

## Infection Prevention in Building Management

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### Introduction

Infectious diseases continue to be a threat to the health of the population and economy in the United States. Influenza and other respiratory infections are associated with substantial morbidity and mortality in older and younger age populations in the U.S.<sup>1-3</sup> Together, influenza and other respiratory infections cause numerous missed days of work and school and ultimately result in billions of dollars in annual medical costs and losses in employee productivity for business.<sup>1,3,4</sup> Gastrointestinal infections, caused by various viral and bacterial pathogens, also impact businesses. Norovirus, a common gastrointestinal infection, has caused numerous outbreaks across the U.S. and has been a consistent concern in the cruise ship industry worldwide.<sup>5-8</sup> Outbreaks on cruise ships have also led to millions of dollars in losses because of delayed voyages, lawsuits and overall reductions in business.

Two common types of infectious illnesses affecting the U.S. population are respiratory and gastrointestinal illnesses. Respiratory and gastrointestinal illnesses affect the U.S. population more commonly than any other infectious illness. Respiratory infections, such as influenza, are caused by viruses that are transmitted by direct or indirect contact transmission. Direct contact occurs when influenza is transferred person-to-person, such as through aerosols or the small droplets produced by a sneeze and directly deposited into the lungs of a nearby individual. Indirect contact occurs when influenza is spread through an intermediate object such as an influenza-contaminated table, door handle or toy. Once the object is contaminated by a large droplet from a cough, sneeze, contaminated hands or tissue, a susceptible individual can be exposed to the virus by touching the object and then touching his or her eyes or mouth.

It is important to note that influenza viruses can survive for hours or even a day on some surfaces, depending on the type of surface, pH, temperature and humidity.<sup>9-12</sup> For indirect contact transmission, hand hygiene is paramount in reducing the likelihood of transmission. For direct transmission, however, where contaminated aerosols are deposited directly into the airways, hand hygiene will not offer protection. The relative contribution of indirect contact versus direct contact for influenza is currently unclear.<sup>13</sup> Norovirus, a gastrointestinal illness, is primarily spread by the fecal-oral route of transmission.<sup>6</sup> Infection may occur through the direct route by ingesting contaminated food or by directly interacting with an infected person through a handshake. Indirect routes may include a fomite, such as a door handle or table, where the virus can survive for days and be spread to susceptible individuals who touch these surfaces and then touch their mouth, ingesting the norovirus.<sup>14</sup> Therefore, hygiene prevention is paramount for reducing transmission of a norovirus, including hand washing and decontamination of the environment in which people work, live or go to school.

Based on the various transmission modes by which respiratory and gastrointestinal viruses can impact health, there are several structural, behavioral, social and institutional factors that may influence the likelihood of infectious disease outbreaks in buildings which house workplaces. Structural factors include the density of workspaces, airflow, temperature and humidity. Behavioral factors include levels of hand

washing and cleanliness of workspaces, common areas and restrooms. Social and institutional factors include: cultural beliefs, work policies surrounding sick days, health insurance/vaccination coverage, surveillance for infection, availability of infection prevention guidelines and infection prevention educational tools. Here we describe the factors that may influence transmission of infection in buildings with a focus on the workplace.

## Structural factors

### *Crowding*

There is accumulating evidence that crowding impacts transmission of infection. Common respiratory infections, including influenza and colds, have been shown to be associated with spending time in crowded environments.<sup>15-17</sup> Gastrointestinal infection outbreaks have also been identified in crowded settings.<sup>18,19</sup> For these reasons, the density and location of workspaces in a building may impact transmission. The type of workspace, for example a crowded cubicle or a shared office space, may increase transmission since sick and healthy people may be working together side by side without walls separating them and sharing equipment and office space. Providing greater separation of individuals may help reduce airborne transmission of respiratory infections, and cleaning and disinfecting work spaces and shared areas or equipment may help reduce indirect transmission of respiratory and gastrointestinal infections.

