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FEATURE

What the Diamond Princess taught the world about covid-19

In the early days of the covid-19 pandemic, there was one place besides China that became infamous as a hotbed of SARS-CoV-2 transmission: a cruise ship. That ship has taught epidemiologists crucial lessons, writes **Chris Baraniuk**

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On 20 February, the World Health Organization announced that more than half the known cases of covid-19 in the world outside China were on a single ship: the Diamond Princess.[1] A 16 year old luxury vessel that cost half a billion dollars to build was stuck in quarantine in Japan with more than 3700 people on board. Hundreds of them had become sick and were confined to their cabins.

The situation was widely lamented. A Japanese epidemiologist described conditions aboard the Diamond Princess as "completely chaotic."[2] The US Centers for Disease Control and Prevention (CDC) questioned the efficacy of the onboard lockdown, and infectious disease expert Anthony Fauci, who is advising the White House on the covid-19 pandemic, said the vessel's quarantine process had "failed."[3]

But since the international spotlight moved away from the stricken cruise ship, data have been published that tell a slightly different story. It seems that the lockdown did have a measurable effect on restricting contagion. And there are signs that the ship's ventilation and wastewater systems did not worsen the spread of disease.

Questions over whether the situation could have been better managed remain. However, the Diamond Princess is emerging as an unfortunate but informative experiment that taught scientists much about covid-19. Those lessons could help authorities aiming to stave off the disease in other places where it spreads easily, such as nursing homes and prisons.

Early data

A paper published in *Infectious Disease Modelling* on 29 February found that the spread of covid-19 on the Diamond Princess fell substantially after passengers were confined to their cabins on 5 February at the request of the Japanese government.[4] A preprint posted by researchers in China on 14 April has corroborated those findings.[5] The researchers examined data on 197 people with symptoms on the ship, using records published by Japanese authorities. There was a total of 712 confirmed cases among passengers and crew, around half of whom were asymptomatic at the time of testing, so the data are limited. But the timeline of infections suggests that transmission mainly occurred before the onboard lockdown. After 5 February, transmission among passengers seems to have been confined to those sharing a cabin with an infected person.

"The quarantine worked for the passengers but unfortunately it did not work for the crew," Yuguo Li, co-author, tells *The BMJ*, noting that infections among crew members, some of whom were making regular contact with passengers in their rooms, continued after 5 February.

Li and his colleagues also analysed the ship's air conditioning and wastewater systems, finding no obvious sign that these mechanisms exacerbated virus transmission. Although ventilation may not generally spread SARS-CoV-2, streams of blown air might help transmit the virus from one person to another in the same room.[6]

The analysis adds weight to the claim that the Diamond Princess lockdown was more effective than some argued back in February, says Martin Hibberd at the London School of Hygiene and Tropical Medicine. "But the issue is that we're not entirely sure how much of a lockdown it really was," he adds. There were reports of passengers continuing to leave their cabins, even eating at buffets, for example.

The large proportion of people aboard the ship who showed no symptoms at the time of testing positive for covid-19 has also piqued researchers' interests. One study published in *Eurosurveillance* on 12 March estimated that 18% of positive cases were "true asymptomatics"—people who never developed symptoms despite being infected.[7]

"The Diamond Princess was critical in starting the idea of asymptomatic cases and whether they can transmit the disease or not," says Hibberd.

Information about cases on the ship has now been picked over by epidemiologists around the world. It has influenced, for example, modelling by the Imperial College team that is advising the UK government on covid-19.[8]

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Lessons for transmission

It may seem obvious to say that a virus will spread more easily in confined spaces—has research on the Diamond Princess really taught us anything on that front? Jürgen Haas at the University of Edinburgh says it has. For one thing, the second "wave" of transmissions among crew members shows how important it is for medical staff, care workers, or anyone interacting with patients with covid-19 to take precautions.

Haas tells *The BMJ* that around 40% of care homes in Edinburgh are thought to be affected by covid-19. He says the Diamond Princess shows just how important it is, for example, to avoid staff working across multiple care homes, where possible.

Plus, it shows what kind of communal areas may be linked to transmission of the disease. "In institutions where you have, for example, common rooms where people make meals or where you have gyms or cinemas, or meeting rooms, these are the areas where the first transmissions happen," he tells *The BMJ*.

Such places are common in cruise ships, care homes, and prisons, and we should carefully consider how we manage them to prevent covid-19 spreading among close knit groups of people, particularly those who are most vulnerable to the disease.

The Diamond Princess was also critical for understanding just how much older people are at risk of developing a severe illness, says Hibbard. Although expected, the effect was "much more marked than we would have imagined compared with other viruses," he says.

Viral transmission aboard ships is not a new concept. Ships packed with troops were instrumental in spreading the 1918 strain of influenza quickly among large numbers of people, and for bringing the disease from the US to Europe. The Diamond Princess is certainly not the only ship to have been affected by covid-19, either. More than half the passengers on board a small cruise ship[9] touring the Antarctic were recently discovered to have caught the disease, for instance, and another Italian cruise ship has been quarantined in Nagasaki, Japan, with 48 staff testing positive for covid-19.

Seagoing vessels are, unfortunately, floating microcosms. They reveal details about how SARS-CoV-2 might spread onshore, hinting at how the virus will get around in the built environment—from leisure centres to office blocks to care homes.

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