Healthier Homes During Epidemics

White Paper Developed by

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Peachtree Corners

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To explore more epidemic guidance, visit www.ashrae.org/covid19.

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Acknowledgments

Healthier Homes During Epidemics was initiated in 2021 in the midst of the COVID-19 pandemic. It provides guidance for home residents and multifamily operators on how to prepare for, and act during, future outbreaks, epidemics, and pandemics.

Terry Brennan, Amy Musser, and I wrote individual sections, reviewed the work of coauthors, and resolved comments from reviewers. A work such as this depends on the dedication and commitment of the authors and their firms, in this case Camroden Associates, Inc.; Vandemusser Design, PLLC; and Schoen Engineering, Inc. Deborah Berlyne, our technical editor, challenged us to achieve greater clarity with fewer words. Hannah Bachman turned a rough document into readable pages with correct references. Graphic designer Walter Grondzik made rough sketches presentable, edited photographs, weaved them into text, and in the process, caught textual errors.

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Lawrence Schoen
October 2021

Glossary

Note: All terms included in this glossary are defined at the term's first or main use in the text, either within the body text or in a footnote.

aerosol: Suspension of fine sold or liquid particles in gas.

air sealing: Sealing of gaps, cracks, and holes in surfaces or building enclosures from the flow of air in walls, ducts, or air-handling units.

air-handling unit: Equipment containing a fan or blower that draws air in from outside; passes it through components that heat, cool, and/or dehumidify it; and blows it out.

clean air delivery rate (CADR): Indicates the volume of filtered air an air cleaner delivers, with separate scores for tobacco smoke, pollen, and dust.

commissioning: A complete startup process for new heating or cooling equipment to make sure that it operates according to manufacturer specifications and the home's parameters.

compartmentalization: Air sealing between units in multifamily buildings.

cross-ventilation: Relies on wind to force cool exterior air into the building through an inlet while an outlet forces warm interior air outside.

door sweep: A small piece of plastic or rubber attached to an aluminum carrier strip and fitted across the bottom of a door.

elbow technique: Burying your nose and mouth in your elbow, preferably while wearing long sleeves, when coughing or sneezing.

energy recovery ventilator: Device that transfers both sensible and latent heat between the incoming air that ventilates a dwelling and the outgoing exhaust air. As a result, when the outside air is cold and dry, the incoming air is warmed and humidified, and when the outside air is hot and humid, the incoming air is cooled and dehumidified.

epidemic: Occurs when an infectious disease spreads very quickly over a larger geographic area than that of an outbreak.

heat recovery ventilator: Device that transfers sensible heat between the incoming air that ventilates a dwelling and the outgoing exhaust air so that the incoming air is warmed in winter or cooled in summer without transferring latent heat.

stack effect: Happens when differences between indoor and outdoor air temperatures cause air to move between floors in a multistory building; can transfer air, including air containing pathogens, from one unit to another that is vertically or diagonally above or below it.

supply air grille: Location from which hot or cold air is pumped back into the home.

tankless flushometer valve: A valve that uses pressure from the water supply system rather than gravity to discharge water into a toilet bowl.

thermal stress: Health problems resulting from extreme heat or cold that the body cannot tolerate or adapt to.

trap primer: A plumbing device or valve that adds water to a plumbing trap.

turnover: The rate at which inhabitants in a single home leave and return.

ventilation: The use of outdoor air to dilute contaminants, which can include airborne infectious disease particles, in the indoor air.

weather stripping: A strip of material below the door typically used to keep out rain, snow, and hot or cold air.

whole-dwelling ventilation system: System in the home designed to provide ventilation for the whole dwelling.

Introduction

In an outbreak of an infectious disease,[1] more cases of the disease occur than expected in a given area or among a specific population during a specific period. In contrast, an epidemic occurs when an infectious disease spreads very quickly over a larger geographic area than that of an outbreak (CDC 2020). A pandemic is the spread of a new disease around the world (WHO 2010). In this document, the word *outbreak* is used to refer to outbreaks, epidemics, and pandemics as defined in this paragraph. The actions taken to protect members of a household are similar for all three.

Outbreaks can extend their reach rapidly, as occurred with the COVID-19 pandemic. Therefore, it may sometimes be necessary to take preventive action before an outbreak reaches your area. People in the United States and other Western countries spend most of their time indoors, primarily in their homes, and the proportion of time spent at home usually increases during an outbreak. For these reasons, the actions taken by homeowners, renters, other household members, and owners or managers of multifamily buildings[2] matter greatly to occupants' health and well-being during an outbreak. Multifamily buildings in the scope of this document include multiunit, multistory apartment buildings; garden apartments; row houses and townhomes with shared party walls; two-, three-, and multifamily houses; and cohousing and group homes.

Recommendations for Most Homes

These recommendations are suitable for most homes. The rest of this document provides more details on each item in this list.

