MIQ COVID-19 Case Incident Report

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CONTENTS

1. Glossary

Aerosol	Any respiratory particle that remains suspended in the air for longer than a few seconds, whatever the size[1] Aerosols are generated when the surface tension of fluid lining the respiratory tract is overcome by force. Breathing, coughing, talking, and singing all generate aerosols, causing an exhalation plume of respiratory particles of varying sizes, containing potentially infective viral material.[2]
Airborne Transmission	When someone with COVID-19 breathes, speaks, coughs or sneezes, they release particles (droplets and aerosols) containing the virus that causes COVID-19. While larger droplets fall quickly to the ground, smaller droplets and aerosols containing the virus can remain suspended in the air. If someone breathes in virus particles that are suspended in the air, they can become infected with COVID-19.[3]
ARPHS	Auckland Regional Public Health Service. Ratonga Hauora-ā-Iwi ō Tāmaki Makaurau. ARPHS is the public health unit for people living in the Auckland region, and is responsible for preventing disease and improving the health of the people in the region.
ARIQCC	Auckland Regional Isolation and Quarantine Coordination Centre. ARIQCC is the management centre for MIQFs in the Northern region. ARIQCC reports directly to both the MoH and MBIE.
Bubble(s)	A group of returnees who stay in the same room(s) and have close contact with one another. Typically, bubbles are couples and/or whānau units.
CDC	Centres for Disease Control. The United States' federal health protection organisation. https://www.cdc.gov/

[1] Morgenstern J. COVID-19 is spread by aerosols: an evidence review. First10EM blog., 30 November 2020 – Updated December 2, 2020. Available at: https://first10em.com/covid-19-is-spread-by-aerosols-an-evidence-review/

[2] Wilson N, Corbett S, Tovey E. Airborne transmission of covid-19 BMJ 2020; 370:m3206 doi:10.1136/bmj.m3206. Available at: https://www.bmj.com/content/370/bmj.m3206

[3] Public Health England. Guidance. Ventilation of indoor spaces to stop the spread of coronavirus (COVID-19) 4 March 2021 https://www.gov.uk/government/publications/covid-19-ventilation-of-indoor-spaces-to-stop-the-spread-of-coronavirus/ventilation-of-indoor-spaces-to-stop-the-spread-of-coronavirus-covid-19

CFD	Computational fluid dynamics.
CNS	Clinical Nurse Specialist.
Coronavirus	A family of related viruses. Many of them cause respiratory illnesses. Coronaviruses cause COVID-19, SARS, MERS, and some strains of influenza, or flu. The coronavirus that causes COVID-19 is officially called SARS-CoV-2, which stands for severe acute respiratory syndrome coronavirus 2.
COVID-19	Infection caused by the novel SARS-CoV-2 virus.
DHB	District Health Board.
Ct value	Cycle threshold value. The Ct value is the number of cycles in a PCR test necessary to produce a detectable amount of RNA.
ESR	Institute of Environmental Science and Research, Te Whare Manaaki Tangata, Taiao hoki.
Fomite	An object that becomes contaminated with infected organisms and which subsequently transmits those organisms to another person. Examples of potential fomites are surfaces, toys, mobile telephones or any inanimate objects.
Health staff	A person who works in a MIQF in a clinical capacity, including staff from DHBs.
HEPA / Air Purifier	High Efficiency Particulate Air. Air purifiers usually use a multilayer filter system composed often of a prefilter, a carbon filter, an antibacterial filter, and a HEPA filter. A HEPA filter uses mechanical filtration to remove airborne particles. A HEPA filter is standardised at a minimum 99.97% efficiency rating for removing particles greater than or equal to 0.3µm (1/83,000 of an inch) in diameter. This means that for every 10,000 particles that are 0.3µm in diameter, three will pass through the filter, and the rest will be trapped by the filter.[4]
Incubation period	The time between infection and onset of symptoms. The mean incubation period has been estimated to be 5.2 days

[4] Health Quality Ontario. Air cleaning technologies: An evidence-based analysis. Ont Health Technol Assess Ser. 2005;5:1–52

	(95% confidence interval [CI], 4.1 to 7.0], with the 95th percentile of the distribution at 12.5 days.[5] The median incubation period has been estimated to be 5.1 days (95% CI, 4.5 to 5.8 days), and 97.5% of those who develop symptoms will do so within 11.5 days (CI, 8.2 to 15.6 days) of infection[6].
Infectivity	The proportion of persons exposed to an infectious agent who become infected by it.
IPC	Infection prevention and control.
Managed Isolation Facility (MIF)	A low-risk facility that hosts returnees that are (generally) asymptomatic and not COVID-19 positive or close contacts of a confirmed or probable case of COVID-19.
Managed Isolation and Quarantine Facility (MIQF)	A term used as a combined reference, for example where requirements apply to all managed isolation facilities (MIFs) and quarantine facilities (QFs). "[A] low-risk facility that hosts returnees that are (generally) asymptomatic and not COVID-19 positive or close contacts of a confirmed or probable case of COVID-19" (Operations Framework v3.3, current at 22 December 2020).
MBIE	Ministry of Business, Innovation and Employment.
MoH	Ministry of Health.
NBS	National Border Solution.
NCTS	National Contact Tracing System.
NITC	National Investigation and Tracing Centre.
Non-health staff	A person who works in a MIQF who does not work in a clinical capacity, including staff of the hotel, MBIE, NZDF, Aviation Security, and other non-health-based agencies.
NRHCC	Northern Region Health Coordination Centre.

[5] Li Q, Guan X, Wu P et al. Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus–Infected Pneumonia. N Engl J Med 2020; 382:1199-1207 DOI: 10.1056/NEJMoa2001316. The basic reproductive number, (R0), was estimated to be 2.2 (95% CI, 1.4 to 3.9), meaning that on average each patient has been spreading infection to 2.2 other people.

[6] Lauer SA, Grantz KH, Bi Q et al. The Incubation Period of Coronavirus Disease 2019 (COVID-19) From Publicly Reported Confirmed Cases: Estimation and Application. Ann Intern Med. 2020 Mar 10 : M20-0504. Published online 2020 Mar 10. doi: 10.7326/M20-0504

NZDF	New Zealand Defence Force.
PCR	Polymerase chain reaction, a standard test used to identify SARS-CoV-2 infections by isolating and amplifying viral RNA. PCR relies on multiple cycles of amplification to produce a detectable amount of RNA.[7]
PHU	Public Health Unit.
PPE	Personal protective equipment. This includes masks, face shields, gloves, gowns and other coverings that people use to prevent the spread of infection to themselves and others.
Quarantine Facility	A higher-risk facility that hosts returnees that are confirmed or probable cases of COVID-19, or are a close contact of a confirmed or probable case of COVID-19.
Returnee	A person who has been checked into a MIQF, including those being transferred between MIQF/Health facilities, until having been checked out from a MIQF.
RQAAAG	(Managed Isolation and Quarantine) Risk, Quality and Assurance Advisor Group.
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2, the virus responsible for the 2019 outbreak of COVID-19 disease.
SOP	Standard operating procedure.
Viral shedding	In the context of the SARS-CoV-2 virus, the shedding (release) of viral particles into the environment. For SARS-CoV-2, shedding primarily occurs when talking, coughing, sneezing, or exhaling. SARS-CoV-2 can also be shed in a person's stool. Shedding is detected by SARS-CoV-2 viral PCR testing. Currently there's no simple way to determine whether a person is shedding infectious virus, or how much. PCR testing cannot distinguish between infective virus and inactive virus.

[7] Service RF. One number could help reveal how infectious a COVID-19 patient is. Should test results include it? Science Sep 29, 2020. Available at: https://www.sciencemag.org/news/2020/09/one-number-could-help-reveal-how-infectious-covid-19-patient-should-test-results

	Shedding can continue for several weeks after a person's symptoms have resolved — there's no standard time frame. Shedding of SARS-CoV-2 genetic material can persist for more than 80 days in the upper respiratory tract, and over 120 days in the stool. Research has identified shedding of infectious SARS-CoV-2 virus particles from up to eight days after symptom onset in hospitalised patients, to up to 70 days after diagnosis in an immuno-compromised person.[8]
WHO	World Health Organisation.

[8] Widders A, Broom A, Broom J. SARS-CoV-2: The viral shedding vs infectivity dilemma. Infect Dis Health. 2020 Aug; 25(3): 210-215. Published online 2020 May 20. doi: 10.1016/j.idh.2020.05.002

2. Executive Summary

Three COVID-19 transmission events occurred at the Pullman Hotel managed isolation facility (MIF) in Auckland in January 2021. These events occurred in the context of increasing global prevalence of SARS-CoV-2 strains with high transmissibility; increasing evidence that aerosols play an important role in SARS-CoV-2 transmission; a non-purpose built facility with confined, poorly ventilated shared spaces; and MIF practices resulting in relatively unrestricted funnelling of returnees through poorly ventilated shared indoor transit areas such as lifts and lift lobbies.

Taken together, these factors appear to have converged in a way that increased opportunities for viral exposure among uninfected returnees at the Pullman. These transmission events are largely reflective of the challenges of managing people returning to New Zealand in facilities which are not purpose built for managing transmissible infectious diseases and, in particular, respiratory viral infections capable of aerosol-mediated transmission.

Transmission in at least two cases we investigated was most likely through exposure to aerosols in a lift or in relation to a lift lobby; both shared spaces that were confined, congested and poorly ventilated. In one case, a returnee's room appears to have been the most likely location of aerosol transmission due to the particular orientation of the door of this room in relation to the lift lobby.

Interventions to prevent transmission of SARS-CoV-2 virus have to-date focused mainly on transmission via large respiratory droplets (ie droplets that fall to the ground within two metres of an infected person and do not remain suspended in the air); and contact, either directly with infected people or indirectly via contaminated surfaces (fomites). Guidance, standard operating procedures, and public health information have, therefore, not been geared toward addressing aerosol-mediated transmission as a potentially significant transmission pathway. This mode of transmission requires particular attention in crowded, congested, and poorly ventilated spaces. Guidance on physical distancing, hand hygiene and mask-use continue to be crucially important. However, further guidance is also needed to minimise the time spent by returnees in shared, enclosed indoor spaces where ventilation is inadequate. In the MIF environment, engineering controls are also needed to manage aerosol transmission risk. These include (where appropriate) changes to corridor and room ventilation arrangements and use of air cleaning through deployment of portable HEPA filtration units.

Multiple areas for improvement to reduce the risk of future transmission events have already been identified and implemented in response to the Pullman transmission incidents. The review panel has made additional recommendations to improve the safety and effective functioning of the MIQF system.

3. Case Incident Review Team and Contributors

The Case Incident Review team was established on 15 February 2021 and included the following members:

NAME	ROLE, ORGANISATION & EXPERTISE	ROLE IN REVIEW TEAM
Dr Penny Andrew	Clinical Lead for Quality and Executive Director of the Institute for Innovation and Improvement, Waitematā District Health Board. Specialist knowledge and skill in incident investigations, and reviews; quality assurance; risk management; and quality improvement.	Incident Review Lead.
Dr Joshua Freeman	Clinical Microbiologist, Clinical Director Infection, Prevention and Control, Canterbury District Health Board. Specialist knowledge and skills in microbiology and infection, prevention and control.	Incident Review Team Member.

The following individuals contributed to the review:

NAME	ROLE, ORGANISATION & EXPERTISE	CONTRIBUTING ROLE
Dr Anna Stevenson	Public Health Physician and Medical Officer of Health, Canterbury District Health Board. Specialist knowledge and skill in public health and epidemiology.	Peer review of the draft report.
Professor Mark Jermy	Department of Mechanical Engineering, University of Canterbury. Specialist knowledge and skill in computational mechanics,	Mathematical modelling.

	biomedical simulation and mathematical modelling. Research areas include fluid mechanics of breathing and blood flow and droplet and particulate transport.	
Mike Yates	Engineer Specialist knowledge and skill in engineering and ventilation systems.	Assessment of the ventilation system at the Pullman Hotel.
Dr Felicity Williamson	Public Health Medicine Specialist. Specialist skill and knowledge in public health and epidemiology.	Provision of data and epidemiology advice.
Interviewees	(see Appendix C)	

Acknowledgements

The review team would like to acknowledge and thank Professor Mark Jermy and his team at the University of Canterbury who led a novel collaboration using modelling to add depth to the source investigation.

The review team would like to thank the individuals who contributed to this review and the time they gave to collecting evidence, providing and analysing data, and who generously gave their time to meet with the team.

4. Case Incident Review Process

In February 2021, the Ministry of Health (MoH) and Ministry of Business Innovation and Employment (MBIE) commissioned an independent incident review of the COVID-19 infections that occurred at the Pullman Auckland Managed Isolation Facility (the Pullman) in January 2021. Three separate incidents of infections with COVID-19 variants among returnees staying at the Pullman in January 2021 have been identified and are included in this review. The terms of reference for this review are included in **Appendix A**.