### *Airflow*

The flow of air through a facility is another important aspect of infectious disease transmission.<sup>20</sup> The need to contain and monitor airborne infectious agents has helped shape important guidelines on laboratory air flow design for working with infectious agents in the laboratory and clinical setting. While there is limited research on the effect of airflow on transmission of infection in the workplace, there are still many important factors to consider for this setting. The factors that impact air movement in a facility include: ventilation (natural or mechanical), individuals moving about by opening and closing doors or moving around other objects, heat generated from individuals and machines and finally, humans breathing, talking, coughing and sneezing.<sup>20</sup> There is growing evidence that recycled air and low airflow may impact transmission of influenza and possibly other respiratory viruses. Although most of the evidence is correlational, there have been hospital, airplane and school dormitory outbreaks that have implicated airflow and/or air filtering as possible risk factors for the spread of influenza or other respiratory infections.<sup>21,22</sup>

A study of the movement of droplets exhaled by a cough, breathing and talking in an airplane was recently published and found that droplets from a single individual predominated in the row directly in front and in back of the individual within 30 seconds of coughing, breathing and talking.<sup>23</sup> In four minutes, the droplets were spread to a total of seven rows. The air ventilation from the plane resulted in a 12 percent reduction in the droplets after four minutes.<sup>23</sup> Although an airplane is a very closed and contained environment, a building with poor air flow and crowding may be at similar risk of influenza outbreaks. Therefore, airflow should be evaluated and considered in building management as a possible focus for mitigation strategies. There is also evidence that natural airflow may be as good or better than mechanical airflow in the clinical setting for reducing the transmission of airborne infections.<sup>24</sup> Unfortunately, many buildings do not offer windows that open and may clean and recirculate air mechanically. Therefore, interventions that target proper mechanical airflow and harness natural airflow, if

possible, should be assessed by building management for the sake of occupants' health.<sup>24</sup>

#### *Temperature and Humidity*

Both temperature and humidity are factors that may impact transmission of infection both indoors and outdoors. For influenza, certain seasonal strains appear to have better transmissibility in cold temperatures with less humidity in animal studies.<sup>25</sup> For humans, there is some debate on temperature since colder temperatures outside result in greater time spent indoors with heating turned on and lower humidity, which may result in heightened risk of influenza transmission. Even though the H1N1 pandemic appeared in the U.S. over the warmer months of the year, animal studies have shown that similar to other strains of seasonal influenza, H1N1 has greater transmissibility in cold and dry conditions.<sup>25</sup> In addition, studies have shown that temperature and absolute humidity are important for influenza virus survival on fomites.<sup>10,26-28</sup> Therefore, monitoring the temperature of buildings and humidity may be important points of intervention for reducing the spread of some infections, such as influenza, in the workplace.

### **Behavioral Factors**

#### *Hand Washing*

Hand washing is one of the simplest and most effective ways to prevent transmission for a number of infectious diseases. Any infection that can be transmitted on objects in the workplace can be potentially prevented by proper hand hygiene. Many individuals in the workplace spend a great deal of time sitting at a desk. Individuals will often eat their food at their desk or in shared designated kitchen or eating spaces. There are many behaviors that can be promoted among occupants in a work place, including hand washing before eating, after using the bathroom, after sneezing and after coughing.

In the workplace, occupants should be encouraged to wash hands by placing reminders in washrooms or hosting educational sessions discussing the importance of effective hand hygiene during all of the critical points throughout the day (i.e. after using a bathroom, before eating, before and after caring for an ill person in the home, etc.). Workplace occupants should also have access to clean bathrooms and sinks with warm water, soap and paper towels. Effective hand washing should take as long as singing "Happy Birthday" twice, include warm water and soap and last approximately 20 seconds. After washing properly, drying hands thoroughly with a paper towel will help further reduce bacteria and also lessens the chance of cross-contamination. Recycled paper towel can be used to reduce the impact on the environment. With a clean paper towel in hand, frequently touched surfaces can be avoided when leaving the washroom, such as the faucet and door handles.

While hand washing with soap and warm water is more effective for removing bacteria or viruses from the hands, keeping hand sanitizer gel or lotion nearby is a good way to prevent sickness among occupants when soap and water isn't readily available. Easy and effective measures to maintain optimal health among building occupants include keeping hands away from mouth, nose or eyes after touching surfaces or interacting with others who are ill and covering one's mouth when coughing or sneezing to prevent the spread of bacteria and viruses in a workspace.

