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Outbreak report

Outbreak of SARS-CoV-2 Delta variant on a single liquified natural gas (LNG) vessel, with estimates of vaccine effectiveness

Nicolas Smoll, Jacina Walker, Mahmudul Hassan Al Imam, Jill Auriac, Ross Andrews, Andrew Jeremijenko, Michael Kirk, Gulam Khandaker

Abstract

In August 2021, there was an outbreak of severe acute respiratory syndrome corona virus-2 (SARS-CoV-2) Delta variant on an international liquified natural gas (LNG) vessel offshore to Gladstone, Queensland. Fourteen of the 26 crew members aboard the vessel tested positive for SARS-COV-2 on PCR during the outbreak. Vaccine effectiveness (VE) was 52% for all lab-confirmed SARS-CoV-2 infections, 65% for symptomatic SARS-CoV-2 infection and 100% for severe SARS-CoV-2. The attack rate (AR) of SARS-CoV-2 Delta variant was 54% (14/26). With heightened public health measures and infection control practices, we were able to declare the outbreak over in 26 days.

Background and methods

We report an outbreak of severe acute respiratory syndrome corona virus-2 (SARS-CoV-2) Delta variant on the *Pan Europe*, an international liquified natural gas (LNG) vessel offshore to Gladstone, Queensland. The aim of this outbreak report is to describe the attack rates and the effectiveness of vaccination aboard this vessel. On 1 August 2021, the Maritime National Coordination Centre notified Central Queensland Public Health Unit (CQPHU) of four symptomatic crew members onboard the LNG vessel. Symptoms were mild with an onset during 29–31 July and included fevers, respiratory symptoms, loss of smell and loss of taste.

The vessel was not granted pratique and was kept at the outer anchorage of Gladstone harbour on arrival on 4 August 2021, a similar response to that which occurred on a similar outbreak on a cargo ship docked at the Port of Santos, Brazil.[1]

A full public health response was initiated by CQPHU and an outbreak response team, led by the Public Health Physician, accessed the vessel on 4 August 2021. Respiratory specimens and serum samples were collected from all crew members onboard to better understand prior infection and current status. Whole genome sequencing was performed on any positive specimen for SARS-CoV-2 to clarify the SARS-CoV-2 variant, or if there were co-primary cases if two strains were detected. Vaccine effectiveness (VE) for symptomatic and severe SARS-CoV-2 was calculated using the following equation:[2,3]

$$1-\left(\frac{ARV}{ARU}\right)\times 100$$

ARV = Attack rate in vaccinated

ARU = Attack rate in unvaccinated

Description of outbreak

The case definition for SARS-CoV-2 diagnosis was a positive reverse transcription polymerase chain reaction (PCR) test. Both respiratory and serum specimens were collected for nucleic acid

testing and serology. Genome sequencing was performed on all positive respiratory specimens. Repeat PCR testing for SARS-CoV-2 was performed on all crew members on a regular basis to monitor the progress of the outbreak. Ethical review for exemption to publish was obtained (HREC/82361).

Twenty-six crew members were aboard the vessel; 14 crew members tested positive for SARS-COV-2 on PCR during the outbreak (Table 1, Figure 1). Six of the crew joined the vessel in Japan on 18 July 2021 (two became symptomatic on 29 July 2021) and four of these six on-signers tested positive for SARS-COV-2 on PCR during the outbreak. Genome sequencing (9 out of 14 positive cases) showed a closely-clustered Delta variant of SARS-CoV-2. Cycle threshold (CT) values of all positive cases ranged from 15.7 to 38.3. Three of the four positive cases who joined the vessel in Japan had CT values between 24.0 and 37.5 on the tests performed on 4 August. The crewperson with a CT value of 38.3 had remained asymptomatic throughout, and had tested negative 12 days later; the CT value could represent early infection with clearance. Chronic intermittent shedding is unlikely as the crew member joined the vessel four months prior, in March 2021. Eight of the 14 positive cases were mildly symptomatic (loss of smell/taste, mild headache, cough, muscular pain and runny nose). None had severe symptoms or required hospitalisation.

