Canterbury
District Health Board
Te Poari Hauora ō Waitaha

CORPORATE OFFICE

Level 1
32 Oxford Terrace
Christchurch Central
CHRISTCHURCH 8011

Telephone: 0064 3 364 4160
Fax: 0064 3 364 4165
Ralph.lasalle@cdhb.health.nz

22 January 2021

9(2)(a) [redacted]

RE Official information request CDHB 10475

I refer to your email dated 9 November 2020 requesting the following information under the Official Information Act from Canterbury DHB. Specifically:

I am requesting the CDHB release all correspondence they have between themselves, Ministry of Health officials, Ministry of Business, Innovation and Employment officials, and any other person(s) or group(s) involved in the Managed Isolation and Quarantine process about the processes and management of the foreign fishermen who have been flown on two chartered flights to New Zealand. For your reference, these flights and the stay in managed isolation have been paid for by three New Zealand fishing companies. The foreign fishermen have been staying at the Christchurch's Sudima Hotel.

Please find attached as **Appendix 1. Note:** We have withheld information which is 'out of scope' of your request and we have redacted information under section 9(2)(a) of the Official Information Act, i.e. *"..to protect the privacy of natural persons, including those deceased".* **Please also note:** From page 59 we are providing you with the final report as opposed to the draft report mentioned in the email which precedes it.

I trust this satisfies your interest in this matter.

You may, under section 28(3) of the Official Information Act, seek a review of our decision to withhold information by the Ombudsman. Information about how to make a complaint is available at www.ombudsman.parliament.nz; or Freephone 0800 802 602.

Please note that this response, or an edited version of this response, may be published on the Canterbury DHB website after your receipt of this response.

Yours sincerely

R LaSalle

Ralph La Salle
Acting Executive Director
Planning, Funding & Decision Support

Out of Scope

[redacted]

From: Anna Stevenson
Sent: Wednesday, 21 October 2020 11:12 a.m.
To: Public Health Specialist Team <publichealthSpecialistTeam@cdhb.govt.nz>
Subject: FW: Double bunking 2nd Tranche[EXTERNAL SENDER]

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From: Canterbury RIQ Ops <riq.ops@canterburyecc.govt.nz>
Sent: Wednesday, 21 October 2020 10:04 AM
To: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Cc: Jessica Meates <Jessica.Meates@cdhb.health.nz>
Subject: Double bunking 2nd Tranche[EXTERNAL SENDER]

Hi Anna,

just a quick follow-up from our discussion this morning around the risks with double bunking. This was discussed immediately afterwards with the Operations team at MIQ in Wellington including Air Commodore Webb. As a result double bunking will not be considered for the 2nd Tranche. We will hold them to that.

9(2)(a)

[redacted]

Canterbury RIQ Ops
Facilities
Regional Emergency
Management Office

Emergency Management Canterbury

Canterbury Civil Defence Emergency Management Group
PO Box 345, Christchurch 8140
Justice & Emergency Services Precinct,
40 Lichfield St, Christchurch

riq.ops@canterburyecc.govt.nz

cdemcanterbury.govt.nz

Unite against COVID-19

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Out of Scope

[redacted]

From: Ramon Pink
Sent: Wednesday, 28 October 2020 11:23 a.m.
To: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Subject: FW: Quick clarification point[EXTERNAL SENDER]

Anna,

This is Cheryl's response to Harriette, re isolation times for Russian mariners.

Regards
Ramon.

Dr Ramon Pink
Medical Offficer of Health/Public Health Physician
Community and Public Health, Division of the Canterbury District Health Board
310 Manchester St, PO Box 1475 Christchurch 8013
9(2)(a) [redacted]

From: Harriette Carr <Harriette.Carr@health.govt.nz>
Sent: Thursday, 22 October 2020 8:57 PM
To: Cheryl Brunton <Cheryl.Brunton@cdhb.health.nz>; Richard Jaine <Richard.Jaine@health.govt.nz>
Cc: Ramon Pink <Ramon.Pink@cdhb.health.nz>; CPHOps <CPHOps@cdhb.health.nz>; Kerry Marshall

RELEASED UNDER

<Kerry.Marshall@cdhb.health.nz>
Subject: Re: Quick clarification point[EXTERNAL SENDER]

Thanks for your very detailed response!
Kind regards
Harriette

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From: Cheryl Brunton <Cheryl.Brunton@cdhb.health.nz>
Sent: Thursday, October 22, 2020 7:37:46 PM
To: Harriette Carr <Harriette.Carr@health.govt.nz>; Richard Jaine <Richard.Jaine@health.govt.nz>
Cc: Ramon Pink <Ramon.Pink@cdhb.health.nz>; CPHOps <CPHOps@cdhb.health.nz>; Kerry Marshall <Kerry.Marshall@cdhb.health.nz>
Subject: FW: Quick clarification point[EXTERNAL SENDER]

Kia ora Harriette

Ramon has asked me to respond as I'm currently lead on this (until Anna back next Tuesday) and will be over long weekend.

It may be a quick question but there isn't really a quick answer. For now, it's no. However, there is a longer explanation.

We have not yet reset the clock for the Russian crew (those who aren't cases). We decided to hold off doing that until we were able at least to look at the Day 6 swab results and consider the information we obtained from the Day 6 case interviews (we have added some specific questions about activities within the MIQF). We feel very strongly that we need to be able to at least attempt to make a more nuanced assessment of risk.

Our problem with a simple re-set – even for the 10 double bunk buddies of our known cases – is that we cannot be confident that their exposure ceased from the time the first 18 cases were moved to the quarantine wing. Although those 10 "higher risk contacts" (the bunk buddies) have been more restricted since as far as their movements are concerned, they are still able to go outside and smoke together. All the rest of the crew (who we are regarding as close contacts) are still able to mix and mingle when outside for smoking. While all the outside activities are supervised, and physical distancing and mask wearing is required and mostly complied with, they can't smoke with a mask on and they smoke frequently (even if not as frequently as they'd like).

At the Day 6 testing, we will probably identify a mix of cases:

1. Some who were infected in Russia
2. Some who were infected on the flights
3. Some who have been infected since arrival in NZ, either on the buses or in the MIQF
4. Maybe some historical cases who didn't test positive on day 3 because their levels of virus are "hovering" around the limit of detection

The number of cases, especially in groups 1, 2 and 3, will also have a bearing on our assessment.

At Day 12, we will be unlikely to pick up cases from 1, 2 and 4. The only certainty at this point is that our 18 cases will be able to leave quarantine after 10 days and 72 hours symptom free.

We would want to look closely at our Day 6 results and interview data and update our risk assessment re: transmission before doing either a general or specific re-set. While we will have results tomorrow, we are unlikely to be able to do that reassessment quickly as we would want to consult with our Micro, IPC and MIQF health colleagues. We would also want to be able to discuss with our Ministry colleagues - not to mention that it's the long weekend coming up!

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I think it is more likely that we could aim to be doing this next week – as soon as we are able. I'm on over the long weekend and would not want to make that call myself.

I know that won't make politicians or fishing companies happy but neither would "leakage" of COVID-19 from the facility either into the community or on to the fishing vessels themselves. Simply adding 3 days will almost certainly not be enough to mitigate that risk.

Ngā mihi, Cheryl

From: Harriette Carr [mailto:Harriette.Carr@health.govt.nz]
Sent: Thursday, 22 October 2020 6:17 p.m.
To: Ramon Pink <Ramon.Pink@cdhb.health.nz>
Cc: Richard Jaine <Richard.Jaine@health.govt.nz>
Subject: Quick clarification point[EXTERNAL SENDER]

Hi Ramon,
Sorry to bother you. There was a query at our end wanting to know whether CPH was resetting the 14 days for all the Russian mariners from Day 3 (i.e. Day 3 + 14 days) or not.

Thanks so much,

Cheers

Dr Harriette Carr
Deputy Director of Public Health
Population Health and Prevention
Ministry of Health
9(2)(a) [redacted]

http://www.health.govt.nz
mailto:Harriette.Carr@health.govt.nz

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[redacted]

From: Marion Poore [mailto:Marion.Poore@health.govt.nz]
Sent: Wednesday, 28 October 2020 5:17 p.m.
To: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>; COVID-19clinical@health.govt.nz; Aoife Kenny <Aoife.Kenny@health.govt.nz>
Cc: Cheryl Brunton <Cheryl.Brunton@cdhb.health.nz>; Ramon Pink <Ramon.Pink@cdhb.health.nz>; Joshua Freeman <Joshua.Freeman@cdhb.health.nz>; Anja Werno <Anja.Werno@cdhb.health.nz>; Jessica Meates <Jessica.Meates@cdhb.health.nz>; Doug Lush <Doug.Lush@health.govt.nz>; Sarah Berger <Sarah.Berger@cdhb.health.nz>
Subject: RE: Rationale used for releasing fishers

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Thanks Anna for this very comprehensive summary and thanks everyone in Canterbury for your contributions to this complex situation – I can imagine the rigorous discussions you will have had !

Many thanks
Marion

Dr Marion Poore; Public Health Physician; Chief Clinical Advisor; Covid-19 Health System Response Directorate
Workdays: Wed – Fri; Phone: 9(2)(a) [redacted] Email: marion.poore@health.govt.nz

MINISTRY OF HEALTH
MANATŪ HAUORA

From: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Sent: Wednesday, 28 October 2020 4:58 pm
To: COVID-19clinical@health.govt.nz; Marion Poore <Marion.Poore@health.govt.nz>; Aoife Kenny <Aoife.Kenny@health.govt.nz>
Cc: Cheryl Brunton <Cheryl.Brunton@cdhb.health.nz>; Ramon Pink <Ramon.Pink@cdhb.health.nz>; Joshua Freeman <Joshua.Freeman@cdhb.health.nz>; Anja Werno <Anja.Werno@cdhb.health.nz>; Jessica Meates <Jessica.Meates@cdhb.health.nz>; Doug Lush <Doug.Lush@health.govt.nz>; Sarah Berger <Sarah.Berger@cdhb.health.nz>
Subject: RE: Rationale used for releasing fishers

Kia ora koutou,

As requested, this email serves as a current status report and a summary of our decision-making process to date.

A charter Singapore Airlines flight carrying 249 people (235 passengers, 14 air crew) arrived in Christchurch on 16/10/20. The flight had departed from Moscow, transiting via Singapore. All passengers were transported via charter bus to the Sudima Airport Hotel to commence 14 days of managed quarantine.

The fishing crew cohort have been a challenging group of guests to manage in the MIQF. Only three of the 235 guests speak English. Approximately 2/3 of the guests are chain smokers and require frequent (up to 4 x hour) visits to the smoking area outside of their rooms. Compliance with requests to physically distance from other crew was patchy and in the first couple of days there was frequent exchanges of cigarettes, lighters, cell phones etc. This was raised on day two by nursing staff and behaviour was much improved after a letter from the crews employers was given to all of them. However, even with best behaviour the sheer volume of traffic through corridors as guests move in and out to smoke has been physically challenging to manage.

Day 3 swab results revealed that the fishing crew cohort had 18 COVID cases. These cases were all sharing rooms with another crew member. [redacted] Case Investigation interviews were carried out that day. Due to language difficulties one 'thorough' interview was undertaken and the rest were more superficial with the essential information for episurv and NCTS gained.

We have no clear information about any quarantine which this cohort may have undergone in Russia prior to their departure. According to the companies employing the crew, all were tested prior to leaving Russia and all 235 who came on flight to NZ tested negative. It has also been reported that two crew did not board the plane because they tested positive. At interview one crewman reported that he was already aware that he had tested positive when he was tested in Russia on the 9th October. His Fitness to Travel Certificate (sourced from the Fishing companies lawyer after not being able to obtain them from MBIE or MoH) states that he was tested on the 11th of October and the virus was not detected. Nursing staff here noted that on day three swabbing all crew offered an open mouth suggesting they had not previously had a nasopharyngeal swab.

Full or partial genomes have so far been able to be sequenced for 12/18 of these cases. The 18 day 3 cases were distributed over 13 rooms within the hotel. There were five rooms in which there were two day 3 cases. In one of these rooms, the two cases had the same B 1.1.77 genotype (the predominant genotype found on WGS), in another the two cases had different genotypes (B 1.1.7 and B 1.1.5) and in a third room neither of the two cases were able to be sequenced by WGS. Both these two latter cases had positive serology suggesting that they were already infected prior to leaving Russia. One of these was the man who told us he had tested positive on the 9th October.

Serology was undertaken on the day 3 group. This was taken as part of the ongoing project to assist the Canterbury Laboratories with validation of their serology assay as well as providing potential adjunct information to determine the timeframe of infection in some cases. Consistent with the history obtained by case investigators the serology

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results support possible historic infection in some, and transmission within the cohort in some although the direction of infection cannot be determined.

All cases were moved to a dedicated quarantine wing under the supervision of IPC staff. The last case was transferred at 2200 Tuesday night (day 4).
All cases were 'red banded'. Their wing is separated and secured from the rest of the hotel and is only entered by nursing staff who carry out twice daily observations. A dedicated smoking area has been created that is only accessible by the cases. They are free to enter and exit this area without supervision. All room-mates of the cases who swabbed negative were 'yellow banded' and have been treated according to standard close contact protocol.. They are escorted by NZDF staff to the exercise area or smoking area as required.

The remaining guests are being managed as high risk contacts ('Blue-plus') – they have potentially been exposed at several points on the journey from Russia to Aotearoa and also at various times in the first 72 hours in the MIQF when, as discussed, compliance with rules was not optimal. The particular factor that cannot be over stated that makes this situation even more challenging is the sheer volume of smokers and the frequency of their smoking. This means that cases were mingling with non-cases at potentially multiple times in the initial three days in hotel corridors and smoking yards.

At Day 6 testing, 8 cases were identified. We await WGS on this group. The day 6 cases were distributed over 7 rooms. Two were in the same room. Two were room-mates of Day 3 cases and it is likely that transmission occurred in that setting. Four were the first case in each of their rooms.

At Day 9 testing 3 cases were identified. We await WGS on this group. The day 9 cases were in three rooms. One was the room-mate of a Day 3 case and the other two were room-mates of Day 6 cases. It is very likely that transmission occurred in that setting.

In total, five cases have been identified among room-mates of previously identified cases: 3 being contacts of Day 3 cases and 2 being contacts of Day 6 cases.

Today day 12 testing is being carried out, we anticipate getting results Thursday morning.

A meeting was held today with the three operational MOH (Pink, Brunton and Stevenson), CDHB Microbiologist Werno, and CDHB Microbiologist and Clinical Director of IPC Freeman, and the IPC Nursing Director Sarah Berger. Confirmation was sought from on the ground nursing staff who were clear that compliance with all physical distancing and other PPE requirements has been high since day 3.

At this meeting we agreed that the clock would be re-set for all close contacts of cases who were roommates. This means that roommates of day 3 cases will have a further 14 days from their last exposure unless they become cases themselves (n=3); roommates of day six cases will have a further 14 days unless they become cases (n=2); and roommates of day nine cases will have a further 14 days unless they become cases. Cases are managed as per usual protocol by being quarantined for at least ten days with at least 72 hours being symptom free at the end of that time.

In total there were 18 day 3 cases, 8 Day 6 cases and 3 day 9 cases.

We further agreed that given the degree of exposure during the first 72 hours, all 'blue-plus' contacts would be treated as per usual protocol for close contacts starting from day 3. This makes their total stay at least 17 days through to Monday November 2.

If there are no further positives on day 12 testing we will re-swab all 'blue-plus' on day 15, and if these are also COVID negative we will release them from the MIQF on day 18 of their stay.

Any positives on day 12 and 15 will be treated as per usual protocol for cases. If these new cases are double bunking their room-mates will be treated as per usual protocol for close contacts with the clock being re-set for 14 days.

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For any remaining yellow banded high risk contacts (roommates of cases) we will also re-swab just before departure on Day 17 (Monday 2 November) noting that (so far) two of these were close contacts of day 6 cases and so, at the earliest, would be released after completing 14 days quarantine on Friday 6 November. We intend to rapid test to confirm the yellow banded close contacts are COVID free on exit from the MIQF.

In summary:

- All cases are managed as per usual protocol
- All roommates of cases are treated as high risk close contacts and managed as per usual protocol
- All other guests have been treated as close contacts and managed with less than usual security for close contacts (but more than usual for 'blue' guests) due to staff capacity issues
- To date we have 29 cases – some of whom would technically be eligible for release this Friday. For logistical/transport reasons we will accommodate them at the Sudima until the majority of the guests ('blue-plus') are eligible for release after 17 days in the MIQF.
- We will get day 12 results tomorrow morning and this will guide further decisions.

We hope this covers off any queries you may have- happy to discuss
Ngā mihi,
nā Anna

From: Doug.Lush@health.govt.nz <Doug.Lush@health.govt.nz> **On Behalf Of** COVID-19clinical@health.govt.nz
Sent: Tuesday, 27 October 2020 4:15 PM
To: Cheryl Brunton <Cheryl.Brunton@cdhb.health.nz>
Cc: Marion.Poore@health.govt.nz; Aoife.Kenny@health.govt.nz
Subject: Rationale used for releasing fishers[EXTERNAL SENDER]

Kia ora Cheryl

There continues to be a lot of interest from Wellington in the rationale that CDHB are applying locally for determining when the fishers can safely be released from their bespoke facility.
I acknowledge both the complexity of the risk matrix and the size of the problem you are dealing with

Would you be so kind as to provide a simple written email explanation that we can use to inform ourselves and other agencies.

Key information might include arrival dates, re-set dates, testing dates, room sharing, release dates for negative testers and for cases (10 days and 48 hours free of symptoms etc).

Please copy this information to Marion and Aoife as I will not be back in office until next Monday.

Many thanks

Dr Doug Lush 9(2)(a) [redacted] **Andi Shirtcliffe** 9(2)(a) [redacted] **Marion Poore** 9(2)(a) [redacted]
Covid 19 Clinical Liaison Desk
****
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From: Marion Poore [mailto:Marion.Poore@health.govt.nz]
Sent: Thursday, 29 October 2020 11:54 a.m.
To: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>; COVID-19clinical@health.govt.nz; Aoife Kenny <Aoife.Kenny@health.govt.nz>; Doug Lush <Doug.Lush@health.govt.nz>
Cc: Cheryl Brunton <Cheryl.Brunton@cdhb.health.nz>; Ramon Pink <Ramon.Pink@cdhb.health.nz>; Anja Werno <Anja.Werno@cdhb.health.nz>; Jessica Meates <Jessica.Meates@cdhb.health.nz>; Sarah Berger <Sarah.Berger@cdhb.health.nz>; Joshua Freeman <Joshua.Freeman@cdhb.health.nz>
Subject: RE: Rationale used for releasing fishers

Many thanks Anna – this is indeed a very good result.

Best wishes
Marion

Dr Marion Poore; Public Health Physician; Chief Clinical Advisor; Covid-19 Health System Response Directorate
Workdays: Wed – Fri; Phone 9(2)(a) [redacted] Email: marion.poore@health.govt.nz

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From: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Sent: Thursday, 29 October 2020 11:50 am
To: COVID-19clinical@health.govt.nz; Marion Poore <Marion.Poore@health.govt.nz>; Aoife Kenny <Aoife.Kenny@health.govt.nz>; Doug Lush <Doug.Lush@health.govt.nz>
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Subject: Rationale used for releasing fishers

Kia ora koutou,

The test from Day 12 have all returned and we have one positive. This person is a close contact (roommate) of a day six case.
This feels like a very good result from an IPC and PPE stance. The case is being moved to quarantine wing now.

We intend to continue with the plan as outlined below.

- The case will be managed as per standard protocol.
- We will re-test all yellow and blue-plus guests on day 15. If these tests return negative we will plan for these guests exit from the Sudima at the completion of 17 days quarantine which will have them leaving next Tuesday.
- The day 3 cases will have completed their quarantine by Friday and will exit with the larger group on Tuesday.
- We will rapid test the remaining 6 close contacts (yellow bands) as close to their release on Tuesday as possible to ensure they remain infection free.

This plan is still dependent on day 15 results being negative but the results today are encouraging.
Happy to discuss
Ngā mihi,
nā Anna

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Sent: Wednesday, 28 October 2020 4:58 pm
To: COVID-19clinical@health.govt.nz; Marion Poore <Marion.Poore@health.govt.nz>; Aoife Kenny <Aoife.Kenny@health.govt.nz>
Cc: Cheryl Brunton <Cheryl.Brunton@cdhb.health.nz>; Ramon Pink <Ramon.Pink@cdhb.health.nz>; Joshua Freeman <Joshua.Freeman@cdhb.health.nz>; Anja Werno <Anja.Werno@cdhb.health.nz>; Jessica Meates <Jessica.Meates@cdhb.health.nz>; Doug Lush <Doug.Lush@health.govt.nz>; Sarah Berger <Sarah.Berger@cdhb.health.nz>
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raised on day two by nursing staff and behaviour was much improved after a letter from the crews employers was given to all of them. However, even with best behaviour the sheer volume of traffic through corridors as guests move in and out to smoke has been physically challenging to manage.

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We further agreed that given the degree of exposure during the first 72 hours, all 'blue-plus' contacts would be treated as per usual protocol for close contacts starting from day 3. This makes their total stay at least 17 days through to Monday November 2.

If there are no further positives on day 12 testing we will re-swab all 'blue-plus' on day 15, and if these are also COVID negative we will release them from the MIQF on day 18 of their stay.