Several pathogens that can cause respiratory and gastrointestinal infectious illnesses can also live for a long time on surfaces such as desks and tables.<sup>9-12</sup>

Doorknobs, computer keyboards and telephones are all places in a workspace that are used every day and may be shared with others. These shared work surfaces could facilitate the spread of infectious illnesses if they are not frequently disinfected.

## Social and Institutional Factors

### *Work Policies and Surveillance*

Partly in response to the 2009 H1N1 pandemic, the Centers for Disease Control and Prevention (CDC) created guidelines for the workplace in preparing and responding to infectious disease outbreaks or pandemics (<http://www.flu.gov/planning-preparedness/business/index.html>). Workplaces should consider developing policies based on these guidelines to prepare the occupants for new or reemerging infectious disease threats that may impact the workplace and society at large. If vaccinations are available to prevent infections, workplaces should encourage occupants to be vaccinated and also hold free vaccine clinics for all occupants, especially those who do not have health insurance that covers vaccination. In addition, polices should discuss the need to assist with child care if schools are closed by the government and cancel workplace gatherings, such as business meetings. In addition, changes to the work environment may be recommended, including asking individuals to work from home when sick, reducing travel and avoiding crowding by spacing out work areas at farther distances. Guidelines for the workplace may also be accompanied by the development and creation of pandemic preparedness kits ([www.flu.gov](http://www.flu.gov)) and/or having supplies such as N95 masks, regular surgical masks, gloves and hand sanitizer on hand to protect susceptible occupants.

Government and local surveillance for infectious diseases is an integral part of identifying and preventing outbreaks in the U.S. workplaces and can harness the power of surveillance by tracking information on absenteeism and identifying changes in work force numbers throughout the year. Using the “usual” illness rates, businesses can compare these rates with periods that appear to have higher than normal absenteeism levels to investigate whether an ongoing outbreak in the local area or globally may be affecting the workplace. Businesses can also contact their local and state health departments to get updates on infections that are causing outbreaks and information on prevention and surveillance data on illness, as this information can assist with planning and preventing future infectious disease outbreaks in the workplace.

### *Health Beliefs*

Several studies have identified social factors, such as cultural beliefs and race/ethnicity, as determinants associated with interest in receiving a vaccination and education about vaccinations.<sup>29-31</sup> Other studies have indicated that these same factors are associated with differences in education and beliefs about infectious diseases.<sup>32,33</sup> Health beliefs are likely to impact health seeking behaviors, vaccination uptake and possibly other preventive efforts for targeting infectious disease transmission in the workplace.

## Conclusion

As infectious diseases continue to impact society today, the protection of building occupants from these infectious threats has become a major challenge for building owners and facility managers. The H1N1 influenza pandemic demonstrated how quickly outbreaks occur within facilities and the need to identify and mitigate these infections rapidly. Here we have described the structural, behavior, social and institutional factors

that should be considered and potentially addressed to reduce infectious disease transmission in buildings, with a focus on the workplace. At the structural level, air flow, temperature and humidity are factors that should be monitored and altered, if possible, to reduce the likelihood of infectious disease transmission. In addition, structural changes to work areas that reduce crowding and shared spaces should be considered.

Behavioral factors, such as hand washing and disinfecting work areas, should be promoted and incorporated into guidelines and educational sessions for building occupants. Restrooms should be kept clean and functioning properly with running warm water, soap and paper towels available. Health beliefs should be considered when creating guidelines and policies within the work place in response to infection prevention, such as vaccination clinics and health care seeking behaviors. Surveillance should be undertaken to identify the normal burden of absenteeism monthly so that these rates can be used to monitor future changes in the monthly rates of absenteeism. State and local health departments will be helpful in identifying outbreaks and providing updates on preventing infectious diseases that emerge or reemerge. The workplace should also have documented protocols on how to respond to an outbreak or pandemic in the community and plans to accommodate sick employees and their children. Together, these efforts can have a measurable impact on reducing the threat of infectious illness transmission among occupants in the workplace.

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