The purpose of the review is to:

- Determine the extent, impact, management and contributory causes of the cases of COVID-19 in the Pullman in New Zealand in January 2021.
- Extract what can be learnt from these infections.
- Provide updated advice and guidance for dissemination to Managed Isolation and Quarantine Facilities (MIQFs) in relation to expected standards, learnings, knowledge, policies, procedures and processes to reduce the risk of further infections.
- Enable the MIQFs to manage similar situations now and into the future.

The review commenced on 15 February 2021. The review process involved:

- Collation and assessment of documents relevant to the review. A list of documents provided to the review team by the MoH and MBIE is set out in **Appendix B.**
- Meeting with people working at the Pullman in January 2021 and working in the MIQF system (**Appendix C**).
- Collection and analysis of further information including:
    - CCTV footage and key card data
    - Hotel floor plans
    - Ventilation system specifications.
- Analysis of data concerning rates of positive cases in returnees from high-risk countries in Auckland's MIFs (**Appendix D**).
- Computational modelling by Professor Mark Jermy (**Appendix E**).

5. Case description

In January 2021, three separate clusters of SARS-CoV-2 variants occurred among returnees at the Pullman, one of eighteen Managed Isolation Facilities (MIFs) in Auckland.

The emergence of SARS-CoV-2 variants is concerning because preliminary data suggest these variants are associated with a higher viral load and possibly a longer period of infectivity[9], which may suggest potential for increased transmissibility. As a result, more intensive public health measures may be required to control transmission.[10]

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[9] Volz E, Mishra S, Chand M et al. Transmission of SARS-CoV-2 Lineage B.1.1.7 in England: Insights from linking epidemiological and genetic data. Preprint at medRxiv https://doi.org/10.1101/2020.12.30.20249034 (2021); and Lewis D. The Superspreading Problem. Uneven transmission of the SARS-CoV-2 coronavirus has had tragic consequences – but also offers clues for how best to target control measures. Nature 2021 (25 February); 590:544-546

[10] On 14 December 2020, authorities of the United Kingdom reported to WHO a variant referred to as SARS-CoV-2 VOC 202012/01 (Variant of Concern, year 2020, month 12, variant 01) lineage B.1.1.7. And On 18 December, national authorities in South Africa announced the detection of a new variant of SARS-CoV-2, named 501Y.V2 (lineage B.1.351) Preliminary data suggest these variants are associated with a higher viral load, which may suggest potential for increased transmissibility; however, this, as well as other factors that influence transmissibility, are subject of further investigation.. Initial assessment suggests these variants do not cause changes in clinical presentation or severity; however if they result in a higher case incidence, this would lead to an increase in COVID-19 hospitalisations and deaths. More intensive public health measures may be required to control transmission of these variants. See: Emergencies preparedness, Responsiveness. SARS-CoV-2 Variants. World Health Organisation Disease Outbreak News 31 December 2020. Available at: https://www.who.int/csr/don/31-december-2020-sars-cov2-variants/en/

Cluster One: South African Variant Cluster

On Saturday 23 January 2021, the MoH was notified of a new positive COVID-19 case of a person living in the Northern Region community (Case A) after being tested at a Community Testing Facility the day before (22 January). Case A had recently been released from the Pullman (on 13 January 2021). While at the Pullman, Case A, returned negative test results for COVID-19 on 2 January and 10 January.

On 25 January 2021, two cases (Cases B and C) who are related to each other and were in a whānau bubble in the Pullman were tested having been identified as being Pullman MIF returnees requiring follow up testing due to Case A. Following initial positive test results, Cases B and C were re-tested on 27 January and second positive results were returned.

Case A arrived at the Pullman on 30 December 2020; they tested negative on day three (2 January 2021) and day 12 (10 January 2021). Cases B and C arrived at the Pullman on 01 January 2021; they tested negative on day three (04 January) and day two (12 January).

Case A's room was on the same floor as the source case, across and down the hallway. Cases B and C's room was on a different floor.

Genomic sequencing confirmed that all three cases had the variant first identified in South Africa (lineage B.1.351), with the source being a returnee who entered the facility on 09 January 2021. The source case was identified as a close contact of an earlier confirmed case during an inbound flight and was isolated on 11 January; a positive COVID-19 test was confirmed on 12 January (day three), and the source case was transferred to the Jet Park Hotel, the Managed Quarantine Facility in Auckland, on 13 January 2021.

Case A became symptomatic in the community (muscle aches in the lower back and legs, malaise, anorexia, headaches and sore eyes), on 15 January, two days after departure from the Pullman. Case A tested positive for COVID-19 on 22 January.

Case B became symptomatic in the community on 15 January (day of departure from the Pullman) and tested positive for COVID-19 on 26 January with a Ct value of 30.4[11]. A second test on 27 January was positive with a Ct value of 34.4.

Case C tested positive on 26 January with a Ct value of 29.7. A repeat test on 27 January was positive with a Ct value of 34.6. Case C had a vaccination on 18 January and experienced symptoms which are unable to be determined if related to COVID-19 illness or adverse reaction to the vaccine.

Re-testing of returnees and staff did not identify any further cases with the South African variant, and no further transmission in the community from this cluster has been detected.

Cluster Two: UK Variant Cluster

[11] Service RF (at footnote 7): In a real time PCR assay, a positive reaction is detected by accumulation of a fluorescent signal. The Ct (cycle threshold) is defined as the number of cycles required for the fluorescent signal to cross the threshold (ie exceeds background level). Ct levels are inversely proportional to the amount of target nucleic acid in the sample

Two cases (Cases D and E) tested positive for a genomically linked UK variant on day 11 of their stay at the Pullman, with both cases being transferred to the Jet Park Hotel following positive test results. The two cases were not travelling in a bubble together. Case D arrived at the Pullman on 13 January; their day three test was negative; they tested positive on day 11 (24 January). Case E arrived on 16 January; their day three test was negative; they tested positive on day 11 (26 January). Case D, who was the first to develop symptoms, was temporally and genomically linked to two COVID-19 cases in Australia.

Cases D and E were staying on the same floor of the Pullman.

Cluster Three: UK Variant Cluster

Three cases (Cases F, G and H) tested positive on day 9 (Case F), 11 (Case G) and 13 (Case H), of their stay at the Pullman and all were genomically linked to a single UK variant (not the same as the variant in cluster two). These cases arrived at the Pullman on 9 January 2021 from the same flight. The cases were travelling separately and were seated at least 10 rows apart on the flight. They did not share common bus transport to the facility. The three returnees were processed at the Pullman's reception on arrival at least 30 minutes apart; and all three returnees occupied different floors of the Pullman.

The two UK variant clusters (clusters two and three) are considered separate transmission events as they had mutational differences showing that they were not directly linked.

6. Investigations

Following notification of cluster one, the Auckland Regional Public Health Service (ARPHS) initiated a Source Investigation that included all three clusters, and recommended a multi-disciplinary management plan. The findings from ARPHS's investigation and management plan are detailed in its report: *Pullman Managed Isolation Facility (MIF) COVID Transmission Investigation and Management Plan. Version 6: 03.022021*.

Further investigation was undertaken utilising a combination of CCTV footage from within lifts; two cameras covering the ground floor lift lobby and reception area; key card data registering entry into a room (but not exit); and mathematical modelling. It should be noted that for cases within a bubble it is also possible to be let back into the room by someone else in the bubble without the use of a key card. Thus, for Case B in particular, additional trips outside the room cannot be excluded.

At least three separate incidents of cross transmission between guests at the Pullman between 09 January and 24 January 2021 have been identified: two cases of transmission of the South African (cluster one), and one of the UK variant (cluster 2).

There is a fourth case from UK variant cluster 3 (Case H) that is *suspicious* for transmission within the Pullman because the case became positive on day 13 with a negative test on day 11. An incubation time of 13 days, while documented, is unusual and is thought to occur in less than 2.5% of cases[12] [13].

The summary discussion below draws on the ARPHS Source Investigation and additional information gathered from further review of CCTV footage, key card data and modelling of aerosol contamination. The intention of the discussion is not to draw definitive conclusions but rather to characterise and explore the most plausible explanations for transmission events while acknowledging uncertainty.

Despite the uncertainties, it is notable that all possible transmission events relate in some way to the movement of guests through shared indoor areas, and in particular the funnelling of guests through lifts and lift lobbies. It is also notable that there was no evidence of breaches of social distancing contributing to any transmission event.

Rather, transmission events appear to have been through exposure to indoor spaces contaminated with suspended infectious aerosols or possibly (for Case B in particular), contaminated surfaces.

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[12] Lauer SA et al (at footnote 6): The Incubation Period of Coronavirus Disease 2019 (COVID-19) From Publicly Reported Confirmed Cases: Estimation and Application. Ann Intern Med. 2020 Mar 10: M20-0504. Published online 2020 Mar 10. doi: 10.7326/M20-0504 The authors undertook pooled analysis of confirmed COVID-19 cases reported between 4 January 2020 and 24 February 2020. There were 181 confirmed cases with identifiable exposure and symptom onset windows to estimate the incubation period of COVID-19. The median incubation period was estimated to be 5.1 days (95% CI, 4.5 to 5.8 days), and 97.5% of those who develop symptoms will do so within 11.5 days (CI, 8.2 to 15.6 days) of infection. These estimates imply that, under conservative assumptions, 101 out of every 10,000 cases (99th percentile, 482) will develop symptoms after 14 days of active monitoring or quarantine.

[13] Li Q et al (at footnote 5): The authors analysed data on the first 425 confirmed cases in Wuhan, China to determine the epidemiologic characteristics of novel coronavirus (2019-nCoV)–infected pneumonia (NCIP). The mean incubation period was 5.2 days (95% confidence interval [CI], 4.1 to 7.0), with the 95th percentile of the distribution at 12.5 days. The basic reproductive number, (R0), was estimated to be 2.2 (95% CI, 1.4 to 3.9), meaning that on average each patient has been spreading infection to 22 other people.

Pullman transmission Case A: Cluster 1 South African variant

According to key card and CCTV footage, there was only one occasion when Case A was out of their room at the same time as the source case. This occurred on 10 January 2021 when case A entered the lobby for one minute before returning to their room in another lift. During this entire time the source case was in the recreation area. The source case had come down to the recreation area 28 minutes earlier in the same lift that case A used to return to their room. However, during the 28-minute interval, that particular lift was used by 35 people to make 27 trips.

The door of Case A's room opened into the level three lift lobby with the door oriented roughly three metres slightly diagonally from one of the lifts (see floor plan, **Appendix E**). The leading hypothesis of how transmission occurred is that Case A was exposed to aerosols exhaled by the source case while the source case waited in the lobby immediately outside Case A's room.

Between 09 and 13 January, the source case visited the level three lift lobby on a total of 14 occasions while case A was in their room. Seven of the 14 occasions were to take the lift down and it was common to have to wait several minutes for a free lift. Case A's exposure to any infectious aerosols in the lobby would have been facilitated by any opening of their room door, even briefly without stepping outside; for example, when leaving out dinner or lunch waste for pick up, or opening the door to check whether the lifts were busy. This risk would have been higher if a mask wasn't worn at the time the door was briefly opened.

Unfortunately the lack of comprehensive CCTV footage means we have been unable to determine whether case A did indeed open their door at the same time or soon after the source case was present in the lobby. Case A did recount instances where they briefly opened their door, only to close it again upon seeing other guests immediately outside their room waiting for a lift. Visits by the source case to the lobby also coincided with the times when dinner waste would have typically been placed immediately outside the door of Case A's room for collection.

Pullman transmission Case B: Cluster 1 South African variant

Key card data and CCTV footage indicate there were seven occasions where case B left their room while either the source case or Case A were at the Pullman and potentially infectious. Six of these trips were to pick up Uber Eats from the ground floor lobby and one was to attend swabbing on floor 14. At no time was Case B out of their room at the same time as the source case, and there was only one occasion when case B was out of their room at the same time as case A. On this occasion, case A was in the recreation area during the entire two-minute period that case B entered the ground floor foyer to pick up an Uber Eats order and returned to the lift. This occurred 18 minutes after case A had come down to the ground floor in a different lift. Notably, during all trips in the lifts, case B always wore what appeared to be an N-95 mask with a valve and consistently used what appeared to be disposable cloths to press the lift buttons.

From the available data, the leading hypothesis around transmission relates to an occasion on 13 January (the day case A departed the facility), when case B used the same lift 90 minutes after case A (the same lift was used both to come down from Case B's room floor and to head back up again).

During this 90-minute interval, the lift was used by 37 other people. Case B's lift trip on 13 January was to pick up an Uber Eats order and during this trip it was noted that there was no hand sanitisation after disposing of the cloth used to press the button of the lift on the way down. It is also possible that there were additional trips made by case B where the key card was not used because they were let back into their room by someone else in the three-person whānau bubble.