Safe manning of the vessel while at anchor was not affected, as the Master, Chief Officer, Second Officer, Second and Third Assistant Engineers and Chief Cook remained unaffected throughout the outbreak. (The Second Cook became symptomatic and tested positive on 4 August.)

On 16 August 2021, when the second round of testing occurred, three of the crew members who had tested negative at baseline testing (4 August) now tested positive, suggestive of quarantine breaches or long incubation periods (5% of cases can have incubation periods longer than 11 to 16 days),[4] leading to the outbreak lasting 26 days.

The single or double dose vaccination rate onboard the ship was 89% (n = 23). Eighteen of the 26 crew on board the vessel were fully vaccinated (69%), five were partially vaccinated with the remaining three not vaccinated. For those with completed doses, the average time since course of vaccination completion was 15.0 weeks (standard deviation, SD: 1.5), with a minimum of 10 weeks.

The attack rate was 54% (14/26). Point estimates of VE were 52% for all lab-confirmed SARS-CoV-2 infections, 65% for symptomatic SARS-CoV-2 infection and 100% for severe SARS-CoV-2.

Public health response

Public Health reviewed the vessel's Outbreak Management plan, which addressed infection control and cleaning and disinfection at a broad level. The local Public Health Unit (PHU) provided additional advice, specific to the environment, on cleaning and disinfection (e.g. soft furnishings, navigation equipment) and on required cleaning techniques. Infection control measures implemented included increased cleaning frequency of frequently-touched surfaces, hand hygiene, use of personal protective equipment (PPE, e.g. masks), crew isolation until deemed negative and daily symptom monitoring during the outbreak. All SARS-CoV-2 positive crew members were isolated in single cabins which they were not allowed to leave. The remaining crew members were quarantined in single cabins and were allowed to perform essential activities to run the vessel. All meals were delivered to the cabin of the positive crew, left on the floor outside the cabin door so no interaction with other crew occurred, and were consumed within the cabin. Used plates/cutlery were subsequently placed outside the room for collection. Staff collecting plates/cutlery/glasses were wearing appropriate PPE and were instructed to refrain from touching other surfaces of the vessel with contaminated gloves.

Confirmed cases were assigned a dedicated bathroom for their use with regular cleaning

Figure 1: Epicurve for the SARS-CoV-2 Delta strain outbreak among the crew of the LNG carrier Pan Europe

