Outbreaks in Dormitories: Literature Search as of August 12, 2020
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Methods

A comprehensive literature search was conducted using Pubmed, WHO Coronavirus database, and preprint literature via Medarxiver. The search focused on outbreaks, disease, and infections in dormitory like settings such as college dormitories, residential halls, apartment complexes, barracks, and cruise ships. The full search strategy returned over 250 potential articles. These articles were reviewed for content and relevance to generate the summary below.

Review

In general, the literature on disease outbreaks and infections in dormitories, apartments, cruises, etc. focuses mainly on the description of the epidemic and tracing to an index person/exposure. Very little has been done with possible interventions to decrease infection and transmission of disease within dormitories. Of the few studies that have been conducted, most are observational in nature, comparing the risk of disease after an outbreak versus implementing an intervention to stop the spread of a disease.

Also, of particular note, is that most studies look at multiple possible explanations for increased risk of transmission, ie: ventilation, building age, room density, cleanliness, all at once. This makes it difficult to assign actual values to the reduction in risk by performing a single change within a dormitory building. In general, the following have been found to be sufficient at reducing risk of infection or shortening a disease outbreak.

Ventilation\textsuperscript{1-4}

The most common intervention described is the changes in ventilation or airflow within the dormitory building. A lot has been done with airflow within the workplace, the studies described here focus exclusively on living spaces. Multiple studies have found that increasing the ventilation has reduced the incidence of disease within buildings. When incidence of disease is compared between two buildings, generally the building with a higher ventilation rate has lower disease rates, on average. While most studies have focused on ventilation using HVAC systems, some have also explored natural ventilation via opening of windows. This seems to be almost as effective at exchanging air within a room as increased ventilation from an HVAC system. Dependent on weather, this can also make for a more comfortable living environment. The issues found with natural ventilation is the spread of aerosols through prevailing winds. Natural ventilation was found to intensify an outbreak of SARS during the 2003 pandemic at an apartment complex in China. This was due from strong wind from infected persons towards uninfected. Therefore, it would be advised to encourage the use of higher ventilation rates and
dependent on the design and structure of the building and other surrounding buildings, to also increase natural airflow within a dormitory room.

**Air Filters**

A second intervention that has shown to work is to change air filters to those with higher efficiency. The gold standard, and best air filtration, is HEPA filters. Within multiple settings, such as hospitals, airplanes, and daycares, HEPA filters have been shown to best filter influenza droplets. HEPA filters are also the most expensive filters to operate and can restrict airflow which can run up costs. Less expensive filters, such as MERV 13-16 have shown nearly the same efficiency as HEPA filters. Reviews have found the much cheaper MERV 7-11 filters to be less efficient.

**Room/Floor Density**

In investigations of outbreaks at dormitories, often an individual is infected by one or more roommates. In settings with minimal living space and multiple people, the rate of infection is much higher than those with more individual space. Studies that compared rates of disease among those within single rooms versus two in a room versus three or more in a room all found that those within single rooms had less risk than those in a two-person room. And those in a two-person room had less risk than those in a room with three or more roommates. Simulations also suggest that limiting the number of students in a room can help prevent the spread of disease.

Other considerations on the density of dormitories is the total number of people living on a particular floor. Similar to the number of roommates, when less people in total live on a floor, the risk of disease appears to be lowered. But, recommendations for how significant a reduction in the total number per floor was not given.

Throughout the literature there was no recommendation on minimum square footage per occupant. The comparisons were made between similar sized rooms with differing number of people living within the room. Of the studies that investigated room density, the rooms were overly crowded, so even a single case had the potential to infect many others. There were also no recommendations about room set up, such as beds on opposite sides of the room or physical barriers between roommates.

**Case Isolation**

One study used Bluetooth technology to track interactions of students living on a campus. Once influenza like symptoms were reported, students would, of their own volition, significantly reduce the number of social interactions they had on a daily basis by about 30%. But, with a high infectivity of COVID-19, a reduction of social interaction by 30% may not be enough to fully stop the spread, a more direct quarantine intervention will be necessary for cases.
Few studies have investigated isolating cases within living quarters when disease occurs. There is evidence to show that removing cases from barracks helped to shorten an outbreak of norovirus in a military base. This quarantine was in tents separated from the non-cases. Simulations have also confirmed that removing and isolating cases will shorten an outbreak. What is less clear is where cases or quarantined individuals should be moved, as simulations just remove cases from their modeling, and recommendations for this are not given in any of the studies.