Any positives on day 12 and 15 will be treated as per usual protocol for cases. If these new cases are double bunking their room-mates will be treated as per usual protocol for close contacts with the clock being re-set for 14 days.

For any remaining yellow banded high risk contacts (roommates of cases) we will also re-swab just before departure on Day 17 (Monday 2 November) noting that (so far) two of these were close contacts of day 6 cases and so, at the earliest, would be released after completing 14 days quarantine on Friday 6 November. We intend to rapid test to confirm the yellow banded close contacts are COVID free on exit from the MIQF.

In summary:

- All cases are managed as per usual protocol
- All roommates of cases are treated as high risk close contacts and managed as per usual protocol
- All other guests have been treated as close contacts and managed with less than usual security for close contacts (but more than usual for 'blue' guests) due to staff capacity issues
- To date we have 29 cases – some of whom would technically be eligible for release this Friday. For logistical/transport reasons we will accommodate them at the Sudima until the majority of the guests ('blue-plus') are eligible for release after 17 days in the MIQF.
- We will get day 12 results tomorrow morning and this will guide further decisions.

We hope this covers off any queries you may have- happy to discuss
Ngā mihi,
nā Anna

From: Doug.Lush@health.govt.nz <Doug.Lush@health.govt.nz> **On Behalf Of** COVID-19clinical@health.govt.nz
Sent: Tuesday, 27 October 2020 4:15 PM
To: Cheryl Brunton <Cheryl.Brunton@cdhb.health.nz>

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Cc: Marion.Poore@health.govt.nz; Aoife.Kenny@health.govt.nz
Subject: Rationale used for releasing fishers[EXTERNAL SENDER]

Kia ora Cheryl

There continues to be a lot of interest from Wellington in the rationale that CDHB are applying locally for determining when the fishers can safely be released from their bespoke facility.
I acknowledge both the complexity of the risk matrix and the size of the problem you are dealing with

Would you be so kind as to provide a simple written email explanation that we can use to inform ourselves and other agencies.

Key information might include arrival dates, re-set dates, testing dates, room sharing, release dates for negative testers and for cases (10 days and 48 hours free of symptoms etc).

Please copy this information to Marion and Aoife as I will not be back in office until next Monday.

Many thanks

Dr Doug Lush 9(2)(a) [redacted] **Andi Shirtcliffe** 9(2)(a) [redacted] **Marion Poore** 9(2)(a) [redacted]
Covid 19 Clinical Liaison Desk
****
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Out of Scope

[redacted]

From: Cheryl Brunton
Sent: Tuesday, 27 October 2020 4:13 p.m.
To: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>; Alizon Paterson <Alizon.Paterson@cdhb.health.nz>
Subject: RE: Request for information from Sealord International.[EXTERNAL SENDER]

Will do

From: Anna Stevenson
Sent: Tuesday, 27 October 2020 4:00 PM
To: Alizon Paterson <Alizon.Paterson@cdhb.health.nz>; Cheryl Brunton <Cheryl.Brunton@cdhb.health.nz>
Subject: FW: Request for information from Sealord International.[EXTERNAL SENDER]

Is this something you could sort out please?
Anna

From: 9(2)(a) [redacted] law.co.nz>
Sent: Tuesday, 27 October 2020 3:52 PM
To: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Cc: Jessica Meates <Jessica.Meates@cdhb.health.nz>
Subject: FW: Request for information from Sealord International.[EXTERNAL SENDER]

Hi Anna

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I spoke to Jess about this a little while ago. She requested I forward to you. Can you give me a call to discuss when you are able please, on 9(2)(a)

Many thanks

9(2)(a)

9(2)(a)

EMAIL: 9(2)(a) *law.co.nz*

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From:

From: 9(2)(a) @moh.gov.sg>
Sent: Friday, 23 October 2020 5:15 pm
To: 9(2)(a) sealord.co.nz>
9(2)(a) staff @moh.gov.singapore

Subject: Request for information from Sealord International.

Dear Sir/Mdm,

I am 9(2)(a) from Singapore Ministry of Health. The Singapore Ministry of Health (MOH) is currently investigating into 10 positive COVID-19 cases who are your employees who have travelled on SQ295 (Singapore to Christchurch) arriving on 16th October. Under Section 55(1)(e) of the Infectious Diseases Act, MOH is requesting for your assistance to provide the following details for the purpose of contact tracing:

1) Names and contact number of the employees who are currently at Sudima Airport Hotel ChristChurch in an excel file.

Should you have any queries, feel free to contact me at my landline below. Thank you for your kind assistance.

Kind regards,

9(2)(a)
Ministry of Health Contact Tracing Center | (65) 6373 3686 | Visit us at http://www.moh.gov.sg
Ministry of Health Hotline | 1800 333 9999
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Championing a healthy nation with our people - To live well, live long & with peace of mind

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[redacted]

From: Cheryl Brunton
Sent: Thursday, 29 October 2020 1:37 p.m.
To: 9(2)(a) [redacted]
Cc: 9(2)(a) [redacted] law.co.nz>; Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Subject: Introduction re: fishing crews

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Kia ora koutou

This email is to introduce you all to 9(2)(a) [redacted] and is acting on behalf of the three fishing companies whose crew are currently in MIQF in Christchurch, having arrived in Christchurch on 16th October on a charter flight from Moscow via Singapore. 9(2)(a) [redacted] would like to liaise with you to keep you in the loop about where these crew will go to when they are released from MIQF.

- Sealord's crew will travel to Nelson to board their vessels
- Maruha's crew will travel to Port Chalmers to board their vessels

The Independent Fisheries crew will board their vessels in Lyttelton.

At this stage, we are looking at the majority of the crew being able to leave MIQF in Christchurch next Tuesday 3rd November.

Anna Stevenson is our PHS lead for MIQF so is your best point of contact here tomorrow and next week. I will be on duty over the weekend.

Ngā mihi, Cheryl

Dr Cheryl Brunton
Medical Officer of Health/Āpiha Hauora o te Hauora
Community and Public Health/Te Mana Ora
Canterbury District Health Board/Te Poari Hauora ō Waitaha
PO Box 1475
310 Manchester Street
Christchurch/Ōtautahi

9(2)(a) [redacted]

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Out of Scope

[redacted]

From: Ashley Bloomfield [mailto:Ashley.Bloomfield@health.govt.nz]
Sent: Thursday, 29 October 2020 12:34 p.m.
To: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Cc: COVID-19clinical@health.govt.nz; Marion Poore <Marion.Poore@health.govt.nz>; Aoife Kenny <Aoife.Kenny@health.govt.nz>; Cheryl Brunton <Cheryl.Brunton@cdhb.health.nz>; Ramon Pink <Ramon.Pink@cdhb.health.nz>; Joshua Freeman <Joshua.Freeman@cdhb.health.nz>; Anja Werno <Anja.Werno@cdhb.health.nz>; Jessica Meates <Jessica.Meates@cdhb.health.nz>; Doug Lush <Doug.Lush@health.govt.nz>; Sarah Berger <Sarah.Berger@cdhb.health.nz>; Aoife Kenny <Aoife.Kenny@health.govt.nz>
Subject: RE: Rationale used for releasing fishers

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Kia ora Anna and other CDHB colleagues
Thanks for an excellent write up, really clear and helpful rationale.

Ngā mihi nui
Ashley

Dr Ashley Bloomfield
Te Tumu Whakarae mō te Hauora
Director-General of Health

email: ashley.bloomfield@health.govt.nz
Mobile: 9(2)(a) [redacted]

www.health.govt.nz

From: Aoife Kenny <Aoife.Kenny@health.govt.nz>
Sent: Thursday, 29 October 2020 9:51 am
To: Ashley Bloomfield <Ashley.Bloomfield@health.govt.nz>
Cc: Stacey Connor <Stacey.Connor@health.govt.nz>
Subject: FW: Rationale used for releasing fishers

Hi Ashley,

See below much more detail from CPH. Apologies this is close to the 1130 meeting.

Aoife

From: Sue Gordon <Sue.Gordon@health.govt.nz>
Sent: Wednesday, 28 October 2020 8:12 pm
To: Aoife Kenny <Aoife.Kenny@health.govt.nz>; Jane Kelley <Jane.Kelley@health.govt.nz>
Cc: Marion Poore <Marion.Poore@health.govt.nz>
Subject: Re: Rationale used for releasing fishers

Thank you this is really helpful- happy for you to forward to Ashley in preparation for tomorrow's 11.30 discussion
Ta Sue

Get Outlook for iOS

From: Aoife Kenny <Aoife.Kenny@health.govt.nz>
Sent: Wednesday, October 28, 2020 6:04:11 PM
To: Sue Gordon <Sue.Gordon@health.govt.nz>; Jane Kelley <Jane.Kelley@health.govt.nz>
Cc: Marion Poore <Marion.Poore@health.govt.nz>
Subject: FW: Rationale used for releasing fishers

Sue and Jane, a more detailed plan.

Aoife

From: Marion Poore <Marion.Poore@health.govt.nz>
Sent: Wednesday, 28 October 2020 5:19 pm
To: COVID-IMT Response Manager <COVID_IMT_ResponseMgr.health.govt.nz@mohgovtnz.onmicrosoft.com>; COVID-IMT Senior Responsible Office & Controller <COVID_IMT-SRO.health.govt.nz@mohgovtnz.onmicrosoft.com>; James Hogan <James.Hogan@health.govt.nz>
Cc: Aoife Kenny <Aoife.Kenny@health.govt.nz>
Subject: FW: Rationale used for releasing fishers

Hi
This has come from Canterbury – hopefully you are the right people for me to be forwarding to

Marion

Dr Marion Poore; Public Health Physician; Chief Clinical Advisor; Covid-19 Health System Response Directorate
Workdays: Wed – Fri; Phone 9(2)(a) Email: marion.poore@health.govt.nz

MINISTRY OF HEALTH
MANATŪ HAUORA

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From: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Sent: Wednesday, 28 October 2020 4:58 pm
To: COVID-19clinical@health.govt.nz; Marion Poore <Marion.Poore@health.govt.nz>; Aoife Kenny <Aoife.Kenny@health.govt.nz>
Cc: Cheryl Brunton <Cheryl.Brunton@cdhb.health.nz>; Ramon Pink <Ramon.Pink@cdhb.health.nz>; Joshua Freeman <Joshua.Freeman@cdhb.health.nz>; Anja Werno <Anja.Werno@cdhb.health.nz>; Jessica Meates <Jessica.Meates@cdhb.health.nz>; Doug Lush <Doug.Lush@health.govt.nz>; Sarah Berger <Sarah.Berger@cdhb.health.nz>
Subject: RE: Rationale used for releasing fishers

Kia ora koutou,

As requested, this email serves as a current status report and a summary of our decision-making process to date.

A charter Singapore Airlines flight carrying 249 people (235 passengers, 14 air crew) arrived in Christchurch on 16/10/20. The flight had departed from Moscow, transiting via Singapore. All passengers were transported via charter bus to the Sudima Airport Hotel to commence 14 days of managed quarantine.

The fishing crew cohort have been a challenging group of guests to manage in the MIQF. Only three of the 235 guests speak English. Approximately 2/3 of the guests are chain smokers and require frequent (up to 4 x hour) visits to the smoking area outside of their rooms. Compliance with requests to physically distance from other crew was patchy and in the first couple of days there was frequent exchanges of cigarettes, lighters, cell phones etc. This was raised on day two by nursing staff and behaviour was much improved after a letter from the crews employers was given to all of them. However, even with best behaviour the sheer volume of traffic through corridors as guests move in and out to smoke has been physically challenging to manage.

Day 3 swab results revealed that the fishing crew cohort had 18 COVID cases. These cases were all sharing rooms with another crew member. [redacted] Case Investigation interviews were carried out that day. Due to language difficulties one 'thorough' interview was undertaken and the rest were more superficial with the essential information for episurv and NCTS gained.

We have no clear information about any quarantine which this cohort may have undergone in Russia prior to their departure. According to the companies employing the crew, all were tested prior to leaving Russia and all 235 who came on flight to NZ tested negative. It has also been reported that two crew did not board the plane because they tested positive. At interview one crewman reported that he was already aware that he had tested positive when he was tested in Russia on the 9th October. His Fitness to Travel Certificate (sourced from the Fishing companies lawyer after not being able to obtain them from MBIE or MoH) states that he was tested on the 11th of October and the virus was not detected. Nursing staff here noted that on day three swabbing all crew offered an open mouth suggesting they had not previously had a nasopharyngeal swab.

Full or partial genomes have so far been able to be sequenced for 12/18 of these cases. The 18 day 3 cases were distributed over 13 rooms within the hotel. There were five rooms in which there were two day 3 cases. In one of these rooms, the two cases had the same B 1.1.77 genotype (the predominant genotype found on WGS), in another the two cases had different genotypes (B 1.1.7 and B 1.1.5) and in a third room neither of the two cases were able to be sequenced by WGS. Both these two latter cases had positive serology suggesting that they were already infected prior to leaving Russia. One of these was the man who told us he had tested positive on the 9th October.

Serology was undertaken on the day 3 group. This was taken as part of the ongoing project to assist the Canterbury Laboratories with validation of their serology assay as well as providing potential adjunct information to determine the timeframe of infection in some cases. Consistent with the history obtained by case investigators the serology results support possible historic infection in some, and transmission within the cohort in some although the direction of infection cannot be determined.

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All cases were moved to a dedicated quarantine wing under the supervision of IPC staff. The last case was transferred at 2200 Tuesday night (day 4).
All cases were 'red banded'. Their wing is separated and secured from the rest of the hotel and is only entered by nursing staff who carry out twice daily observations. A dedicated smoking area has been created that is only accessible by the cases. They are free to enter and exit this area without supervision. All room-mates of the cases who swabbed negative were 'yellow banded' and have been treated according to standard close contact protocol.. They are escorted by NZDF staff to the exercise area or smoking area as required.

The remaining guests are being managed as high risk contacts ('Blue-plus') – they have potentially been exposed at several points on the journey from Russia to Aotearoa and also at various times in the first 72 hours in the MIQF when, as discussed, compliance with rules was not optimal. The particular factor that cannot be over stated that makes this situation even more challenging is the sheer volume of smokers and the frequency of their smoking. This means that cases were mingling with non-cases at potentially multiple times in the initial three days in hotel corridors and smoking yards.

At Day 6 testing, 8 cases were identified. We await WGS on this group. The day 6 cases were distributed over 7 rooms. Two were in the same room. Two were room-mates of Day 3 cases and it is likely that transmission occurred in that setting. Four were the first case in each of their rooms.

At Day 9 testing 3 cases were identified. We await WGS on this group. The day 9 cases were in three rooms. One was the room-mate of a Day 3 case and the other two were room-mates of Day 6 cases. It is very likely that transmission occurred in that setting.

In total, five cases have been identified among room-mates of previously identified cases: 3 being contacts of Day 3 cases and 2 being contacts of Day 6 cases.

Today day 12 testing is being carried out, we anticipate getting results Thursday morning.

A meeting was held today with the three operational MOH (Pink, Brunton and Stevenson), CDHB Microbiologist Werno, and CDHB Microbiologist and Clinical Director of IPC Freeman, and the IPC Nursing Director Sarah Berger. Confirmation was sought from on the ground nursing staff who were clear that compliance with all physical distancing and other PPE requirements has been high since day 3.

At this meeting we agreed that the clock would be re-set for all close contacts of cases who were roommates. This means that roommates of day 3 cases will have a further 14 days from their last exposure unless they become cases themselves (n=3); roommates of day six cases will have a further 14 days unless they become cases (n=2); and roommates of day nine cases will have a further 14 days unless they become cases. Cases are managed as per usual protocol by being quarantined for at least ten days with at least 72 hours being symptom free at the end of that time.

In total there were 18 day 3 cases, 8 Day 6 cases and 3 day 9 cases.

We further agreed that given the degree of exposure during the first 72 hours, all 'blue-plus' contacts would be treated as per usual protocol for close contacts starting from day 3. This makes their total stay at least 17 days through to Monday November 2.

If there are no further positives on day 12 testing we will re-swab all 'blue-plus' on day 15, and if these are also COVID negative we will release them from the MIQF on day 18 of their stay.

Any positives on day 12 and 15 will be treated as per usual protocol for cases. If these new cases are double bunking their room-mates will be treated as per usual protocol for close contacts with the clock being re-set for 14 days.

For any remaining yellow banded high risk contacts (roommates of cases) we will also re-swab just before departure on Day 17 (Monday 2 November) noting that (so far) two of these were close contacts of day 6 cases

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and so, at the earliest, would be released after completing 14 days quarantine on Friday 6 November. We intend to rapid test to confirm the yellow banded close contacts are COVID free on exit from the MIQF.

In summary:

- All cases are managed as per usual protocol
- All roommates of cases are treated as high risk close contacts and managed as per usual protocol
- All other guests have been treated as close contacts and managed with less than usual security for close contacts (but more than usual for 'blue' guests) due to staff capacity issues
- To date we have 29 cases – some of whom would technically be eligible for release this Friday. For logistical/transport reasons we will accommodate them at the Sudima until the majority of the guests ('blue-plus') are eligible for release after 17 days in the MIQF.
- We will get day 12 results tomorrow morning and this will guide further decisions.

We hope this covers off any queries you may have- happy to discuss
Ngā mihi,
nā Anna

From: Doug.Lush@health.govt.nz <Doug.Lush@health.govt.nz> **On Behalf Of** COVID-19clinical@health.govt.nz
Sent: Tuesday, 27 October 2020 4:15 PM
To: Cheryl Brunton <Cheryl.Brunton@cdhb.health.nz>
Cc: Marion.Poore@health.govt.nz; Aoife.Kenny@health.govt.nz
Subject: Rationale used for releasing fishers[EXTERNAL SENDER]

Kia ora Cheryl

There continues to be a lot of interest from Wellington in the rationale that CDHB are applying locally for determining when the fishers can safely be released from their bespoke facility.
I acknowledge both the complexity of the risk matrix and the size of the problem you are dealing with

Would you be so kind as to provide a simple written email explanation that we can use to inform ourselves and other agencies.

Key information might include arrival dates, re-set dates, testing dates, room sharing, release dates for negative testers and for cases (10 days and 48 hours free of symptoms etc).

Please copy this information to Marion and Aoife as I will not be back in office until next Monday.

Many thanks

Dr Doug Lush 9(2)(a) [redacted] **Andi Shirtcliffe** 9(2)(a) [redacted] **Marion Poore** 9(2)(a) [redacted]
Covid 19 Clinical Liaison Desk
****
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[redacted]

From: Joshua Freeman
Sent: Wednesday, 4 November 2020 3:46 p.m.
To: Caroline McElnay <Caroline.McElnay@health.govt.nz>; Naomi Gough <Naomi.Gough@health.govt.nz>; Jane Kelley <Jane.Kelley@health.govt.nz>; Tara Swadi <Tara.Swadi@health.govt.nz>
Cc: Marion Poore <Marion.Poore@health.govt.nz>; Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Subject: RE: Interim source investigation report[EXTERNAL SENDER]

Kia ora Caroline / Naomi,

I hope you don't mind me wading in. I totally agree this is a highly pertinent question (that we shouldn't shy away from) but in my view we've got a way to go before we can answer it.

We need to wait until we have:

- WGS data through on the second staff member and the potential source (waiting to hear back from ESR on this, hopefully later today / this evening).
- All staff testing results through
- Completion of all interviews

At the moment we have a reasonable working hypothesis about when transmission occurred and from whom but once the info above comes through this could send us off in a new direction.

I'm sure you're aware that any changes in national guidance around PPE use (particularly the specification of mask) would have absolutely enormous flow on implications across the system. Any evidence suggesting possible benefit would need to be weighed against the risk of any unintended consequences for the system as a whole.

Nga mihi,

Josh

Joshua Freeman
Clinical Microbiologist
Clinical Director, Infection Prevention and Control
CDHB

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From: Caroline McElnay <Caroline.McElnay@health.govt.nz>
Sent: Wednesday, 4 November 2020 3:16 PM
To: Naomi Gough <Naomi.Gough@health.govt.nz>; Jane Kelley <Jane.Kelley@health.govt.nz>; Tara Swadi <Tara.Swadi@health.govt.nz>
Cc: Marion Poore <Marion.Poore@health.govt.nz>; Joshua Freeman <Joshua.Freeman@cdhb.health.nz>; Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Subject: RE: Interim source investigation report[EXTERNAL SENDER]

Many thanks Naomi – it may be too early yet but is there any indication that the answer to question 1 re appropriate PPE for health care workers directly dealing with positive cases is yes and therefore requires an urgent change to current protocols?

Caroline

From: Naomi Gough <Naomi.Gough@health.govt.nz>
Sent: Wednesday, 4 November 2020 2:46 pm
To: Caroline McElnay <Caroline.McElnay@health.govt.nz>; Jane Kelley <Jane.Kelley@health.govt.nz>; Tara Swadi <Tara.Swadi@health.govt.nz>
Cc: Marion Poore <Marion.Poore@health.govt.nz>; Joshua Freeman <Joshua.Freeman@cdhb.health.nz>; Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Subject: Interim source investigation report

Colleagues,

Update on source investigation findings to date- please note that the investigation is ongoing and confirmation on the accuracy of details is still required.

