

COVID-19 Scientific Advisory Group

Rapid Evidence Brief

Topic: Have clusters of COVID-19 over time been described in condos, apartments and/or hotels? What are the most commonly hypothesized mechanisms of transmission?

Context

- On May 29, 2020 a resident of the Verve Condominiums in Calgary, Alberta became positive with COVID-19. Shortly thereafter, further residents became infected and an outbreak was declared. As of July 6, 2020 there were 58 residents linked to the outbreak, with 55 confirmed positive with SARS-CoV-2 with a clustering of cases on the higher floors and along the same side of the building.
- Public Health officials, including the Calgary Zone Medical Officer of Health have conducted epidemiological investigations and environmental sampling, though have not identified a primary source of the outbreak. The predominant hypothesis is that COVID-19 was transmitted through droplet and contact with contaminated fomites in the elevators; however given the lack of epidemiological links or evidence of contact sources, other environmental sources including the role of HVAC and plumbing are being explored.
- This brief review has been written at the request of the Calgary Zone Medical Officer of Health to explore mechanisms of transmission of SARS-CoV-2, in similar facilities to inform ongoing investigations of the Verve Condominium outbreak. It should be read in parallel with the recent Scientific Advisory Group (SAG) Rapid Evidence Review on the [role of HVAC systems in the transmission of SARS-CoV-2](#).
- Consistent with recommendations from the previous SAG Rapid Evidence Review on the [role of HVAC systems in the transmission of SARS-CoV-2](#), a multi-disciplinary team is being developed to explore mechanisms of transmission in indoor spaces.

Key Messages from the Evidence Summary

- There is a paucity of evidence describing clusters or outbreaks of SARS-CoV-2 infection in condos, apartments and hotels. Available studies and media reports are summarized below.
- Epidemiological investigations of multi-residential building and hotel outbreaks in the primary literature and reports in the media suggest droplet and contact with contaminated fomites as the likely source of transmission. One media report explored the role of plumbing wastewater systems as a source of respiratory exposure to SARS-CoV-2.
- Based on preliminary investigations of the Hong Mei House in Hong Kong, as reported in the media, investigators suspect a bathroom pipe that appeared to be altered with self-refitting exhaust pipes. The report suggests this contributed to transmission of SAR-CoV-2 from one resident to another, 10 floors below the index patient. An epidemiological analysis coupled with environmental study of this cluster has not been reported in the peer-reviewed academic literature or otherwise. Therefore, although mechanistically possible to transmit viral particles via plumbing systems, uncertainty remains on the contribution to transmission in indoor spaces, particularly hotels and multi-residential buildings.
- Built environments serve as potential transmission vectors for the spread of COVID-19 by inducing close interactions with individuals, by containing fomites and through viral exchange and transfer through the air or other systems (Dietz et al., 2020). Based on this rapid brief, the past review on HVAC systems, and the fact that humans spend >90% of their daily lives inside the built environment, *“it is crucial to understand the potential transmission dynamics of COVID-19 within built environments, the human behavior spatial dynamics and building operational factors that may promote or mitigate the spread of COVID-19”* (Dietz et al., 2020).

Committee Discussion

Due to the short timeline required for this evidence brief, it did not undergo committee review.

Recommendations

1. We recommend that the CMOH continue to support the development of a provincial multi-disciplinary team consisting of plumbing and mechanical engineers, HVAC engineers, building engineers, medical and public health experts to be established to explore the role of the built environment, with attention to multi-residential settings including the Verve condominium outbreak, in the transmission of viral pathogens including SARS-CoV-2. In addition to supporting the specific analysis of the cause of transmission in the current Verve Condominium outbreak., this team should strive to use robust epidemiologic, engineering, environmental and aerodynamics/aerobiology study designs to identify associations between virus (detected by PCR or preferable culture) collected from air samples and the physical environment, with viable virus and ultimately with transmission.
Rationale: This recommendation aligns with that previously proposed in the SAG Rapid Review on the role of HVAC systems in the transmission of SARS-CoV-2 with the extension of including plumbing and building engineers. They will provide contextual expertise to understand the function and potential role of plumbing wastewater systems in the transmission of SARS-CoV-2.
2. We recommend that this local multidisciplinary team work in collaboration with a recently identified national working group through CADTH and PHAC to further investigate and review the developing national and international evidence regarding the role of the build environment, including HVAC and plumbing systems, in the transmission of COVID-19.