- Stay at home as much as possible because it is likely to be the safest place.
- Keep the home comfortable so that everyone in your household can stay there. This means running your heating and cooling systems in the same way as you usually do and using outdoor air for ventilation only as much as the weather permits.
- Limit indoor visits to or from other households.
- If you have one or more toilet room or bathroom exhaust fans, run at least one of these fans whenever anyone is home. Running these fans can

1. A disease caused by the entrance into the body of pathogenic agents or microorganisms (organisms of microscopic or ultramicroscopic size) that grow and multiply there.
2. These include multiunit, multistory apartment buildings; garden apartments; row houses and townhomes with shared party walls; two-, three-, and multifamily houses; and cohousing and group homes.

reduce contamination in the air from the toilet and increase ventilation throughout the home.
- Use compatible filters (e.g., in furnaces and central air conditioning systems) that have the highest rating or performance number available.
- Use portable air cleaners, but only if they have proven technology.
- If a household member develops symptoms or has a high risk of exposure, isolate them as soon as you find out.
- If a household member is highly vulnerable to complications from infection because of age or health status, give them a protected space to stay in.

Sources of Outbreak Risk in the Home

In any home, if one member of the household contracts an infectious disease, the other members of the same or nearby households have a higher risk of infection. For example, during the COVID-19 pandemic, a study showed that when one household member became infected, another family member became infected in 16% of households, and the risk of infection was highest in spouses. Quarantining the infected person when symptoms started greatly reduced transmission risk (Li et al. 2020).

Infectious organisms have varying ability to spread from one person to another through the air. Defining which ones spread in this way is beyond the scope of this report. When people cough, sneeze, sing, shout, laugh, or even just breathe, they expel tiny, liquid drops of saliva and respiratory fluid. When a person is infected, some of the particles they expel contain one or more of the bacteria or viruses causing the disease. Large particles settle onto surfaces within several feet of the infected person. Smaller particles may travel much farther and remain floating in the air much longer than larger particles. Although they are small enough to float in the air, these smaller particles are still larger than the disease organism, and these particles can be captured with filters. If particles enter a person's mouth, nose, or eyes, that person could develop the infection.

The following is a list of sources of transmission pathways in the home. Whether they apply to a given home depends on the home's characteristics, its heating and cooling systems, and how crowded it is.

- Air that contains pathogens (bacteria, viruses, or other microorganisms that can cause disease) can transfer these pathogens within rooms—through gaps, cracks, and joints in walls, doors, and windows (including those between rooms in one home and party walls between two separate homes); through air ducts, shafts, and common hallways; and even by wind from an open window in one home through another window into a neighboring or attached home.
- Plumbing waste systems—especially if plumbing traps[3] do not work properly or pipes leak—can release pathogens into the room and transfer them between rooms or between homes (if they share a wall) through

3. Curved pieces of drainpipe made from metal or polyvinyl chloride (PVC) underneath drains that create barriers in the drainpipes to prevent sewer gas (a mixture of toxic and nontoxic gases produced by decomposing sewage) from rising back up through the drain and into the house.

open air or pipes. Even when plumbing systems are properly trapped, some toilets can release plumes of aerosols[4] that might contain pathogens.
- Insects and rodents, such as mosquitoes and mice, can carry pathogens into homes.
- People can spread disease in single-family homes and multifamily buildings by spending time in close contact with others who are or are not members of their household in common areas, such as laundry rooms, elevators, lobbies, restrooms, and mail rooms.

Attached houses and those that are very close to one another can more easily transfer air that contains pathogens to each other than detached homes. The risk of disease spread increases with the degree of connectivity of different homes as well as crowding and turnover (the rate at which inhabitants leave and return) within a home.

About This Guide

Preparing your home in advance can help you, your family, and other household members stay physically and mentally healthy during an outbreak. This guide describes strategies for protecting household members from infection and for isolating those who develop the infectious disease or have a high risk of severe outcomes if they become infected. This guide also describes the supplies you might need, the information you should gather about your home and its heating and cooling systems, and other actions you can take before or during an outbreak to minimize your household's risk of illness.

How to apply the general recommendations in this guide to your home and its occupants will depend on how the disease organism is transmitted; the home's layout and its heating, ventilation, and cooling (HVAC) system capabilities; and how the HVAC system is used. For example, if the disease in the outbreak is transmitted primarily through the air, improving ventilation and filtration is critical. However, if the disease is transmitted primarily through contact with surfaces, keeping them clean is important.

4. Suspensions of fine solid or liquid particles in gas.

Outbreak Preparations

To prepare your home for a future outbreak, you need to gather certain emergency supplies and information about your home. You might also consider purchasing portable air purifiers, fans, or other items as well as making certain upgrades to your home, as described in this section.

Emergency Supplies

Obtaining emergency supplies will prepare your home for many types of emergencies, including disease outbreaks.