Currently 2 cases in health care workers at the Sudima
Both have been interviewed in depth about their movements and activities in the MIQF during their shift however interviews are continuing as new information emerges

Case 1
Genomic sequencing on case 1 shows a link to a particular genotype in Russian sailors that crossed rooms and affected several people.
Case one had several touch points with this group of sailors
23rd October a transfer of infectious Sailers, and on this day disposed of rubbish in a manner that could possibly lead to fomite dispersion into the air
The 23rd was their first day in the Sudima, so it is possible they may not have been as confident with the IPC procedures.
On the 29th case 1 was also involved with a Russian sailor who tested positive. 9(2)(a) was involved with his transfer and provided direct healthcare to him in his room (blood pressure check). The sailor had a high CT value at this time.
Genomic sequencing has not been completed yet.
Interviews thus far have also highlighted a possibility of contamined scissors but more information is required on this.

Case 2
Asymptomatic and tested positive on the 2nd November
Further interviewing is ongoing
Being asymptomatic, it is difficult to point to the likely incubation period and exposure event. However, they were PCR negative on 29/10. Case two was very familiar with IPC procedures and very confident in recalling the details of 9(2)(a) activities and movements.
At this stage of it, it is suspected that case 2 was also involved in the patient transfer and direct patient care on 29th October.

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Currently it is considered that the 29th October patient transfer and patient care is the most likely source of exposure. Further information is required before conclusions are drawn
Reasons are, the event links both cases, a high degree of close contact with an infectious case, a known high risk activity and both cases tested negative on the 29th.

1. Genomic sequencing for the case on the 29th to link to case 1
2. Genomic sequencing on case 2 to determine if it is the same strain
3. Further interviewing with case 2
4. Find out more about the scissors

What questions does this pose so far?

1. Given appropriate PPE was used, does this mean that in environments such as quarantine with highly infectious people that PPE precautions need to be higher in those providing direct patient care?
2. Is there something about the biology of highly infectious cases we need to get a better understanding of?
3. Is there something about smoking we need to understand better
4. Are certain strains more virulent and capable of superspread events?

We need further information before diving into these questions, but this is where the thinking has got to so far. I will provide further updates as they become available.

Kind regards
Naomi

Naomi Gough
Deputy-Director Public Health
Office of the Director of Public Health
Population Health and Prevention
Ministry of Health
9(2)(a) [redacted]
Fax: 03 3350286

http://www.medsafe.govt.nz
mailto:Naomi.Gough@health.govt.nz

****
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[redacted]

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Cc: Marion Poore <Marion.Poore@health.govt.nz>; Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Subject: RE: Interim source investigation report[EXTERNAL SENDER]

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Kia ora Caroline / Naomi,

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Nga mihi,

Josh

Joshua Freeman
Clinical Microbiologist
Clinical Director, Infection Prevention and Control
CDHB

From: Caroline McElnay <Caroline.McElnay@health.govt.nz>
Sent: Wednesday, 4 November 2020 3:16 PM
To: Naomi Gough <Naomi.Gough@health.govt.nz>; Jane Kelley <Jane.Kelley@health.govt.nz>; Tara Swadi <Tara.Swadi@health.govt.nz>
Cc: Marion Poore <Marion.Poore@health.govt.nz>; Joshua Freeman <Joshua.Freeman@cdhb.health.nz>; Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Subject: RE: Interim source investigation report[EXTERNAL SENDER]

Many thanks Naomi – it may be too early yet but is there any indication that the answer to question 1 re appropriate PPE for health care workers directly dealing with positive cases is yes and therefore requires an urgent change to current protocols?

Caroline

From: Naomi Gough <Naomi.Gough@health.govt.nz>
Sent: Wednesday, 4 November 2020 2:46 pm
To: Caroline McElnay <Caroline.McElnay@health.govt.nz>; Jane Kelley <Jane.Kelley@health.govt.nz>; Tara Swadi <Tara.Swadi@health.govt.nz>
Cc: Marion Poore <Marion.Poore@health.govt.nz>; Joshua Freeman <Joshua.Freeman@cdhb.health.nz>; Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Subject: Interim source investigation report

Colleagues,

Update on source investigation findings to date- please note that the investigation is ongoing and confirmation on the accuracy of details is still required.

Currently 2 cases in health care workers at the Sudima
Both have been interviewed in depth about their movements and activities in the MIQF during their shift however interviews are continuing as new information emerges

Case 1
Genomic sequencing on case 1 shows a link to a particular genotype in Russian sailors that crossed rooms and affected several people.
Case one had several touch points with this group of sailors
23rd October a transfer of infectious Sailers, and on this day disposed of rubbish in a manner that could possibly lead to fomite dispersion into the air
The 23rd was their first day in the Sudima, so it is possible they may not have been as confident with the IPC procedures.
On the 29th case 1 was also involved with a Russian sailor who tested positive. 9(2)(a) was involved with his transfer and provided direct healthcare to him in his room (blood pressure check). The sailor had a high CT value at this time.
Genomic sequencing has not been completed yet.

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Interviews thus far have also highlighted a possibility of contamined scissors but more information is required on this.

Case 2
Asymptomatic and tested positive on the 2nd November
Further interviewing is ongoing
Being asymptomatic, it is difficult to point to the likely incubation period and exposure event. However, they were PCR negative on 29/10. Case two was very familiar with IPC procedures and very confident in recalling the details of 9(2)(a) activities and movements.
At this stage of it, it is suspected that case 2 was also involved in the patient transfer and direct patient care on 29th October.

Currently it is considered that the 29th October patient transfer and patient care is the most likely source of exposure. Further information is required before conclusions are drawn
Reasons are, the event links both cases, a high degree of close contact with an infectious case, a known high risk activity and both cases tested negative on the 29th.

1. Genomic sequencing for the case on the 29th to link to case 1
2. Genomic sequencing on case 2 to determine if it is the same strain
3. Further interviewing with case 2
4. Find out more about the scissors

What questions does this pose so far?

1. Given appropriate PPE was used, does this mean that in environments such as quarantine with highly infectious people that PPE precautions need to be higher in those providing direct patient care?
2. Is there something about the biology of highly infectious cases we need to get a better understanding of?
3. Is there something about smoking we need to understand better
4. Are certain strains more virulent and capable of superspread events?

We need further information before diving into these questions, but this is where the thinking has got to so far.
I will provide further updates as they become available.

Kind regards
Naomi

Naomi Gough
Deputy-Director Public Health
Office of the Director of Public Health
Population Health and Prevention
Ministry of Health
9(2)(a)
Fax: 03 3350286

http://www.medsafe.govt.nz
mailto:Naomi.Gough@health.govt.nz

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[redacted]

From: 9(2)(a) [redacted] law.co.nz]
Sent: Friday, 30 October 2020 11:43 a.m.
To: 'cheryl.brunton@chdb.health.nz' <cheryl.brunton@chdb.health.nz>
Cc: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>; Jessica Meates <Jessica.Meates@cdhb.health.nz>
Subject: release dates[EXTERNAL SENDER]

Hi Cheryl, Anna

I realise you are both flat out, but by way of an update, 9(2)(a) [redacted] has decided to stay in NZ for the short term. 9(2)(a) [redacted] has made some progress, which we are all heartened to hear.

In relation to the high risk close contacts, and positive cases, I'd be grateful if we could have an indication of the days on which they are likely to be released. I realise that there is the 10 day/72 hour requirement, but the spreadsheet we (gratefully) received did not have names in it, so we are not able to close the loop with the information that we have here. I acknowledge that the release dates are not set in stone, but rather are indicative. They will assist the companies in preparations for the coming weeks.

Many thanks

9(2)(a) [redacted]

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9(2)(a) [redacted]

EMAIL: 9(2)(a) [redacted] law.co.nz

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[redacted]

From 9(2)(a) [redacted] law.co.nz]
Sent: Tuesday, 3 November 2020 3:10 p.m.
To: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Cc: Karalyn van Deursen <Karalyn.Vandeursen@cdhb.health.nz>
Subject: Letter to crew

Hi Anna

Attached is the letter in both English and Russian. The Russian translation has just come in.

We'd be grateful for confirmation that it has been circulated amongst the crew.

Many thanks

9(2)(a) [redacted]

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2 November 2020

Dear all,

EXTENDED STAY IN ISOLATION

As you are aware, your stay in the Managed Isolation and Quarantine Facility has been extended. That is because a staff member who has been helping to care for you has tested positive for COVID-19 in the last few days, and the public health team have required the stay to be extended for now.

We do not yet know how long you will be required to stay, but we want to reassure you all that you have our full support. We understand that the extended time in isolation must be very challenging for you, and if there is anything that we can do to help you, please contact your Russian speaking company representative. The contact phone numbers are:

Independent Fisheries:	Maruha	Sealord
9(2)(a) [redacted]	9(2)(a) [redacted]	9(2)(a) [redacted]

If you are unable to contact the company representative, please contact reception at the hotel and they will let us know that you wish to speak to us.

Please be assured that your positions on the fishing vessels remain secure and we look forward to welcoming you on board when it is safe for you to leave the facility.

We have full confidence in the health authorities and teams that are managing your care, and we are assisting them in any way that we can.

Yours faithfully,

9(2)(a) [redacted]

Independent Fisheries Ltd **Maruha (NZ) Corporation Ltd** **Sealord Charters Ltd**

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2 ноября 2020

Уважаемые господа,

КАС. ПРОДЛЕНИЯ ПРЕБЫВАНИЯ В ОБСЕРВАТОРЕ

Как вы уже знаете, ваше пребывание в обсерваторе было продлено. Это произошло из-за того, что один из работников обсерватора, ухаживающий за вами, получил положительный результат теста на Ковид-19 несколько дней назад, и коллектив специалистов по контролю за состоянием здоровья населения счел необходимым продлить срок вашего пребывания.

Мы пока еще не знаем, насколько долго продлится ваше пребывание, но хотим вас заверить, что мы окажем вам свою полную поддержку. Мы понимаем , что задержка вас в обсерваторе является для вас серьезным испытанием, и если вам нужна от нас какая-либо помощь, свяжитесь с русскоговорящим представителем своей компании по контактным номерам, указанным ниже :

Индепендент Фишериз	Маруха	Силорд
9(2)(a) [redacted]	9(2)(a) [redacted]	9(2)(a) [redacted]

Если вы не сможете связаться с представителем своей компании, позвоните на стойку регистрации гостиницы, и они передадут нам, что вы хотели с нами связаться.

Ваше рабочее место на судне останется закрепленным за вами, и мы будем приветствовать ваше возвращение на борт судна после безопасной выписки из обсерватора.

Мы располагаем полной уверенностью в коллективе персонала, заботящегося о вас, как и в госслужащих системы здравоохранения, и со своей стороны будем оказывать им свою посильную помощь.

С уважением,

9(2)(a) [redacted]

Independent Fisheries Ltd **Maruha (NZ) Corporation Ltd** **Sealord Charters Ltd**

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[redacted]

-----Original Message-----
From: 9(2)(a) [redacted] law.co.nz]
Sent: Wednesday, 4 November 2020 12:13 p.m.
To: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Cc: Karalyn van Deursen <Karalyn.Vandeursen@cdhb.health.nz>; Jessica Meates <Jessica.Meates@cdhb.health.nz>
Subject: Update[EXTERNAL SENDER]

Hi Anna

Appreciate that you will still have your hands full, but was wondering if were any further down the path of allowing some Of the crew to be discharged from MIF?

My clients primary concern remains the welfare of their crew and your staff caring for them, and do not want to pose any public health risk. However, if there is any prospect of a partial release, then they'd be grateful for that.

Many thanks

9(2)(a) [redacted]

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[redacted]

From: 9(2)(a) [redacted] law.co.nz]
Sent: Thursday, 5 November 2020 3:57 p.m.
To: 'Marion Poore' <Marion.Poore@health.govt.nz>
Cc: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Subject: information [EXTERNAL SENDER]

Hi Marion

Please see attached.

If there is any further info that we can provide, please do not hesitate to ask.

My clients would like to understand a clearer picture of the planned release, any retesting of non-COVID cases, and timelines later today, please. I appreciate that you are all flat out, but the extent to which they are in a holding pattern that they have no concrete information about, is creating problems from their end.

Look forward to hearing from you.

Kind regards

9(2)(a) [redacted]

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9(2)(a)

EMAIL: 9(2)(a) law.co.nz

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NAME	POSITION	COMPANY *VESSEL*	VESSEL LOCATION
[redacted]	9(2)(a)	Independent *Irvinga*	Lyttelton
		Independent *Irvinga*	Lyttelton
		Independent *Irvinga*	Lyttelton
		Independent *Irvinga*	Lyttelton
		Independent *Irvinga*	Lyttelton
		Independent *Irvinga*	Lyttelton
		Independent *Irvinga*	Lyttelton
		Independent *Irvinga*	Lyttelton
		Independent *Irvinga*	Lyttelton
		Independent *Irvinga*	Lyttelton
		Independent *Irvinga*	Lyttelton
		Independent *Irvinga*	Lyttelton
		Independent *Irvinga*	Lyttelton
		Independent *Irvinga*	Lyttelton
		Independent Repair crew	Lyttelton
		Independent Repair crew	Lyttelton
		Independent Repair crew	Lyttelton
		Independent Repair crew	Lyttelton
		Independent Repair crew	Lyttelton

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[redacted] 9(2)(a)

Independent Repair crew	Lyttelton
Sealord *Meridian 1*	Nelson
Sealord *Meridian 1*	Nelson
Sealord *Meridian 1*	Nelson
Sealord *Meridian 1*	Nelson
Sealord *Professor Mykhaylo Aleksandrov*	Nelson
Sealord *Professor Mykhaylo Aleksandrov*	Nelson
Sealord *Professor Mykhaylo Aleksandrov*	Nelson
Sealord *Professor Mykhaylo Aleksandrov*	Nelson
Sealord *Professor Mykhaylo Aleksandrov*	Nelson
Maruha *Te Raukura*	Dunedin, later Nelson
Maruha *Te Raukura*	Dunedin, later Nelson
Maruha *Te Raukura*	Dunedin, later Nelson
Maruha repair crew	Dunedin, later Nelson
Maruha repair crew	Dunedin, later Nelson
Maruha *Aleksey Slobodchikov*	Dunedin, later Nelson
Maruha *Aleksey Slobodchikov*	Dunedin, later Nelson

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[redacted]

From: Anthea Oliver [mailto:Anthea.Oliver@health.govt.nz]
Sent: Thursday, 5 November 2020 10:23 a.m.
To: 'Canterbury Regional Isolation & Quarantine' <canterbury.riq@canterburyecc.govt.nz>; Megan Gibbs <Megan.Gibbs@cdhb.health.nz>; Jessica Meates <Jessica.Meates@cdhb.health.nz>; Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Subject: RE: Ministry of health senior advisor [EXTERNAL SENDER]

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Mōrena team

I had the below email forwarded onto me and just wanted to clear up any confusion surrounding Tara's visit. I just had a chat with her to understand more about what she is going to be doing down in Christchurch. She plans to work with Canterbury Public Health to help communicate their decisions and actions surrounding the release of the mariners to Dr Bloomfield and the Minister. The decision about when and how to release the mariners sits with CPU and she has confidence in their plan, but just wants to be there to ensure these messages get can get quickly communicated to Dr Bloomfield and the Minister in the language they are used to.

Please let me know if you have any questions.

Thanks,
Anthea

From: 9(2)(a) [redacted]@NZDF.mil.nz>
Sent: Thursday, 5 November 2020 8:07 am
To: Jade Murray <Jade.Murray@health.govt.nz>; Anthea Oliver <Anthea.Oliver@health.govt.nz>
Cc: 9(2)(a) [redacted]@mbie.govt.nz>
Subject: FW: Ministry of health senior advisor [ ]

*** [ ] This message may contain classified information ***

Do we know about this team?

From: Canterbury Regional Isolation & Quarantine [mailto:canterbury.riq@canterburyecc.govt.nz]
Sent: Thursday, 5 November 2020 7:40 a.m.
To: 9(2)(a) [redacted]@NZDF.mil.nz>
Subject: Fwd: Ministry of health senior advisor

9(2)(a) [redacted]

Sent from mobile account.

From: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Sent: Wednesday, November 4, 2020 8:50 PM
To: Jessica Meates; Megan Gibbs; Canterbury Regional Isolation & Quarantine
Subject: Ministry of health senior advisor

Kia ora koutou,

We were advised late afternoon that Tara Swadi from the MoH will be at CPH from tomorrow. One of her roles is :

> *Mariners – the Minister has said that he wants to sign off the release of each and every mariner from the Sudima based on their last contact with the nurses/any other possible risk. I will support the development of this information with the MIQ people in Christchurch and the PHU and help translate it to 'Ministers' speak*

It's not clear what this will look like in terms of the investigation into the two healthcare workers who have become cases or the decision around how we safely exit the Russian mariners, but I guess we'll find out soon.

Just letting you know there's another agent in the mix!

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Nāku, nā
Anna

Dr Anna Stevenson
Public Health Physician
Health in all Policies team
Community and Public health
Canterbury District Health Board
Cell 9(2)(a) [redacted]

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[redacted]

From: Ramon Pink
Sent: Friday, 6 November 2020 10:50 p.m.
To: Jessica Meates <Jessica.Meates@cdhb.health.nz>; Joshua Freeman <Joshua.Freeman@cdhb.health.nz>; Anna Stevenson <Anna.Stevenson@cdhb.health.nz>; Louisa Sullivan <Louisa.Sullivan@cdhb.health.nz>; Megan Gibbs <Megan.Gibbs@cdhb.health.nz>
Cc: 'Caroline.McElnay@health.govt.nz' <Caroline.McElnay@health.govt.nz>; Tanya McCall <Tanya.McCall@cdhb.health.nz>; Neil Brosnahan <Neil.Brosnahan@cdhb.health.nz>
Subject: Exit process of International Mariners

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Kia ora koutou,

This evening a Russian marine 9(2)(a) [redacted] was identified as symptomatic in the pre exit health check (sore throat). A rapid PCR test was negative.

This individual will remain in quarantine until symptom free for 48 hours, as per protocol. I have discussed with Josh Freeman, and we agree that the room mate of this symptomatic mariner, be released as planned.

I have had a conversation with Dr Caroline McElnay, Director of Public Health. We agree that the exit process for this cohort of Russian mariners should proceed as planned.

Receiving ports (Neslon, Lyttleton and Dunedin) have been notified.

Kind regards
Ramon.

Dr Ramon Pink
Public Health Physician
Community and Public Health, Division of the Canterbury District Health Board
310 Manchester St, PO Box 1475 Christchurch 8013
9(2)(a) [redacted]

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[redacted]

From: Tara Swadi [mailto:Tara.Swadi@health.govt.nz]
Sent: Friday, 6 November 2020 5:35 p.m.
To: Ashley Bloomfield <Ashley.Bloomfield@health.govt.nz>; Sue Gordon <Sue.Gordon@health.govt.nz>; Caroline McElnay <Caroline.McElnay@health.govt.nz>
Cc: Jane Kelley <Jane.Kelley@health.govt.nz>; Aoife Kenny <Aoife.Kenny@health.govt.nz>; Anna Stevenson <Anna.Stevenson@cdhb.health.nz>; Ramon Pink <Ramon.Pink@cdhb.health.nz>; Joshua Freeman <Joshua.Freeman@cdhb.health.nz>
Subject: Rationale for release of mariners from Sudima summary

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Hi all
Attached is a two page summary of the situation and rationale for release of the mariners from the Sudima isolation facility, for your information.
Thanks.

Ngā mihi,
Tara

Tara Swadi
Chief Advisor Public Health, Strategic Operations, COVID-19 Health Systems Response | Ministry of Health | New Zealand
9(2)(a) [redacted] **E:** Tara.Swadi@health.govt.nz

Summary of public health rationale for release for Sudima mariners

Background information

On 16 October, 235 mariners arrived in Christchurch and entered managed isolation. Of the 235 mariners isolated at the Sudima, 31 have tested positive for COVID-19. Of these, 24 are considered recovered. The remaining 7 will continue to be assessed for recovery on a daily basis. There were 5 close contacts who have undertaken at least 14 days of managed isolation since the date of the last contact with a case. To date, these mariners have been in isolation for 21 days. A thorough investigation into any potential contact with two 9(2)(a) who are positive cases has taken place and is detailed below.

Exposure of crew to Cases A and B

Case A
Case A worked on Friday from 9-4pm doing health checks on the guests during 9(2)(a) infectious period. Case A wore full PPE including a mask and a visor. 9(2)(a) role initially was to take the temperature and get an O2 sat measurement using a pulse oximeter on the guests. The guests wore a mask during this time. 9(2)(a) performed her duties on **three** guests. This was at the start of the round, so 9(2)(a) PPE was fresh. After these three guests, case A and her colleague **swapped roles** for operational reasons. Case A then supported 9(2)(a) colleague in performing the same duties, but acted as scribe, staying at least 1m away from the guests at all times. This occurred for a further 63 guests. It is important to note this exposure was on Friday, **we are now seven days post that exposure with no cases detected.**

Case B
Case B worked the night shift on Monday night. During this time, 9(2)(a) only cared for **cases,** and therefore did not expose any at-risk people. The only other action 9(2)(a) undertook was delivering a letter to all the guests but 9(2)(a) did this by slipping an envelope under the door, which no one answered. 9(2)(a) was still in full PPE.

From the assessment above, it is deemed that there are **no close contacts among the crew** from either 9(2)(a)

The three guests who case A took the temperature of are at a marginally higher risk. It has been decided that these guests will be reswabbed and rapidly analysed. The clinical decision has been made to leave this swabbing as late as possible to have the most up to date information, hence the swabs have been taken early evening today (6 November).

