in the evening of 3 February, the Japanese government declined immediate disembarkation of passengers and adopted the anchorage quarantine approach by sending quarantine officers to the ship.

The quarantine team (Figure 1) surveyed the health condition of all passengers and crew members over the night and identified 273 individuals (264 passengers, 9 crew members) who complained of symptoms or had close contact with the index case. Throat swabs of these persons were tested by reverse transcriptase polymerase

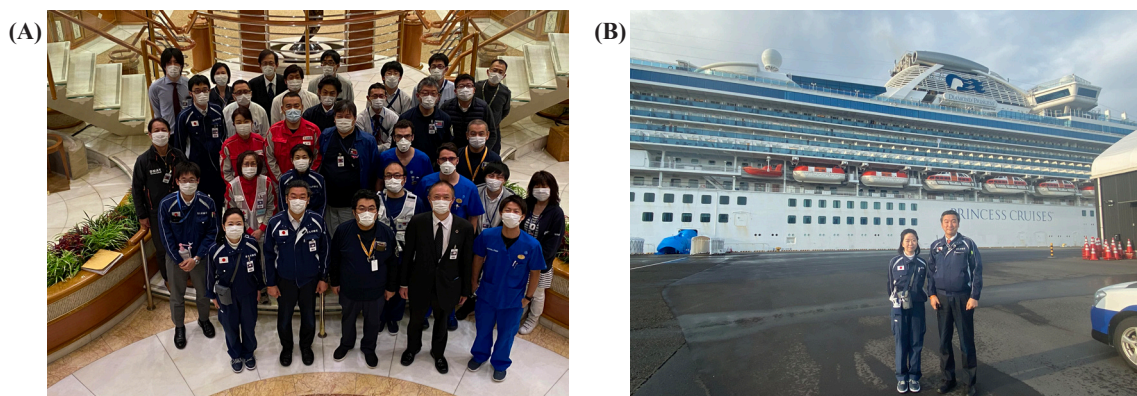


Figure 1. (A), Authors with members from the Ministry of Health, Labour and Welfare and medical team after the disembarkment of all passengers and crew members; (B), Authors after the completion of mission (left: Jimi, right: Hashimoto).

chain reaction (RT-PCR) test, but due to the limited laboratory capacity, test results were reported in several stages. The first report on 5 February revealed positive testing in 10 of 31 samples (32%), signalling a very challenging task ahead. A set of quarantine measures were introduced on 5 February. Full test results were released on 7 February, with 61 persons (60 passengers and 1 crew member) tested positive out of 273 persons, or a positive rate of 22%.

Principle approaches and measures

The enormous challenges to control this outbreak were unprecedented. They included an emerging infection with a novel pathogen with largely unknown characteristics, the unique confined environment of a cruise ship, predominantly senior passengers often with multiple comorbidities, language and culture diversity of passengers and crew members from 57 countries and regions, and complicated command lines among many parties (registered country of the ship, operation company, captain, ministries of Japanese government, local governments and others). Because the PCR tests revealed an apparent and serious outbreak on the ship, immediate disembarkation and onshore quarantine was first considered. However, because of logistic difficulties of transportation and onshore quarantine facility for a large number of possibly infected people, the decision was made to control the outbreak on the ship. At the same time, this decision implied tremendous operations to maintain daily services for more than 3,700 residents in terms of health, food and sanitation including waste disposal, which required massive mobilization of relevant personnel and internal coordination.

While the quarantine aimed to prevent the importation of COVID-19 into Japanese society, the Japanese government took several measures under the principles of *i*) zero deaths among all on board, *ii*) rapid establishment and thorough implementation of an infection control system, and *iii*) maintenance of health

conditions and relief of anxieties among passengers and crew members. Some illustrations of what had been done are as follows.

With regard to the measures for "zero deaths", all 712 persons (PCR positive cases) were sent to designated hospitals. In addition, regardless of PCR results, approximate 200 individuals were transported to hospitals or onshore facilities, including those with serious underlying health conditions and/or senior passengers. Physical and mental health consultations were made available on the ship.