Items to stock in advance in case of an outbreak include the following:

- Spare high-efficiency filters to replace the one(s) used by your HVAC system (see the Air Filtration section).
- Soap and hand sanitizer.
- Disposable gloves (see local or national guidance on when to use them).
- Household products for cleaning and sanitizing (reducing or eliminating pathogenic agents) of household surfaces. If a pathogen can be spread by surfaces, cleaning surfaces without sanitizing them is often enough to eliminate the pathogen. Use sanitizers only when public health guidance recommends doing so.
- Sheet plastic and painter's tape, especially if your home is crowded and you might need to section off part of a room to isolate an ill person.
- A portable air cleaner and replacement filters for it (see Figure 1 and the Portable Air Cleaners section) to remove contaminants from the air in the bedroom of a sick household member or to reduce the risk of pathogen spread when someone from outside the household needs to enter the home.
- Face masks (Figure 2) in case a disease might be transmitted through the air. These masks must fit tightly around the face and allow little, if any, air to flow around the edges when the wearer breathes in or out.

Ventilation

Use of Ventilation to Dilute Contaminants in the Air

The term *ventilation* in this document refers to the use of outdoor air to dilute contaminants, which can include airborne infectious disease particles, in the indoor air. All of the strategies in this section can increase ventilation, which is helpful during an outbreak. However, increasing ventilation in the home should be done with caution for the following reasons:

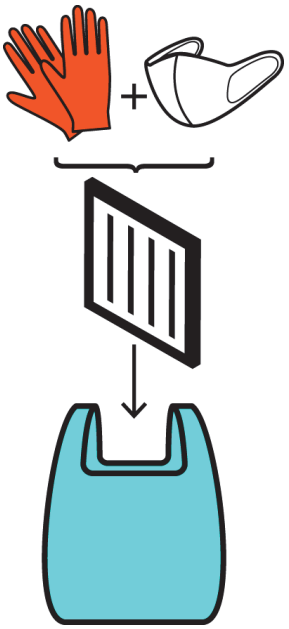

Figure 1 Be prepared to change the filters of portable air cleaners.

Source: Lawrence Berkeley National Laboratory. Reprinted with permission.

Figure 2 Have tightly fitting face masks available for airborne disease outbreaks.

Source: Lawrence Berkeley National Laboratory. Reprinted with permission.

- Home is the safest place to be during an outbreak, so the home needs to be comfortable enough to allow household members to remain there.
- Too much ventilation may have unwanted effects on indoor humidity (see the Outdoor Air and Humidity Effects sidebar).
- Bringing outdoor air into the home is only beneficial if the outdoor air is cleaner than the indoor air.

Windows

The simplest approach to ventilation is to open windows, if the weather allows. In many climates, this strategy has limited utility and carries the disadvantages of increasing noise and threatening security. Furthermore, the ventilation rate from open windows is not predictable and should not be relied on.

Find out which of your windows can be opened and whether each one has an undamaged screen to prevent insects from coming inside. Window screens are especially important when insects, such as mosquitoes, can spread the outbreak disease. If your windows do not have screens and you might need to keep your windows open during an outbreak, consider installing screens or purchasing mosquito net canopies or tents for your home's beds.

You can further increase the ventilation from windows by placing an electric fan so that it blows into or out of an open window. Purchase a fan that fits tightly into the window. Blowing air with the fan into a room will ventilate the room

Outdoor Air and Humidity Effects

If your air-conditioning system is turned on and the outdoor air is hot and humid, bringing more outdoor air into your home makes the indoor air more humid. If indoor humidity remains above 65% for more than a day, stop increasing the ventilation in your home to avoid moisture and mold problems.

If your heating system is turned on when the outdoor air is cold, bringing more outdoor air into your home will make the indoor air drier. (See the Indoor Humidity and Humidifiers sidebar.)

See Objective 2, Manage Moisture, of ASHRAE's *Indoor Air Quality Guide* for more information about indoor humidity (ASHRAE 2018).

Indoor Humidity and Humidifiers

Some incorrect published reports claim that ASHRAE recommends maintaining 40% to 60% relative humidity indoors. Opinions are mixed on whether controlling humidity helps control outbreaks. Preventing the air from becoming too humid benefits IAQ in general. See Objective 2, Manage Moisture, of ASHRAE's *Indoor Air Quality Guide* for more information about indoor humidity (ASHRAE 2018).

Whatever benefit might be achieved from increasing humidity will be outweighed by the risks of humidifying and the even greater risks of overhumidifying homes, especially in cold climates. Therefore, running a humidifier at home solely to control an outbreak is not recommended.

more effectively than blowing the air out of the room but could create drafts. For other considerations, see the Protected Space for High-Risk Household Members and Caring for a Household Member with the Infectious Disease sections.