Plan for exit

All test results from the staff at the Sudima have returned negative results. While testing scheduled have been slightly different for each mariner based on close contact with known cases, all the mariners have been thoroughly assessed, and swabbed at least 3 times, some up to 5 times. Based on the known incubation period of SARS-CoV-2, the isolation period of the mariners, the risk assessment of the 9(2)(a) and the current health status of the mariners, it has been deemed that the majority are cleared to exit isolation. This has been assessed by the local Medical Officer of Health and the Clinical Director of IPC and Clinical Microbiologist in Canterbury and agreed with the Director of Public Health at the Ministry of Health.

All the mariners are cleared to leave with the following exceptions:

1. The 7 not yet recovered cases

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2. The 3 who [redacted] cared for, until they get the negative result from the rapid test.

Post exit

The employers of the crew have provided a detailed comprehensive plan for the crew when they leave isolation. Broadly, the crew are split into two groups; maintenance workers and fisherman.
The maintenance workers will exit the MIF and go straight to the vessels to undertake their work, estimated to take up to six weeks. While they undertake this work, they will live on the vessels. Post this, they will leave New Zealand.
The fisherman will also live on the vessel post release from the MIF. Shore leave can be restricted for both groups, and the employers have indicated they will act under 'level 4' precautions. More details are provided in Appendix 1.

Further swabbing of the mariners in the next week will be arranged as part of port worker testing.

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Appendix 1. Post isolation activities for Sudima guests

The Sudima guests are made up of maintenance workers and fishing crew who are assigned to 7 different vessels, all moored in three different ports in NZ (Lyttleton, Nelson, Dunedin). Each vessel has between 78-82 fishing crew. The crew will be undertaking fishing trips for the next 6 -12 months. There are 73 maintenance crew who will work on the vessels for the next 2-6 weeks, then depart New Zealand.

Both the maintenance crew and the fishing crew will be accommodated on board the vessels. The fishing crew and the maintenance crew will have interaction; however the company have noted they intend to apply COVID-19 Level 4 guidelines to limit interactions.

There are three companies operating the 7 vessels, who have slightly different timings and plans related to the intended activity of the vessels.

Sealord

- The *Meridian 1* was due to sail 3rd November. As soon as crew arrive the vessel will be put to sea 8 hours later.
- Shore leave will be prohibited for the first seven days after crew arrive on board, with further restrictions to be review on day six.
- The *Meridian 1* will be at sea for approximately 20 days. She will return to port as soon as the *Profesor Mykhaylo Aleksandrov* is ready to sail. Maintenance on this vessel will commence once it returns to port.

- Maintenance on *Profesor Mykhaylo Aleksandrov* has commenced after maintenance crew arrived on the weekend.
- *Profesor Mykhaylo Aleksandrov* is scheduled to sail on 24 or 26 November and will be at sea for 25 days.
- There will be a 36 hour turn around between fishing trips.
- A fence has been erected around the vessels and the port company has moved the area available to the public back. 24 hour watches will be kept on the gangways.
- Doctors on both vessels will monitor crew health and take temperatures on a regular basis.

Independent Fisheries

- Independent will put their first vessel to sea as soon as maintenance is completed.
- They anticipate the first vessel sailing in mid-November, the second in the first week of December and the third in the second week of December.
- Shore leave will be prohibited for the first 14 days after crew arrive at the vessels
- The vessels will be at sea for 3-4 weeks.
- The vessels will be located on the biosecurity berth, where public access is not available.
- There will be a maximum of 72 hours turn around between fishing trips.
- There is a doctor on board each vessel.

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Maruha

- Maintenance on the vessels will commence as soon as the maintenance crew arrive.
- Maruha anticipate that *Te Raukura* will sail in the first week of December and *Aleksey Slobodchikov* in the middle of December.
- Shore leave will be prohibited for the first seven days after crew arrive on board, with further restrictions to be review on day six.
- In Nelson the vessels will be on the same wharf and security fencing will be in place to stop the public from entering and the crew from leaving the vessel.
- The vessels will be at sea for about 3 weeks. Doctor onboard will check the crews at the end of the voyage and if no symptoms or high temperatures are present shore leave will be allowed.
- There will be 48 hours turn around between fishing trips.

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[redacted]

From: Daniel Williams
Sent: Monday, 9 November 2020 12:51 p.m.
To: Rebekah Smith <Rebekah.Smith@health.govt.nz>; Astrid Koornneef <Astrid.Koornneef@health.govt.nz>
Cc: COVID-19 NCCS Analytics and Reporting <COVID-19_NCCS_Analytics_and_Reporting@health.govt.nz>; Anna Stevenson <Anna.Stevenson@cdhb.health.nz>; Kerry Marshall <Kerry.Marshall@cdhb.health.nz>; Nicola Laurie <Nicola.Laurie@cdhb.health.nz>; Ramon Pink <Ramon.Pink@cdhb.health.nz>; Annabel Begg <Annabel.Begg@cdhb.health.nz>; Fiona Humpheson <Fiona.Humpheson@cdhb.health.nz>
Subject: RE: Ministry situation reports and international mariners at Sudima Airport Hotel Christchurch

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Hi Rebekah and Astrid
On behalf of our team following our IMT meeting this morning, please could I raise two issues with you and the Ministry's analytics team.
Your sitrep from yesterday says:

- By 31 October, MIF Staff Case A felt fatigued, and on 1 November, they had a temperature, runny nose and mild nausea. They were tested on the same day at the CBAC. They are undertaking isolation and quarantine at home.

1. This person did not have a fever at any stage.
2. We are very grateful that this staff member sought testing for 9(2)(a) mild symptoms even though 9(2)(a) just had a negative test – if 9(2)(a) hadn't, we'd

be in a much bigger mess. However, the continued reporting of 9(2)(a) symptoms and activities in this way seems to imply blame rather than gratitude towards 9(2)(a) and 9(2)(a) situation has been discussed explicitly in this way in the media. This is unfortunate and unfair. The Ministry has already released enough information about 9(2)(a) and 9(2)(a) family that many people in our community know who 9(2)(a) is.

We continue to depend on people like this staff member to protect our community from COVID-19. We would be grateful if you could pay careful attention to this when you are considering sharing their details.
Many thanks
Daniel

Dr Daniel Williams
Public Health Physician
Community and Public Health
Canterbury District Health Board
310 Manchester St
PO Box 1475
Christchurch 8140
New Zealand
9(2)(a)

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Megan Gibbs

From: Megan Gibbs
Sent: Monday, 9 November 2020 7:25 AM
To: Shona Meyrick
Subject: Fishers: conditions of release

Importance: High

Hi Shona
Following up on our conversation on Friday – there was discussion around re-testing this group at day 7. I'm not sure if that is the only requirement but at present no-one here in the RIQ or at Public Health has seen those conditions. Just wanting to support setting up any testing etc well in advance and ensure we are well resourced to get it done in the 3 ports.
This week is Show week in Christchurch, Friday is a public holiday and so testing on that day will require a bit of thought.
Any info gratefully received am progressing getting the info on behalf of the MIf and Public Health.
Many thanks
Megan

Megan Gibbs
Health Manager,
Managed Isolation and Quarantine Facilities (MIQFs)
235 Antigua Street
Christchurch 8140,
New Zealand.

Mobile: 9(2)(a) [redacted]
Megan.Gibbs@cdhb.health.nz

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Out of Scope

[redacted]

From: Jane Kelley [mailto:Jane.Kelley@health.govt.nz]
Sent: Tuesday, 10 November 2020 4:42 p.m.
To: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>; Joshua Freeman <Joshua.Freeman@cdhb.health.nz>; Tara Swadi <Tara.Swadi@health.govt.nz>; Caroline McElnay <Caroline.McElnay@health.govt.nz>; Margareth Broodkoorn <Margareth.Broodkoorn@health.govt.nz>; Naomi Gough <Naomi.Gough@health.govt.nz>; Shona Meyrick <Shona.Meyrick@health.govt.nz>; Marion Poore <Marion.Poore@health.govt.nz>; Ramon Pink <Ramon.Pink@cdhb.health.nz>; Sarah Berger <Sarah.Berger@cdhb.health.nz>; Alan Pithie <Alan.Pithie@cdhb.health.nz>; Sarah Metcalf <Sarah.Metcalf@cdhb.health.nz>; Aoife Kenny <Aoife.Kenny@health.govt.nz>
Subject: Discussion points from todays meeting

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Hi all,

Thank you for your time we really appreciate all the effort that CPH and CDHB has put into this report.

Main discussion points were:

- Loop in the most appropriate persons for further discussion and confirmation of what recommendations have already been actioned or addressed
- Establishment of a working group proposed – explore whether or not there is already an existing working group where these recommendations can be addressed
- Ministry to check release of pandemic stock dated 2009 for N95 Masks

- Ventilation for discussion to Science and Technical Team
- Provide context for Public Health Risk Statement

Many Thanks
Jane

Group Manager Strategic Operations
Group Manager Office of the Deputy Chief Executive (Acting)
Covid-19 Health System Response
9(2)(a) [redacted]

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Megan Gibbs

From: Megan Gibbs
Sent: Tuesday, 10 November 2020 12:24 PM
To: Shona Meyrick
Subject: Mariners testing

HI Shona
Following up on behalf of the team down here regarding the requirements for testing of the mariners, day 7.
Any update?
Thanks
Megan

Megan Gibbs
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Megan Gibbs

From: Giselle Wansa-Harvey <Giselle.Wansa-Harvey@health.govt.nz>
Sent: Tuesday, 10 November 2020 6:00 PM
To: Megan Gibbs; Shona Meyrick
Cc: Cathie McGregor
Subject: Re: further testing fishers[EXTERNAL SENDER]

Hey Megan
We are just awaiting confirmation on whether testing can occur on the Monday in lieu of long weekend. Cathie in my team will be in contact with you guys, Nelson and Dunedin re the testing of the Russian fishermen.

Regards
Giselle

Get Outlook for iOS

From: Megan Gibbs <Megan.Gibbs@cdhb.health.nz>
Sent: Monday, November 9, 2020 11:46:24 AM
To: Shona Meyrick <Shona.Meyrick@health.govt.nz>; Giselle Wansa-Harvey <Giselle.Wansa-Harvey@health.govt.nz>
Subject: further testing fishers

Hi
MOoH has requested clarification on which day the Ministry would consider day 7.
Thanks
Megan

Megan Gibbs
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Mobile 9(2)(a) [redacted]
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Megan Gibbs

From: Anna Stevenson
Sent: Monday, 16 November 2020 9:26 PM
To: Megan Gibbs
Subject: FW: Draft report on International Mariners outbreak with spread to healthcare workers at Sudima MIQ

Nāku, nā
Anna

Dr Anna Stevenson
Public Health Physician
Health in all Policies team
Community and Public health
Canterbury District Health Board
Cell: 9(2)(a) [redacted]

From: Caroline McElnay [mailto:Caroline.McElnay@health.govt.nz]
Sent: Tuesday, 10 November 2020 10:04 a.m.
To: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>; Naomi Gough <Naomi.Gough@health.govt.nz>; Aoife Kenny <Aoife.Kenny@health.govt.nz>; Tara Swadi <Tara.Swadi@health.govt.nz>; Marion Poore <Marion.Poore@health.govt.nz>; Jane Kelley <Jane.Kelley@health.govt.nz>
Cc: Public Health Specialist Team <publichealthSpecialistTeam@cdhb.govt.nz>; Joshua Freeman <Joshua.Freeman@cdhb.health.nz>; Sarah Berger <Sarah.Berger@cdhb.health.nz>; Alan Pithie <Alan.Pithie@cdhb.health.nz>; Sarah Metcalf <Sarah.Metcalf@cdhb.health.nz>
Subject: RE: Draft report on International Mariners outbreak with spread to healthcare workers at Sudima MIQ

Thanks Anna

I've discussed with Jane Kelley and she will be in touch with details for a zoom call – if not today then definitely tomorrow. She will also consider who is best to attend from the Ministry

Many thanks

Caroline

Dr Caroline McElnay

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Director of Public Health
Ministry of Health
New Zealand

C: 9(2)(a) [redacted]

From: Anna Stevenson <Anna.Stevenson@cdhb.health.nz>
Sent: Tuesday, 10 November 2020 9:09 am
To: Caroline McElnay <Caroline.McElnay@health.govt.nz>; Naomi Gough <Naomi.Gough@health.govt.nz>; Aoife Kenny <Aoife.Kenny@health.govt.nz>; Tara Swadi <Tara.Swadi@health.govt.nz>; Marion Poore <Marion.Poore@health.govt.nz>; Jane Kelley <Jane.Kelley@health.govt.nz>
Cc: Public Health Specialist Team <publichealthSpecialistTeam@cdhb.govt.nz>; Joshua Freeman <Joshua.Freeman@cdhb.health.nz>; Sarah Berger <Sarah.Berger@cdhb.health.nz>; Alan Pithie <Alan.Pithie@cdhb.health.nz>; Sarah Metcalf <Sarah.Metcalf@cdhb.health.nz>
Subject: Draft report on International Mariners outbreak with spread to healthcare workers at Sudima MIQ

Conclusion

This is an early report that has been authored by Drs Berger, Freeman and Stevenson with assistance from RIQ healthcare leads, ESR staff and it has been discussed with local Infectious Diseases staff who all support the recommendations made. Other investigations and evaluations of the International Mariner outbreak and transmission to healthcare staff are likely in the near future e.g. the CDHB is intending to produce a serious adverse event report and various debriefs are planned. These future reviews may generate other recommendations.

This report concludes that the current MIQF service in Christchurch was severely stress-tested by the International Mariner cohort who brought with them high numbers of early and highly infective COVID cases. This combined with behavioural challenges (chain-smoking and double bunking) and environmental challenges (inappropriate ventilation and confined spaces) led to a total of 31 confirmed cases in the mariners and two in New Zealand healthcare staff. The report outlines that current IPC protocols in New Zealand are primarily directed at droplet and fomite transmission mitigation but, consistent with the changing evidence base internationally, we believe in this instance transmission was likely due to airborne micro-droplets of SARS-CoV-2. We support the careful introduction of fit tested N-95 masks for staff working in quarantine wings and facilities where there is a high burden of diease.

Kia ora koutou,

Attached please find as requested the draft report we have written on the outbreak at the Sudima MIQ. We would appreciate the opportunity to talk you through the detail and findings of this report if possible. We suggest a zoom meeting at some point today. Please let us know if this is feasible from your end.

I have also attached two recent papers on relevant topics.

Ngā mihi,

nā Anna

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International mariners outbreak October -November 2020

EpiSurv number 20-109137-CH

31 COVID cases were identified during the 'International Mariners' stay in the Sudima Hotel/Managed Isolation and Quarantine facility. A further two cases occurred in healthcare staff who were caring for the Mariners. This report summarises the management of the cases in both crew and staff and makes recommendations on how any future such visits should be managed to better protect guests and staff from infection.

Contents

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Executive Summary

- **The effectiveness of IPC measures at the Sudima Hotel have in effect recently undergone severe stress testing due to an unusually high burden of highly infectious cases in the facility at one time; all from the International Mariners cohort. Numerous factors contributed to this high burden, the most important of which was the practice of double bunking. We conclude roughly 35% of all cases in the cohort were due to transfer between room-mates.**
- **A total of 33 cases occurred in association with the cohort of 235 International Mariners:**
    - **12 cases likely to have been incubating or infectious at the time of arrival**
    - **5 cases positive after day 3, either incubating on arrival or acquired during first 48 hours in the facility, e.g. through interactions related to smoking**
    - **12 cases likely to have been acquired from a room-mate (for 5 of these, the direction of transmission is uncertain as both positive on the same day)**
    - **2 likely historic cases who happened to be sharing a room (both had very high CT values and strongly positive IgG serology on Day 3)**
    - **2 cases among health staff exposed to crew detected on Sunday 1/11 and Tuesday 3/11. Both these staff had returned negative tests on Thursday 29 October.**
- **Two independent transmission events to 9(2)(a) staff occurred during routine contact with cases who were likely at or near the peak of infectiousness (very high viral load based on CT values at or around the time of exposure). Routine contact included transfer to the quarantine wing for one case and routine daily health checks for the other. For these exposure events, the calculated attack rates are 1/48 and 1/96 respectively. If all infected cases are included in these calculations (i.e. those with lower viral load and including the full duration of infectivity) then the calculated attack rates would be substantially lower.**
- **Both transmission events occurred despite apparently rigorous adherence to current IPC protocols / processes and currently recommended best practice with regard to PPE use and specifications.**
- **Both events are likely to have occurred in the corridor of the quarantine wing, immediately outside the door of the room of a highly infectious case, and soon after the door was opened.**
- **Current IPC protocols / processes and recommendations around PPE use in MIQF are well designed to address the risk of contact and droplet transmission but are less well geared toward managing the risk of transmission via small airborne microdroplets**
- **Following a thorough source investigation, it seems likely that both transmission events occurred through exposure to small, airborne microdroplets emitted from the rooms of cases at or around the peak of infectivity. The movement of infectious microdroplets from the room to the corridor may possibly have been facilitated by a pressure differential and a lack of air conditioning use by the infected cases.**
- **Greater focus is needed in quarantine wings of MIQF and specific quarantine facilities on managing the risk of transmission via small airborne microdroplets. The two principal ways to manage this risk are 1) ensuring adequate ventilation specifications in all quarantine wings and 2) moving from Type IIR medical masks to N-95/P2 masks for staff entering quarantine areas or coming into direct contact with confirmed cases (in CDHB this is only 9(2)(a)). Ideally, this should be accompanied by a fit testing programme for staff working in quarantine wings / facilities.**
- **In addition, all 'special' groups (e.g. sports teams, essential workers) seeking to come to NZ must have a formal public health risk assessment prior to departure that is**

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documented and shared with the receiving DHB and Public Health Unit. An initial assessment should be undertaken by MoH staff in conjunction with MBIE staff. This should cover issues such as pre-flight testing, pre-trip quarantine in country of origin, and any particular requirements to do with culture, sport, jobs, training, smoking while in MIQF etc. Any variation in usual protocol should have local operational input into the decision making. Funding to manage any such variations must be addressed early in planning. The final requirements need to be communicated clearly to the RIQ in advance of arrival. Pre-trip testing requirements should be validated and made available to the RIQ teams/Public Health Unit and MOH.

Background and context

A charter Singapore Airlines flight carrying 249 people (235 passengers, 14 air crew) arrived in Christchurch on 16/10/20. The flight had departed from Moscow, transiting via Singapore. All passengers were transported via charter bus to the Sudima Airport Hotel to commence 14 days of managed quarantine.

During the first 2-3 days the fishing crew cohort were a challenging group of guests to manage in the MIQF. Only three of the 235 guests spoke English. Approximately 2/3 of the guests were chain smokers and required frequent (up to 4 x per hour) visits to the smoking area outside of their rooms. Compliance with requests to physically distance from other crew was patchy and in the first couple of days there was frequent exchanges of cigarettes, lighters, cell phones etc. This was raised on day two by 9(2)(a) staff and behaviour was much improved after a letter from the crew's employers was given to all of them. However, even with best behaviour by guests the sheer volume of traffic through corridors as they moved in and out to smoke was physically challenging to manage.

Day 3 (19 October) swab results revealed 18 COVID cases among the international mariners' cohort. Case Investigation interviews were carried out that day. Due to language difficulties one 'thorough' interview was undertaken and the rest were more superficial with the essential information for Episurv and NCTS gained.

A decision was made to 'lock down' the Sudima and declare it as a quarantine facility. Staff were required to only work at the Sudima and not be rotated to any other MIQF.

Day 3 cases were all sharing rooms with another crew member.

We have no clear information about any quarantine which this cohort may have undergone in Russia prior to their departure. According to the companies employing the crew, all were tested prior to leaving Russia and all 235 who came on flight to NZ tested negative. It has also been reported that two crew did not board the plane because they tested positive. At interview one crewman reported that he was already aware that he had tested positive when he was tested in Russia on the 9th October. His Fitness to Travel Certificate (sourced from the Fishing companies' lawyer after not being able to obtain them from MBIE or MoH) states that he was tested on the 11th of October and

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the virus was not detected. Nursing staff here noted that on day three swabbing all crew offered an open mouth suggesting they had not previously had a nasopharyngeal swab.

Full or partial genomes have been sequenced for 26 of the 31 cases (5 are unable to be sequenced due to the low level of RNA present). This has revealed four different genotypes, indicating multiple independent introductions among the cohort. This can be explained either by inadequate quarantine prior to departure or multiple independent exposure events between the end of the pre-departure quarantine and arrival. The 18 Day 3 cases were distributed over 13 rooms within the hotel. There were five rooms in which there were two Day 3 cases. For further detail on timing of positive results and room sharing see appended line listing. Serology was undertaken on the Day 3 group as part of the ongoing project to assist the Canterbury Laboratories with validation of their serology assay as well as providing potential adjunct information to determine the timeframe of infection in some cases. Consistent with the history obtained by case investigators the serology results support possible historic infection in two of the 18 positives on day 3. One of these was the man who told us he had tested positive on the 9th October.

All confirmed cases were moved to a dedicated quarantine wing under the close supervision of seven CDHB IPC Service Clinical Nurse Specialists, along with the CDHB IPC Nursing Director. The last case was transferred at 2200 Tuesday night 20 October (Day 4).

All confirmed cases were 'red banded'.[1] They were managed as per confirmed case protocols in the MBIE Infection Prevention and Control Standard Operating Procedures (Version 1.1-19th October 2020). Their wing was separated and secured from the rest of the hotel and was only entered by 9(2)(a) staff who carried out twice daily observations. A dedicated outdoor smoking area was created with secure fencing in an internal courtyard area that was only accessible by the confirmed cases. This cohort were able to move to and from this outdoor area without 9(2)(a) MIQF staff escort supervision through an exit door at the end of the corridor in the quarantine wing.