Some work has looked into the COVID-19 outbreak on the Diamond Princess cruise ship. Simulations of the data from this outbreak suggest that while quarantining and isolating cases was effective at reducing the number of total infections on the ship, isolation within rooms also contributed to the spread of COVID-19 between rooms. The most effective intervention at reducing further cases would have been to remove them from the ship while non-cases remained in quarantine. Other studies of previous SARS outbreaks on campuses in Asia in 2003, found that isolating known cases was also effective at reducing incident cases. There was no information offered from the search on how quarantining should happen or where isolated cases should go. As seen from the Diamond Princess cruise ship, isolating within a room in close proximity to non-cases does increase the risk of transmission to those non-cases. Perhaps more separation should be considered for those cases.

Cleaning\textsuperscript{13, 15}

While not an intervention, there is evidence suggesting that those in rooms that are cleaner tend to have less flu-like reported symptoms. While this is not an intervention that can be controlled by the university, there may be the opportunity to offer cleaning products to help increase disinfection within a room. In studies where there were shared toilet facilities, more routine cleaning of the facilities was also related to lower rates of disease.

Hand Hygiene\textsuperscript{13, 16}

One study conducted a trial whether introducing hand sanitizer dispensers within residence halls would reduce illness rates. Of the dormitories that received the hand sanitizing stations, illness rates dropped significantly compared to those that did not receive the stations. A hand hygiene educational program was introduced within all residence halls and there was a significant increase in self-reported hand hygiene overall. These stations may already be installed within dormitories at OSU, but if they have not been, there is some evidence to suggest they can help in the reduction of illness. Meta-analysis also suggests that paper towels may be more effective than hand dryers at reducing the amount of bacteria on hands after washing, although this may exacerbate other issues with fomite transmission. In dormitories with common toilet facilities, this may be an intervention to consider especially if COVID-19 is able to spread through fecal material.

Case Studies of COVID-19 in Dormitory-like Settings\textsuperscript{17-26}
There have been some case studies on COVID-19 spread and containment in settings similar to dormitories. Some of these studies, such as those focusing on prisons in the United States and migrant worker housing in Singapore, have shown that COVID-19 can be spread rapidly throughout the entire living area, even when some mitigation techniques are applied such as testing or quarantine. This may be due to asymptomatic spread and the delayed implementation of the previously described interventions. Other case studies, such as those on military bases, have shown that when proper transmission mitigation has been implemented, the incidence of COVID-19 is greatly reduced. This was specifically seen at the Joint Base San Antonio-Lackland in Texas. Over 10,000 new trainees reported between March and April 2020. Interventions included quarantining, social distancing, early screening, and isolation, and even though these trainees slept in barracks similar to dormitories, there were only 5 incident cases detected. So, while dorms may be an area that could have an outbreak, with proper interventions the number of new cases can be kept to a minimum.

Lately, there have been numerous reports of COVID-19 outbreaks at summer camps. At the overnight camps, the campers and staff sleep in close quarters, similar to what happens in dorm rooms. The most notable outbreak is from a large outbreak from an overnight camp in Georgia. Testing found that 260 of 344 campers that were tested had positive results for COVID-19, equating to an attack rate of 44%. Other reports have found outbreaks at overnight camps in other states such as Michigan, Oregon, and Wisconsin. The transmission is likely due to the sleeping in close quarters to others and from droplets expelled during singing and chanting. Also, of note is the high attack rates seen among young persons, which suggests that this rapid spread in a dorm like setting is possible even among the young adults that will be living in on- and off-campus housing.

**Conclusion**

While the literature has few studies investigating the prospective ability of interventions to reduce the spread of disease in living quarters, there are some that retroactively look at outbreaks. The most conclusive interventions from past years suggest increasing ventilation, using greater efficiency filters, and limiting the number of people per room and floor of a building. Less is present on the best way to isolate a known case. As mentioned before, most of these studies are not investigating a single intervention, but rather multiple. Models with risk reduction are also missing from the literature, therefore it is impossible to be able to put a value on a specific intervention. Reading through the studies of dormitories versus the Diamond Princess cruise ship outbreak, it should be noted that the populations of these two differ drastically. Dormitories are generally young adults who suffer from few comorbidities when compared to the much older population on a cruise ship. These studies may be difficult to apply to our younger dormitory population but can give a worst-case scenario of how COVID-19 could spread when proper mitigation is not performed.