Do not overly sacrifice comfort when using windows to ventilate your home. If opening the windows causes indoor air to become too cold, hot, or humid, occupants can develop thermal stress (health problems resulting from extreme heat or cold that the body cannot tolerate or adapt to), especially household members who are already unwell. A ceiling fan (as shown in Figure 3) can improve comfort when the air is too hot or humid.

Use caution when opening a window near another home's window or balcony or near other sources of contamination, such as trash and truck loading areas.

Some window air conditioners have vent controls, as shown in Figure 4. You can increase ventilation by moving the vent knob to OPEN.

Exhaust Fans

Many homes have exhaust fans in kitchens and bathrooms (as shown in Figure 5). As these exhaust fans remove air from the home, outdoor air is pulled into the home through cracks and other leaks in the home's exterior. You can use

Figure 3 Use a ceiling fan (if available) to improve comfort in hot or humid conditions.

Source: Amy Musser

bathroom exhaust fans to provide ventilation during an outbreak if they function properly and are vented to the outdoors.

To find out whether an exhaust fan works, hold a piece of paper up to the grille (see Figure 6) while the fan is turned on. If the paper sticks to the grille, the fan is working. To make sure that the fan is sending the air to the outdoors, look for an outlet outside the home and find out whether air is blowing out of it by putting your hand in front of the outlet. If the outlet has a damper, see whether it opens when the fan is turned on and closes when it is off, as shown in Figure 7. Before an outbreak, fix any exhaust fans that do not work properly. If you do not have kitchen or bathroom exhaust fans, consider adding them as a home upgrade, especially if you are remodeling a bathroom or kitchen. If bathroom fans are connected to a light switch, consider installing a switch that offers the option of turning the fan and light on separately.

If you have working bathroom exhaust fans, you can operate one or more of these fans continuously during an outbreak when the home is occupied. Use one

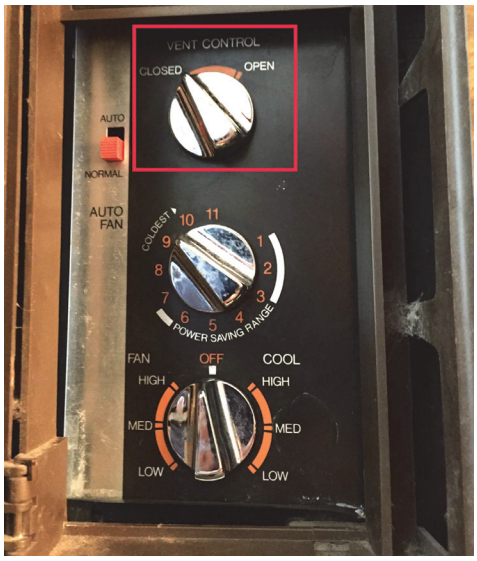

Figure 4 Window air conditioner with vent control (upper knob) that can be set to OPEN position for more ventilation.
Source: Amy Musser

Figure 5 Bathroom exhaust fan.
Source: Lawrence Berkeley National Laboratory. Reprinted with permission.

Figure 6 Confirmation of exhaust fan operation using a sheet of paper.
Source: Amy Musser

Figure 7 Exhaust fan outlet dampers: open (left) and closed (right).
Source: Schoen Engineering Inc. Reprinted with permission.

bathroom exhaust fan for small and mid-sized homes and two for larger homes. See the Outdoor Air and Humidity Effects sidebar and the discussions of bathrooms and shared bathrooms for other considerations. Kitchen fans are less suitable for continuous operation because they can be noisy and can have high flow rates, but they can be ideal for temporary use when visitors or repair people need to enter the home.

Building codes require all public bathrooms, including those in multifamily buildings, to have exhaust fans. These fans should be operated as required by local building codes, either continuously at a lower airflow rate or intermittently at a higher airflow rate.

Whole-Dwelling Ventilation Systems

Some homes have systems designed to provide ventilation throughout the structure. These whole-dwelling ventilation systems are most common in newer homes and homes that are built to green building standards. If you have such a system, find out how its controls work and whether you can operate it at a higher airflow rate or for a longer runtime to provide more ventilation than usual during an outbreak. If you do not have a whole-dwelling ventilation system, you should strongly consider having one installed.

These systems take many forms. The simplest ones use exhaust fans that run continuously or have controllers to run them intermittently. These fans serve a similar function to the recommended continuous operation during an outbreak of a regular bathroom exhaust fan when a home is occupied (see the Exhaust Fans section). The fans in whole-dwelling ventilation systems are designed to operate continuously and are usually quieter than regular bathroom exhaust fans.

Other types of whole-dwelling ventilation systems bring outdoor air directly into the home through an independent fan, a dehumidifier, or ductwork that is integrated into the home's warm air furnace or central air conditioning system. Energy recovery ventilators[5] and heat recovery ventilators[6] are other types of

5. Device that transfers both sensible and latent heat between the incoming air that ventilates a dwelling and the outgoing exhaust air. As a result, when the outside air is cold and dry, the incoming air is warmed and humidified, and when the outside air is hot and humid, the incoming air is cooled and dehumidified.

whole-dwelling ventilation systems that simultaneously supply and exhaust air while reducing the energy effects of ventilation.