The leading hypothesis for how transmission occurred in Case C is from Case B subsequent to departure from the MIF as Case C only left the room on one occasion for swabbing when either case A or the source case were present in the facility; while Case B left the room daily to pick up Uber Eats deliveries.

Pullman transmission Case E: Cluster 2 UK variant

The leading hypothesis for how transmission occurred in cluster 2 relates to an occasion on 17 January when Case E used a lift three minutes after the same lift was vacated by Case D; the source case. No-one else used the lift during these three minutes. Both the source case (Case D) and Case E were wearing standard issue medical masks during their trip. While fomite transmission cannot be completely excluded as case E pressed the same lift button as Case D without subsequently sanitising their hands, aerosol-mediated transmission is considered the likely mode of transmission here. This conclusion is based on both the current literature (see below) and modelling of air contamination using Pullman specific data (see **Appendix E**).

***Possible* Pullman transmission Case H: Cluster 3 UK variant**

Case H arrived on the same flight as the two others in the cluster (Cases F and G), but of the three cases in this cluster, Case H is arguably the most suspicious for transmission within the Pullman itself because they became positive on day 13 with a negative test on day 11. The other two cases (Cases F and G) had negative day 3 tests and positive day 11 tests. An incubation time of 13 days, while described, is unusual and is thought to occur in less than 2.5% of cases.[14] One possibility is that transmission occurred on 18 January 2021 when case H used a particular lift 11 minutes after one of the other cases (the lift was used 14 times by others in that 11-minute interval). Another possibility is that transmission occurred on 15 January when case H passed through the ground floor lift lobby to catch a lift back to their room six minutes after one of the other cases passed through the lobby to pick up Uber Eats; different lifts were used. Transmission on the flight or at the airport is also possible and cannot be fully excluded. Because case H was in a bubble with others, it is also possible that there were additional trips outside the room where the key card was not used because they were let back into their room by someone else in their bubble.

Additional investigations

[14] See footnotes 5 and 6.

A number of additional investigations have been commissioned by the MoH and MBIE, with the advice of a Technical Advisory Group. These include:

- An audit of infection, prevention and control (IPC) at the Pullman, dated 26 January 2021.
- Environmental surface sampling at the Pullman by ESR (the Institute of Environmental Science and Research, Te Whare Manaaki Tangata, Taiao hoki).15
- On-site and plans assessments of the ventilation system at the Pullman including fresh air delivery to rooms, en-suite exhaust rates and corridors' fresh air supply; and the ventilation system in the lifts.
- Analysis of data to determine whether the Pullman had relatively higher volumes of returnees from high risk countries and a higher number of positive cases.

Findings from these investigations are referred to in the discussion below.

7. Findings

A) WHERE DID THE TRANSMISSION LIKELY TAKE PLACE?

It is not possible to conclude with absolute certainty where and how transmission occurred in any of the transmission events within the three clusters. At best, an assessment of the most likely place and mode of transmission can be made, based on the current scientific literature evaluating the relative importance of different modes of SARS-CoV-2 transmission; and the epidemiological evidence collected from the local investigation.

Understanding the possible modes of transmission is important in order to identify high-risk environments and activities that disproportionately contribute to transmission risk and to ensure effective preventative measures are appropriately prioritised and targeted.

[15] The specific aim of the environmental survey was to undertake sampling of surfaces in rooms, lifts, common shared areas, or ventilation systems and test for the presence of SARS-CoV-2 RNA using RT-qPCR. Environmental sampling was completed following the principles documented in the World Health Organization (WHO) recommendations for environmental surface sampling of SARS-CoV-2 RNA. No SARS-CoV-2 RNA was detected in the samples.

B) THE LITERATURE

There are a number of key findings from the scientific literature on transmission of SARS-CoV-2 virus that we believe are relevant to this review.

- SARS-CoV-2 is a respiratory virus. Respiratory viruses are transmitted in three main ways, through:
  i. contact transmission, where someone comes into direct contact with an infected person or touches a surface that has been contaminated (fomites).
  ii. droplet transmission via large respiratory droplets that contain the virus. Droplet transmission requires close proximity to an infectious person because droplet particles by definition follow a ballistic trajectory and fall within 1-2 metres rather than remaining suspended in the air.
  iii. airborne transmission of smaller droplets known as aerosols that are suspended in the air over longer distances and time than droplet transmission. [16]

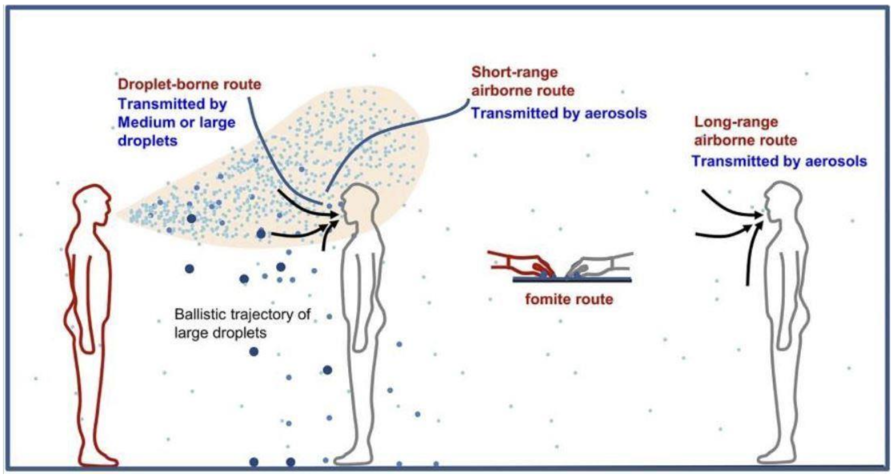

Diagram 1: from Wei 2016 [17]

During the initial stages of the pandemic there was concern about indirect transmission via virus contamination of surfaces (fomites), and while there is significant indirect evidence for fomite transmission (see diagram 2 below),[18] there is an emerging consensus that fomite transmission is unlikely to be a major mode of transmission for SARS-CoV-2. This conclusion is

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[16] The Lancet Respiratory Medicine. COVID-19 transmission—up in the air. Lancet Respir Med. 2020 Dec; 8(12):1159. doi: 10.1016/S2213-2600(20)30514-2; and Asadi S, Bouvier N, Wexler AS, Ristenpart WD. The coronavirus pandemic and aerosols: Does COVID-19 transmit via expiratory particles? Aerosol Sci Technol. 2020 Apr 3; 0(0):1-4. Available at: https://doi.org/10.1080/02786826.2020.1749229

[17] Wei J, Li Y. Airborne spread of infectious agents in the indoor environment. Am J Infect Control. 2016 Sep 2;44(9 Suppl):S102-8. doi: 10.1016/j.ajic.2016.06.003. PMID: 27590694

[18] Jimenez JL. COVID-19 Data Dives: Why Arguments Against SARS-CoV-2 Aerosol Transmission Don't Hold Water – Medscape – Jul 30, 2020. Available at: https://www.medscape.com/viewarticle/934837?src=uc_mscpedt&faf=1#vp_1

based on a growing body of research, research commentary, and an absence of credible case reports of fomite transmission despite widespread transmission internationally.[19]

- Infection control guidelines have stated that most respiratory virus transmission occurs from large droplets produced by coughing, sneezing, and breathing in close proximity to another person. This understanding has led to physical distancing being the cornerstone of public health advice.[20]

- Initially it was thought that aerosol mediated transmission of SARS-CoV-2 was unlikely, but growing evidence from interdisciplinary research groups has highlighted that a large proportion of infective microdroplets are small enough to remain suspended in the air over time and expose individuals at distances beyond two metres from an infected person.[21] We now have a significant body of evidence demonstrating airborne spread from asymptomatic and pre-symptomatic infected cases to others in the same 'room' (for example, restaurant, bus, office) but who were not in direct or indirect contact with the case.[22] In July 2020, over 200 scientists published a statement calling for international bodies to recognise the potential for aerosol-mediated transmission of COVID-19 as they were concerned that people would not be fully protected by adhering to the current recommendations.[23] The evidence base for aerosol-mediated transmission has only grown since then.

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[19] The Lancet Respiratory Medicine (at footnote 16); Lewis D. COVID-19 rarely spreads through surfaces. So why are we still cleaning? Nature. 2021 (February);590(7844):26-28. doi: 10.1038/d41586-021-00251-4; and Jarvis MC. Aerosol Transmission of SARS-CoV-2: Physical Principles and Implications. Front. Public Health, 23 November 2020. https://doi.org/10.3389/fpubh.2020.590041

[20] The Lancet Respiratory Medicine (at footnote 16);

[21] For example: Bourouiba L. Turbulent Gas Clouds and Respiratory Pathogen Emissions: Potential Implications for Reducing Transmission of COVID-19. JAMA. 2020;323(18):1837–1838. doi:10.1001/jama.2020.4756; and Chen W, Zhang N, Wei J, Yen H, Li Y. Short-range airborne route dominates exposure of respiratory infection during close contact Building and Environment. 2020; 176:106859-.

[22] Morgenstern J (at footnote 1); and Tufekci Z. We Need to Talk About Ventilation. How is it that six months into a respiratory pandemic, we are still doing so little to mitigate airborne transmission? The Atlantic. July 31, 2020. Available at: https://www.theatlantic.com/health/archive/2020/07/why-arent-we-talking-more-about-airborne-transmission/614737/

[23] Morawska L, Milton DK, It Is Time to Address Airborne Transmission of Coronavirus Disease 2019 (COVID-19). Clinical Infectious Diseases. Volume 71, Issue 9, 1 November 2020, Pages 2311–2313,https://doi.org/10.1093/cid/ciaa939

	Droplets	Fomites	Aerosols
Outdoors << Indoors	X	✓	✓✓
Similar viruses demonstrated	X	✓	✓
Animal models	?	✓	✓
Superspreading events	X	X	✓✓
Supersp. Patterns similar to known aerosol diseases	n/a	n/a	✓
Importance of close proximity	✓	X	✓✓
Consistency of close prox. & room-level	X	X	✓
Physical plausibility (talking)	X	✓	✓
Physical plausibility (cough, sneeze)	✓	✓	✓
Impact of reduced ventilation	X	X	✓
SARS-CoV-2 infectivity demonstrated in real world	X	X	✓
SARS-CoV-2 infectivity demonstrated in lab	X	✓	✓
"Droplet" PPE works reasonably well	✓	✓	✓
Transmission by a/pre-symptomatics (no cough)	X	✓	✓
Infection through eyes	✓	✓	✓
Transmission risk models	✓	✓	✓

Key:
✓: evidence
✓✓: very strong ev.
X: no evidence
X: evidence against
n/a: not applicable
(v1.45, 13-Sep-2020)

Only including the items that could bear on multiple pathways. See other slides for details and references

Table: preliminary summary of the evidence supporting each of the three routes of transmission. Aerosols has the most supporting evidence. Fomites has significant supporting evidence. Ballistic droplets have very little supporting evidence.

Diagram 2: from Jimenez 2020[24]

- The quantitative importance of aerosol-mediated transmission relative to transmission by other routes is still under debate and likely varies between environments, but the precautionary principle demands that measures to mitigate against this mode of transmission should be urgently and vigorously adopted.[25]

- Emerging data also suggests that risk of transmission depends on several factors, including contact pattern, host-related infectivity/susceptibility to infection, and the environment. The role of ventilation of indoor spaces is increasingly recognised as an important environmental consideration.[26]

- Contact patterns, including the duration of contact, contact frequency, proximity to index case and types of activities influence transmission risk, highlighting the need for tailored prevention strategies for different settings.