Practical Guidance

1. Facilities maintenance and engineering departments and staff of multi-residential buildings and hotels should consult the standards and practice guidance provided by plumbing and mechanical industry organizations such as American Society of Safety Engineers (ASSE) International and the International Association of Plumbing and Mechanical Officials (IAPMO). This is in addition to those standards and guidelines provided by American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), the Canadian Standards Association (CSA), the European Federation of Heating and Ventilation Engineers (RHEVA), and Chartered Institution of Building Services Engineers (CIBSE) on how to *operate* and use building services to minimize the spread of any potential pathogens through HVAC systems.
2. Practical recommendations to minimize transmission in multi-residential buildings and hotels include but are not limited to: 1) adequate and frequent cleaning of high-touch surfaces in the common areas; 2) frequent hand washing; 3) closing non-essential amenities (e.g. gyms, pools, saunas, steam rooms, outdoor playgrounds, recreation rooms) during an outbreak; 4) minimizing number of people in elevators to ensure adequate physical distancing; 5) ensure HVAC systems are functioning properly; and 6) continue to encourage physical distancing or the use of masks when physical distancing is difficult to maintain (Eykelbosh, 2020)
3. Practical recommendations to minimize potential transmission risk through wastewater plumbing systems include but are not limited to: 1) investigating unexplained foul odors in bathrooms, kitchens or wash areas; 2) ensuring water appliances in bathrooms and kitchens are fitted with a functioning U-bend/U-trap; 3) opening a tap on all water appliances for at least 5 seconds twice a day to prevent the loss of the water trap seal within a U-bend/U-trap; 4) sealing any disconnected, open, cracked or leaking wastewater pipework from an appliance and 5) continuously monitor whole system performance for large or tall buildings (Gormley, Aspray, & Kelly, 2020).

Strength of Evidence

Most of the evidence presented originated from media reports that described clusters or outbreaks of COVID-19 in hotels or apartments and did not describe potential mechanisms of transmission in detail. The four articles identified as primary literature had small sample sizes, were case reports, or preprints. Details on mechanisms of transmission were not described in enough detail and only one study conducted environmental sampling.

Limitations of this review

Due to time constraints, this review did not undergo the normal committee review process and thus may be missing the interdisciplinary expertise that arises from committee discussion. In addition, the inclusion and exclusion criteria for this review were scoped narrowly to facilitate the tight turnaround, to avoid duplication of content from previous rapid reviews and to ensure applicability to the question posed by the Medical Officer of Health. We were unable to connect with Public Health organizations across jurisdictions to determine whether investigations have occurred or are occurring related to outbreaks or clusters in these indoor environments., which may have contributed to the possible mechanisms of transmission being explored. Included studies were published in 2020 and in English; thus, it is likely that relevant studies are missing from this review.

Summary of Evidence

Nineteen references were included in the narrative synthesis below. Seven were media (4 identified through the grey literature search, 2 through additional Google searches). Seven were guidelines/recommendations from national or international organizations, 1 was a correspondence letter, and five were studies from the 44 references identified in the primary and grey literature search. Databases were searched for English-language articles published in 2020. The full search strategy can be found in the appendix of this report.

Evidence from the grey literature

Media reports:

Seven media reports were identified that reported clusters or outbreaks of COVID-19 in hotels or apartment complexes. Three of these, reported between Feb 10-12, 2020, highlighted the cluster of two cases in the high-rise tower **Hong Mei House**, in Tsing Yi, Northwest of Hong Kong (Creery, 2020; List, 2020; Regan, 2020).

Two residents of the Hong Mei House became infected with COVID-19, with the second resident infected 1.5 weeks after the first. The two initial patients lived 10 floors apart but were on the same vertical block of apartments – number 7. Three additional cases were linked to the Hong Mei House, specifically to the index patient living on the higher floor. Two of these were individuals who lived with the resident, the other was a relative not living in the same apartment (Creery, 2020; List, 2020; Regan, 2020).