Homes that have any of these types of ventilation systems already receive the benefits of diluting pathogens in the indoor air using outdoor air, and running them at a higher airflow rate or continuously will enhance their benefits. Refer to the Outdoor Air and Humidity Effects sidebar and *Indoor Air Quality Guide: Best Practices for Design, Construction, and Commissioning* (hereafter *IAQ Guide*; ASHRAE 2018) for more detailed information.

Air Filtration

Good home air filtration improves indoor air quality (IAQ) and is especially beneficial during an airborne infectious disease outbreak. If your HVAC system has a filter, find out whether you can replace it with a high-efficiency filter and upgrade the filter slot (see Strategy 7.2 in the *IAQ Guide*; ASHRAE 2018). Many air conditioners and furnaces have 1-inch-deep filter slots, which limit the types of filters that they can accommodate. If the filter slot is large enough to use 2-inch-thick filters, many more filter options are available. If your HVAC system has a 1-inch-deep filter slot, consult an HVAC contractor about upgrading to a 2-inch slot, and get a 2-inch-deep slot when replacing the air conditioner or furnace.

Filtering the air in your home during an outbreak is a good idea because filters remove airborne infectious particles. To filter the air, you need a filter and a fan to blow or suck air through the filter. A central HVAC system, portable air cleaners, or a combination thereof can filter air in homes effectively.

As particles that are removed collect on the filter, they reduce the flow of air. In extreme cases, the air can pull the filter out of its rack, at which point it does more harm than good. To avoid this problem, change your filters regularly. Some better filters need to be replaced more frequently, so check them more often.

Air-Handling Units

Air-handling units contain fans or blowers that draw air in; pass it through components that heat, cool, and/or dehumidify it; and then blow it out. Air-handling units used for home heating, cooling, or both usually contain filters that clean particles from the heated or cooled air that they deliver to the home's rooms. Central air-handling units usually use ducts to deliver air to some or all of the rooms in the home. Some smaller air-handling units, such as those that serve a single room or that deliver heated or cooled air without using ducts, have washable screens and cannot accept a filter that is efficient enough to remove sufficient amounts of small particles.

When the filter is in the air-handling unit, it cleans the air more effectively if it runs more often than it does to heat or cool the house (see Strategies 7.1 and 7.2 in the *IAQ Guide*; ASHRAE 2018). Filter fit (see Figure 8) is also an important consideration for effectiveness; air that bypasses a filter is not cleaned. Poorly installed filters (see Figure 9) are not effective. The most effective air-cleaning

6. Device that transfers sensible heat between the incoming air that ventilates a dwelling and the outgoing exhaust air so that the incoming air is warmed in winter or cooled in summer without transferring latent heat.

Figure 8 Tightly fitted, high-MERV filter in central air-handling unit.
Source: Amy Musser

Figure 9 How not to install air filters in an air-handling unit.
Source: Schoen Engineering Inc. Reprinted with permission.

Table 1 Efficiency of MERV Filters at Various Particle Size Ranges
Source: Adapted from Table 12-1, ASHRAE 2017.

MERV	Efficiency at Size Range in Microns (µm)		
	0.3 to 1.0 µm	1.0 to 3.0 µm	3.0 to 10.0 µm
8	No rating	20%	70%
9	No rating	35%	75%
10	No rating	50%	80%
11	20%	65%	85%
12	35%	80%	90%
13	50%	85%	90%

Note the high efficiency of a MERV-13 filter for removing 1.0 to 3.0 µm particles. Many particles capable of carrying a pathogen are larger than 1 µm.

strategies combine good filtration approaches with increased air-handling unit runtime. See the HVAC System Operation section for more information on how to increase clean air delivery during outbreaks.

Filter Efficiency

A filter that is able to remove the small particles containing viruses or bacteria can reduce the transmission of airborne diseases. The size of the smallest particle capable of carrying a pathogen is about 0.5 µm, which is large enough to be captured by filters, even though viruses themselves are smaller. For example, the size of the SARS-CoV-2 virus, which is responsible for causing COVID-19, is 0.08 to 0.12 µm. The remainder of the particle is composed of saliva and respiratory fluid.

Filters used in HVAC systems are rated for their ability to remove particles of a certain size range. See Table 1, which shows the efficiencies of common minimum efficiency reporting value (MERV) filters for three ranges of particle size. This table supersedes the MERV filters table in Strategy 7.2 in the *IAQ Guide* (ASHRAE 2018). The filter's MERV indicates, on a scale of 1 (least effective) to 16 (most effective), how effectively the filter traps particles, including those carrying pathogens, as well as dust, pollen, mold, and other irritants. Use filters in air-handling units that have as high a MERV as possible. ASHRAE recommends MERV 13 filters for outbreaks.