- Host factors include the viral load which peaks early in the disease course, with the highest viral loads observed from symptom onset to day five indicating a high level of infectiousness during this period. Supporting these findings, transmission events are estimated to mostly occur in a short window, likely a few days prior to and following symptom onset. Of note some

[24] See footnote 18
[25] Jarvis MC (at footnote 19); and Lewis, D. Mounting evidence suggests coronavirus is airborne – but health advice has not caught up. Nature 2020 (08 July); 583. Available at: https://www.nature.com/articles/d41586-020-02058-1
[26] Cevik M, Marcus JL, Buckee C, and Smith TC. SARS-CoV-2 Transmission Dynamics Should Inform Policy. Clinical Infectious Diseases, 23 September 2020. https://doi.org/10.1093/cid/ciaa1442; and Jarvis MC (at footnote 19);

early evidence suggests that those infected with the UK variant may have a longer period of infectivity.[27]

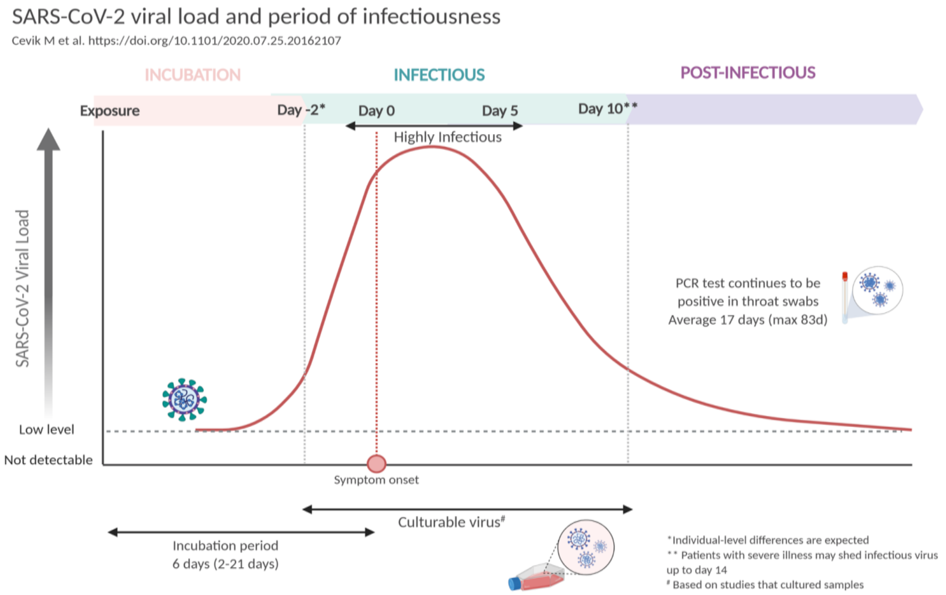

Diagram 3: from Cevik et al[28]

- Environmental factors play a bigger role than initially suspected. We now know that SARS-CoV-2 is much more efficiently spread in enclosed and crowded environments with poor ventilation. Prolonged contact in an enclosed setting can lead to increased risk of transmission, especially when combined with environmental factors such as poor ventilation and crowding.[29]

- Given the recognised modes of transmission, SARS-CoV-2 will spread more easily in crowded places, close-contact settings (especially where people have close range conversations), and confined and enclosed spaces with poor ventilation. The risk is higher in settings where these factors overlap.

- To date, interventions to prevent infection with SARS-CoV-2 have focused mainly on transmission via droplets and contact (including contact via surfaces) because the importance of aerosol mediated transmission is only just beginning to be widely accepted. Mitigation measures and public health guidance for the droplet and contact modes of transmission are physical distancing, regular hand washing, wearing of masks, surface decontamination/disinfection, and isolation of cases. Guidance, standard operating procedures, and public health information have thus not yet focused specifically on mitigating

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[27] Jarvis MC (at footnote 19); and Lewis D (at footnote 25)
[28] Cevik M et al (at footnote 26)
[29] Lewis, D. The super spreading prob. Uneven transmission of the SARS-CoV-2 coronavirus has had tragic consequences — but also offers clues for how best to target control measures. Nature 2021 (February); 590(25): 544-546; Jarvis MC (at footnote 19); and Morgenstern J (at footnote 1)

the risk of aerosol-mediated transmission outside of particular procedures carried out in healthcare settings.[30]

- Therefore the risk of aerosol-mediated transmission in crowded, congested, poorly ventilated spaces needs to be addressed with interventions that go beyond existing guidance on physical distancing, hand hygiene and mask use.[31]

- Accumulation of infectious aerosols in indoor spaces where ventilation is inadequate means that exposure time is a key factor, so minimising time in enclosed and poorly ventilated shared spaces is a key mitigating strategy. Social distancing and appropriate use of masks will help to reduce aerosol transmission as well as large droplet transmission, but additional precautions specific to aerosols are also needed.[32]

- Additional aerosol-specific precautions, mainly centred around engineering controls are also required, including (where feasible) improvements in ventilation arrangements and air cleaning using portable HEPA filtration units.[33]

- Self-isolation for MIQF guests with symptoms is crucial. Peaking of viral load early in the disease course indicates that preventing onward transmission requires immediate self-isolation upon symptom onset, prompt testing and robust contact tracing. While pre-symptomatic transmission makes a significant contribution to transmission in most settings, a substantial proportion of transmission is caused by those with symptoms, especially in the first few days after symptom onset. Messages should prioritise isolation practice, and policies should include supported isolation and quarantine.[34]

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[30] Jarvis MC (at footnote 19); Anderson EL, Turnham P, Griffin JR, Clarke CC. Consideration of the aerosol transmission for COVID-19 and public health. Risk Anal. (2020) 40:902–7. doi: 10.1111/risa.13500
[31] Jarvis MC (at footnote 189); and Morgenstern J (at footnote 1)
[32] Cevik M et al (at footnote 26); Jarvis MC (at footnote 19)
[33] Jarvis MC (at footnote 19); Jayaweera M, Perera H, Gunawardana B, Manatunge J. Transmission of COVID-19 virus by droplets and aerosols: a critical review on the unresolved dichotomy. Environ Res. (2020) 188:109819. doi:10.1016/j.envres.2020.109819; Nazarenko Y. Air filtration and severe acute respiratory syndrome coronavirus 2. Epidem Health. (2020) 42:e2020049.doi: 10.4178/epih.e2020049; andChristopherson DA, Yao WC, Lu M, Vijayakumar R, Sedaghat AR. High efficiency particulate air filters in the era of COVID-19: function and efficacy. Otolaryngology. (2020). doi: 10.1177/0194599820941838. [Epub ahead of print]; https://www.nytimes.com/interactive/2021/02/26/science/reopen-schools-safety-ventilation.html
[34] Cevik M et al (at footnote 26)

C) EVIDENCE COLLECTED FROM THE INVESTIGATIONS - FACTORS THAT MAY HAVE CONTRIBUTED TO THE COVID-19 TRANSMISSION

1. ENVIRONMENT

I. PHYSICAL SPACE

The Pullman building is a 14 level high rise with capacity for approximately 350 returnees. The building has five lifts: three lifts are available for use by the returnees and healthcare staff, and two are used as service lifts (for example for food and linen). The three lifts were in high demand as the returnees and staff were dependent on them to move around the facility and movement was frequent (see below).

The lifts and the lobbies leading to the lifts are relatively small, confined spaces. The lift lobbies and lifts were 'pinch points' that returnees were funnelled into and returnees frequently had to queue to wait for an empty lift. To illustrate the congestion in the lifts, one of the cases interviewed recounted on one occasion waiting through eight occupied lifts stopping on the second floor before a vacant lift arrived that they were able to use. The lift lobbies on the ground floor (also known as the first floor) and 14th floor were particular areas of congestion. On the ground floor is reception, the exercise and smoking areas, and the deliveries pick up area (eg Uber Eats, supermarket and coffee). On the 14th floor, returnees' testing (swabbing) on days 0/1, 3, and 12 was carried out.

Of note, the cross-transmission event constituting cluster two appears to have occurred through the use of a lift three minutes after it was vacated by the source case (despite medical masks being worn by both the source and secondary case). Modelling data specifically based on the Pullman lifts suggests aerosol contamination and non-negligible infection risk can persist (it takes approximately 30 minutes for the risk to drop by 50%) after a lift has been used by an infectious case, even when both the source case and the exposed person are masked (see **Appendix E**).

II. VENTILATION

The Pullman ventilation system is over 40 years old and would not meet current Building Code standards. Issues of concern included:

- the ventilation of the lifts was poor due in part to the grilles in the floor and ceiling being covered over and obstructed.
- the corridors and lift lobbies were ventilated by a fresh air system that was operating for only two hours per day.
- bedrooms were dependent on open windows for fresh air delivery and the air flow rates from the bedroom en-suite exhaust systems were variable and generally lower than specified in the plans.

The Infection Prevention and Control Standard Operating Procedures (IPC SOP) v1.4, current at the time of the incidents, refers to adequate ventilation indoors as one of the measures critical to prevent transmission of SARS-CoV-2: *'The use of masks is part of a comprehensive package of infection prevention and control measures. A mask alone, even when it is used correctly, is insufficient to provide adequate protection or source control. Hand hygiene, physical distancing, avoidance of touching one's face, respiratory etiquette, adequate ventilation in indoor settings, testing, contact tracing, quarantine, isolation and other IPC measures are critical to prevent human to human transmission of SARS-CoV-2 whether or not masks are used.'* [Section 4. Personal Protective Equipment (PPE), p11]

III. ROOMS OPENING ONTO THE LIFT LOBBY

On some of the floors there is a room that is situated directly opposite the lifts. Entrance and exit to the room is via a door that opens directly into the lift lobby (a confined, poorly ventilated, high use space). The door of these particular rooms is also directly in the path of the air intake for the corridor which at the time of the transmission events was operational for two hours a day (see floor plan, **Appendix E**).

Case A in cluster one occupied one of these rooms, and the source case occupied a room on the same floor. CCTV and key card data indicate the source case visited the lobby to either exit or enter a lift on a total of 14 occasions while the secondary case was present in the adjoining room. Seven of these occasions was to go down which may have required a wait of several minutes before arrival of a vacant lift (of note the secondary case recounted an occasion when the lift doors on this floor opened with occupants inside a total of eight times before a vacant lift arrived). Four visits by the source case were while the corridor ventilation was operational and presumably generating a strong current of air channelled directly across the lobby toward the room of the secondary case. If during any of these four visits the source case happened to stand in the path of the airflow (for example looking out the window at the end of the lobby), this would likely have increased the risk of infectious aerosols making their way into Case A's room. These visits were also around the time guests would typically open their door to leave out their dinner waste for collection.

Although no CCTV footage is available to confirm whether Case A opened their door while or soon after the source case was in the lobby, it remains a possible scenario that could have increased exposure risk. Preliminary air circulation modelling based on two key assumptions suggests an infection risk of approximately 15% over a 2-hour period for an unmasked occupant in the room. The key assumptions are 1) that the source case is masked and in the lobby for one minute and 2) all aerosols pass into Case A's room (see **Appendix D**). However, more sophisticated computational fluid dynamics (CFD) modelling is underway to help evaluate risk in different scenarios, for example, with the door briefly opened and when the door is closed the entire time.

In terms of alternative hypotheses about when and how transmission might have occurred, examination of key card and CCTV data reveal only one instance where both the source case and the secondary case were outside their room at the same time. The secondary case used the same lift as the source case to return to the 3rd floor but 28 minutes after the source case used it to come down to the ground floor (the lift had made 27 trips during the 28 minute interval). The secondary case went to the ground floor but was turned back as the exercise area was full.

They returned directly to their room. The source case was in the exercise area during the entire time and returned to their room 15 minutes after the secondary case.

IV. PHYSICAL DISTANCING

People described physical distancing (two metres or more as per the Operations Framework and IPC SOP) being generally well maintained. There were physical spacing markers (two metres apart) on the floors leading to the lifts and there was a guard posted on the ground floor checking to ensure spacing was maintained as returnees entered and exited the lifts. Guards were also posted in the exercise and smoking areas to ensure physical distancing.

There were incidents of returnees not maintaining physical distancing. People reported that one of the most common bubble breaches was returnees sharing a lift with another person(s) outside of their bubble and this was observed to happen two to three times per week. This was ascribed to returnees' frustration at having to wait for access to an empty lift.

Three high-use, shared spaces where the required two metre physical spacing could not occur were identified: the lift lobbies, the corridors leading to the returnees' rooms (1.7m wide), and a narrow passageway on the 14th floor between the lift lobby and testing room (approximately 1.3m wide). People described the crossover of returnees in these areas was short, except in the lift lobbies and corridors leading to the lobbies where queuing occurred.

On the 14th floor, staff mitigated the risk of congestion, by calling returnees to come for swabbing and managing calls based on the numbers arriving and/or waiting.

V. CCTV CAMERAS

During ARPHS's investigation it was noted that, at the time of all three clusters, there were no CCTV cameras or guards present on floors other than the ground. Therefore, the corridors and lift lobbies were 'invisible' and it is possible that there was mingling and breaches of physical distancing by returnees for longer periods in these spaces. Staff told the review team that the lack of CCTV cameras on the floors worried them and they had requested cameras be installed, however this didn't happen. The lack of CCTV cameras on the floors did not meet the standards set out in the MIQF Operations Framework v3.3 which states: 'The facility must have security cameras installed with a view of all room doors to monitor returnee movement from their room'.

VI. CLEANING

People reported that a high standard of cleaning was maintained following IPC protocols and this was supported by the findings of the IPC audits conducted in December 2020 and on 26 January 2021. There was regular cleaning of lifts throughout the day. And there were specific cleaning procedures for the management of symptomatic returnees using the lifts, and for returnees who test positive and are transferred to Jet Park.

2. EQUIPMENT

The provision of equipment, including PPE, cleaning products and swabs was managed well. The correct equipment was available and in working order. Returnees were provided with a pack of 14 medical masks and additional masks were readily available. Hand sanitiser was placed around the facility and guards posted outside the lifts on the ground floor to observe hand hygiene, mask-use and physical distancing. Returnees were actively prompted to correct any breach.

Training of staff in IPC guidelines and PPE use was reported to be good for some groups (for example the Health Team, who have good knowledge of PPE requirements) but problematic for some non-health staff, in particular for groups with relatively high turnover (for example NZDF staff on three-week rotations, and contractors).