All room-mates of the confirmed cases who swabbed negative at Day 3 were identified as "high risk" close contacts and 'yellow banded'. They were managed as per close contact protocols in the MBIE Infection Prevention and Control Standard Operating Procedures (Version 1.1-19th October 2020). This included being escorted by a MIQF staff member (NZDF staff) as required to a "fresh air" and smoking area that was exclusively dedicated to this group.

The remaining guests were also managed as close contacts from a public health point of view. This included daily health checks and the use of enhanced contact and droplet precautions by staff as per close contact protocols in the MBIE Infection Prevention and Control Standard Operating Procedures (Version 1.1 – 19th October 2020). This approach was taken because they had potentially been exposed at several points on the journey from Russia to Aotearoa and also at various times in the first 72 hours in the MIQF when, as discussed, compliance with rules was not optimal. The particular factor that made this situation even more challenging was the sheer volume of smokers and the frequency of their smoking. This means that cases were mingling with non-cases at potentially multiple times in the initial 2-3 days in hotel corridors and smoking yards.

One variation to the MBIE Infection Prevention and Control Standard Operating Procedures (Version 1.1 – 19th October 2020) was initiated after discussion with the Canterbury Technical Advisory Group and with endorsement of the Medical Officer of Health. For the sole purpose of managing the sheer number of smokers and the frequency with which they smoked, a temporary category "Blue+"

[1] The Christchurch MIQFs use a wristband system to easily identify guests infection transmission risk level: Red for confirmed or probable cases, Yellow for close contacts and blue for all other guests.

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was established. This category was used to accommodate the fact that personal escorting of this large group of remaining close contacts was completely unfeasible. Blue+ guests were not personally escorted to the smoking or exercise area by NZDF staff but were otherwise managed as "yellow band" guests. Instead, additional security and supervision was placed at key points in all guest corridors throughout the managed isolation areas to ensure social distancing rules were adhered to. The smoking and exercise area for these guests was completely separate from the smoking area from both confirmed cases and roommates of these confirmed cases. There were three separate areas in use, one for each of the three groups for "fresh air" and smoking.

At Day 6 testing, 8 further cases were identified. The Day 6 cases were distributed over 7 rooms. Two were in the same room. Two were room-mates of Day 3 cases and it is likely that transmission occurred in that setting. Four were the first case in each of their rooms.

At Day 9 testing on 25 October an additional 3 cases were identified. The Day 9 cases were in three rooms. One was the room-mate of a Day 3 case and the other two were room-mates of Day 6 cases. It is very likely that transmission occurred in that setting.

After the Day 9 test results, it was agreed by the clinical oversight team (three operational MOH (Pink, Brunton and Stevenson), CDHB Microbiologist Werno, and CDHB Microbiologist and Clinical Director IPC Freeman, and the IPC Nursing Director Berger) that the clock would be re-set for all close contacts of cases who were roommates. This meant that roommates of Day 3 cases had a further 14 days from their last exposure unless they became cases themselves (n=3); roommates of Day six cases had a further 14 days unless they became cases (n=2); and roommates of Day nine cases had a further 14 days unless they became cases. Cases were managed as per usual protocol by being quarantined for at least ten days with at least 72 hours being symptom free at the end of that time. Confirmation was sought from on the ground 9(2)(a) staff who were clear that compliance with all physical distancing and other PPE requirements had been high since Day 3.

The clinical oversight team agreed that given the degree of exposure during the first 72 hours, all other guests (aside from confirmed cases and "high risk" close contacts i.e. roommates) contacts would be treated as per usual protocol for close contacts starting from day 3. This made their total stay at least 17 days through to Monday November 2.

At Day 12 testing I case was identified. This person was a close contact (roommate) of a Day six case.

At Day 15 1 further case was identified. This person was a close contact (roommate) of a Day six case.

In total, seven cases have been identified among room-mates of previously identified cases: 3 being contacts of Day 3 cases and 4 being contacts of Day 6 cases. Five additional pairs of cases tested positive on the same day and had the same genotype. This gives a total of 12 cases of presumed transmission between roommates (an additional pair in the same room had weak positive results and positive serology on day 3 and are thought likely to be historic cases).

In total there were 18 Day 3 cases, 8 Day 6 cases and 3 day 9 cases 1 Day 12 case and 1 Day 15 case.

Overview of cases and likely mechanisms of transmission:

A total of 33 cases associated with the International mariners (for detail on room sharing and timing of positive cases, see appended line listing):

- 12 cases likely to have been incubating or infectious at the time of arrival

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- 5 cases positive after day 3, either incubating on arrival or acquired during first 48 hours in the facility, e.g. through interactions related to smoking
- 12 cases likely to have been acquired from a room-mate (for 5 of these, the direction of transmission is uncertain as both positive on the same day)
- 2 likely historic cases who happened to be sharing a room (both had very high CT values and strongly positive IgG serology on Day 3)
- 2 cases among health staff exposed to crew detected on Sunday 1/11 and Tuesday 3/11. Both these staff had returned negative tests on Thursday 29 October. (See text next page for details)

Whole genome sequencing revealed a total of 4 different genotypes (available for 27 of 33 cases to date, 5 unable to be sequenced).

- 15 B.1.1.77 (one partial sequence B.1.1 assumed to be same strain as discussed with Dr Phil Carter and Dr Joep de Ligt, ESR)
    - Nine likely incubating or infectious at time of arrival
    - Six likely to have been acquired from a room mate
- 9 B.1.1.7 (two partial sequence B.1.1.5 assumed to be same strain as discussed with Dr Phil Carter and Dr Joep de Ligt, ESR)
    - Four likely incubating or infectious at time of arrival
    - Four likely to have been acquired from a room mate
    - One staff member acquired from one of the above crew members
- 2 B.1.1.0
    - One likely incubating or infectious at time of arrival
    - One likely acquired from a room mate
- 1 B.1.1.77 6 nucleotide variant distinct from major cluster likely incubating or infectious at time of arrival (as discussed with Dr Phil Carter and Dr Joep de Ligt, ESR)

Outbreak spread to healthcare workers

On Monday morning 2 November a positive COVID swab result was obtained from one of the 9(2)(a) staff at the Sudima. The 9(2)(a) had last worked a shift on Friday 30 October and had given a negative routine swab on Thursday 29 October. 9(2) was slightly fatigued 9(2)(a) on Saturday night and developed a slight runny nose mid Sunday . Being particularly cautious, and with a clear understanding of expectations around testing even if mildly symptomatic 9(2) chose to get a check swab that day.

Actions taken:

- Immediate case investigation started with an HPO interviewing the case
- Close contacts of the 9(2)(a) were identified and quarantined (n=9) including 9(2)(a) 9(2) who was year 9(2) student at 9(2)(a) was swabbed on the evening of the 2nd and returned a negative test. 9(2) was put in quarantine (starting 3 November) in the family home and 9(2)(a) isolated in a Campervan on the same property.
- Testing of all 99 staff rostered on the Friday shift was required. Some staff rostered on the Thursday also chose to be swabbed
- Whole genome sequencing was requested on the case swab

The case was interviewed by Drs Freeman, Stevenson and Berger and re-interviewed several times over the next few days as more information came to light.

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On Tuesday afternoon 3/11 another staff member swab was reported as positive.

Actions taken:

- Immediate case investigation started with an HPO interviewing the case
- Close contacts of the 9(2)(a) were identified and quarantined including 9(2)(a) . They were swabbed on the evening of the 3rd and returned negative tests. The second case was quarantined in a MIQF.
- Testing of all 193 staff at the Sudima was required including translators, security, hotel staff and healthcare staff.
- Whole genome sequencing was requested on the case swab

By Wednesday 4/11 14 close contacts had been identified and were being monitored daily. The first case had spent an hour shopping in a local 9(2)(a) on Sunday morning. The manager of the store was contacted on Monday 2/11 by Dr Ramon Pink and while advised that only casual contacts might be identified the Manager decided to 'deep clean' the store overnight. A CPH Health Protection Officer visited the store early on Tuesday 3/11 and reviewed all CCTV footage and was able to confirm no close contacts were generated on this visit. A decision was made at MoH to alert all COVID app users of a potential exposure.

The Ministry of Education's local lead was advised of the case's 9(2) and met with the Principal of 9(2)(a) to advise there was no risk to the school community. A letter was sent to the Principal.

At the Minister of Health's request, a 'Pop-up' clinic was set up at Princess Margaret Hospital on Wednesday 4 November. This required significant resource, particularly staff (n=20) and when the number of swabs taken was reviewed and compared to baseline it was not felt to add any extra value over and above existing CBACs and GP swabbing clinics. No further pop-ups were actioned.

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Information from case interviews

Staff case 1 (Episurv number:20-389166-CH) Genotype: B.1.1.7

DATE	SHIFT	Infectious status	Potential exposures for acquisition	Potential onward exposure to guests	History from Case 1	Corroborative history from observers
23/10	0900-1600	Uninfected	Replaced wrist bands and involvement of transfer of 3 of the positive day 6 cases with matching genotype. CT values of these case by E gene assay indicate they were highly infectious: 18, 31, 32.	9(2)(a)	Full PPE (goggles for eye protection). "Calm and planned" procedure with adherence to protocol. Close contact (within 2m) approximately 1-2 minutes per guest while placing new band on wrist. The cases stood at the door of their room wearing a mask to have their bands replaced. The cases did not speak or cough throughout the procedures. No recollection of any breaches in PPE use or protocol. No specific buddy observing when the group of 9(2)(a) were doffing at the end of process.	IPC 9(2)(a) 1: Full PPE. Orderly procedure with adherence to protocol. Close contact (within 2m) per guest approximately 1-2 minutes while placing new band on wrist. The cases wore masks and didn't speak or cough throughout the procedures. IPC 9(2)(a) 2: Observed case 1 touching / adjusting mask while walking in the corridor between guests on 23/10. 9(2) hands had clean gloves and hand hygiene was performed between this event and contact with the last guest. There is a possibility that 9(2) gown cuffs had been contaminated and were now close to 9(2) face. At one stage a fishing crew case walked past Case 1 in the corridor while 9(2) was performing hand hygiene. There is a theoretical possibility that 9(2) hands could have been contaminated by small airborne micro-droplets in that encounter.
24/10	1300-1700		Assisted with deliveries of lunch to quarantine area			
25/10 - 27/10	Not at work	Uninfected				
28/10	0900-1600	Uninfected	Assisted with observations in quarantine unit.		Role during observations was cleaning of equipment: thermometer, pulse oximeter, hand sphygmomanometer. No breach of PPE recalled.	Unavailable
29/10	0900-1600	Uninfected Tested negative	In the ??morning replaced wrist band on day 12 case with matching genotype. CT value by E gene assay: 15		Full PPE (visor for eye protection). "Calm and planned" procedure with adherence to protocol. Close contact (within 2m) approximately 1-2 minutes with case while placing new band on wrist. The case stood at the door of their room wearing a mask to have their bands replaced. The cases did not speak or cough throughout the procedures. No recollection of any breaches in PPE use or protocol. Occurred under observation of experienced IPC nurse. No "buddy" observed doffing at end of process.	9(2)(a) colleague: No breaches in protocol. Close contact (within 2m) per guest approximately 1-2 minutes while placing new band on wrist. IPC 9(2)(a) 3: Very orderly and calm procedure with no major breaches in protocol besides noting there was no replacing of gloves with hand hygiene immediately after placing on new band. Maximum 1-2 minutes within 2m of case while placing new band
			Involved in rubbish collection in quarantine wing in afternoon. Possibly tidied up doffing station rubbish from yellow and "blue plus zones"		Some general concerns about rubbish bins being overfilled and having to compress rubbish bins with hand. No specific recollection of this on that day. Wearing full PPE (visor for eye protection) throughout process and recalls adherence to protocol.	IPC 9(2)(a) 4: On interviewing case found knowledge of rubbish collecting protocol a little hazy with some deviations- for example use of Clinnell wipes on arms rather than alcohol-based hand rub.
30/10	0900-1600	Infectious	9(2)(a)	Involved in taking daily observations	Took temps on 3 close contacts and one set of observations on a high risk" close contact (positive day 15) before swapping to be the scribe – cleaning equipment for 63 additional close contacts.	ACNM / 9(2)(a) colleague Took temps on 3 close contacts and one set of observations on a"high risk" close contact (positive day 15) before swapping to be the scribe – cleaning equipment for 63 additional close contacts.

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CASE 1: SUMMARY OF FINDINGS

- Very limited direct contact with guests of matching genotype during incubation period.
    - Changed bands for 3 guests of matching genotype on 23/10. Cumulative contact time: 3-6 minutes. Transmission at this point would give an incubation time of approximately 8-9 days.
    - Changing of band for a further guest with matching genotype 29/10. Cumulative contact time 1-2 minutes. Transmission at this point would give an incubation time of approximately 2.5 days.
    - It's estimated that for the 12 highly infectious cases transferred (ie CT <20), approximately 48 people were directly involved in their physical transfer, giving an attack rate of roughly 1/48 (2%)
- No major breaches in PPE protocol reported or observed.
- Several minor PPE breaches and lack of knowledge of protocols were identified but these are unlikely to present major transmission risk. These include:
    - An IPC 9(2)(a) observer recalled a minor breach where case 1 adjusted their mask between guests during the 23/10 band change process, but this was with clean gloves and following hand hygiene after the last guest contact. In principle, however, this could have increased the risk of mucous membrane inoculation / transmission through a contaminated gown cuff.
    - Doffing of full PPE was not observed on either the 23rd or 29th, but no breaches recalled or reported by the case.
    - Some difficulties recollecting processes around rubbish disposal.

CASE 1: CONCLUSIONS / DISCUSSION

- Four direct contact events with potential source cases during a closely observed and highly protocolised process. Full PPE worn on all occasions with a mask on the source case. No major breaches in PPE use although no direct formal observation of doffing process by buddy. Unobserved, subconscious breaches during the doffing process cannot be excluded.
- Two of the potential source cases (one from the 23rd and the other from the 29th exposure) had very low CT values (implying high viral load) and were presumably highly infectious at the time of contact. It seems most likely that transmission occurred during one of these two encounters.
- Possible mechanisms of transmission include:
    - inhalation of small droplet nuclei during direct contact /close proximity to both the case and the room of the infected case.
    - inoculation of mucous membranes / inhalation due to contamination during the doffing process.

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Staff Case 2 Episurv number: 20-389222-CH) Genotype: B.1.1.77

DATE	SHIFT	Infectious status	Potential exposures for acquisition	Potential onward exposure to guests	History from Case 2	Corroborative history from observers
22/10	0630-1920	Uninfected Tested negative	Observations in quarantine wing	[redacted]	Observations of 9 positives before swapping to scribe role for remaining 9. Full PPE. No breaches in PPE protocol.	
23/10	0630-1915	Uninfected	Shift lead. No direct contact with guests.		N/A	N/A
24/10	0630-1900	Uninfected Tested negative	Shift lead. No direct contact with guests.		N/A	N/A
25-26/10	Not at work					
27/10	0843-2105	Uninfected	Delivered lunch and other items to quarantine wing.		Full PPE. No breaches in protocol.	
28/10	0715-1915	Uninfected	Entered quarantine wing briefly to pick up recordings.		Full PPE. No breaches in protocol.	
29/10	0715-1915	Uninfected. Tested negative.	Involved in transfer of day 12 positive case. Assisted while colleague took BP on the same case.		Very orderly and calm procedure for band removal and replacement with no breaches in protocol. Occurred under observation of experienced IPC nurse. Case did not speak or cough during procedure. Was wearing mask entire time. Time for taking BP less than 1 minute	[redacted] colleague: No breaches in protocol. Close contact (within 2m) per guest approximately 2 minutes while cutting old band from wrist. (maximum estimated time) IPC [redacted] 3: Very orderly and calm procedure with no major breaches in protocol besides noting there was no replacing of gloves with hand hygiene immediately after cutting old band. . Maximum 2 minutes within 2m of case while new band being placed.
30/10-1/11	Not at work					
2/11-3/11	1837-0700	Infectious	[redacted]	Slipped letters under doors of guests in full PPE.	Wore full PPE and donned / doffed appropriately. No breaches in protocol.	

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CASE 2: SUMMARY OF FINDINGS

- Exposure on 22/10 to 10 cases with matching genotype during the process of taking observations. This included manual BP collection, pulse oximetry and aural temperature taking. No breaches in PPE recalled or reported. Appears to have been adherence to all IPC protocols with three [redacted] staff involved in the process (the third was the scribe).
- Six of these cases had low CT values (<20) when tested 3 days earlier and are presumed to have been highly infectious on the 22/10
- Besides the exposure on the 22nd, case 2 had little direct contact with guests before they became infectious after the 29th (although the Case cannot rule out assisting with the odd health check on 23rd and 24th).

CASE 2: DISCUSSION / CONCLUSIONS

- Exposure most likely on the 22/10 while involved in taking observations from one of the 10 cases with matching genotype. No major breaches in PPE or IPC process identified. Exposure on the 22/10 with a negative test on the 29th and a positive on the 3/10 would give a latency period of at least 7-12 days (latency period is equivalent to incubation time but for asymptomatic cases).
- Issues that may have increased risk include:
    - Reported concern about removing stethoscope from ears during manual BP collection with potentially contaminated gloved hands coming up to head area (many guests with significant hypertension)
    - Routine doffing of gowns between every positive case on 22/10 may have increased risk of fomite transmission
    - Pressure differentials between the room and the corridor may have created turbulence and increased the risk of exposure to droplet nuclei from the air in the rooms of highly infectious cases with low CT values (high viral load).
        - Our current understanding is that the corridor is passively ventilated with respect to rooms. Each room has an air-conditioner that has an intake of outside air and when running should create positive pressure with respect to the corridor. It is uncertain whether rooms of cases with matching genotype had air-conditioning on or not during the process of taking observations on the 22/10.
        - Our current understanding is that the air conditioning in the case rooms draws in outside air but was manually operated and unlikely to have been in use as most days the weather was coolish. With the air conditioning turned on, this would have created positive pressure relative to the corridor. The net impact of air conditioning on risk of exposure in the corridors is uncertain.
        - It's estimated that for the 12 highly infectious cases (ie CT <20) undergoing regular health checks during the two prior and three days after testing positive, approximately 96 people were exposed to a similar extent to this case, giving an attack rate of roughly 1/96 (1%)

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Rest of International mariners stay

We have been in close communication with the employers representative 9(2)(a) throughout. Letters translated into Russian were distributed regularly to the crew from the Medical Officer of Health and from the employers explaining what was happening and providing telephone numbers they could call for support of required. The employers have been very reassuring to the crew about their ongoing job security.

Late afternoon Thursday 5 November a meeting was held with the clinical oversight team (three operational MOH (Pink, Williams, and Stevenson), CDHB Microbiologist and Clinical Director of IPC Freeman, and the IPC Nursing Director Berger, Infectious Disease physicians Metcalfe and Pithie. Other attendees included MoH Liaison staff, the associate charge nurse manager of the Sudima and RIQ staff) to consider the level of exposure the two staff cases may have had with the International mariners.

Case 1 had close contact with 3 guests (already designated as "close contacts") on Friday 30 (taking observations for health checks) and casual contact with a further 63 "close contact" guests (scribing results of health checks).

Case 2 did the health checks on quarantined cases on Monday night 2 November and helped deliver letters to all crew by sliding them under their doors later that night. 9(2)(a) was in PPE when doing this which was changed between floors.

It was agreed that the level of exposure was minimal and very unlikely to generate extra cases

The three guests who were deemed to have casual contact with Case One were rapid swabbed as an exit check which was approximately one week after their last (minimal and low risk) exposure to the case – these tests were negative. One guest failed their health check with a sore throat. He was rapid-swabbed and this test was negative. [2]

The remaining 230 guests were cleared to leave and were transferred onto buses which took them directly to their employer's ships at Nelson, Lyttelton and Dunedin. Two conditions for exit were required by the MoH:

1) No shore leave for one further week and
2) All mariners to have a negative COVID swab at one week post exit. This testing has been arranged by Ministry of Health staff in liaison with local Public health Units.

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[2] On 12 November the last two mariners were released from the MIQF.

