COVID-19 outbreak on the Costa Atlantica cruise ship: use of a remote health monitoring system

Running Title: COVID-19 outbreak on a cruise ship: a remote health monitoring system

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Teaser

We developed and introduced a browser-based health monitoring system in the outbreak of COVID-19 on a cruise ship in Japan occurred on the Costa Atlantica. This remote monitoring minimized the activity of support staff onboard the ship and prevented their infection.

The second outbreak of coronavirus disease 2019 (COVID-19) on a cruise ship in Japan occurred on the Costa Atlantica, which was at anchor in Nagasaki for repairs.[1] No passengers were aboard. We considered disembarking all 624 crew members and then monitoring their health status because isolation is difficult inside the ship owing to the demands of essential work. Additionally, the medical resources onboard the ship were limited: the ship's doctor and two nurses were insufficient to monitor the symptoms of all the crew members. However, there was no available accommodations for the crew members. Each nonessential crew member had to be isolated in a passenger cabin, and we decided to provide support from outside the ship to minimize the chance of infection in medical support staff. Therefore, a remote health monitoring system was needed.

Using a smartphone, each crew member entered their health status into a browser-based system, including their age, sex, underlying diseases, smoking history, height and weight; the system was accessed by scanning a two-dimensional bar code. Additionally, we requested that the crew members self-report their body temperature and any symptoms, such as coughing, difficulty breathing, runny nose, sore throat, red eyes, headache, and new loss of taste/smell, each day. We considered a body temperature ≥37.5°C to be a fever. We collected the information

shared with the ship's medical center and the supporting medical staff twice a day (Figure 1A) and used it to help the ship's doctor examine patients, perform CT scans, and triage crew members needing transportation to a hospital.

Excluding one nurse who boarded the ship on April 26, the remaining 623 crew members were tested for SARS-CoV-2 by loop-mediated isothermal amplification or polymerase chain reaction from April 21-25, and 148 were positive. One additional COVID-19 case was confirmed on May 3. A total of 95.2% (594/624) of the crew entered their health data at least once, and an average of 83.2% of the crew reported their symptoms each day from April 28 through May 29. Of these, 23.7% (141/594) of the crew complained of any of the relevant symptoms, including fever. The most commonly reported symptom was a cough, followed by a runny nose and a new loss of smell (Figure 1B). The actual number of crew members who reported any symptoms decreased from 78 on April 28 to 29 on May 5 and 13 on May 12, as shown in the daily cumulative number of affected crew members in the figure. Twice per day, we discussed with the medical staff the crew members' health statuses and the need for transportation of crew members to the hospital. We transferred 11 crew members to the hospital without delay, including 6 COVID-19 patients with pneumonia, and no crew members died.

In contrast to the first COVID-19 outbreak on the Diamond Princess cruise ship in Japan,[2] we monitored all crew members' health statuses remotely without the disembarkation of asymptomatic or mild COVID-19 patients. This remote monitoring allowed us to minimize the activity of support staff onboard the ship and prevented their infection. The early detection of infection outbreaks by monitoring is crucial, and this remote monitoring system would also be useful in other settings, including nursing care facilities and home care situations.

Author Contributions

Eiichiro Sando contributed to the study design, data collection, data analysis, data interpretation, figures, and writing of the manuscript. Shinji Narukawa contributed to the system development, data collection, data analysis, and writing of the manuscript. Konosuke Morimoto and Katsumi Nakata contributed to supervising the study and writing the manuscript.

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Conflict of Interest

Shinji Narukawa is an employee of Fujitsu Limited. All remaining authors have declared no conflicts of interest. Eiichiro Sando received no rewards from Fujitsu Limited.

Reference

1 National Institute of Infectious Diseases. <Rapid report> Outbreak of novel coronavirus disease (COVID-19) on a cruise ship docked in Nagasaki city: preliminary interim report. https://www.niid.go.jp/niid/en/2019-ncov-e/2484-idsc/9650-covid19-20-e.html

2 T Yamagishi, H Kamiya, K Kakimoto, et al. Descriptive study of COVID-19 outbreak among passengers and crew on Diamond Princess cruise ship, Yokohama Port, Japan, 20 January to 9 February 2020. Euro Surveill 2020; 25(23).

Figure Legends

Figure 1. Remote health monitoring in Nagasaki

Panel A. Health monitoring system

Panel B. Number of crew members who had symptoms

Panel A shows the remote health monitoring system, which was accessed via a smartphone. Crew members reported their own health status via smartphone. The information was collected in the task force headquarters and shared with the ship medical center and medical support staff twice per day. Panel B shows a combined bar and line graph. The first axis for the bar graph shows the cumulative number of crew members who reported each symptom, including a fever ≥37.5°C. The second axis for the line graph shows the changes in the number of crew members who entered the data. Some crew members disembarked in groups. The crew members were disembarked sequentially, with priority given to those who were negative for SARS-CoV-2 by LAMP/PCR and symptom-free.