High turnover of staff makes training challenging as it needs to be provided to every new member and people reported limited resources to provide this training (see below). These issues were noted by the IPC CNS auditor in January 2021. The auditor noted that knowledge of and compliance with PPE requirements on the day of the audit were patchy, with some staff on their first day of work needing to wear N95 masks for tasks and none had been fit tested. The IPC CNS auditor had to demonstrate and support fit-checking. Staff recommended greater longevity of roles to reduce high turnover and pressure on continuous training.

3. PEOPLE

I. MOVEMENT OF RETURNEES

There was a lot of movement of returnees in the facility at the time of these incidents (January 2021), identified by investigations (for example key card use, CCTV records) and described by people in the facility. The Operations Framework, which sets out expected practice, states 'To reduce the likelihood of chains of transmission between returnees, returnees should not move freely throughout the MIQF. The preference is for returnees to stay in their rooms as much as possible, except for when they are undertaking supervised activities' (section 6.3, Minimising returnee movement throughout the facility).

People described the movement of returnees in the facility as 'constant'. The lifts were in high demand (for example, in one 28min CCTV sequence from one lift, 35 returnees entered and exited the lift 27 times). There was queuing on the floors waiting for lifts and on the ground floor where reception and access to the exercise and smoking areas are located, and where returnees came to collect deliveries. Queuing was also reported to occur on other levels with long waits for a vacant lift on occasions. Some delivery companies would advise returnees of a delivery and the returnee would make their way to the ground floor rather than wait for a call from reception to manage traffic. At peak times up to 25-30 people could be in the ground floor reception area.

Access to the exercise and smoking areas was on a 'first come, first served' basis; there was no booking system and returnees could exercise and smoke multiple times per day. This is despite the Operating Framework specifying 'MIQFs are expected to have a booking system for use of the outdoor exercise area' (section 10.10, Exercise).

The exercise area was open for an average of 12 hours per day (7am -7pm), although could be closed for periods during arrivals or testing to allow for sufficient lift access. The smoking area was open 24 hours a day. Returnees would take a lift to the ground floor, walk to the area, sign in and check if a space was available (capped at 20 in the exercise area, and 6-8 in the smoking area). If the areas were full, they would either queue or be told by the guard posted in each area to come back later, in which case guests would return to their room via the lift.

II. IPC PROTOCOLS

People reported that, in most cases, returnees are conscientious and follow the precautions. This is supported by the findings of the audit in January 2021: 'IPC principles were observed to be applied throughout the facility by all MIF workforce, there was good evidence of PPE utilisation and IPC risks were mitigated as much as possible within the constraints of a hotel environment'.

While the vast majority of returnees are conscientious, at any one time there are a small number of returnees who do not want to be in the facility and repeatedly breach the rules. Breaches of standard precautions (hand hygiene, physical distancing and use of masks) were recorded in the facility's incident reporting system. The most common breaches reported to the review panel were bubble breaches in the lifts, failure to follow hand hygiene in the lifts (seen in cluster two) and preference for using a personal mask.

For example, one of the cases wore their own-supplied N95 mask with a valve; these masks are not recommended for source control as they are largely ineffective at reducing the shedding of aerosols into the environment by the wearer (wearing a mask to protect others is known as "source control").[35]

When breaches occurred, returnees were reminded by staff and the breach corrected. Incidents are reviewed by the Operations Manager and Site Security Manager and escalated to ARIQCC as required (the Operations Framework provides a graduated approach to responding bubble breaches).

A Ministry of Health audit programme was in place to ensure that staff and returnees are adhering to Ministry IPC guidance. The IPC audit is based on the current IPC Standard Operating Procedures (IPC SOP) and includes hand hygiene, PPE use, cleaning, and environmental audits.

An IPC audit in January (26 January 2021) noted 'Infection prevention and control practices appear to be sound and applied appropriately, with good evidence of PPE utilisation and attention to a high standard of cleaning. IPC risks are mitigated as much as possible within the constraints of a hotel environment. Processes such as departures and positive case transfer were observed and seen to be effective and compliant with IPC SOPs'.

4. POLICIES AND PROCEDURES

[35] The Infection Prevention and Control Standard Operating Procedures v1.4 provides that returnees should only wear the supplied medical face mask during their time in a MIQF [section 5, p22]:

The MIQF Operations Framework v3.3 and a 'suite' of national SOPs 'set out the minimum health and wellbeing requirements that MIQFs must meet.' These policies and procedures were updated by the MBIE and MoH and were available to staff and returnees (for example information in the Welcome Pack).

Standards were not consistently applied. In some cases, this is because the design of the building does not allow application (for example returnees were not 'always able to maintain at least 2m from each other'). In other cases, Operations framework and IPC SOP standards were inconsistent with each other and appropriate application was not clear. An example is the standards for the management of symptomatic returnees. The Operations Framework states a symptomatic and close contact (eg bubble member) should be isolated in their room but must be offered opportunities for exercise and/or smoking [Sections 10.3.1 and 10.3.3]. While the IPC SOP states symptomatic returnees must remain in their rooms until test results are known, and close contacts may leave their room for approved, escorted exercise [Section 5.1]. This led to symptomatic returnees being swabbed at their room door and then, while awaiting the test result, they were allowed out of their rooms under escort of staff to exercise and/or smoke, which could happen several times per day.

Staff pointed out the inconsistency that a lower standard is applied to symptomatic returnees than is applied to staff who are symptomatic – they must self-isolate until their test result is known; and to returnees undergoing day 0/1 testing – returnees are required to remain in their rooms until the test result is known.

People also noted that the definitions and language used in the Operations Framework and SOPs is not always consistent and this creates confusion and inconsistencies in the way the standards are applied.

Other concerns have already been noted such as:

- the movement of returnees was not minimised
- there was no CCTV in the corridors monitoring returnee movement on the floors
- there was no exercise booking system to help to control returnee movement; and
- ventilation was inadequate.

These issues did not appear to be identified by the audit programme.

5. ORGANISATION AND MIQ SYSTEM

I. CULTURE

People consistently reported that there was excellent teamwork and communication among staff and with the returnees; the staff were committed to providing a safe environment and were very supportive of each other.

Similar findings were reported in the January 2021 IPC audit with evidence of strong leadership and communication across the MIF teams and good teamwork between the MIF Manager, Site Security Manager, Hotel Manager and Charge Nurse Manager; and a Site Security Manager was actively involved in supporting IPC practices.

The Health Team were particularly commended for their hard work and the support they gave to other non-health staff, providing education, training and advice to staff even when it was not their responsibility.[36]

II. STAFFING

People (both within and outside the Health Team) consistently commented that the Health Team was under-resourced, with insufficient staffing levels to undertake all the tasks expected of them. On some days there were a large number of tests required and testing could take the Health Team up six hours to complete, depending on the number of nurses available. The team reported that on busy days this compromised their ability to complete all the other tasks expected of them including the health and wellbeing checks (for new arrivals), the daily health checks, swabbing of symptomatic returnees etc.

As an example, the IPC audit report of January 2021 notes that on the day of arrival of one of the source cases in January, two Health Team staff were off sick; one agency and one DHB Health Care Assistant provided cover with a workload including 25 day 0/1 swabs, 87 new arrival assessments, and providing advice to over 300 returnees present in the hotel as required. The report notes that support is needed to achieve planned health staffing levels and an effective IPC training programme.

As noted above, people consistently commented, too, on the high turnover of some staff groups such as NZDF. This creates challenges for training that often needs to be provided on the day of arrival, as well as challenges for good teamwork.

III. INFORMATION

Staff and returnees reported having ready access to information and updates. One of the cases described the information provided about IPC precautions and expected practice as clear and comprehensive. Information was provided pre-arrival with a bus briefing, there was a 'Welcome Pack' that provided helpful information, and staff were available to give advice (for example, guards outside the ground floor lifts and in the exercise and smoking areas would consistently correct returnees if they were not following expected practice). Whiteboards in the lift areas on each floor were used to provide daily updates to returnees.

In two cases (cluster one), there was an interval of five to -seven days between onset of the returnees' symptoms and the returnee undergoing testing. In both cases the returnees were unsure about whether they needed to be tested as the information they were given at the time of exit from the Pullman was to 'get tested immediately if they developed any symptoms of COVID-19'.

[36] The Operations Framework v3.3 provides that the MoH is responsible for setting health and wellbeing requirements for staff training and induction; DHBs are responsible for training of all health staff in IPC and other health and wellbeing requirements; and MBIE is responsible for training of all non-health staff [Section 4, Staffing, p28]

In one case, the returnee experienced symptoms (muscle aches, headaches, and tiredness), that are not COVID-19 symptoms listed in the information provided to them; in the other case the returnee had hay-fever like symptoms that they have experienced previously. One of the returnees recommended clearer guidance encouraging returnees to get tested immediately if they have any symptoms for a period after exit.[37]

IV. CLINICAL GOVERNANCE

Many people commented that clinical governance at all levels: within the Pullman and other MIQFs, regionally across Auckland, and nationally, needs to improve. This includes IPC clinical governance at all levels, and multidisciplinary governance particularly at the Auckland Regional level.

The Operations Framework v3.3 states that 'The MIQF should have an IPC clinical governance framework in place including an IPC specialist that oversees IPC requirements at each MIQF' [Section 3.2 IPC plan]; however, this is not in place.

There are three IPC nurses that provide IPC expertise (support, education and training) to the 18 Auckland MIQFs, the port and the airport. In Rotorua there is one IPC nurse covering three MIQFs. In Christchurch there are six IPC nurses covering six MIQFs. The three Auckland MIQF IPC nurses do not have an IPC specialist that oversees IPC requirements at each MIQF and provides them with expert advice and support. When the current IPC support structure was established, senior IPC medical consultants filled this role for a month. People consistently commented that this specialist support is needed.

At the regional level, people noted that there is no clear, connected multidisciplinary clinical governance group/network that includes IPC, public health, occupational health and leadership from the agencies involved in staffing the MIQFs; there is a lack of clarity and transparency about roles and responsibilities and who to go to/connect with to address issues and make improvements.

V. LEARNING SYSTEM

Several people commented that the audit system was a 'tick box' exercise and that it had failed to pick up important issues and there is no evidence of any learning from the audits: identifying common themes in a facility and across the MIQFs; identifying and sharing best practice; identifying what to focus on and what auditing can be stopped. People noted that there is a process for reporting incidents but a lack of transparency about what is being done with the information and questioned whether we are learning from this information, and quickly making improvements: *"We have suggested a lot of things, for example bubble breaches, but we don't get a sense it's led to improvements, whether these recommendations have embedded we don't know. This goes to the heart of clinical governance. We are not connected."*

[37] In April 2020 the CDC expanded its official list of possible symptoms of COVID-19 adding six new symptoms. Its current list of possible symptoms is: fever or chills, cough, shortness of breath or difficulty breathing, fatigue, muscle or body aches, headache, new loss of taste or smell, sore throat, congestion or runny nose, nausea or vomiting, diarrhoea. See: https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html

8. Summary of Key Findings

- The staff working in the Pullman were committed to providing a safe environment and protecting the welfare of the returnees. Teamwork and communication among staff were excellent and returnees felt well informed and supported. The staff should be commended for their hard work and commitment.

- For two instances of transmission (one each from clusters one and two), the most likely explanation is aerosol-mediated transmission associated with the use of a lift and lift lobby. For one other transmission event from cluster one, aerosol-mediated transmission is also deemed possible although where and when this might have occurred remains uncertain. Aerosol-mediated transmission is increasingly recognised as a significant mode of SARS-CoV-2 transmission, particularly in confined and poorly ventilated indoor settings. The precautionary principle demands that measures to prevent this mode of transmission should be vigorously applied.

- For the secondary case in cluster two, transmission most likely occurred in a lift; and for one of the cases in cluster one, the leading hypothesis is that transmission occurred in the returnee's room which opened directly into the lift lobby and directly into the flow of intake air for the corridor. For cluster three, when and where transmission occurred is less certain and may have occurred in one of three settings (a shared flight, at the airport, or at the Pullman). However for one of the cases who tested positive on day 13, there is a higher suspicion for transmission in the Pullman. For this case, potential opportunities for exposure were identified including use of a lift 11 minutes after a potential source case.

- The available evidence from CCTV footage and key card data suggests there was minimal opportunity for direct contact occurring between any of the cases in the Pullman. However, an undocumented breach event cannot be 100% excluded given there was not full visibility of returnee movement (no CCTV in the corridors on each floor). Likewise, transmission by surface contact cannot be fully excluded, but in light of current evidence this mode of transmission is deemed less likely.

- In the context of aerosols being the most likely mechanism of transmission, the most significant factors contributing to transmission risk in the Pullman are the environment: the building design, with confined, poorly ventilated shared spaces (in particular the lifts and lift lobbies); and the people: infections with highly infectious variants, the high level of movement of returnees in the facility, and congestion at 'pinch points' where returnees were funnelled into confined, poorly ventilated spaces.