Overall Discussion and conclusions regarding staff cases

Two independent transmission events from guests to 9(2)(a) staff occurred despite good adherence to currently recommended best IPC practice and protocols as specified in the MBIE Infection Prevention and Control Standard Operating procedures (V 1.1. 19 October 2020). Both events were associated with direct contact with one or more cases who had a high viral load and are presumed to have been highly infectious at the time. During these brief periods of contact, cases were wearing a Type IIR medical mask at all times and the staff members were wearing full PPE including a Type IIR medical mask and either goggles or a visor. Fomite transmission via self-inoculation of mucous membranes somewhere during the doffing process cannot be fully excluded. However, based on the history obtained and the current weight of scientific evidence, this is deemed to be less likely than respiratory transmission via airborne microdroplets in association with close proximity to highly infectious cases in a setting where ventilation was likely suboptimal. There is increasing recognition that respiratory spread is the primary mode of transmission for SARS-CoV-2. In both of these episodes there was no obvious droplet spread (e.g. coughing, sneezing) and no obvious breaches that would increase the risk of contact transmission. For these reasons, transmission via droplet nuclei (aerosols) must be considered. Despite good adherence to IPC protocols, multiple factors may have contributed to transmission events in this case including:

- Cases were allowed to leave their rooms at will to go to the outdoor smoking area. There is some suggestion that smokers might be more susceptible to COVID and also more infectious.[3] Smokers almost always cough. Although 9(2)(a) staff do not report coughing occurring in their presence almost certainly crew would have been coughing during their stay and this combined with being highly infectious could generate substantial amounts of airborne micro droplets which could remain suspended in their rooms and the corridors. One possibility is that the air flow between the corridors and the rooms might have contributed to higher concentrations of airborne micro- droplets in the corridor.
- Over a period of hours the air within hotel rooms of highly infectious cases may possibly have become contaminated with infectious airborne micro-droplets, particularly if the air conditioning unit was not turned on.
- A pressure differential at the door of the room could conceivably have created turbulence when the door was opened or shut and thereby increased risk of exposure to infectious airborne micro droplets for those standing immediately outside in the corridor. Notably both transmission events are likely to have occurred in the corridor / at the door of a room of a highly infectious case and within minutes of the door opening.
- It should be noted that the circumstances above have been encountered before and since by staff without transmission events occurring. Indeed, other staff members who remain uninfected were present at the time transmission is thought to have occurred to these individuals. Calculated attack rates for exposure to highly infectious cases in this cohort range from 1-2%.
    - When any procedure with a known probability / risk of harm is repeated multiple times, it's reasonable to expect the instances where harm occurs to increase. The high burden of infectious cases in the Sudima at the same time substantially increased opportunities for transmission events to staff during routine interaction with guests.

[3] This is a growing theme in the literature but not certain yet

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- We note that the staff who deliver health checks and surveillance swabbing for guests in the Christchurch MIQF are highly trained fully registered nurses:
    - Around 60% are employed on MECAs at Grade 6 and Grade 7 indicating a high average level of clinical experience
    - Transferable knowledge and skills on transmission-based precaution and use of PPE are brought to the role from previous clinical experience
    - All new 9(2)(a) staff are required to attend an Orientation Day. This includes IPC training specific to MIQF setting (including COVID-19 transmission, PPE donning and doffing and nasopharyngeal swabbing) provided by IPC Clinical Nurse Specialists
    - At least weekly on-site visits are made by IPC team members with on-going ad hoc guidance and training delivered
    - New graduate nurses received specific training by IPC Clinical Nurse Specialists during their orientation

- In this case transmission occurred despite a Type IIR medical mask on the case and full PPE on both staff members. The assumption that adherence to current PPE protocols provides 100% protection is not necessarily correct or scientifically based, particularly in built environments where ventilation may at times be suboptimal and risk of transmission via small, airborne microdroplets may therefore be higher.

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Recommendations

General

- All 'special' groups (e.g. sports teams, essential workers) seeking to come to NZ must have a formal public health risk assessment that is documented and shared with the receiving DHB and Public Health Unit. An initial assessment should be undertaken by MoH staff in conjunction with MBIE staff. This should cover issues such as pre-flight testing, pre-trip quarantine in country of origin, and any particular requirements to do with culture, sport, jobs, training, smoking while in MIQF etc. Any variation in usual protocol should have local operational input into the decision making. Funding to manage any such variations must be addressed early in planning. The final requirements need to be communicated clearly to the RIQ in advance of arrival. Pre-trip testing requirements should be validated and made available to the RIQ teams/Public Health Unit and MOH.
- A more detailed assessment and understanding of staffing requirements should be undertaken by the local MIQF team (including the IPC specialists) and the Public Health Unit responsible for overseeing IPC at the receiving facility. This should include capacity to meet requirements e.g. appropriate training facilities for sports teams in wet and dry weather.
- Until the risk assessments and mitigation measures are specified and agreed between the DHB MIQF and the MOH/MBIE, permission should not be given for these groups to enter NZ
- If English is not the primary language spoken consideration to the need for and number of translators required is critical. The International Mariners required almost 24/7 translator support and we were fortunate to be able to find Russian interpreters at short notice. If English is not the primary language it would be good to have language specific information already written up for distribution before guests arrive including legal letters of isolation etc
- A specific issue learned with the International mariners' cohort is the need to understand the smoking requirements. MIQF are not set up to manage large numbers of chain-smoking guests (over 150 in this cohort). If we have such a cohort again we need to consider hosting them in rooms with opening windows/balconies that don't require them to exit the facility to smoke. Alternatively, we need considerably more staff to manage the physical distancing security requirements of such guests. This is a non-trivial issue- it was a significant contributor to the spread of COVID in this cohort and a significant stress on staff, not to mention the cleaning requirements post their exit.
- 'Double bunking' was the single most important known risk-factor facilitating spread within the facility. Double bunking almost certainly led to the infection of 12 mariners (35% of all cases) and was likely a contributing factor to the infection of two of our staff. This must not be allowed to happen again.
- The timing of the arrival of 'special' groups, particularly from high-risk countries, must be considered such that they arrive in the normal working week and their stay is unlikely to be affected by holiday weekends or critical leave times such as Christmas when staffing and laboratory capacity are even more restricted than usual.

Staffing of MIQFs

- Needs to be appropriately matched to the number of guests and their specific demands (e.g. chain smoking)

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- Experienced staff are required at all times and ongoing staff training is required to upskill and orientate new staff to new environments (Hotels as MIQFs) as well as ensure complacency and fatigue do not become separate risk factors.
- When there is high infection load the ratio of highly experienced and IPC specialists must increase. Having such surge capacity available at all times is critical to this response but will need to be resourced. The downstream benefits of having highly trained IPC specialists has been seen in other areas where IPC technical guidance and advice is required (e.g. ARC)
- A PMS should be established so that nurses can electronically record observations and make notes. This will help ensure that contacts with guests and with each other can be retrospectively tracked if needed for the purposes of a contact tracing investigation. (This is being worked on now at CDHB.)
- The intensive support of on the ground IPC specialists is critical to the management of our MIQFs in Christchurch. Such support is received from staff induction to crisis events such as covered in this report. The IPC specialist team needs to be well integrated into the MIQF management and healthcare team.
- CPH case investigators frequently observed that staff did not know who they worked with or their names- regular masking does not help with this. This was particularly the case between staffing groups e.g. security does not know names of 9(2)(a) staff. Name badges are being considered currently.
- More generally, the intensive workload in a high-risk environment with frequent changes of PPE will inevitably lead to staff fatigue and burnout. This combined with unrelenting negative social media and social stigma puts us at risk of resignations in this workforce (some have already been received). Operating at full capacity with complex groups adds further risk to the safe management of these groups. We must control flow of guest numbers in the MIQF in relation to capacity to allow for management of community cases/contacts and to allow for safe work conditions.

Built environment

- Engineering review of ventilation specifications of quarantine spaces in Canterbury MIQFs, with regard to corridors and rooms of cases and the pressure differentials between them. Assessment of opportunities to reduce risk by improving ventilation, particularly in the rooms of confirmed cases and the connecting corridors is required. Questions include: should all confirmed cases have rooms with opening windows/balconies? What options are available to reduce the viral load suspended in the room air? What options are available to minimise staff exposure to airborne microdroplets of SARS-CoV-2 when the door to the corridor is opened?
- The Sudima hotel does not have a CCTV system which meant we could not review staff movements, particularly with a view to assessing PPE compliance. CCTV should be a requirement of at a minimum, quarantine facilities where cases are being cared for
- Donning/doffing stations need to be set up with respect to adequate space for 9(2)(a) staff to utilise them. Close proximity to guest rooms is not ideal and capacity pressures should not in any way compromise this.
- Waste management processes are needed that are capable of dealing with large amounts of PPE waste and that do not expose nurses to excess risk caused by weight or over flow
- Corridors need to be wide enough to deal with expected guest traffic- again, passage of chain smokers and their minders was excessive in early days of their stay.

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Individuals

- Both staff cases felt confident in their training and described the working environment as calm. Guests were highly compliant and there was no evidence of behaviours associated with increased droplet dispersion such as coughing or shouting and no obvious PPE breaches. Any infection opportunities were likely a combination of bad luck, highly infectious cases (low CT), high viral loading in the air, and possibly minor PPE breaches that were not recognised by the 9(2)(a) . We particularly note concerns about the challenges of removing stethoscope ear pieces without self-contamination and possible brushing of a potentially contaminated cuff against a mask.
- Use of digital BP devices is recommended wherever possible (noting that this cohort were frequently hypertensive and manual BP devices were being used which are the most appropriate in this situation.)

Some things had already been recognised as risks and practice has already changed- e.g. reduced doffing in quarantine wing occurred the day after the transfer of the first guests to quarantine. The importance of real-time quality improvement is critical to staff confidence – knowing their concerns have been heard and addressed.

Personal Protective Equipment

- Because of the potential risk of self-contamination during the doffing procedure itself, IPC protocols should keep doffing to a minimum (e.g. gloves and hand hygiene) during the course of providing care for cohorted groups of positive cases within a quarantine facility or quarantine wing in managed isolation. Strict adherence to buddy system for doffing process following direct contact with confirmed cases.
- Change current practice/SOP from Type IIR medical masks to N-95/P2 masks for staff entering quarantine areas or coming into direct contact with confirmed cases (in CDHB this is only registered nurses). Ideally, this should be accompanied by a fit testing programme for staff working in quarantine wings/facilities.

Conclusion

This report has been authored by Drs Berger, Freeman and Stevenson with assistance from RIQ healthcare leads, ESR staff and it has been discussed with local Infectious Diseases staff who all support the recommendations made. Other investigations and evaluations of the International Mariner outbreak and transmission to healthcare staff are likely in the near future e.g. various debriefs are planned by local and central agencies. These future reviews may generate other recommendations.

This report concludes that the current MIQF service in Christchurch was severely stress-tested by the International Mariner cohort who brought with them high numbers of early and highly infective COVID cases. This combined with behavioural challenges (chain-smoking and double bunking) and environmental challenges (inappropriate ventilation and confined spaces) led to a total of 31 confirmed cases in the mariners and two in New Zealand healthcare staff. The report outlines that current IPC protocols in New Zealand are primarily directed at mitigating droplet and fomite transmission but, consistent with the changing evidence base internationally, we believe in this instance transmission was likely due to airborne micro-droplets of SARS-CoV-2. We support the careful introduction of fit tested N-95 masks for staff working in quarantine wings and facilities along with a review of ventilation specifications in all quarantine wings and facilities.

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Appendix One: International Mariner/Sudima Cases – By original room

Original Room Number	Swab date	Current Room	EPISURV	E gene PCR CT	WGS
1111	Day 3	2103	20-388503-CH	34	U
	Day 3	2101	20-388515-CH	35.3	U
1117	Day 3	2106	20-388509-TI	13.6	B.1.1.77
	Day 6	2124	20-388691-CH	29	B.1.1.77
1118		1118			
	Day 3	2107	20-388511-TI	17.2	B.1.1. 77
1121	Day 3	2108	20-388534-CH	24.1	B.1.1.77 6 SNP variant
		1121			
1126					
	Day 3	2105	20-388522-CH	16.6	B.1.1. 77
1201	Day 9	2208	20-388748-CH	28	B.1.1.77
	Day 3	2109	20-388530-CH	13.3	B.1.1. 77
3105	Day 6	2122	20-388690-TI	32	B.1.5partial
	Day 15	2212	20-389081-CH	24.3 (Abbott Assay)	B.1.1.7
3120	Day 3	2111	20-388510-CH	13.4	B.1.1. 77
	Day 3	2112	20-388514-CH	26.2	B.1.1. 77
3203	Day 3	2114	20-388537-CH	13.7	B.1.1.7
	Day 3	2113	20-388536-TI	25	B.1.1.7
3205	Day 6	2218	20-388710-CH	31	B.1.5partial
	Day 9	2209	20-388747-TI	32	B.1.1.7
3206	Day 6	2215	20-388704-CH	23	B.1.1.77
	Day 6	2217	20-388709-CH	16	B.1.1.77
3210	Day 6	2216	20-388705-CH	18	B.1.1.7
	Day 12	2211	20-388969-CH	15 (approx)	B.1.1.7
3214	Day 3	2115	20-388524-CH	40	U
		3214			
4205	Day 3	2110	20-388508-CH	23	B.1.10
	Day 6	2219	20-388707-TI	16	B.1.10
5107	Day 6	2220	20-388717-CH	17	B.1.1.77
	Day 9	2210	20-388749-CH	18	B.1.1.77
5113	Day 3	2116	20-388512-CH	15.4	B 1.1.77
		5113			
5212	Day 3	2218	20-388521-CH	20.3	B 1.1.77
	Day 3	2117	20-388513-CH	36	B.1.1partial
5216	Day 3	2119	20-388525-CH	35.2	U
	Day 3	2120	20-388523-CH	36	U
Sudima Staff	Symptomatic on 31/10/20. Tested on 1/11/20	N/A	20-389166-CH	16.2	B.1.1.7
	Tested 03/11/20	N/A	20-389222-CH	Abbott 16.22	B.1.1.77

KEY	
	Day 3 Positive swab (19/10/2020)
	Day 6 Positive swab (22/10/2020)
	Day 9 Positive swab (25/10/2020)
	Day 12 Positive swab (28/10/2020)
	Day 15 Positive swab (31/10/2020)
	Negative swab results

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Research

JAMA Internal Medicine | Original Investigation

Filtration Efficiency of Hospital Face Mask Alternatives Available for Use During the COVID-19 Pandemic

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IMPORTANCE Procuring respiratory protection for clinicians and other health care workers has become a major challenge of the coronavirus disease 2019 (COVID-19) pandemic and has resulted in nonstandard practices such as the use of expired respirators and various decontamination processes to prolong the useful life of respirators in health care settings. In addition, imported, non–National Institute for Occupational Safety and Health (NIOSH)-approved respirators have been donated or acquired by hospitals as a potential replacement for limited NIOSH-approved N95 respirators.

OBJECTIVE To assess fitted filtration efficiencies (FFEs) for face mask alternatives used during the COVID-19 pandemic.

DESIGN, SETTING, AND PARTICIPANTS For this quality-improvement study conducted between April and June 2020, we used the Occupational Safety and Health Administration's Quantitative Fit Testing Protocol for Filtering Facepiece Respirators in a laboratory atmosphere supplemented with sodium chloride particles to assess the FFEs of a variety of respirators worn by a male volunteer and female volunteer.

MAIN OUTCOMES AND MEASURES The FFEs of respirators commonly worn by clinicians and other health care workers and available respirator alternatives during the COVID-19 pandemic.

RESULTS Of the 29 different fitted face mask alternatives tested on 1 man and 1 woman, expired N95 respirators with intact elastic straps and respirators subjected to ethylene oxide and hydrogen peroxide sterilization had unchanged FFE (>95%). The performance of N95 respirators in the wrong size had slightly decreased performance (90%-95% FFE). All of the respirators not listed as approved in this evaluation (n = 6) failed to achieve 95% FFE. Neither of the 2 imported respirators authorized for use by the Centers for Disease Control and Prevention that were not NIOSH-approved tested in this study achieved 95% FFE, and the more effective of the 2 functioned at approximately 80% FFE. Surgical and procedural face masks had filtering performance that was lower relative to that of N95 respirators (98.5% overall FFE), with procedural face masks secured with elastic ear loops showing the lowest efficiency (38.1% overall FFE).

CONCLUSIONS AND RELEVANCE This quality-improvement study evaluating 29 face mask alternatives for use by clinicians interacting with patients during the COVID-19 pandemic found that expired N95 respirators and sterilized, used N95 respirators can be used when new N95 respirators are not available. Other alternatives may provide less effective filtration.

Invited Commentary

Related article

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A major concern during the coronavirus disease 2019 (COVID-19) pandemic has been protection of clinicians and other health care workers from severe acute respiratory syndrome coronavirus (SARS-CoV-2) infection by respiratory aerosol and contact transmission. A widespread, acute shortage in personal protective equipment, primarily filtering facepiece respirators (henceforth referred to as respirators), has prompted the implementation of nonstandard practices to fill the need for protection in health care settings. The Centers for Disease Control and Prevention (CDC) has developed contingency and crisis strategies to provide alternatives for respirators, including use beyond expiration dates, decontamination and reuse, and use of non-National Institute for Occupational Safety and Health (NIOSH)-approved respirators.[1]

Comparative fitted filtration efficiencies (FFEs), combined intrinsic filtering efficiency of material and efficacy of fit to the face, for respirator alternatives have not previously been quantified in a comprehensive manner, and health care facilities are faced with prioritization of their available options without clear data to guide decision-making. To address this need, we have performed a series of FFE evaluations for a wide range of 29 respirators and face masks used by health care facilities, including expired N95 respirators, N95 respirators that have undergone sterilization, CDC-approved imported respirators, respirators not listed as approved, and surgical or procedure masks with ties and ear loops.

Key Points

Question How effective are the aerosol filtration efficiencies for fitted face mask alternatives used during the coronavirus disease 2019 pandemic?

Findings In this quality-improvement study of 29 fitted face mask alternatives, expired N95 respirators with intact elastic bands and masks that had been subjected to ethylene oxide and hydrogen peroxide sterilization had unchanged fitted filtration efficiencies (FFEs) of more than 95%, while the performance of N95 respirators in the wrong size resulted in decreased FFEs between 90% and 95%. As a group, surgical and procedure masks had lower FFEs relative to N95 respirators, with masks secured with elastic ear loops showing the lowest performance.

Meaning When new N95 respirators are unavailable, N95 respirators past their expiration date; sterilized, used N95 respirators; and other less common respirators can be acceptable alternatives.

Methods

Fitted filtration efficiency tests were conducted between April and June 2020 in a custom-built exposure chamber (US Environmental Protection Agency Human Studies Facility in Chapel Hill, North Carolina). The institutional review board at the University of North Carolina at Chapel Hill waived the need for study approval as well as individual consent needed for device testing. Face masks available by purchase or contribution to the local UNC Health Care facility were fitted on an adult male volunteer (weight, 75 kg; height, 178 cm; head circumference, 58.5 cm) with no beard. For sex comparison of small and regular-sized face masks commonly used in health care facilities, an adult female volunteer was also tested (weight, 53 kg; height, 160 cm; head circumference, 56.0 cm). Fitted filtration efficiency tests were conducted as prescribed by the Occupational Safety and Health Administration's Modified Ambient Aerosol CNC Quantitative Fit Testing Protocol For Filtering Facepiece, Table A-2.[2]

Accordingly, FFE was measured during a series of repeated movements of the torso, head, and facial muscles to simulate typical occupational activities experienced by a mask wearer. A Particle Generator 8026 (TSI) was used to supplement ambient particle counts in the chamber, with sodium chloride particles having a count median diameter of 0.05 µm, as measured by a scanning mobility particle sizer. Particle concentration in the chamber was allowed to stabilize for 30 minutes prior to testing. All face masks were fitted with sampling probes using a Fit Test Probe Kit for Disposable Facepieces 8025-N95 (TSI) to allow sampling of aerosol inside of the face mask. Face masks fitted with sampling probes can be seen in the Figure. A pair of Condensation Particle Counters 3775 (TSI) was run in single particle analysis mode to continuously monitor particles (0.02-3.00 µm) in the chamber just outside of the face mask (ambient) and behind the face mask at a sampling rate of 1 second. Ambient particle counts/cc were typically in the range of 2000 to 5000. Ten feet of 0.25-inch conductive rubber tubing was used for each sampling line, and a small piece of nonconductive tubing and stopcock served as a connector between the sampling port and the conductive tubing sampling line. The ambient sampling line and masks sampling line were made identical to reduce variability in the system.

The temperature during testing ranged from 23 °C to 29.5 °C, and the relative humidity was 10% to 50%. The overall FFE was averaged from start to end of the testing period, and the average standard deviation over the period of sampling was computed (total testing time was about 3 minutes). Three respirator sterilization methods were tested on used masks: ethylene oxide (EtO) (500 mg/L-hours at 50 °C, 16-hour cycle), steam (121 °C, 15 minutes), and vaporized hydrogen peroxide (8 g/min, 260 PPM, 100-minute cycle). Each sterilization load was monitored with mechanical, chemical, and biological indicators specific to the sterilizer manufacturer's instructions. The FFE of these sterilized, used masks was measured after a single sterilization cycle as described above.