Initial investigations pointed to a bathroom vent pipe of the second patient that appeared to be altered with self-refitting exhaust pipes. An improperly sealed vent pipe, that connects to the discharge pipe (removes wastewater from the toilet, sink or drain) and carries sewer gases and odors out through the roof, could theoretically carry infected fecal material into the building's ventilation system and blow it into people's bathroom through the air fan. Infected material from the first patient's apartment could have traveled down the pipes and entered the room via the broken vent in the second patient's bathroom. This media report details how the plumbing system is designed in the building and highlights this scenario as differing from the experience in the Amoy Gardens during SARS in 2003, where dry U bends were implicated as part of the transmission problem. (Regan, 2020). The design of the pipes in Hong Mei House ensured water was always sitting in the U-bend or U-trap, preventing gases from entering the home. When the U-trap is not filled with water, the air in the discharge pipe of the bathroom can enter the indoor environment, especially when the extraction fan in the bathroom is turned on.

Health officials eventually evacuated residents living in apartments numbered seven on all 34 floors because their toilet discharge pipes were linked, and they advised the public to maintain drainage pipes by regularly pouring water into drain outlets and U-traps, and to put the toilet seat lid down before flushing to avoid spreading contaminated aerosols (Regan, 2020). The Centre for Health Protection reported to the media on February 15 that testing of asymptomatic residents of apartments numbered even were completed and all 101 samples tested negative for SARS-CoV-2. The Food and Environmental Hygiene Department and the Housing Department's technical infection found that among the 34 apartments, 25 units had proper vent pipe connection while the other nine units had disconnected the vent pipes (Daily, 2020).

On July 7, 2020 it was reported that Melbourne, Australia was returning to strict lockdown for a 6-week period following a significant increase in COVID-19 infections due to infection control breaches in the hotel quarantine system (Thiessen, 2020). Since the Australia travel ban in March, all travelers returning from overseas have been

required to self-isolate for 14 days in hotel rooms. In 24 hours, 200 cases were reported, the worst increase since the country's onset of the pandemic. Thirty-one cases occurred in a 5-star luxury hotel in Melbourne. The outbreak associated with this hotel has been postulated to be linked to private security contractors involved in the Victoria state's hotel quarantine system. Security staff and quarantine-hotel residents claimed hotel guards engaged in sexual activity with guests during quarantine, shook hands, shared the elevators, wore personal protective equipment for prolonged periods of time without changing it, received only 6 hours of infection control training, were caught sleeping during shifts and allowed quarantined families to move between rooms to play cards and games (Thiessen, 2020). Additionally, the security company at the index hotel also provided guards to a public housing estate, resulting in 42 people getting infected including guards, families and close contacts and the housing estate being placed on lockdown. In this instance person to person contact appears to explain the outbreak, rather than HVAC or plumbing issues in a multi-residential setting.

On July 12, 2020, 21 cases of COVID-19 were identified as part of a cluster at the Crossroads Hotel in Casula in Sydney, Australia (McGowan & Wahlquist, 2020). Ten cases were people who attended the hotel and another 11 are contacts of those cases. Nearly all cases dined at the hotel restaurant, one person stayed at the hotel and another worked at the hotel. It is not known if the hotel worker was the source of the outbreak. People who attended the hotel were asked to self-isolate until 14 days post exposure and there is no follow-up data as yet (McGowan & Wahlquist, 2020). No other discussion was provided on possible sources of transmission in the media report.

On April 28, 2020 a cluster of COVID-19 cases were reported at the Saskatoon Confederation Inn (Lang, 2020). The exact number of individuals were not reported. The primary source was determined to be a regular traveler from the north who was diagnosed with COVID-19 during his stay at the hotel. The report indicates that he infected a 'couple other of his friends' that were staying at the Inn. All staff at the Inn were tested and all were negative for SARS-CoV-2. The infected individuals were moved to another location in Saskatoon after the Inn owner contacted Saskatchewan Health and the facility underwent cleaning (Lang, 2020).