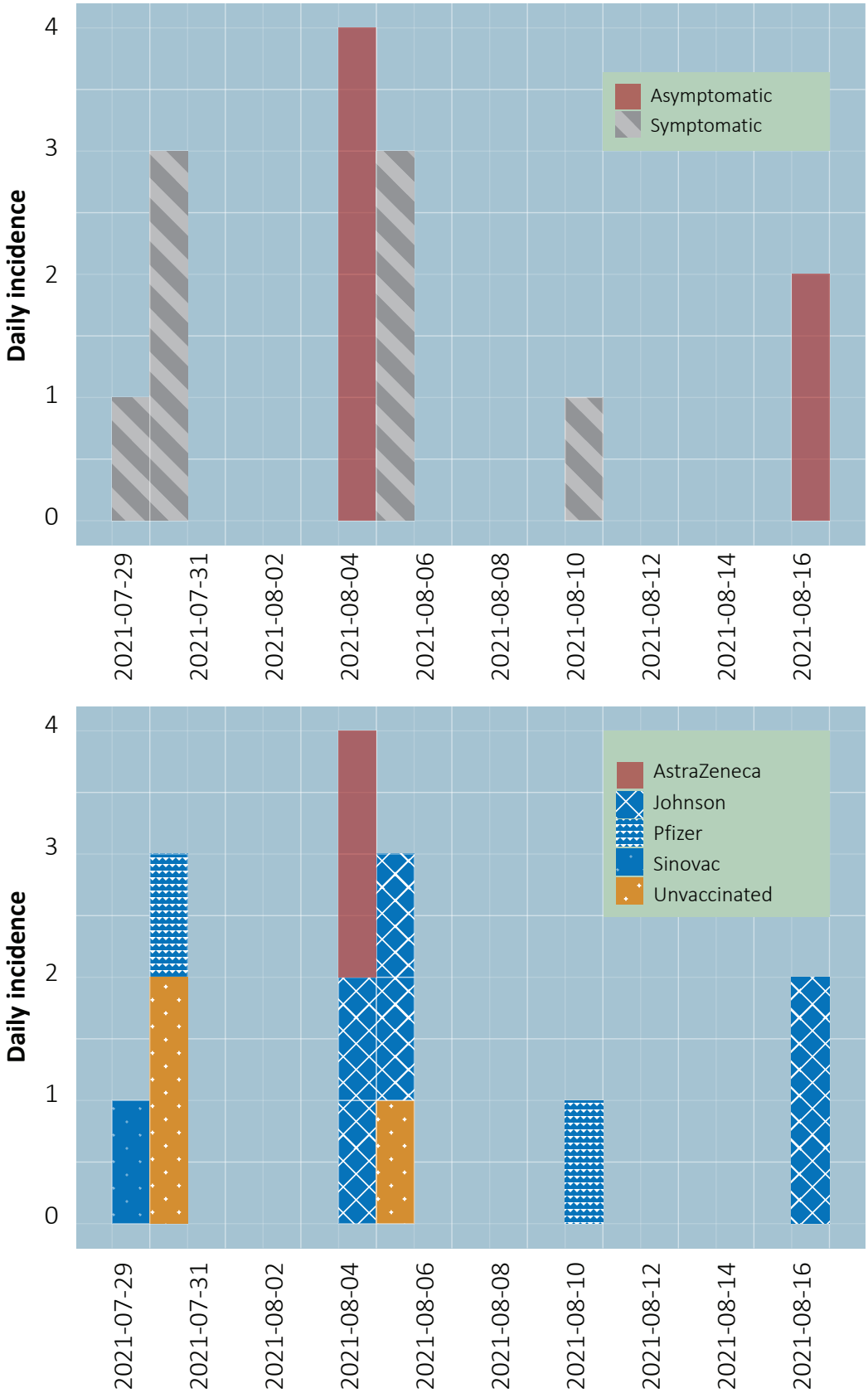

Table 1: Demographic and clinical variables by infection status

	No infection (n = 12)	Infection (n = 14)	Total (N = 26)	*p* value[a]
Age, years				**0.400**
Median (range)	37 (28–49)	37 (27–60)	37 (27–60)	
Vaccination status				**0.236**
Complete	10 (83.3%)	8 (57.1%)	18 (69.2%)	
Incomplete	2 (16.7%)	3 (21.4%)	5 (19.2%)	
Not vaccinated	0 (0.0%)	3 (21.4%)	3 (11.5%)	
Vaccine brand				**0.411**
AstraZeneca	1 (8.3%)	2 (14.3%)	3 (11.5%)	
Johnson	9 (75.0%)	7 (50.0%)	16 (61.5%)	
Pfizer	2 (16.7%)	1 (7.1%)	3 (11.5%)	
Sinovac	0 (0.0%)	1 (7.1%)	1 (3.8%)	
Unvaccinated	0 (0.0%)	3 (21.4%)	3 (11.5%)	
Time since CC[b]				**0.371**
Median (range)	15.3 (9.9, 17.6)	15.3 (12.9, 15.3)	15.3 (9.9, 17.6)	
Asymptomatic				
Missing	12	0	12	
Asymptomatic	0	6 (42.9%)	6 (42.9%)	
Symptomatic	0	8 (57.1%)	8 (57.1%)	
CT value: 04/08/2021[c]				
Missing/not (+)	12	3	15	
Median (range)	NA	26.4 (15.7, 38.3)	26.4 (15.7, 38.3)	
CT value: 16/08/2021[c]				
Missing/not (+)	12	3	15	
Median (range)	NA	34.7 (22.2, 37.2)	34.7 (22.2, 37.2)	
CT value: 23/08/2021[c]				
Missing/not (+)	12	5	17	
Median (range)	NA	33.5 (29.4, 37.2)	33.5 (29.4, 37.2)	