Almost all air-conditioner and furnace filters available to residential consumers use filters that have static electric charges on some of the fibers. The performance of these filters decreases over a period of weeks (Li 2020), so filters should be replaced every three months. A voluntary system for testing the efficiency of MERV filters as they age is available, but at the time of this writing, no manufacturers have chosen to use this system to test their filters for the consumer market.

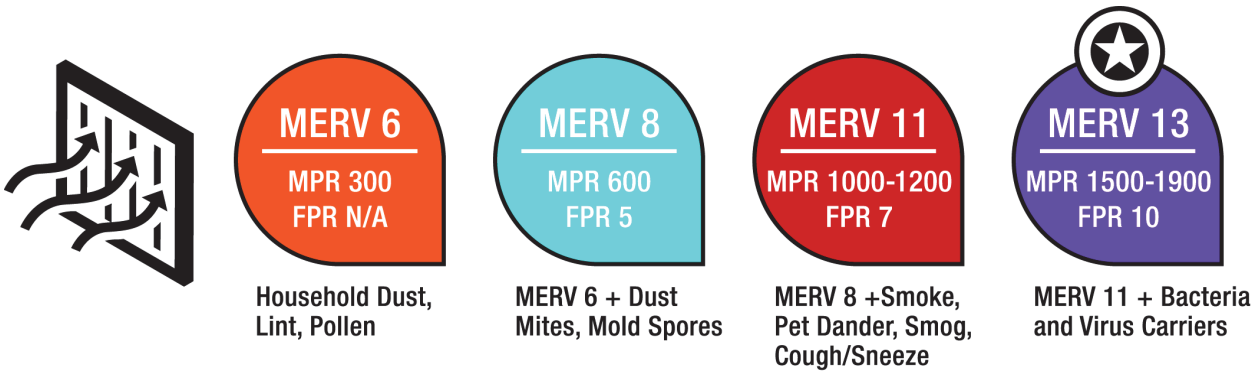

Figure 10 Types of particles that can be filtered at different MERVs.
Source: Lawrence Berkeley National Laboratory. Reprinted with permission.

Many of the filters sold to residential customers at retail stores use an alternate rating system,[7] but the MERV equivalent is sometimes provided in the fine print.

Regardless of the rating system used for a filter, the higher the rating or MERV (as illustrated in Figure 10), the more effectively the filter removes particles from the air that passes through it. However, for cleaning a room's air, the amount of air passing through the filter may be more important than the filter's efficiency because the room air passes through the filter several times. For this reason, operating your central HVAC system for longer than usual during an outbreak can help clean the air of pathogens. See the Air-Handling Units section.

High-efficiency filtration has benefits in ordinary times and during outbreaks of airborne infectious diseases. High-efficiency particulate air (HEPA) filters, a type of pleated mechanical air filter that is supposed to filter at least 99.97% of 0.3 µm airborne particles, filter air even more effectively than MERV filters. HEPA filters are not suitable or necessary for central HVAC systems in homes, but they are commonly used in portable air cleaners (see the Portable Air Cleaners section).

Do not count on window air conditioners, minisplit HVAC systems,[8] or other ductless HVAC units to effectively filter air. Washable screens on these units have no rating for particle removal.

Do not use an unproven technology to clean the air in your home. These technologies can be expensive to install and operate, might be no more effective than the filtration system you already have, and can even be harmful. Avoid using any filtration system that releases ozone. No performance or safety standards are available to determine the effectiveness or safety of devices that release ions, peroxide, or other substances into the air, despite the claims of their manufacturers. Ultraviolet (UV) radiation of the appropriate type (UV-C) can, in theory, disinfect

7. See www.consumerreports.org/cro/air-filters/buying-guide/index.htm for information on other systems.
8. Small, low-capacity heat pump or air conditioner, often in or close to the living space it serves. These indoor units are often ductless and serve a single room, but some can accommodate a small amount of ductwork and serve a few closely grouped rooms.

air, but using UV radiation for this purpose is challenging in the small space available in a residential air-handling unit and is expensive. Almost all novel technologies are unrated, of questionable efficacy, and almost impossible to compare with the standard technology of particle filtration by a central air-handling unit or portable air cleaner.

For additional information, see the following:

- ASHRAE COVID-19 filtration guidance at www.ashrae.org/technical-resources/filtration-disinfection#mechanical
- U.S. Environmental Protection Agency guidance on air cleaners and air filters in the home at www.epa.gov/indoor-air-quality-iaq/air-cleaners-and-air-filters-home

Portable Air Cleaners

Portable air cleaners (Figure 11) are small, self-contained appliances consisting of a fan and one or more filters. They often have a high-efficiency main filter, such as a HEPA filter, plus a less efficient prefilter that keeps larger particles from clogging the high-efficiency filter. Figure 12 shows a typical portable air cleaner in a bedroom.