Results

Table 1[3,4] shows FFEs for all face masks tested. A Controlled Air Purifying Respirator system (MAXAIR) fitted with a face shield supplied by the device manufacturer prevented more than 99% of particles from entering the test individual's breathing space. N95 respirators up to 11 years past their expiration (expired in 2009 and 2011) and N95 respirators subjected to EtO and vaporized hydrogen peroxide sterilization retained FFEs more than 95%. Although N95 respirators with exhalation valves (Particulate Respirator 8511 [3M]) are not generally used in health care settings because the expired air is not

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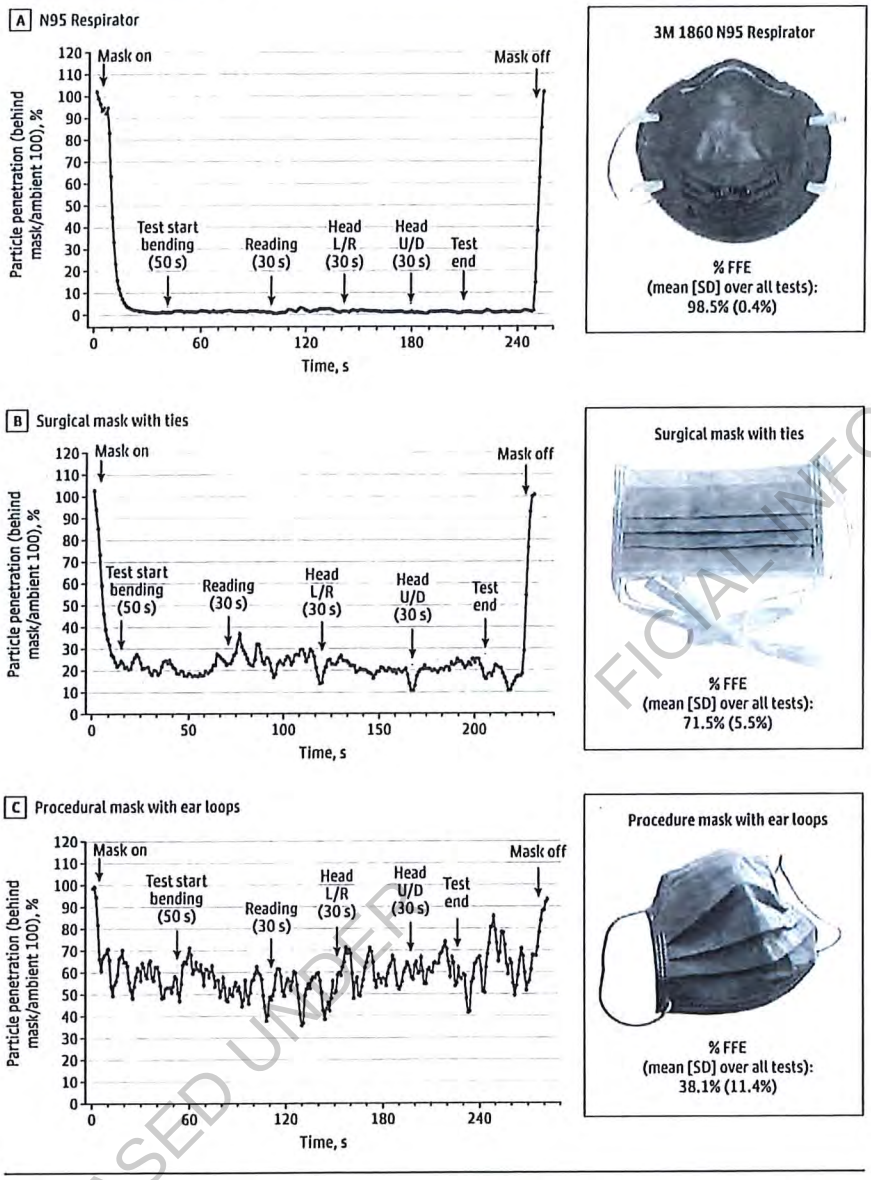
Figure. Evaluation of Fitted Filtration Efficiency (FFE) Using the Occupational Safety and Health Administration Modified Ambient Aerosol CNC Quantitative Fit Testing Protocol for Filtering Facepiece



When used on a man, the overall FFE for a National Institute for Occupational Safety and Health-approved N95 respirator was 98.5% (A), the overall FFE of a surgical mask with ties was 71.5% (B), and the overall FFE of a procedural mask with elastic ear loops was 38.1% (C). Data correspond to particle penetration into the face mask as expressed as the percentage of total particle/cc measured simultaneously outside of the face mask.

filtered by the face mask, their FFE was also more than 95%. All of the respirators not listed as approved (eg, KN95 [Guangdong Fei Fan]) and the 2 CDC-approved, imported, non-NIOSH-approved respirators (DTC-3X-1 and DTC-3X-2 [Dasheng]) in this evaluation failed to achieve 95% FFE. As expected, surgical and procedure masks had substantially lower average FFEs than the N95 respirators, and the variability in their performances was observed to be largely dependent on the tightness of the contact between the material and the test individual's facial skin. In all tests, the FFE of masks with ties outperformed those with ear loops.

Finally, Table 2 compares respirator and face mask FFEs for the man and woman. The small 1860 N95 respirator (3M) on the man and the regular 1860 N95 respirator on the woman failed to achieve an FFE more than 95%; however, both were more than 90% efficient. All other single-sized N95 face masks reached more than 95% FFE on both the man and woman. The mask with ear loops was less efficient on the woman's face relative to the man's face.

Discussion

While Controlled Air Purifying Respirator systems and new NIOSH-approved N95 respirators fitted to the face are clearly the preferred choice of protection from bioaerosols, the avail-

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Table 1. Face Mask Fitted Filtration Efficiency (FFE) Against Submicron Particle Penetration

Face mask	Condition	Approved	% FFE (SD)[a]	No. of masks tested on male test individual
Commonly used				
MAXAIR Controlled Air Purifying Respirator system[b]	New	NA	99.6 (0.1)	1
3M 8210 N95[b]	New	Yes[c]	97.9 (0.5)	2
3M 8210 N95[b]	Expired in 2011	NA	98.5 (0.4)	3
3M 1860 N95[b]	New	Yes[c]	98.5 (0.4)	1
3M 1860 N95[b]	Expired in 2009	NA	97.0 (1.0)	3
3M 1860 N95[b]	EtO sterilized	NA	98.1 (0.5)	3
3M 1860 N95[b]	H_2O_2 sterilized	NA	96.8 (0.7)	1
3M 1870+ Aura N95[b]	New	Yes[c]	99.2 (0.3)	1
3M 1870+ Aura N95[b]	Autoclaved	NA	98.0 (0.4)	3
Halyard Health 46827 N95[b]	New	Yes[c]	99.5 (0.1)	1
Surgical mask				
With ties	New	NA	71.5 (5.5)	4
With ear loops	New	NA	38.1 (11.4)	3
Less commonly used				
Dasheng DTC-3Z with head straps[b]	New	Yes[c]	99.2 (0.3)	1
3M 8511 N95 with exhaust valve[b]	New	Yes[c]	98.0 (0.5)	1
Moldex 2200 N95[b]	New	Yes[c]	97.8 (0.5)	1
One Sperian HC-NB295F Duckbill[b]	New	Yes[c]	97.7 (0.7)	1
3M 9010 CN N95[b]	New	Yes[c]	97.6 (0.8)	1
Dasheng DTC-3W with head straps[b]	New	Yes[c]	95.5 (1.2)	1
Safemark Magic City 6950 Duckbill[b]	New	Yes[c]	95.2 (1.3)	1
U-Line S-9632	New	Yes[c]	94.2 (1.4)	1
SAS Safetycorp 8617 Duckbill	New	Not listed	93.2 (1.4)	1
Willson Saf-T Fit N1105 medium/large (Honeywell)	New	Yes[c]	93.0 (1.8)	1
Fangtian Duckbill FT-032 with exhaust valve	New	Not listed	86.2 (2.8)	1
Safe-Life N95 B150	New	Not listed	85.9 (2.0)	1
Jia Hu Kang KN95 mask with ear loops	New	Not listed	85.1 (2.2)	1
Dasheng DTC-3X1 with ear loops	New	Yes (CDC only)[d]	79.7 (4.4)	1
Zhongshan Dongfeng Huangshang GM700	New	Not listed	79.2 (6.8)	1
Dasheng DTC-3X2 with ear loops	New	Yes (CDC only)[d]	76.8 (5.5)	1
Guangdong Fei Fan KN95	New	Not listed	53.2 (6.8)	1

Abbreviations: CDC, Centers for Disease Control and Prevention; EtO, ethylene oxide; H_2O_2, vaporized hydrogen peroxide; NA, not applicable; NIOSH, National Institute of Occupational Safety and Health.

[a] The FFE percentage corresponds to the mask condensation particle counter counts/ambient condensation particle counter counts × 100. The FFE percentage and SD were calculated across the length of the test.

[b] Mask functioned at or above 95% FFE.

[c] Denotes NIOSH-approved N95 particulate filtering facepiece respirators.[3]

[d] Denotes CDC-approved, imported, non-NIOSH-approved respirators manufactured in China.[4]

Table 2. Face Mask Fitted Filtration Efficiency (FFE) Against Submicron Particle Penetration

Face mask	% FFE (SD)[a]	
	Man	Woman
3M 1860 N95		
Small	91.1 (4.0)	98.6 (0.4)
Regular	98.4 (0.5)	93.1 (1.6)
3M 8210 N95 (one size only)[b]	99.4 (0.3)	98.2 (0.7)
3M 8511 N95 with exhalation valve[b]	98.1 (0.7)	98.3 (0.9)
Surgical mask		
With ties	69.8 (5.1)	68.9 (10.9)
With ear loops	39.7 (10.5)	26.5 (14.0)

[a] The FFE percentage corresponds to the mask condensation particle counter counts/ambient condensation particle counter counts × 100. The FFE percentage and SD were calculated across the length of the test.

[b] Mask functioned at or above 95% FFE.

ability of these items may be compromised during periods of high demand, such as a pandemic. The current study provides a comparative evaluation of particle penetration for commonly available face masks and alternatives while fitted to the face at baseline and under nonstandard conditions (eg, expired, sterilized) using a worst-case scenario of exposure to very small aerosols. Results of this study show that, despite an 11-year expiration, N95 respirators with intact headbands exceeded 95% FFE. Recently, sterilization and decontamination of face masks has emerged as a novel method to prolong the limited supply of existing respirators.[5] Both EtO and vaporized hydrogen peroxide, which are effective sterilization agents and well known for material compatibility, had no deleterious effect on FFE after a single sterilization. A potential disadvantage of EtO sterilization is that the wearer may be exposed to residual EtO within the face mask. We also evaluated steam sterilization for 2 respirator models. Steam visibly distorted the 1860 N95 respirators, making them unsuitable

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for reuse. However, 1870+ Aura face masks (3M) were not visibly altered and maintained more than 95% FFE when subjected to a single cycle of steam autoclaving.

Neither of the CDC-approved, imported respirators lacking NIOSH certification functioned at or above 95% efficiency, and the most effective face mask achieved only 79.7% FFE. These respirators, which have elastic ear loops and a vertical fold design, were least effective when the test individual bent at the waist and looked up and down. Procedure masks with ear loops performed at 38.1% FFE and were the least effective when moving the head left and right (21.2% FFE), and created visible gaps between the face mask and the wearer. Taken together, these data suggest that elastic ear loops may not provide adequate tension to maintain a tight fit during a typical range of motions. Moreover, these findings illustrate the importance of fit for maximizing the overall effectiveness of both respirators and masks.

Clinicians and other health care workers are exposed to polydispersed aerosols when caring for patients, particularly during aerosol-generating procedures. SARS-CoV-2 virions are 50 to 200 nm in diameter[6] but can be transported and transmitted on much larger droplets, which may be the major source of transmission. The count median diameter of particles in the test atmosphere was measured at 50 nm, likely smaller than SARS-CoV-2 virions or droplets containing the virus. However, the particle size of the test atmosphere was very similar to the sodium chloride particle size used to test and certify N95 respirators (75 ± 20 nm), which is deemed appropriate by the US Code of Federal Regulations (42 CFR §84, subpart K). Based on the mechanisms of particle deposition that govern filtration by face masks (ie, diffusion, impaction, interception, and sedimentation), it is clear that protection against aerosols with a count median diameter of 50 nm would also confer similar or better protection against much larger aerosols or droplets larger than 3 µm.[7] In fact, for masks with an electric charge (such as those manufactured by 3M), the most penetrating particle size was found to be 30 to 60 nm,[8] which is similar in size to those used for measurements in this study.

Limitations

A limitation of this study is the decision to test each mask on a single man (and woman for a few comparisons) rather than a large number of individuals with a full range of facial configurations. On the other hand, the use of 1 common individual allowed for testing of a larger quantity of masks in a short period of time, which addressed the urgent need for hospital infection prevention decision-making.

Conclusions

Evidence from previous studies suggests that even face masks with less than 95% FFE (eg, surgical masks) are effective in preventing acquisition of epidemic coronaviruses (ie, severe acute respiratory syndrome coronavirus 1, SARS-CoV-2) by clinicians and other health care workers except possibly during aerosol-generating procedures.[9-11] For prevention of a related coronavirus, severe acute respiratory syndrome coronavirus 1, N95 respirators had no increased prevention benefit over surgical masks.[10] However, the CDC and Infectious Diseases Society of America has recommended the use of N95 respirators especially during aerosol-generating procedures as long as the supplies are available. This evaluation provides quantitative results on which health care administrators, supply chain leaders, and hospital epidemiologists can make evidence-based decisions to protect clinicians and other health care workers during a pandemic or long-term mask shortage.

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Annals of Internal Medicine

REVIEW

Transmission of SARS-CoV-2: A Review of Viral, Host, and Environmental Factors

Eric A. Meyerowitz, MD*; Aaron Richterman, MD, MPH*; Rajesh T. Gandhi, MD; and Paul E. Sax, MD

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the etiologic agent of coronavirus disease 2019 (COVID-19), has spread globally in a few short months. Substantial evidence now supports preliminary conclusions about transmission that can inform rational, evidence-based policies and reduce misinformation on this critical topic. This article presents a comprehensive review of the evidence on transmission of this virus. Although several experimental studies have cultured live virus from aerosols and surfaces hours after inoculation, the real-world studies that detect viral RNA in the environment report very low levels, and few have isolated viable virus. Strong evidence from case and cluster reports indicates that respiratory transmission is dominant, with proximity and ventilation being key determinants of transmission risk. In the few cases where direct contact or fomite transmission is presumed, respiratory transmission has not been completely excluded. Infectiousness peaks around a day before symptom onset and declines within a week of symptom onset, and no late linked transmissions (after a patient has had symptoms for about a week) have been documented. The virus has heterogeneous transmission dynamics: Most persons do not transmit virus, whereas some cause many secondary cases in transmission clusters called "superspreading events." Evidence-based policies and practices should incorporate the accumulating knowledge about transmission of SARS-CoV-2 to help educate the public and slow the spread of this virus.

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* Drs. Meyerowitz and Richterman contributed equally to this work.

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Transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which causes coronavirus disease 2019 (COVID-19), requires that a minimum but as yet unknown dose of replication-competent virus be delivered to a vulnerable anatomical site in a susceptible host. A combination of viral, host, and environmental characteristics affect transmission. In this review, we discuss the evidence about the relative importance of these factors.

Methods

To review the extensive accumulating evidence about the transmission of SARS-CoV-2, we attempt to answer the following key questions. First, what is the evidence for the environmental viability of the virus in experimental and real-world settings? Second, what viral and host factors affect transmission? Third, what is the evidence for various modes of transmission? Fourth, what is the period of infectiousness for a person with SARS-CoV-2 infection? Fifth, what are the population transmission dynamics, and what is the role of superspreading events?

Data Sources

We manually searched electronic databases, including LitCovid (a literature hub for articles related to COVID-19 indexed on PubMed) and the medRxiv preprint server, for English-language titles and abstracts published from 1 January through 7 September 2020; we also searched reference lists of relevant articles and institutional or governmental reports of SARS-CoV-2 transmission.

Study Selection

Articles were included if they provided relevant information on the key questions. Selected articles included laboratory-based studies of the virus, instructive case and cluster reports, and other observational or modeling studies. Reviewers critically assessed each of the included studies, which had to be self-consistent and detailed enough to support their major conclusions. Limitations of important studies are noted when the studies are cited.

Data Extraction

One reviewer extracted data, and another verified accuracy.

Limitations

It is not possible to assess the exact route of transmission for many transmission events because risk factors often overlap; for example, persons may be exposed through both respiratory droplets and surface contamination.

Environmental Viability of the Virus

In experimental conditions, viable SARS-CoV-2 was cultured from aerosols (fine particles suspended in the air) and various surfaces after inoculation with $10^{5.25}$ 50% tissue culture infectious dose per milliliter ($TCID_{50}$/mL) for aerosols and 10^5 $TCID_{50}$/mL for surfaces, correlating to a reverse transcriptase polymerase chain reaction cycle threshold of 22 to 24, a typical value obtained from a nasopharyngeal sample of a person with COVID-19. Cycle thresholds correlate inversely to viral load, so higher cycle thresholds indicate lower viral loads (1). Viral RNA decayed steadily over time in all conditions, although viable virus was isolated for up to 3 hours from aerosols and up to 72 hours from various surfaces; the longest reported viability was on plastics and stainless steel, with half-lives around 6 hours (1).

A similar experiment found that infectious virus could be isolated from various surfaces after inoculation with a much larger amount of virus (7 to 8 log units

$TCID_{50}$/mL) (2). The same study found that the virus was highly stable at low temperatures but sensitive to heat, with inactivation of the virus in 5 minutes at 70 °C. In addition, SARS-CoV-2 could not be cultured after incubation with various disinfectants, confirming experimentally the effectiveness of cleaning procedures.

In real-world settings, studies have identified SARS-CoV-2 RNA from samples taken from contaminated environmental surfaces, most commonly high-touch surfaces (Table 1) (3–21). Viral RNA levels are markedly lower on environmental surfaces than in the nasopharynx of source individuals, as shown in studies of a quarantine hotel and used dining utensils (3, 4). The few studies that have assessed the presence of replication-competent virus with culture have isolated it rarely in air particles of varying size (5, 6).

Viral and Host Factors Affecting Transmission

Binding of the viral spike (S) protein to the host angiotensin-converting enzyme 2 (ACE2) receptor is a critical step for cell entry, and as a result, host ACE2 distribution determines viral tropism (22, 23). Viral load is highest in the upper respiratory tract (nasopharynx and oropharynx) early in disease and then increases in the lower respiratory tract (sputum), suggesting that the upper respiratory tract is the usual initial site of viral replication, with subsequent descending infection (24).

Susceptibility to SARS-CoV-2 infection increases with age; children younger than 10 years are around half as susceptible as adults (25–28). Viral RNA testing of household contacts in Iceland showed 6.7% and 13.7% positivity in children and adults, respectively, and testing in Wuhan, China, showed 4% and 17.1% positivity (29, 30). Decreased ACE2 expression in children compared with adults may partly explain the lower susceptibility seen in children (31, 32).

The relative probability of transmission from an infected child compared with that from an adult is not well understood. Replication-competent virus is readily isolated from children who are infected, and there are conflicting reports about the relative viral loads in children compared with adults, with some studies not controlling for time since symptom onset, a key determinant of viral load (32–35). Multiple large contact tracing studies have suggested a lower secondary attack rate for young children, but these must be interpreted with caution because children are less likely to have symptomatic disease and therefore less likely to be identified as index cases (35–38). Moreover, these studies predominantly took place during periods of school closures, which may have had a confounding effect on the likelihood of a child being an index case.

One study of households in the United States found that household contacts of patients with immunocompromising conditions and COVID-19 had increased risk for infection, a finding that has not yet been replicated but which suggests that this population may be more likely to transmit the virus (39).

Key Summary Points

Respiratory transmission is the dominant mode of transmission.

Vertical transmission occurs rarely; transplacental transmission has been documented.

Cats and ferrets can be infected and transmit to each other, but there are no reported cases to date of transmission to humans; minks transmit to each other and to humans.

Direct contact and fomite transmission are presumed but are likely only an unusual mode of transmission.

Although live virus has been isolated from saliva and stool and viral RNA has been isolated from semen and blood donations, there are no reported cases of SARS-CoV-2 transmission via fecal–oral, sexual, or bloodborne routes. To date, there is 1 cluster of possible fecal–respiratory transmission.

Viral factors may also contribute to transmissibility. For instance, a marked increase in the prevalence of SARS-CoV-2 bearing a D614G mutation has been noted over time (40). Whether this mutation provides a selective advantage to the virus has been debated (41). It has now been shown that this variant infects human ACE2 cell lines more efficiently than wild-type virus, that progeny virus has increased expression of S protein, that the S protein has a higher rate of binding to ACE2, and that in vivo viral loads may be higher for this variant (40, 42–44).

Evidence for Various Modes of Transmission

To date, conclusive evidence exists for respiratory transmission of SARS-CoV-2 and transmission to and between certain domestic and farm animals, as well as rare vertical transmission. Direct contact or fomite transmission is suspected and may occur in some cases. Sexual, fecal–oral, and bloodborne transmission are theorized but have not been documented.

Respiratory Transmission

When a virus spreads through respiratory transmission, it does so either with virions suspended on large droplets or fine aerosols expelled from the respiratory tract of the primary case patient. Droplets are classically considered to be particles larger than 5 μm that fall to the ground within about 6 feet and aerosols to be particles smaller than 5 μm that can remain suspended in the air for prolonged periods; however, this dichotomization may be an oversimplification, and distinguishing droplet and aerosol transmission is difficult in clinical settings (45–47).

The dominant route of transmission of SARS-CoV-2 is respiratory (48). Growing evidence indicates that in-

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fectious virus can be found in aerosols and in exhaled breath samples (5, 6, 49), and it is likely that under certain circumstances, including during aerosol-generating procedures, while singing, or in indoor environments with poor ventilation, the virus may be transmitted at a distance through aerosols.

Nevertheless, there is abundant evidence that proximity is a key determinant of transmission risk (50, 51). A detailed contact tracing study of train passengers that included 2334 index cases and 72 093 close contacts found that the secondary attack rate was closely linked to both the distance between seats and the duration of shared travel (52). In a cluster investigation of 112 cases linked to fitness classes in South Korea, high-intensity exercise in densely packed rooms yielded the most cases; a less crowded Pilates class with a presymptomatic instructor, on the other hand, had no associated secondary cases (53). That proximity so clearly increases risk for infection suggests that classic droplet transmission is more important than aerosol transmission (51).