On June 22, 2020 the BBC reported the need for extra police enforcement at a tower block in Göttingen, Germany that was under quarantine. Seven hundred people were placed in quarantine on June 18 after two residents tested positive, then more tests identified 102 infections in the tower block. Göttingen officials have attributed the outbreak to poor living and working conditions in the tower, with overcrowding in small apartments (19 to 39 square metres) (BBC, 2020).

Gormley, Aspray and Kelly (2020) summarize in a correspondence letter their 2017 experimental study of a full-scale two-storey wastewater plumbing test-rig investigating potential transmission in wastewater systems. They used *Pseudomonas putida* as a test organism to represent pathogens flushed into the system (Gormley et al., 2020). Viable organisms were shown to be transmitted between rooms on different floors of a building, carried within the system airflow. Droplet fallout resulted in contamination of surfaces within the system and rooms. The interconnectedness of the wastewater plumbing network in buildings, the systems sensitivity to overuse, underuse, high temperature and potentially high numbers of infected people are seen a possible transmission concerns particularly when self-isolating could potentially contribute to additional transmission according to the authors (Gormley et al., 2020). They make recommendations to minimize transmission through wastewater plumbing systems.

Recommendation Documents

A number of organizations have released guidelines or public health recommendations for hotels and multi-unit residential buildings (AHS, 2020; ASHRAE, 2020; CDC, 2020a, 2020b; Eykelbosh, 2020; D. o. Health, 2020; N. Health, 2020; NMHC, 2020). The National Collaborating Centre for Environmental Health in British Columbia released COVID-19 precautions for multi-unit residential buildings which discusses various possible modes of transmission including surface contamination and indirect contact, airborne transmission via aerosols, and transmission via contact with feces (Eykelbosh, 2020). The document provides guidance for cleaning and disinfection, high touch surfaces in common areas, personal protective equipment, enhanced cleaning measures and frequency of cleaning, precautions on elevators, laundries and washrooms and precautions related to

building ventilation. However, they do not comment on the role of plumbing wastewater systems in transmission of SARS-CoV-2 or ways to mitigate potential for transmission.

The International Association of Plumbing and Mechanical Officials (IAPMO) have released a number of COVID-19 related technical resources, codes and standards, including the brief COVID-19 Transmission Prevention Guidance from the Uniform Plumbing Code (IAPMO, 2020). It highlights basic concepts and fundamentals to minimize the spread of pathogens through plumbing systems including water supply, fixtures, wastewater and specific conditions in healthcare facilities.

Evidence from the primary literature

Five articles conducted evaluated clusters of COVID-19 cases either in hotels, a chalet or home environments. All these studies suggest transmission of SARS-CoV-2 by close contact with infected individuals or through contaminated environments.

Danis et al. (2020) conducted an epidemiological investigation to identify secondary cases associated with an Englishman infected in Singapore who stayed in a chalet in the French Alps (Danis et al., 2020). This individual attended a conference in Singapore linked to COVID-19 confirmed cases between 18-23 January 2020. On January 24 he flew from London to Geneva, stayed one night in Saint-Gervais-les-Bains, Haute-Savoie, France and then three nights in a chalet in the ski resort of Contamine-Montjoie, Haute-Savoie. On January 28 he flew back to the UK from Geneva. He was symptomatic from January 24, 2020 to the end of his stay in France. He stayed in the chalet with 10 other adult British tourists (apartment 1) and a British family of 2 adults and 3 children (apartment 2). Of these, 12 were tested positive for SARS-CoV-2 indicating an overall attack rate of 75% among the tourists/residents in those apartments. One pediatric case visited three different schools while symptomatic. In addition, 5 other adult British tourists arrived in apartment 1 of the chalet after the index case had left. Overall 172 contacts were identified, 169 were contacted and 73 were tested. All tested negative for SARS-CoV-2 except for one case, who tested positive during hospitalization. The authors conclude this to be a super-spreading event, whereby a complex combination of factors including the host, virus, behavior of individuals and the environment (proximity and air flow dynamics, contaminated environment) all played a role in the transmission of the virus (Danis et al., 2020).