- The ventilation system was not designed for use in an isolation facility and a number of issues were identified which potentially increases the risk of aerosol transmission, including minimal ventilation in the lifts even on movement, limited fresh air ventilation in the corridors (two hours per day), and lower en-suite exhaust flows in the rooms than specified by the building code.

- The location and orientation of rooms occupied by returnees that open directly into the lift lobby render occupants vulnerable to aerosol transmission, particularly when doors are opened, even briefly (for example placing dinner waste outside the door for collection).

- Movement and congestion of returnees increases the risk of aerosol transmission, by increasing potential exposure time, aerosolised viral load and opportunities to breach physical distancing.

- Allowing symptomatic returnees to leave their room while awaiting a test result increases the risk of aerosol-mediated transmission by increasing congestion (a lift was held for the returnee while they smoked or exercised), potentially increasing aerosolised viral load and opportunities for exposure, particularly in confined and poorly ventilated shared spaces.

- Policies, standard operating procedures, and the audit programme are focused on preventing droplet and contact transmission rather than aerosols as a potentially significant mode of transmission.

- For aerosol-mediated transmission, limiting opportunities for exposure is the key strategy to decrease the risk of transmission. Therefore, limiting time in enclosed, shared spaces, social distancing and masking of guests for both source control and personal protection are all important risk mitigation measures.[38] Immediate isolation for those with symptom onset as well as prompt testing and results is crucial. In addition, engineering controls are needed to reduce aerosol transmission risk including improvements to ventilation arrangements, and air cleaning that can be done using appropriately located portable HEPA filtration units.

- The transmission events and their likely causes that have been identified raise issues that likely also apply to other MIQFs, particularly high rise facilities dependent on lifts for movement to exercise and smoking areas.

- Other factors have been identified that, while not directly contributing to these incidents, are important for the safe and effective operation of the MIQF system and need to be addressed.

These include:

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[38] The Operations Framework states that N95/P2 particulate respirators may be indicated in closed spaces with poor ventilation: *[*(section 3.3.2.3, p16]. Morgenstern J (at footnote 1) notes that It still isn't clear exactly when N95s are needed and although it is true that N95s filter more aerosols than surgical masks, it is a misconception that surgical masks are useless against aerosols. A well-fitting surgical mask will filter the majority of the larger (>1 micron) aerosols that are thought to be transmitting COVID-19. (Jimenez JL 2020 at footnote 18) When combined with good ventilation and the relatively low infectivity of SARS-CoV-2, an 80% effective surgical mask may be enough for most situations and is certainly better than no mask. The review team considers N95/P2 particulate respirators are not required in the lifts and lift lobbies with the mitigations that have been identified in place. However this remains another potential risk mitigation tool to be explored if necessary.

- Sufficient resourcing and support for the Health Team, particularly with mitigation measures being taken that will increase the team's workload, for example (where appropriate) swabbing returnees at their room doors.

- Sufficient IPC resourcing and IPC specialist support, in particular for the three IPC nurses that cover the 18 MIQFs across the Auckland region.

- The need for an effective clinical governance framework that is connected locally (within each MIQF), regionally, and nationally, and includes multidisciplinary input from IPC, public health and occupational health.

- The need for a focus on developing a 'learning system', with more IPC and other relevant clinical expertise involved in the design of audit tools; analysis of incidents and audits to identify best practice, what should be the focus of future audits; and rapid, continuous improvement incorporated into the audit programme.

9. Recommendations

A number of measures have been already been taken to address the risks identified in this review.

Immediate measures were taken to manage the incidents:

- Closing of the Pullman to incoming returnees, isolation of returnees in the Pullman prior to their exit, and emptying of the Pullman (completed on 06 February 2021).
- The IPC nurse remained on site and weekly IPC audits were undertaken.
- Increasing the frequency of staff testing (twice weekly).
- Testing of community contacts.
- Self-isolation and testing of returnees on day five following exit.
- Daily contact of returnees exiting the Pullman to check their health and wellbeing.

The Pullman was re-opened on 16 February 2021 with further measures in place:

- Reopening at reduced capacity (50%) and returnees occupying lower levels to reduce demand on the lifts.
- Cohorting of returnees, with returnees from two flights. This has enabled separation of the flights on different floors and separation of movement, for example exercise in mornings or afternoons according to the flight.
- Installation CCTV cameras in corridors and lift lobbies, and upgrade of exiting cameras.
- Changes to the ventilation system and practices, including:
  - running the fresh air system to the corridors 24hrs per day.
  - placement of air purifiers in the lifts and corridors.
  - changes in practices in opening and closing windows to increase fresh air dilution and prevent movement of air from confined spaces, with updated information for returnees.

- Continuing day 0/1 testing and isolation in rooms until results are available, and isolation in rooms after day 12 testing until the returnee exits.
- Introduction of a booking system for exercise and returnees.
- Deliveries brought and left at returnees doors.
- Testing of returnees at the room door.
- Increased PPE for all Health Team staff.
- Closing of rooms opening into the lift lobbies.
- A review of the ventilation systems in all MIQF facilities (currently underway).

The review panel has made the following additional recommendations

No.	Recommendation	Priority	Timeframe	Responsible
1	Review the Operations Framework, Standard Operating Procedures and audit programme to highlight the risks of aerosol-mediated transmission and the measures that are needed to reduce the risk of this mode of transmission	High	Within 1 month	MoH MBIE
2	Review the management and procedures for symptomatic returnees: symptomatic returnees should remain in their rooms until results are available and medical authorisation has been given to end isolation	High	Within 1 month	MoH
3	Review the information provided to returnees on exit from the MIFs regarding symptoms that should prompt a returnee to get tested, and encourage the returnee to seek testing if the returnee has any doubt.	High	Within 1 month	MoH
4	Review the resourcing of the Health Team, their workload, and their responsibilities	Medium	Within 3 months	NRHCC Ministry of Health
5	Review the resourcing of the IPC team across the Northern Region, including IPC nurses, nurse educators, and specialist IPC support for each facility and the region	Medium	Within 3 months	NRHCC Ministry of Health
6	Identify groups of non-health staff with high turnover rates and identify ways to reduce turnover and requirements for constant training	Medium	Within 3 months	MBIE
7	Develop a multidisciplinary clinical governance framework and network with local (MIQF), regional and national clinical and IPC governance that is connected and has clear responsibilities	Medium	Within 3 months	NRHCC MBIE
8	Develop a 'learning system' using information from incidents and audits, and adapt the audit programme to incorporate continuous quality improvement	Medium	Within 3 months	MBIE

10. Case Incident Review Feedback

For future case incident reviews the review team recommends:

- A thorough source investigation is taken by a public health team. This will require the relevant public health team to be adequately resourced to enable this to happen.

- The public health team undertaking a source investigation and a case incident review team require timely and direct access to all relevant information. This includes:
  - better records of systems and movements such as movements between floors, movements in and out of returnees' rooms, meal delivery and other deliveries to rooms, visiting a floor. All records should be digitalised including lift access.
  - accurate recording of timing. Timing recorded across different systems, eg CCTV and key cards needs to be synchronised so there are no disparities in timing between systems.
  - an agreed set of data/information to be provided as a start for an investigation/review. This should include key card use, lift use, CCTV records, breaches, communal/shared space use, interactions between returnees and staff, interactions between staff, airport information, transport information, ventilation information, cleaning information; records of relevant meetings; and records from any other investigations/reviews. A process should be put in place to ensure this information can be provided promptly and a register is kept.
  - a list of people relevant to the investigation/review, including their role, their manager, the organisation they work for and contact details.

- An up-to-date 'register' is kept of all information considered relevant for a source investigation/case incident review that includes the date and source of the information and the date the information was provided to the investigators/review team.

- An up-to-date 'register' is kept of all mitigations/recommendations that are made and put in place as an investigation/review progresses. This should include the date and source of the mitigation/recommendation, the person(s) responsible for ensuring the mitigation/recommendation is put in place, and date the mitigation/recommendation is completed (in place).

- Adequate resourcing of the review team including administrative support.

11. Appendix

APPENDIX A: TERM OF REFERENCE

11 February 2021

Terms of Reference for the Independent Incident Review of 3 guest COVID-19 infections at the Pullman Auckland Managed Isolation Facility: January 2021

Background

The Pullman Auckland is a 14 storey 272-room managed isolation facility with capacity for around 350 guests/ returnees. In January 2021, three guests tested positive for COVID-19 after completing their managed isolation at the Pullman (and all having tested negative on days 3 and 12) and it is assumed that all three contracted COVID-19 during their stay at the Pullman (Between 30 December and 15 January).

Incident Review purposes:

a) To determine the extent, impact, management and contributory causes of the cases of COVID-19 in the Pullman hotel Managed Isolation facilities in New Zealand between 9 and 24 January 2012
b) To extract what can be learnt from these infections
c) To provide updated advice and guidance for dissemination to Managed Isolation and Quarantine facilities in relation to expected standards, learnings, knowledge, policies, procedures and processes to reduce the risks of further infections
d) To enable the MIQFs to manage similar situations now and into the future.

Scope of the Incident Review

The review will focus at the actions and activities undertaken at the Pullman Auckland Hotel during January 2021.

Questions to be answered by the review team include

i. Can a root cause of the infections be identified?
ii. Was the clinical governance provided to the team at the Pullman appropriate?
iii. Were the staffing levels and capability appropriate given the range of tasks to be undertaken?

iv. Were the staff given appropriate training and advice in how to use PPE and apply IPC protocols
v. Did uncontrolled movements of returnees contribute to the spread of the virus?
vi. Are there ways to reduce the aerosol transmission in the hotel (ventilation, timing of guest movements, use of lifts and stairs)
vii. Are there issues identified with the operation of the Pullman that might pose a risk in other MIQFs

Methodology

The Incident review will follow the Draft Ministry of Health COVID-19 Case Incident Review Process and the Case Incident Report Template. The final report should report on

- The Environment
- Equipment
- People
- Policies and Procedures
- Organisation and the MIQ System.

The Reviewers will have full access to any information held by the Ministry of Health, MBIE and Auckland Regional Public Health Service, the Pullman hotel. In addition, the reviewers may use

- Te Tiriti o Waitangi as the framework to provide guidance, direction and recommendations on this review work program
- existing data/documents describing the facility and service type/s
- any information or reports from DHB Public Health Units relating to likely modes of transmission
- any highly relevant literature from other jurisdictions that address the purposes of this review
- An equity-based approach that ensures we capture any variations on how this has impacted the guests
- interviews with key stakeholders including clinicians and managers related to the incidents
- collation of opinions and insights from any relevant parties, including the three returnees who tested positive
- interviews may be done in person or by phone, teleconference or suitable virtual techniques. Site visits may be undertaken.

Review domains

a. staffing information, (numbers, qualifications, rosters)
b. residents / families/Whanau, education, communication, impact, awareness, etc
c. staff, resident and visitor IPC and COVID-19 educational opportunities (identifying infections, preventing the spread, documentation, training - influenza vaccination coverage of staff and guests)
d. IPC activities (IC precautions, COVID-19 preparedness, - increased emphasis on hand washing, respiratory etiquette, cleaning procedures, physical distancing, staff and contractors entering, leaving, work profiles (multiple facilities), internal activities / clustering, dedicated areas for suspected/confirmed cases

e. preventing the spread –procedures to prevent spread, procedures around moving positive cases into quarantine facility
f. availability / access to PPE, cleaning products, hand washing facilities and products
g. number of guests affected, equipment and supplies at the time of the outbreak and subsequently
h. summary of cases – pre-existing conditions, time in care, recognition of illness
i. notification interval for confirmed cases and responses
j. decision making at the time re staff allocation, clustering of cohorts etc

Independent Incident Review Team

Qualities and Experience:

- skills in conducting clinical or incident reviews and report writing
- skills in reviewing and evaluating policies and procedures
- an in-depth technical knowledge of Infection Prevention Control practices
- time to dedicate to this work over the coming days and weeks.

Incident Review members will not have a perceived or actual conflict of interest.

The Ministry of Health and MBIE's technical advisors will be available to provide information and support to the Independent Incident Reviewers. MBIE's national quality and risk group and the Ministry of Health's Clinical and Operational Governance Group will provide governance and approval of the incident review report.