The role of ventilation in preventing or promoting spread also highlights the importance of respiratory transmission. In a study of household transmission in China, opening windows to allow better air movement led to lower secondary household transmission (54). Poor ventilation has been implicated in numerous transmission clusters, including those in bars, churches,

Table 1. Review of Studies Assessing Viral RNA on Surfaces and in Air Samples

Setting	Findings	Viable Virus Assessed?	Reference
Quarantine hotel room (China)	Viral RNA found on 8 of 22 surfaces with high cycle thresholds in rooms of 2 presymptomatic individuals	Not assessed	3
Chopsticks (Hong Kong)	Viral RNA found on chopsticks at levels several logs lower than in respiratory tracts of 5 patients	Not assessed	4
Microbiology laboratory (Spain)	4 of 22 high-touch surfaces positive, all with cycle thresholds >30	Not assessed	7
Laboratory (China)	No samples positive by standard PCR techniques; 13 of 61 high-touch surfaces positive by droplet digital PCR, indicating very low levels of viral RNA	Not assessed	8
Hospital (China)	25% of 200 surfaces positive, high-touch surfaces most likely to be positive; 0 of 44 air samples positive	Not assessed	9
Hospital (Iran)	0 of 10 air samples measured 2–5 m from patients were positive for viral RNA	Not assessed	10
Hospital (Nebraska)	>70% of surfaces in patient rooms positive for viral RNA	Assessed/no viable virus detected	11
Hospital (Italy)	2 of 26 samples positive (both from CPAP helmets) with very low viral loads	Not assessed	12
Hospital (Wuhan, China)	0 of 90 surfaces positive after sanitization	Not assessed	13
Hospital (Singapore)	Surfaces positive before but not after sanitization; no air samples positive	Not assessed	14
Hospital (Hong Kong)	Extensive air sampling at close range (10 cm from chin) showed no positive air samples; viral RNA found in saliva and on surfaces	Not assessed	15
Hospitals (Wuhan)	Very low/undetectable levels in patient areas; detectable RNA in aerosols in poorly ventilated PPE removal areas that cleared with improved sanitization/ventilation	Not assessed	16
Hospitals (Wuhan)	Surfaces and air up to 4 m from patients frequently positive for viral RNA	Not assessed	17
Hospital (Milan, Italy)	High-touch surfaces and air samples positive for RNA in patient areas but not clean areas	Not assessed	18
Hospital (London, England)	Surfaces and air samples frequently positive for viral RNA at high cycle thresholds >30; more likely to be positive in areas closer to patients with COVID-19	Assessed/no viable virus	19
Hospital (Florida)	Viable virus isolated from 2 patients with COVID-19 from air samples collected 2–4.8 m away (no cycle threshold reported for either patient), with extremely low viral concentrations of 0.006–0.074 $TCID_{50}$ units/mL air	Assessed/viable virus detected	6
Hospital (Nebraska)	Air samples were taken around 6 patients with COVID-19 (no cycle threshold for patients and no distance at which air samples were taken reported), and an aerodynamic particle sizer spectrometer measured and separated air particles; viral growth confirmed from particles <1 μm and 1–4 μm in size	Assessed/viable virus detected	5
Radiation oncology clinic (New Jersey)	0/128 environmental surface samples were positive for SARS-CoV-2 RNA before they were cleaned and disinfected	Not assessed	20
Ferryboat, nursing home, and COVID-19 isolation ward (Greece)	SARS-CoV-2 RNA was detected on a variety of environmental surfaces, including an air conditioning filter and ventilation duct and in 1/12 air samples tested during an outbreak	Not assessed	21

COVID-19 = coronavirus disease 2019; CPAP = continuous positive airway pressure; PCR = polymerase chain reaction; PPE = personal protective equipment; SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2; $TCID_{50}$ = median tissue concentration infectious dose.

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and other locations (55–57). By contrast, such events have rarely occurred outside, and then only in the context of crowding (58–60). In 1 illustrative study of individuals at a religious event who traveled on 2 buses with poor ventilation, 35% of those on 1 bus acquired infection compared with none on the other bus, again highlighting the importance of ventilation (61). In this case, proximity to the single known index patient did not correlate with risk for infection.

In addition, studies have found that masking, both in health care settings and in the community, decreases transmission of SARS-CoV-2 (51, 62–65). A study in China found that mask use in the household before symptom development markedly reduced risk for household transmission (54). All of this evidence supports the dominant role of respiratory spread of this virus.

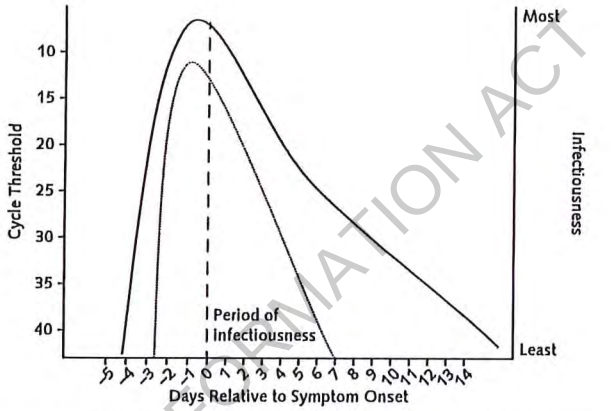
Direct Contact and Fomites

There is currently no conclusive evidence for fomite or direct contact transmission of SARS-CoV-2 in humans. Rhesus macaques can be infected with SARS-CoV-2 through direct conjunctival inoculation but develop less severe pulmonary disease than macaques inoculated through an intratracheal route (66).

Reports suggesting fomite transmission are circumstantial. For example, in a cluster of infections associated with a mall in China, several affected persons reported no direct contact with other case patients (67). The investigators noted that these individuals used shared common facilities (such as elevators and restrooms) and proposed fomite or respiratory transmission in those settings. In a detailed investigation of a large nosocomial outbreak linked to 119 confirmed cases at a hospital in South Africa, fomite transmission was proposed given the separated distribution of cases in multiple wards (68). However, the hospital did not have a universal mask policy at the time of the outbreak, there was no special ventilation, and the burden of infection among health care workers was substantial. As a result, respiratory transmission from infected staff cannot be excluded. As noted in the description of all known transmission clusters in Japan, it can be difficult to identify primary cases in large health care–associated outbreaks (57). In the case of a suspected transmission during an evacuation flight, the person who acquired infection reportedly wore an N95 mask at all times except when using a toilet that was shared with another passenger with asymptomatic infection (69).

Poor hand hygiene was associated with increased risk for infection among health care workers, and daily use of chlorine or ethanol cleaning products in the household was associated with decreased risk (54, 70). Although this might indirectly suggest direct contact or fomite spread, it can be difficult to tease out the relative importance of simultaneous interventions because, for example, excellent hand hygiene may be associated with better infection control practices overall. As will be discussed in the next section, live virus can be isolated after the period of infectiousness, which suggests a minimum necessary inoculum to initiate infection (71, 72). On the basis of currently available data, we suspect that the levels of viral RNA or live virus transiently remaining on surfaces are unlikely to cause infection, especially outside of settings with known active cases.

Figure 1. The period of infectiousness for immunocompetent, symptomatic adults (*dotted line*) and respiratory tract viral load with time (*solid line*).



The vertical dashed line represents symptom onset.

Domestic Pets and Farm Animals

Several studies have documented that SARS-CoV-2 can infect domestic animals, including cats, dogs, and ferrets (73–76). The virus replicates well in cats (but not in dogs) and is transmissible between cats and ferrets (75, 77). There are no confirmed cases of transmission from domestic pets to humans. Minks are susceptible to SARS-CoV-2 infection and are farmed in some areas where cases of transmission from minks to human farm workers is suspected (78, 79).

Vertical Transmission

Many studies have evaluated the possibility of vertical transmission of SARS-CoV-2 (80). There are several reports of positive SARS-CoV-2 IgM in neonates (81, 82). Although IgM does not cross the placenta, and thus its presence may indicate in utero infection, IgM testing is prone to false positivity, particularly in the setting of significant inflammation (83). There are also several reports of early nasopharyngeal positivity on polymerase chain reaction testing after delivery in neonates, including a description of 3 infants with positive results on day 2 of life and another of an infant with positive results 16 hours after delivery (84, 85). Several case reports have found placental infection by SARS-CoV-2, and 1 has shown transplacental transmission (86–89). In addition, breast milk can harbor viral RNA, although no confirmed transmissions to infants from breast milk have been reported (90–92). Taken together, these studies suggest that vertical transmission of SARS-CoV-2 rarely occurs.

Fecal–Oral (or Fecal Aerosol) Transmission

Fecal-oral transmission was theorized early in the outbreak because of the known high concentration of ACE2 receptors in the small bowel (93). No evidence currently supports fecal-oral transmission in humans,

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and intragastric inoculation of SARS-CoV-2 in macaques did not result in infection (94). Although viral RNA is commonly detected in stool, live virus has only rarely been isolated (95–99). This has led some to wonder whether viral aerosolization with toilet flushing could lead to transmission (100). In February 2020, there were news reports of an outbreak from possible fecal aerosol transmission at a multistory apartment complex in Hong Kong; however, an investigation showed that the secondary case patients were likely infected during a dinner party (101). One study did find low detectable levels of RNA in air samples near patient toilets at a hospital in Wuhan, although isolation of live virus was not assessed (16). The spatial distribution of a cluster of 3 infected families living in vertically aligned apartments connected by drainage pipes in a high-rise apartment building in Guangzhou, China, as well as the presence of viral RNA in another vertically aligned, unoccupied apartment, suggests the possibility of fecal aerosol transmission in rare cases (102). Taken together, given how rarely live virus has been isolated from stool, the low levels of replication-competent virus in stool that might be aerosolized from toilet flushing seem highly unlikely to cause infection except under unusual or extraordinary circumstances.

Sexual Transmission

No current evidence supports sexual transmission of SARS-CoV-2. Viral RNA has been found in semen, although infectious virus has not been isolated (103). Vaginal fluid has been negative except in a single case that reported RNA with a low viral level (104, 105). One study reported lack of transmission to a discordant partner among 5 couples who remained sexually active while 1 partner was in the period of infectiousness (106). For linked transmissions between sexual partners, exclusion of respiratory transmission would not be possible.

Bloodborne Transmission

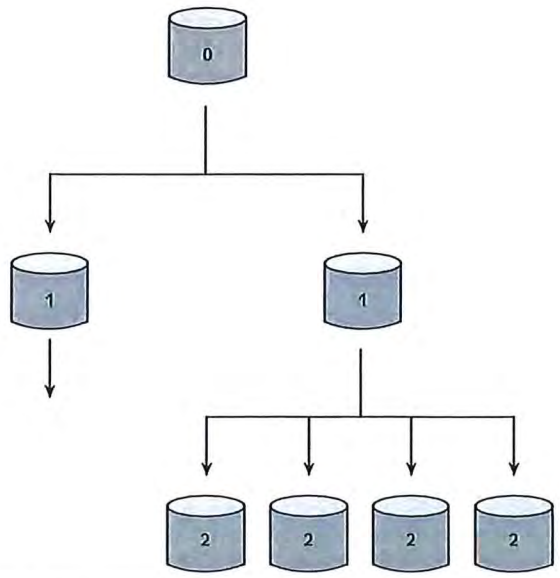
The proportion of persons with viral RNA detectable in blood is currently unknown. An early study found viral RNA in only 3 of 307 blood specimens (95). Another study detected viral RNA in 32.9% of 85 blood samples from symptomatic persons, including 22 of 28 from those requiring hospitalization (107). In another study, viral RNA was detected in 27% (19 of 71) of hospitalized patients (44% of those on a ventilator, 19% of those receiving supplemental oxygen by nasal cannula, and 0% of those on ambient air) and 13% (2 of 16) of outpatients with COVID-19 (108). Viral RNA was found in blood from 4 blood donors without symptoms. The samples were discarded and not administered to other patients (109). To date, no replication-competent virus has been isolated from blood samples, and there are no documented cases of bloodborne transmission.

Transmission Determinants by Symptoms and Timing: the "Period of Infectiousness"

Persons who have SARS-CoV-2 with or without symptoms can transmit. Those without symptoms may be presymptomatic, or they may remain asymptomatic. Transmission can occur from persistently asymptomatic persons, although they seem to be less likely to transmit, and when they are most infectious is currently unknown (110–114). Data are mixed about the dynamics of viral shedding in those with persistently asymptomatic infection (112, 115, 116).

Among those who develop symptoms, 1 report of 3410 close contacts of 391 case patients in China found that the secondary attack rate increased with the severity of the index case and that the specific symptoms of fever and expectoration were associated with secondary infections (113). In another study, researchers determined that transmissibility peaks around 1 day before symptom onset by analyzing a group of 77 transmission pairs (117). Assuming an incubation period of 5.2 days, they estimated that infectiousness started 2.3 days before symptom onset, peaked around a day before symptom onset, and declined rapidly within 7 days (117, 118). In their cohort, they estimated that 44% of secondary cases were acquired from persons who were presymptomatic at the time of transmission. Other studies have replicated these important findings (119–121). Modeling using observed viral load kinetics further supports these findings, suggesting that the threshold viral load for a 50% probability of transmission is approximately $10^{7.5}$ viral RNA copies/mL and that infected persons are likely to be above this threshold for only about 1 day (122). The amount of presymptomatic transmission varies between populations on the basis of the extent of active case findings and isolation and quarantine of close contacts. The proportion of presymptomatic transmission will be higher in areas without case tracking and isolation of contacts.

Figure 2. A branching schematic of heterogeneous (i.e., overdispersed) transmission with $R_0 = 2$.



The index case transmits to 2 secondary cases. One secondary case has no further transmissions, and the other secondary case transmits to 4 tertiary cases.

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Table 2. Features of Instructive Superspreading Events

Setting (Reference)	Cases/Total at Risk (Attack Rate), *n/N (%)*	Index Case	Key Features
Korean call center (136)	94/216 (43.5)	Not identified in report	Most cases found on the 11th floor of the call center: indoors with workers in very close proximity
Church in Arkansas (55)	35/92 (38)	Pastor was presymptomatic and then symptomatic during series of events he led at church	Events included 5 indoor church-related events over several days, some of which included singing
Wedding in Jordan (137)	76/350 (21.7)	Bride's father had fever, cough, and runny nose starting 2 d before event	2-h indoor wedding ceremony; additional 9 confirmed case patients who did not attend wedding were household contacts of those who did
Choir in Washington state (138)	53/61 (86.7)	1 person had "cold-like" symptoms starting 3 d before event	2.5 h in multipurpose room with chairs close together; question of whether singing aerosolized the virus
U.S.S. *Theodore Roosevelt* (140)	~1000/1400 (~60–70)	Not identified in report	Close quarters; social distancing, mask use, and avoiding common areas all associated with decreased risk
Overnight camp in Georgia (139)	260/354 (78) of those who were tested had positive results (out of 597 who attended)	Not identified in report	Staffers but not campers were expected to wear cloth masks; windows and doors of cabins were not opened to increase ventilation; activities included "daily vigorous singing and cheering"; lodging consisted of 31 cabins with an average of 15 persons in each cabin
International business conference in Boston (141)	At least 90 direct cases leading to sustained local transmission with progeny virus found in at least 35% of infections thereafter in Boston area during a major outbreak and exported to multiple other states	Presumed single introduction from Europe to Boston via this conference	Conference details not described in the manuscript, although presumed hours of close, indoor, unmasked contact

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Viral loads of SARS-CoV-2 in the respiratory tract decrease rapidly after symptom onset, with higher loads shifting from the upper to the lower respiratory tract (24, 123, 124). Patients with severe disease have higher respiratory viral loads than those with mild disease, although all loads decline with time (125). Researchers from China estimated the duration of RNA shedding from various sites based on detailed sample analysis of 49 patients with COVID-19 and reported a median duration of shedding from the nasopharynx of 22 days for mild and 33 days for severe cases, with some persons shedding for longer than 2 months (97). Figure 1 shows the period of infectiousness and respiratory tract viral load in cycle threshold with time.

Of note, the period of infectiousness is far shorter than the duration of detectable RNA shedding. For mild to moderate cases, infectious virus can be isolated from samples only up until about day 8 of symptoms. Multiple studies have found virtually no viable virus in patients with mild or moderate disease after 10 days of symptoms despite frequent ongoing RNA shedding (24, 126, 127). Higher viral loads are associated with increased likelihood of isolation of infectious virus (24, 127). In a study that included patients from 0 to 21 days after symptom onset, viable virus was isolated in 26 of 90 samples but no viral growth was found when the cycle threshold was greater than 24 or the patient had had more than 8 days of symptoms (128). A study of a major outbreak at a nursing facility in Washington found viable virus 6 days before symptom onset through 9 days after symptom onset (129).

It may be possible to isolate infectious virus longer in hospitalized patients who have severe disease or are critically ill. A group from the Netherlands evaluated 129 hospitalized patients, including 89 who required intensive care, and collected samples from the upper and lower respiratory tracts (71). Isolation of infectious virus occurred a median of 8 days after symptom onset. The probability of isolation of infectious virus was less than 5% after 15.2 days and decreased with time after symptom onset, lower viral loads, and higher neutralizing antibody titers; the latest isolation of infectious virus was 20 days after symptom onset.

Despite late isolation of infectious virus, no late transmissions have been documented, including in health care settings. Perhaps the most detailed real-world confirmation of this period of infectiousness comes from a detailed contact tracing study from Taiwan that found no linked transmissions after index patients had had symptoms for at least 6 days (72). In this study, nearly 3000 close contacts (including nearly 700 health care workers not wearing appropriate personal protective equipment at the time of exposure) of 100 confirmed case patients were followed closely. Hundreds of health care worker exposures occurred after an index patient had had symptoms for at least 6 days,

and no late transmissions were found, even in health care settings.

A helpful case report from Hong Kong described a patient with unrecognized COVID-19 who was admitted to a general ward for 35 hours before intubation for respiratory failure (130). Seven staff and 10 patients had close contact, and none developed COVID-19 or had a positive test result for SARS-CoV-2 during follow-up. Of note, the patient had had symptoms for 7 days by the time of admission, and although he had a relatively high viral load—in the range where infectious virus has been isolated in other studies—he did not transmit. Despite these high-risk interactions and relatively high viral load, he may have been outside the period of infectiousness.

Population-Level Transmission Dynamics, Transmission Heterogeneity, and the Role of Superspreading Events

In infectious disease transmission dynamics, the basic reproductive number, or R_0, describes the average number of secondary cases generated from an index case in an entirely susceptible population. Estimates for the R_0 of SARS-CoV-2 have ranged from 2 to 3 (131, 132). The number of secondary transmissions per index case can show levels of heterogeneity (Figure 2). Overdispersion refers to transmission with high heterogeneity. In such cases, most index cases do not lead to any secondary transmissions and a smaller minority lead to many secondary transmissions in clusters, in what are sometimes called "superspreading events" (133).

There is mounting evidence that SARS-CoV-2 transmission is highly overdispersed. Contact tracing investigations during the early epidemic in China estimated that 80% of secondary infections arose from 8.9% of index cases (134). This has been further supported by a modeling analysis that used the expected number of local and imported cases in all countries to estimate that approximately 10% of cases lead to 80% of secondary transmissions, a phylodynamic study that used SARS-CoV-2 genetic sequences in Israel to estimate that fewer than 10% of infections lead to 80% of secondary cases, and another detailed contact tracing report of all identified clusters of infection in Hong Kong that found that approximately 20% of infections caused 80% of secondary transmissions (56, 131, 135). In this last report, 1 transmission cluster accounted for more than 10% of all known cases in Hong Kong at the time and 30% of locally acquired cases. Highly publicized superspreading events have occurred, including outbreaks at a Korean call center, a church in Arkansas, a wedding in Jordan, a choir practice in Washington, and an overnight camp in Georgia (Table 2) (55, 136–141). As noted in an analysis of COVID-19 cases in Japan, transmission clusters are frequently characterized by presymptomatic and young adult index cases in settings associated with heavy breathing in close proximity (57). A systematic review of transmission clusters found that most occurred indoors (60). High viral load in the index case at the time of transmission is presumed to be important, but whether other specific host factors contribute to superspreading events remains unknown.

The household is another extremely important site of transmission for SARS-CoV-2, with a meta-analysis of 40 studies finding an overall household secondary attack rate of 18.8% (95% CI, 15.4% to 22.2%) (142). In a demonstrative contact tracing study from South Korea including nearly 60 000 contacts of more than 5700 case patients, the attack rate among household contacts was 11.8%, compared with 1.0% for nonhousehold contacts (37). Household attack rates vary with community prevalence and household factors like age distribution, density, and ventilation in the living space (54, 143). In addition, results from serologic and RNA testing may differ depending on timing and characteristics of tests (144). After superspreading events, additional transmission frequently occurs among contacts living in the same household.

Conclusions

In the midst of the COVID-19 pandemic, initial uncertainty about transmission, at times fueled by waves of misinformation or overinterpretation of in vitro studies, understandably led to fear among both health care workers and the general public. Through the extraordinary dedication of health care workers, public health leaders, and scientists around the globe, and with rapid knowledge sharing, we have made remarkable progress in our understanding of transmission of this virus and how to reduce its spread. The accumulated evidence suggests that most transmission is respiratory, with virus suspended either on droplets or, less commonly, on aerosols. Transmission dynamics are heterogeneous, with a major role for superspreading events in sustaining the epidemic. These events often include persons in close proximity in indoor settings with poor ventilation for extended periods. We must continue to stay up to date with the new and emerging evidence and work quickly to revise our policies to reflect this new information.

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