Regarding the infection control measures, from 5 February, all passengers were requested to stay in their own cabins until completion of *i*) 14-day observation, *ii*) confirmation by a negative PCR test, and *iii*) health check-up by physicians at disembarkation. Crew members needed to support the daily life of passengers, but those with symptoms waiting for PCR result and close contacts were requested to stop working and self-isolate in the cabins. From 7 February, thermometers were distributed, and daily body temperature was monitored, and PCR tests were performed as needed. Infection control guidance was provided repeatedly to both passengers and crew members. All were strongly urged to wear masks and exercise regular hand sanitation. For crews, observing the rules of infection prevention and control while serving passengers was enforced. Repeated strict instructions were given to observe the practice of zoning on board. Such infection control measures were also applied to support staff coming from outside the ship.

Finally, for maintenance of physical and mental health for passengers and crew, general medical care for health maintenance was secured, including the supply of regular medicines for comorbidities for those who had chronic conditions. Additionally, mental health support was provided for psychological problems such as insomnia and anxiety. To facilitate communication, 2,000 iPhones were distributed, and mobile base stations and Wi-Fi routers were enhanced.

Reflections

The preliminary analysis is available on the website of the National Institute of Infectious Diseases (NIID) (2), which carries a crucial graph showing the number of confirmed COVID-19 cases with reported onset dates, from 6 to 17 February 2020. Further updated data until 21 February, when all quarantined passengers were disembarked, appear in the background document (3) for the expert taskforce meeting on the new coronavirus infection convened by the Cabinet Secretariat. Note that in these graphs, robust data were missing on 5 and 6 February before body temperature monitoring was started, and PCR testing was not systemically done. Nevertheless, a consistent decline in new PCR-positive cases is observed among passengers after 7 February, two days after quarantine started, although new cases among crew members peaked only on 13 February.

These findings led the NIID to express their preliminary view (4) as follows – "Based on the number of confirmed cases by onset date, there is clear evidence that substantial transmission of COVID-19 had been occurring before the implementation of quarantine on the Diamond Princess on 5 February. The decline in the number of confirmed cases, based on reported onset dates, implies that the quarantine intervention was effective in reducing transmission among passengers. Transmission toward the end of the quarantine period, which is scheduled to end for most passengers on 19 February, appears to have occurred mostly among crew or within each passenger cabins". With regards to the 712 hospitalized persons, there were 7 deaths while 527 have been discharged from hospitals (at the time of 18 March 2020). Japanese passengers who returned to their homes were recommended to monitor their health condition and avoid unnecessary outings for additional 14 days. Among those who returned home, 9 (at the time of 18 March 2020) became PCR-positive, but there is no evidence to suggest that they generated a new infection in Japan.

This quarantine exercise required tremendous efforts and faced many challenges that the world had

never experienced. Unfortunately, present epidemics in many parts of the world urged countries to adopt drastic restriction of move of people which are presenting similar challenges we had, in even larger scale. Therefore, the case of Diamond Princess has implications of more than a cruise ship but deserves full scientific analysis to learn lessons from this operation as well as to study the characteristics, particularly the transmission of COVID-19.

References

1. World Health Organization. Coronavirus disease 2019 (COVID-19) Situation Reports. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/> (accessed April 15, 2020).
2. National Institute of Infectious Diseases. Field Briefing: Diamond Princess COVID-19 Cases, 20 Feb Update. Published 21 February 2020. <https://www.niid.go.jp/niid/en/2019-ncov-e/9417-covid-dp-fe-02.html> (accessed April 15, 2020)
3. Ministry of Health, Labour and Welfare. Background Document 1, the Third Meeting of the Expert Taskforce meeting on the new coronavirus infection, 24 February 2020. http://www.kantei.go.jp/jp/singi/novel_coronavirus/senmonkakaigi/sidai_r020224.pdf (accessed April 16, 2020) (in Japanese)
4. National Institute of Infectious Diseases. Field Briefing: Diamond Princess COVID-19 Cases. Published 19 February 2020. <https://www.niid.go.jp/niid/en/2019-ncov-e/9407-covid-dp-fe-01.html> (accessed April 16, 2020)

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