Portable air cleaners are rated according to their clean air delivery rate (CADR), which indicates the volume of filtered air that an air cleaner delivers, with separate scores for tobacco smoke, pollen, and dust, rather than a score for filter efficiency alone. The CADR and the size of the room an air cleaner can effectively handle are listed on the product's packaging and on the unit.

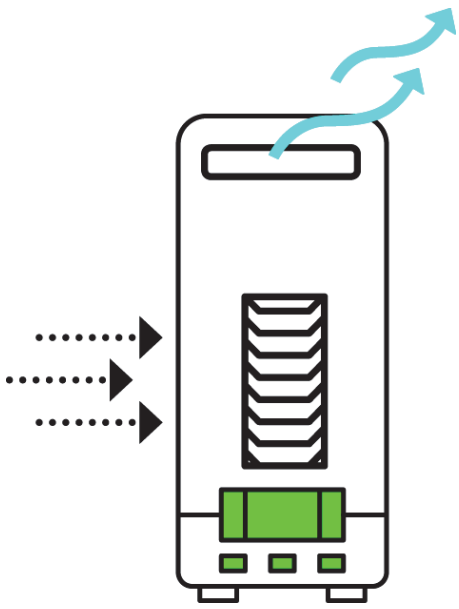

Figure 11 Conceptual diagram of a portable air cleaner.
Source: Lawrence Berkeley National Laboratory. Reprinted with permission.

Figure 12 Typical use of a portable air cleaner device.
Source: Amy Musser

For more information, see the following:

- Strategy 7.2 in the *IAQ Guide* (ASHRAE 2018), in particular the section Best Practices for Filter Selection and System Design, for more details on selecting a portable air cleaner
- ASHRAE guidance on using portable air cleaners in homes during the COVID-19 pandemic at www.ashrae.org/file%20library/technical%20resources/covid-19/in-room-air-cleaner-guidance-for-reducing-covid-19-in-air-in-your-space-or-room.pdf
- Information from the U.S. Environmental Protection Agency on portable air cleaners and air filters in the home at www.epa.gov/indoor-air-quality-iaq/air-cleaners-and-air-filters-home

Figure 13 illustrates many of the actions described herein to increase ventilation and improve filtration.

Bathrooms

In general, toilets that discharge water into the bowl more vigorously, such as those with a tankless flushometer valve (which uses pressure from the water sup-

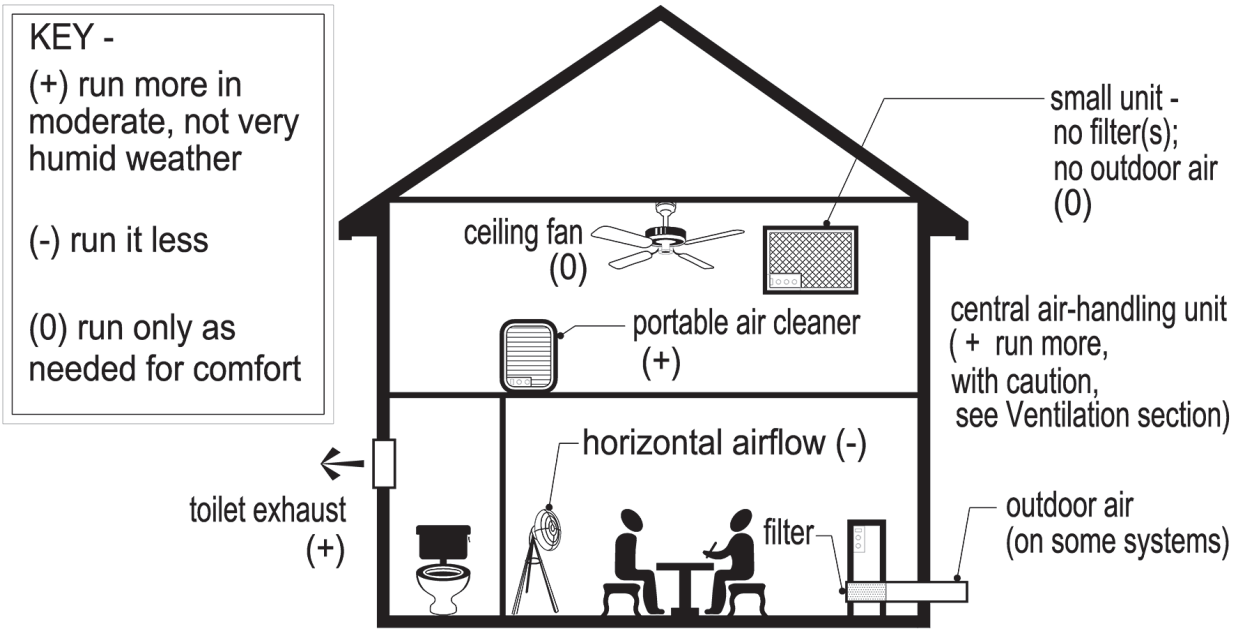

Figure 13 Actions that increase ventilation and improve filtration in a home.
Source: Schoen Engineering Inc. Reprinted with permission.

ply rather than gravity) or pressure-assisted flushing (which uses a pocket of air that is compressed by pressure from the water supply), produce more aerosols that might transmit infectious pathogens than toilets that operate by gravity alone (Johnson et al. 2013). Closing the toilet lid before flushing can reduce the amount of infectious aerosol released (Best et al. 2011).