a Rank sum test used for age, and simulated Fisher exact tests with 500 replicates used for categorical variables.

b Time since course complete (CC; in weeks) represents the time since dose of Johnson & Johnson, or second dose of Astra Zeneca (n=2). Note all Pfizer immunizations were incomplete (only received 1 dose).

c Not all persons tested positive at each test, hence the missing CT values on each date.

and disinfecting after each use. No additional precautions were recommended for handling standard waste, but those handling healthcare waste were required to use standard precautions.

Cleaning and disinfection of frequently-touched surfaces was instituted on a daily basis. Later, a full two-step comprehensive touch-point deep clean commenced on 31 August 2021, using a cleaning and disinfection procedure which was methodically undertaken over several days. First, each hard surface was cleaned with a detergent, then followed with a disinfectant 1,000 ppm bleach solution. Specific guidance was provided by the PHU for the cleaning of internal and external surfaces of the ship (e.g. accommodation areas, soft furnishings, handrails, hatches and their closing mechanisms etc.).

Discussion

The attack rate of SARS-CoV-2 Delta variant was 54%, even in a highly vaccinated population; however, in this population, it caused mild disease. Safe manning of the vessel while at anchor was not affected, and transmission onboard was unlikely driven by the catering crew. Vaccines for SARS-CoV-2 used by these crew members have high efficacy rates between 67% and 95%.[5–9] Here we demonstrated that the combinations of vaccines listed in Table 1 had a VE of 65.3% for symptomatic infection for SARS-CoV-2 Delta variant and 100% against severe infection (e.g. hospitalisation/death).

Outbreaks of SARS-CoV-2 on various types of ships (cargo, navy, cruise ships) and crew numbers (< 50 in cargo ships to > 1000 in cruise ships) have variable attack rates and mortality even in younger populations.[10] An outbreak with the first strain of SARS-CoV-2 (pre-Variant on Concern (VOC)) on a cruise ship, the MS *Artania*, in Perth, Australia resulted in 51 known cases and one death among crew members; among passengers, there were 30 cases and three deaths.[11] Aboard the *Diamond Princess* cruise ship (2666 passengers, 1045 crew; total 3711), an outbreak with the first strain of SARS-CoV-2 (pre-VOC) resulted in 712 confirmed cases, for an attack rate (AR) of 20%, with 13 deaths.[12] A 56-day outbreak with the first strain of SARS-CoV-2 (pre-VOC), on the United States Navy aircraft carrier the USS *Theodore Roosevelt* with 4,779 total crew (average age 27 years), resulted in 1,271 confirmed cases, for an AR of 27%; of the confirmed cases, 23 (1.8%) were hospitalised, four (0.3%) received intensive care, and one died.[13] A SARS-CoV-2 Delta VOC outbreak on a South Korean navy ship with a total of 301 crew resulted in 272 confirmed cases for an AR of 90% in unvaccinated soldiers, of whom 7% (n = 19) were hospitalised,[14] a substantially higher attack rate than that observed in this outbreak (AR 54% with no hospitalisations).

Although the AR of SARS-CoV-2 Delta strain was high among the vaccinated population aboard the vessel (54%), it was much higher (90%) in the unvaccinated population aboard the South Korean Navy ship.[14] With heightened public health measures and infection control practices, we were able to declare the outbreak over in 26 days.

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