Timeframes

The Independent Incident Review will begin on 15 February 2021 and a draft report will be submitted to the Ministry of Health on 1 March 2021. The final report will be submitted to MBIE's National Risk, Quality and Assurance Advisory Group on 10 March

APPENDIX B: LIST OF DOCUMENTS INCLUDED IN THE PULLMAN MIQ COVID-19 CASE INCIDENT

1	Pullman Managed Isolation Facility (MIF) COVID Transmission Investigation and Management Plan Pullman Management Plan Version 6 03 February 2021
2	Infection Prevention and Control Standard Operating Procedures v1.4 Released 22 December 2020
3	MIQF Operations Framework v3.3 current at 22 December 2020
4	MIQ Welcome Pack English Version 5.4 December 2020
5	Optional Material – Poster Before You Open Your Door
6	National MIQ Ventilation Survey Appendix A1 - Pullman Hotel, Auckland 31 January 2021
7	Nat MIQ Investigation App A1 Pullman 31 January 2021
8	Out08-com-ACS-QA006 Service Technical Report 18 February 2021
9	Out08-com Results 18 February 2021
10	Pullman-Auckland 26 January 2021 audit draft v2 MIQF IPC Audit Tool (Pullman Hotel, Auckland) 26 February 2021
11	Pullman-Auckland Dec 2020 MIQF IPC Audit Tool (Pullman Hotel, Auckland) 11 December 2020
12	Pullman Corridor Dimensions
13	ESR Final Report. Environmental sampling and testing for SARS-CoV-2 RNA Pullman Hotel Managed Isolation Facility Auckland 04 February 2021
14	Memo On-site flow assessments at the Pullman MIF: recommendations and risk mitigations
15	Letter to Guests Negative Pressure v3
16	Optional Material – Poster Before You Open Your Door
17	Case Investigation Report: Ex-Pullman MIF returnees 31 January 2021
18	Interim Guidance: Environmental management at the Pullman Auckland to reduce the risk of airborne transmission of SARS-CoV-2
19	Potential Changes to Operational Settings – current, enhanced, and heightened. MIQ LT Workshop 13 January 2021 (updated 25 January)
20	Memo. Risk Mitigation recommendation in Managed Isolation and Quarantine Facilities 29 January 2020
21	Health Report. Risk Mitigations to Support the Safe Re-Opening of the Pullman Managed Isolation Facility 15 February 2021
22	Briefing. Options to strengthen transmission risk management in MIQFs 26 January 2021
23	Risk Mitigation recommendation in Managed Isolation and Quarantine Facilities 26 January 2020
24	MIQF IPC Audit Tool: (Pullman Hotel, Auckland) 11 December 2020
25	Technical Advisory Group – Pullman incident review 2 February 2021
26	COVID-19 Technical Advisory Group – Pullman case incident review Technical Advisory Group Meeting Minutes – DRAFT 2 February 2021
27	Copy of flights since 1 June 2020
28	Pullman Rydges High Risk Returnees
29	Health Report. Risk mitigations to support the safe re-opening of the Pullman Managed Isolation Facility 15 February 2021
30	Infection and Prevention Control. Standard Operating Procedures Version 1.4 Released 22 December 2020
31	Operations Framework. Managed isolation and quarantine facilities Version 3.3 – current at 22 December 2020
32	Minutes MIQ Risk and Assurance Advisory Group (RQAAG) Meeting 13 January 2021
33	Agenda Technical Advisory Group – Pullman incident review 4 February 2021
34	Copy of Question evidence tracker MBIE

35	Interim Guidance: Environmental management at the Pullman Auckland to reduce the risk of airborne transmission of SARS-CoV-2
36	Letter to guests Negative Pressure v3
37	Potential Changes to Operational Settings – current, enhanced, and heightened MIQ LT Workshop 13 January 2021 (Updated 25 January) [MIQ scenarios op settings 13 Jan 2021]
38	Memo Risk Mitigation recommendation in Managed Isolation and Quarantine Facilities 29 January 2020 [sic]
39	Agenda – MIQ Risk, Quality and Assurance Advisory Group 13 February 2021
40	Agenda - Agenda – MIQ Risk, Quality and Assurance Advisory Group 24 February 2021
41	MBIE Briefing. Options to strengthen transmission risk management in MIQFs
42	Technical Advisory Group Agenda 2 Feb 2021
43	Copy of evidence tracker MBIE
44	Potential Changes to Operational Settings – current, enhanced, and heightened. MIQ LT Workshop 13 January 2021 (updated 25 January)
45	Weekly Surveillance Report 12 February 2021 (WGS Epidemiology Summary Report)
46	Public Health advice for reopening Pullman Hotel Managed Isolation Facility 05 February
47	Memo. Case Investigation Report: Ex-Pullman MIF returnees 02 February 2021
48	Memo. Case Investigation Report: Ex-Pullman MIF returnees 03 February 2021
49	Public Health Risk/Mitigation Statement for in-MIF Covid-19 transmission (Pullman Auckland) 04 February 2020
50	Managed Isolation & Quarantine Facility (MIF) – Pullman Hotel, Auckland. Scope of Work for the Verification of Ventilation Air Flow Rates
51	COVID-19 Technical Advisory Group – Pullman case incident review. Technical Advisory Group Meeting Minutes – Draft. 29 January 2021
52	Pullman High Risk Returnees as of 2021-02-23
53	Technical Advisory Group Pullman Incident Review Agenda and Meeting Minutes Draft 02 February 2021

APPENDIX C: REVIEW TEAM MEETINGS

The review panel met with:

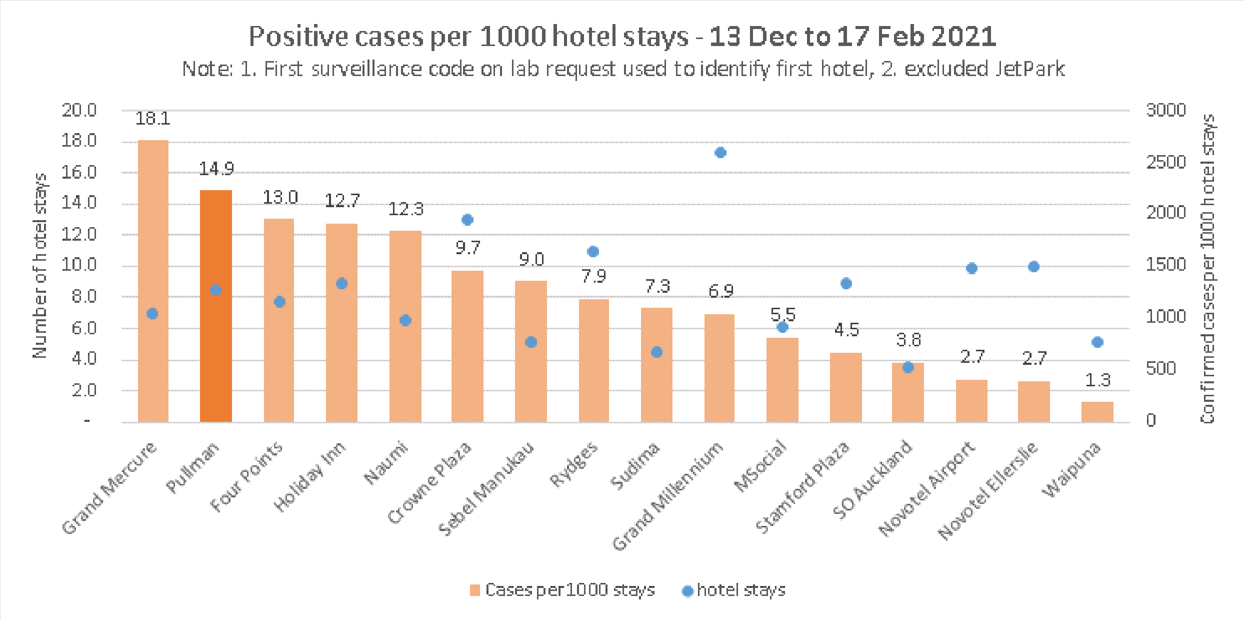
Name	Role and Organisation
Pauline Fuimaono Sanders	Clinical Nurse Director (CND), Northern Managed Facilities
Wendy Allsop	Charge Nurse Manager (CNM) at the Pullman, Northern Managed Facilities
Adam Gordon	ARIQCC Lead, NZDF
Ivan Green	ARIQCC Incident Controller, NZDF
Andrew August	Managed Isolation Facility (MIF) Managers at the Pullman in January 2021, NZDF
Paul Cockerson	Managed Isolation Facility (MIF) Managers at the Pullman in January 2021, NZDF
Shayne Gray	General Manager Quality and Assurance, MBIE
Lisa McLernon	Manager Service Operations and Compliance, MBIE
John Byrne	Advisor Supplier Relations, MBIE
A returnee	Case in one of the cohorts
Jennifer Lean	Wellness Coordinator at the Pullman
William Francis Dittmer	Wellness Coordinator at the Pullman
Dr Maria Poytner	Clinical Director, ARPHS
Dr Sally Roberts	Clinical head of microbiology, LabPlus, Auckland District Health Board; Clinical Lead, Infection, Prevention Control Programme, Health Quality and Safety Commission
Carol Jarvis	Infection Prevention Control Clinical Nurse Specialist, Northern Managed Facilities

APPENDIX D: ANALYSIS OF AUCKLAND MIF RETURNEE DATA

Did the Pullman have relatively higher volumes of returnees from high risk countries and a higher number of positive cases?

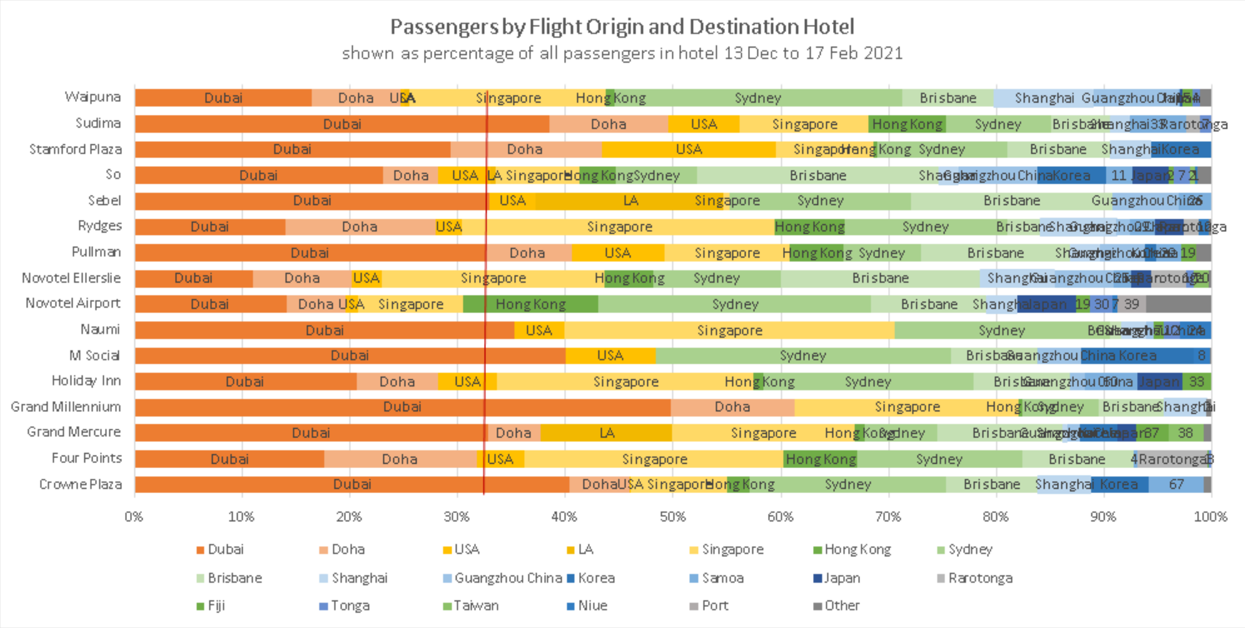
The Pullman did have relatively higher volumes of returnees from high risk countries and a higher number of positive cases; that is, it had relatively higher rates in both but not exceptionally high.

In the period in question, the Pullman had a high rate of positive cases (15 per 1000 hotel stays) but not the highest (Grand Mercure at 18 cases per 1000 hotel stays).



The Pullman also had a relatively higher proportion of guests from high risk areas; being in the top third of hotels.

The Grand Millennium had the highest rate of returnees via Dubai yet a relatively low positive case rate.



Passengers by Flight Origin and Destination Hotel
shown as percentage of all passengers in hotel 13 Dec to 17 Feb 2021
Waipuna
Sudima
Stamford Plaza
So
Sebel
Rydges
Pullman
Novotel Ellerslie
Novotel Airport
Naumi
M Social
Holiday Inn
Grand Millennium
Grand Mercure
Four Points
Crowne Plaza
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Dubai
Doha
USA
LA
Singapore
Hong Kong
Sydney
Brisbane
Shanghai
Guangzhou China
Korea
Samoa
Japan
Rarotonga
Fiji
Tonga
Taiwan
Niue
Port
Other

Modelling risk of airborne transmission of SARS-CoV-2 in elevators (based on the Pullman hotel, Auckland)

Prof. Mark Jermy mark.jermy@canterbury.ac.nz , Dr Jason Chen
Dept. Mechanical Engineering, University of Canterbury
10 March 2021

Elevators are a potential risk point for guest-to-guest and guest-to-staff transmission of SARS-CoV-2 in MIQF. Airborne particles, exhaled by a COVID-positive person can persist for some time in the confined, poorly-ventilated space of an elevator, and be breathed in by another person, who might enter the elevator some time after the infectious person has left.