Hoefer et al. (2020) presented a case report on the management of cases and contacts of a confirmed case of SARS-CoV-2 associated with a hotel in southern Tenerife, Spain (Hoefer et al., 2020). The index case arrived in Tenerife on the 17th of February with their partner and a group of 8 individuals, considered close contacts. Three close contacts and the individual's partner tested positive for SARS-CoV-2, with only one individual being symptomatic starting on the 25th February. The remaining contacts were isolated in their hotel rooms and continuously monitored. Four days later, a fifth member of the group tested positive, though was asymptomatic. Two other guests tested positive and one other contact tested positive. A total of 8 individuals became infected. Over the course of the investigation, 9 close contacts and 24 casual contacts were advised to self-monitor for the duration of the incubation period. Over 400 samples from hotel guests, hotel workers and other cases under investigation were tested for SARS-CoV-2. Authors of the paper believe the specific tools used to mitigate this outbreak were: (i) the rapid action taken to quarantine the hotel, (ii) the field clinic set up outside the hotel to work closely with the staff and guests of the hotel to monitor symptoms and have a direct line of communication, (iii) close collaboration between the field clinic, hospitals and the public health authorities, and finally (iv) specific recommendations provided to other hotels with information to guests regarding how to act if experiencing symptoms corresponding to COVID-19 (Hoefer et al., 2020).

Jiang et al. (2020) investigated environmental contamination in two rooms of a quarantine hotel after 2 presymptomatic persons who stayed there were confirmed as having COVID-19 (Jiang et al., 2020). Two Chinese students studying overseas returned to China on March 19 (patient A) and March 20 (patient B), 2020. On the day of arrival, neither had fever or symptoms and were transferred to a hotel for 14-day quarantine. On the morning of the second day of quarantine, they had no fever or symptoms but were tested positive for SARS-Cov-2. They were transferred to hospital for treatment. At admission they remained presymptomatic but nasopharyngeal swab, sputum, and fecal samples were positive for SARS-CoV-2 with high viral loads. Symptoms started on day 2 of hospitalization for patient A and day 6 for patient B. Environmental surfaces of the two rooms in the quarantine

hotel were sampled approximately 3 hours after the patients were identified as positive. Samples were taken of the door handle, light switch, faucet handle, thermometer, television remote, pillow cover, duvet cover, sheet, towel, bathroom door handle, and toilet seat and flushing button. Twenty-two samples from the 2 rooms were collected. Eight (36%) samples were positive for SARS-CoV-2 RNA. Surface samples collected from the sheet, duvet cover, pillow cover, and towel tested positive for SARS-CoV-2 RNA, and surface samples collected from the pillow cover and sheet had a high viral load in patient A's room and one surface sample from the faucet in patient B's room was positive. All control swabs were negative for SARS-CoV-2. The authors were not able to isolate viable virus to demonstrate infectivity of the virus from inanimate objects; though highlight the potential role for surface contamination in the transmission of SARS-CoV-2 and the importance of strict environmental hygiene practices, including appropriate laundering and handling of linens (Jiang et al., 2020).

Liu et al. (2020) collected and analyzed epidemiologic data related to a cluster of COVID-19 cases, which likely originated from an asymptomatic traveler (Liu, Huang, & Xiang, 2020). On March 19, 2020 the index patient returned to Heilongjiang Province from the United States, where COVID-19 cases were detected and was asked to quarantine at home. At the time Heilongjiang had not reported any new cases since March 11, 2020. On April 9, it was determined that the index patient had remained asymptomatic since returning from the U.S., though SARS-CoV-2 serum antibody tests on April 10 and 11 showed previous infection with SARS-CoV-2 (serum IgM negative, IgG positive). Past SARS-CoV-2 nuclei acid and serum antibody tests on March 31 and April 3 were negative. Patient B1.1 was the downstairs neighbor of the index patient. They used the same elevator in the building but not at the same time and did not have close contact otherwise. Close contacts of patient B1.1 became infected, transmitted to others at a party, one of which was hospitalized for a stroke and subsequently transmitted to others in the hospital. All individuals who lived in the same community and had close contact with SARS-CoV-2 positive patients or visited the two hospitals were tested. The index patient remained asymptomatic and a total of 71 SARS-CoV-2 positive cases had been identified. The authors conclude this cluster was attributed to droplet-contact transmission by the asymptomatic patient to surfaces in the elevator (Liu et al., 2020).

Qian et al. (2020) extracted case reports from the local Municipal Health Commissions of 320 prefectural cities in China, not including Hubei province, between 4 January and 11 February 2020 (Qian, Miao, Zheng, Luo, & Li, 2020). The authors identified all outbreaks involving three or more cases and reviewed the major characteristics of the enclosed spaces in which the outbreaks were reported and associated indoor environmental issues. A total of 7324 cases with minimum data elements were found, accounting for 66.7% of the 10,980 confirmed non-Hubei cases in China during the study period. The outbreaks were categorized by infection venues: homes (apartments and villas), transport, restaurants and other food venues, entertainment venues, shopping venues and a miscellaneous category (e.g. hotel rooms). Of the 318 outbreaks identified, 254 (79.9%) occurred in a home (one in a villa, all others in apartments). Most of these outbreaks included only three to five cases. For outbreaks with more than 6 cases, no particular pattern was identified over time, which the authors conclude suggest a sporadic nature. The authors were not able to identify exact transmission routes from the outbreaks; however they suggest close contact and via fomite route as main drivers of transmission and they suggest that long-range aerosol transmission may occur when certain conditions are met, such as crowded enclosures or spaces with poor ventilation (Qian et al., 2020).

Evolving Evidence

Preliminary findings from this report suggest similar findings to those identified in the rapid review on the role of HVAC systems in the transmission of SARS-CoV-2. The role of the built environment and indoor transmission of SARS-CoV-2 needs to be studied with rigorous epidemiologic, engineering (plumbing, mechanical, HVAC), infectious disease modeling and microbiological methods that complement each other. As jurisdictions continue to lower the curve of COVID-19, opportunities to investigate, report and reflect on outbreaks and clusters within

hotels or multi-residential buildings may become available and will hopefully contribute to an understanding of the possible mechanisms of transmission in these spaces.

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(If applicable) Date of re-assessment:

Authorship and Committee Members

This report was written by Dr. Jenine Leal and assisted by Ms Heather Gagnon, and scientifically reviewed by Dr. Braden Manns (co-chair), Dr. Lynora Saxinger (co-chair), and Dr. Elizabeth MacKay.

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Appendix

List of Abbreviations

AHS: Alberta Health Services
ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASSE: American Society of Safety Engineers
CIBSE: Chartered Institution of Building Services Engineers
CMOH: Chief Medical Officer of Health
COVID-19: Coronavirus Disease-2019
CSA: Canadian Standards Association
HVAC: Heating, ventilation and air conditioning
IAPMO: International Association of Plumbing and Mechanical Officials
NCCEH: National Collaborating Centre for Environmental Health in British Columbia
RHEVA: European Federation of Heating and Ventilation Engineers
SAG: Scientific Advisory Group
U.S.: United States

Methods

Literature Search

A literature search was conducted by Lauren Seal from Knowledge Resources Services (KRS) within the Knowledge Management Department of Alberta Health Services. KRS searched databases for articles published in 2020 and included: OVID Medline, PubMed, CINAHL, TRIP Pro, LitCOVID /WHO Covid-19 Database/CEBM/Covid-evidence.org/evidence Aid COVID/CDC/Health Canada/NHS/Australian Health/New Zealand Health. A Google Scholar/Google Advanced Search was also conducted. A secondary Google search by the writer was conducted to identify media reports on outbreaks in apartments, condos and hotels. The full search strategy is included below; briefly, the search strategy involved the following concepts:

- SARS-CoV-2 or COVID-19 or Coronavirus
- Outbreaks or clusters or transmission
- Residential buildings including hotels, apartments, condos, inn, hostels, motels

Articles identified by KRS in their search were pre-screened for obvious irrelevance against the inclusion/exclusion criteria listed in Table 1 below. 25 articles were identified by KRS with references and abstracts provided for further review. Following full-text review, 16 were excluded from the review in accordance with the inclusion/exclusion criteria stated below and 9 articles were included in the review.