This summary presents estimates of the risk by airborne (aerosol) transmission.

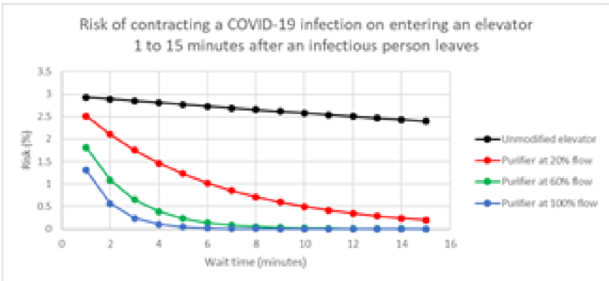
Surface (fomite) transmission was not considered. "Large droplet" transmission is not considered as it requires both persons to be present simultaneously.

Funded by MBIE COVID-19 Innovation Accelerator Fund contract CIAF-160 UOCX2004

UC UNIVERSITY OF CANTERBURY Te Whare Wānanga o Waitaha CHRISTCHURCH NEW ZEALAND

Modelling risk of airborne transmission of SARS-CoV-2 in elevators (based on the Pullman hotel, Auckland)

- Risk of airborne (aerosol) transmission of COVID-19 on entering an elevator was estimated with a simple modelling approach.



- Risk persists for some time after the infectious person leaves, due to the presence of airborne exhaled particles (aerosol).
- Risk reduces with time.
- Risk reduces much more rapidly with operation of an air purifier.

- The absolute percentage risk shown on the graph depends on the assumptions about viral load and mask effectiveness. The relative changes in risk with time and with purifier operation do not depend strongly on these assumptions.
- Further modelling is under way.

Modelling to explore the elevator lobby hypothesis for the Pullman Hotel cross-infection incident

Prof. Mark Jermy mark.jermy@canterbury.ac.nz
Dr Jason Chen
Dept. Mechanical Engineering
University of Canterbury

10 March 2021

Funded by MBIE COVID-19 Innovation Accelerator Fund contract CIAF-160 UOCX2004

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Contact history

The source case is accommodated in room 3018, and visited the lift lobby while Case A was in room 3013 a total of 14 times while infectious.

7 of these trips were to go down in the elevator, with a wait of a possible few minutes for a vacant elevator car.

4 of the visits to the lobby were while the 1000 L/s corridor ventilation intake was operational.
During one of these, it is possible that Case A opened the door of their room.

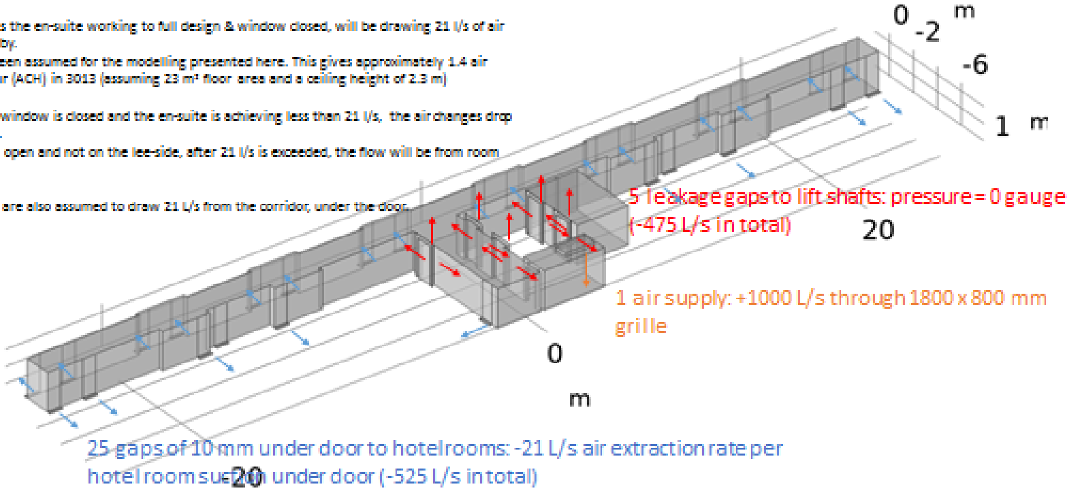
Corridor model

When the mechanical ventilation is active, 1000 L/s passes through the grille in the elevator lobby.

If room 3013 has the en-suite working to full design & window closed, will be drawing 21 l/s of air from the lift lobby.
This state has been assumed for the modelling presented here. This gives approximately 1.4 air changes per hour (ACH) in 3013 (assuming 23 m² floor area and a ceiling height of 2.3 m)

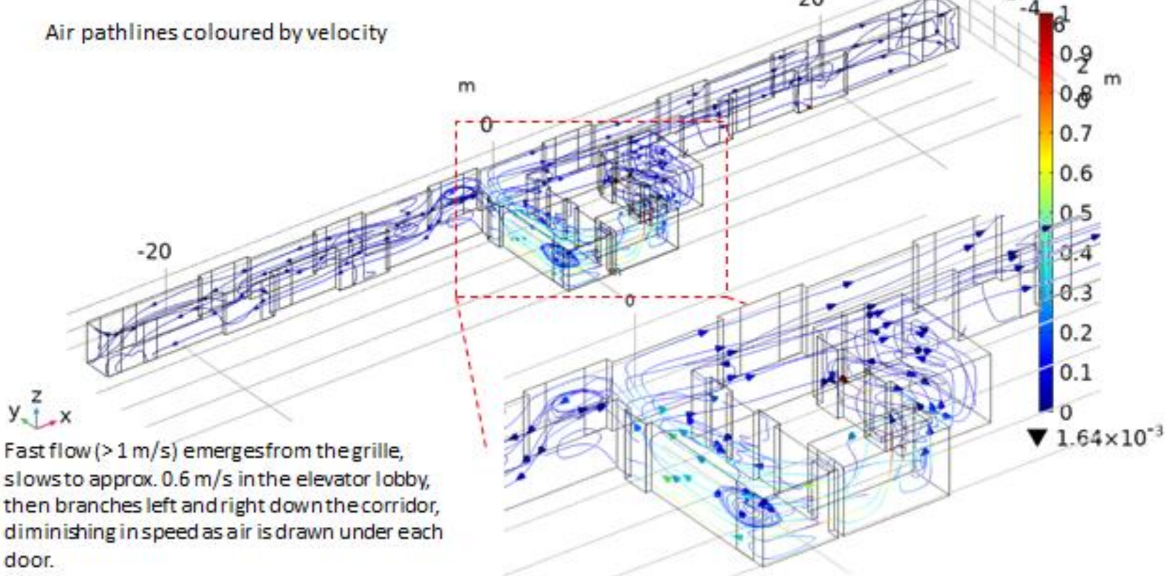
However, if the window is closed and the en-suite is achieving less than 21 l/s, the air changes drop proportionately.
If the window is open and not on the lee-side, after 21 l/s is exceeded, the flow will be from room to lift lobby.

All other rooms are also assumed to draw 21 L/s from the corridor, under the door.

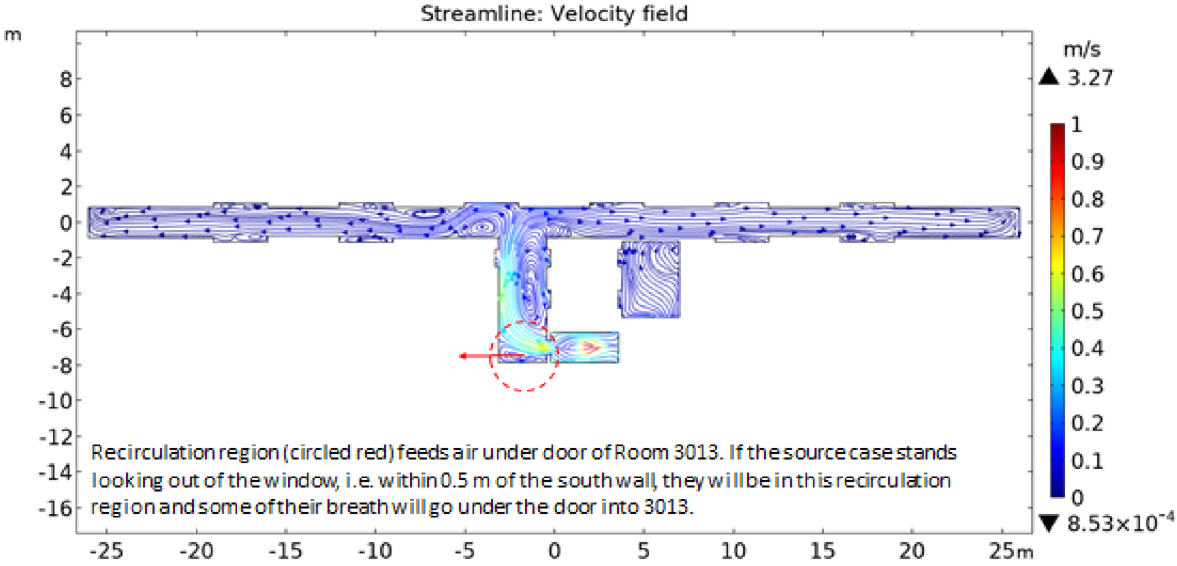


Assumed: No windows open, doors perfectly sealed except for the nominal 10mm under-door gap, walls, floors, and ceilings are impermeable. Air is uniform in temperature. Dimensions estimated from the plans available. Volume of the corridor is 264 m³, including the elevator lobby (219 m³ not including the lobby).

CFD modelling results



Fast flow (> 1 m/s) emerges from the grille, slows to approx. 0.6 m/s in the elevator lobby, then branches left and right down the corridor, diminishing in speed as air is drawn under each door.


Streamline: Velocity field
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0.5
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0.2
0.1
0
▼ 8.53×10^-4
Recirculation region (circled red) feeds air under door of Room 3013. If the source case stands looking out of the window, i.e. within 0.5 m of the south wall, they will be in this recirculation region and some of their breath will go under the door into 3013.

AIRC modelling: Room 3013 closed door

AIRC 2.1 model (assumes exhaled breath is instantly and uniformly mixed in any given room).
Further assumptions:

- Source case stands in the elevator lobby for 1 minute, exhaling particles at a rate typical of light exercise while speaking, wearing a mask that is 50% effective, exhaling particles at a median rate, with 10^{11} RNA copies per mL sputum.
- All of the source case's exhaled breath is carried under the door into room 3013 without loss of exhaled particles.
- Case A is in room 3013, unmasked, breathing at a rate typical of resting.
- Room 3013 has 23 m^2 floor area and a ceiling height of 2.3 m
- No virus in the room at the start of 1 minute.
- Risk is summed over 120 minutes (after which concentration of virus has decayed to negligible levels).

Risk over 2 hours exposure is 15% with 1.4 ACH in Room 3013 (21 L/s)
Risk over 2 hours exposure is 5% with 6 ACH in Room 3013 (if 3013 had a purifier)

The assumptions (1) that all the exhaled breath enters the room and (2) no particles deposit on the walls, are pessimistic.

Values may differ slightly from those previously reported by email due to changes in the assumed value of the room volume and ventilation flow rate.

Absolute risk percentages should be treated with caution, as they depend on uncertain assumptions about virulence.
Relative risk percentages are of value i.e. using a purifier reduces the risk in 3013 to one third.

AIRC modelling: generic room

Assumptions as room 3013 except:

- Modelling any other room on the corridor which receives 21 L/s from the corridor
- Assuming that the source case's exhaled breath is diluted by a factor of 21 L/s divided by 1000 L/s ventilation flow
- Assuming 1.4 ACH in the room

- Risk integrated over 120 mins, with source case spending 1 min in the corridor, is 0.4% (one fortieth that of the risk in room 3013)

AIRC modelling: Room 3013 open door

If Case A opened the door of their room while the source case was in the lobby, and the windows in 3013 were closed, risk would be the same as the closed door scenario, as it was assumed all particles enter the room.

If the windows were open, the risk might be reduced if the wind was in a direction that pressurized room 3013, and blew air back into the corridor.

AIRC modelling: generic room

Assumptions as room 3013 except:

- Modelling any other room on the corridor which receives 21 L/s from the corridor
- Assuming that the source case's exhaled breath is diluted by a factor of 21 L/s divided by 1000 L/s ventilation flow
- Assuming 1.4 ACH in the room

- Risk integrated over 120 mins, with source case spending 1 min in the corridor, is 0.4% (one fortieth that of the risk in room 3013)

Next steps

1) CFD model of particle motion as they pass under the door (10 mm under-door gap): determine what fraction of particles impact the door and what fraction are carried into the room. (in progress 2 Mar 21)

2) CFD model of corridor with improved resolution: including tracking particles exhaled from a person standing in the elevator lobby.

3) CFD model of corridor with air purifiers, as installed, including tracking particles.