Table 1. Inclusion and exclusion criteria for results of the literature search

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none">- Epidemiological studies or media reports describing COVID-19 outbreaks and clusters in hotels, multi-residential buildings or related indoor spaces.- Information or description pertaining to mechanisms of transmission	<ul style="list-style-type: none">- Articles presenting theories of transmission mechanisms without reference to COVID-19 outbreaks or clusters- Epidemiological studies describing outbreaks or clusters in hotels, multi-residential buildings or related indoor spaces due to other viruses (e.g. SARS, Influenza).- Published before 2020- Articles not in English

*Search Strategy***Medline/PubMed**

- 1 exp Coronavirus/ or exp Coronavirus Infections/ or coronaviru*.mp. or "corona virus*".mp. or ncov*.mp. or n-cov*.mp. or COVID-19.mp. or COVID19.mp. or COVID-2019.mp. or COVID2019.mp. or SARS-COV-2.mp. or SARSCOV-2.mp. or SARSCOV2.mp. or SARSCOV19.mp. or Sars-Cov-19.mp. or SarsCov-19.mp. or SARSCOV2019.mp. or Sars-Cov-2019.mp. or SarsCov-2019.mp. or "severe acute respiratory syndrome cov 2".mp. or "2019 ncov".mp. or "2019ncov".mp. (36417)
- 2 exp Disease Outbreaks/ (104617)
- 3 outbreak*.mp. (129966)
- 4 exp Disease Transmission, Infectious/ (68586)
- 5 (transmission adj2 chain*).mp. (912)
- 6 (transmission adj2 report*).mp. (884)
- 7 (transmission adj1 cluster*).mp. (409)
- 8 2 or 3 or 4 or 5 or 6 or 7 (214871)
- 9 apartment*.mp. (2230)
- 10 condo*.mp. (26562)
- 11 residence.mp. (77817)
- 12 building.mp. (106182)
- 13 hotel*.mp. (4049)
- 14 motel.mp. (65)
- 15 inn.mp. (1251)
- 16 hostel*.mp. (824)
- 17 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 (216442)
- 18 1 and 8 and 17 (173)
- 19 limit 18 to yr="2019 -Current" (118)

CINAHL

- S1 (MH "Coronavirus+")
- S2 (MH "Coronavirus Infections+")
- S3 coronaviru*
- S4 "corona virus"
- S5 ncov*

- S6 n-cov*
- S7 COVID-19 OR COVID19 OR COVID-2019 OR COVID2019
- S8 SARS-COV-2 OR SARSCOV-2 OR SARSCOV2 OR SARSCOV19 OR SARS-COV-19 OR SARSCOV-19 OR SARSCOV2019 OR SARS-COV-2019 OR SARSCOV-2019
- S9 "severe acute respiratory syndrome cov 2" OR "severe acute respiratory syndrome coronavirus**"
- S10 "2019 ncov" OR 2019ncov OR Hcov*
- S11 S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 12,524
- S12 (MH "Housing+") 15,035
- S13 apartment* OR condo* OR residence OR building OR hotel* OR motel* OR inn OR hostel*
86,586
- S14 S12 OR S13 99,102
- S15 (MH "Disease Outbreaks") 32,488
- S16 (MH "Disease Transmission+") 15,803
- S17 outbreak OR transmission N2 chain OR transmission N2 cluster* OR transmission N2 report*
40,704
- S18 S15 OR S16 OR S17 54,232
- S19 S11 AND S14 AND S18 80
- S20 S11 AND S14 AND S18 Limiters - Published Date: 20191201-20200731 58

TRIP Pro

(coronavirus OR "corona virus" OR COVID-19 OR SARS-COV-2) AND (transmission OR outbreak OR "transmission cluster" OR "transmission cluster" OR "transmission chain" OR "transmission report) AND (apartment OR condo OR hotel OR hostel OR inn OR motel) from:2019

Google Scholar/Google Advanced Search

(coronavirus OR "corona virus" OR COVID-19 OR SARS-COV-2) AND (transmission OR outbreak OR cluster OR "transmission cluster" OR "transmission chain" OR "transmission report) AND (apartment OR condo OR hotel OR hostel OR inn OR motel)

LitCOVID/WHO Covid Database/CEBM/Covid-evidence.org/evidence Aid COVID/CDC/Health Canada/NHS/Australian Health/New Zealand Health

(apartment OR condo OR hotel OR hostel OR inn OR motel)

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