Because sewer gas[9] is unpleasant to smell and can be harmful and infectious, drainpipes have a P shape to hold water and prevent the sewage gas from leaking into the room. These are called plumbing traps or P-traps because of their shape. See Figure 14 for a depiction of seals in plumbing traps. The traps of plumbing appliances—water- or drain-connected devices—remain filled by the normal flow of wastewater. Appliances and floor drains that are not used regularly can become dry when the water in them evaporates, which breaks the seal. Periodically using the appliance or adding water to the floor drain can prevent this problem. Another solution is to install a trap primer that automatically injects water into the trap, but these devices need to be installed by a plumber, which can be expensive.

Studies have shown that some infectious disease transmissions have been spread by plumbing chases in high-rise buildings (Wang et al. 2021).

Pest Control

Pests (such as mosquitoes and mice) can spread certain infectious diseases. Controlling pests is always beneficial but is particularly so during an outbreak if pests can transmit the disease in question. The walls that separate the indoors from

9. Mixture of toxic and nontoxic gases produced by decomposing sewage.

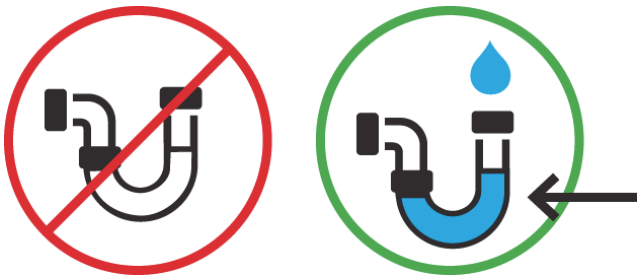

Figure 14 Plumbing Traps. The trap on the left has no water and must be avoided. The trap on the right has water (blue) that keeps sewer gas out of the room.

Source: Lawrence Berkeley National Laboratory. Reprinted with permission.

the outdoors should be well sealed to keep pests out (see Strategy 3.5 in the *IAQ Guide* [ASHRAE 2018] and the Compartmentalization section of this document).

Plans for Protecting High-Risk Household Members and Isolating the Sick

When planning for an outbreak, decide how you would protect people who are vulnerable to serious health effects if they were to develop the infection (e.g., because of age or health status), and isolate sick household members and those who are at high risk of exposure outside the home (e.g., because their work brings them into close contact with many other people). See the Protected Space for High-Risk Household Members and Caring for a Household Member with an Infectious Disease sections.

Crowding

Crowding is important to consider for both public health and planning to keep your household safe during an outbreak. Crowded housing, especially when bathrooms and sleeping spaces are shared, complicates efforts to protect high-risk household members and isolate those who are sick. Identify in advance any options for spreading out the members of your household in the home. For example, some household members might move to the home of a friend or relative or into a mobile or vacation home, if one is available, during an outbreak.

For Managers of Multifamily Buildings

Filtration

Central HVAC systems that supply air to common areas and apartments should follow guidance for HVAC systems. ASHRAE guidance for outbreaks calls for at least a MERV-13 filter that is fitted tightly to the filter rack (ASHRAE 2021); see the Air Filtration section for more information.

Ventilation

Exhaust fans can influence the direction of airflow, as explained in the Ventilation subsection of the Outbreak Preparations section. Make sure that exhaust fans in shared bathrooms, kitchens, and other high-occupancy areas work at full capacity when in use (see the section Shared Bathrooms in Multifamily Buildings, Group Homes and the section Shelters and Common Spaces).

If fans in bathrooms used by several households or in a single apartment are connected to a light switch, consider installing a switch that offers the option to turn on the fan and the light separately. If someone in an apartment or attached house has the infectious disease, that person could operate their exhaust fan continuously to try to maintain lower air pressure than in the surrounding units, which would prevent air from their home from flowing to neighboring apartments or attached houses.

Common Spaces

Managers of multifamily buildings that have common spaces (such as public meeting rooms, bathrooms, or laundry rooms) should make sure that the ventilation systems in these buildings are in good working order. Some codes require each elevator to have a fan that provides 1 cfm/ft^2 of ventilation (ICC 2017a). Confirm that each of these fans is operational and provides at least this amount of airflow, and replace fans with larger ones, when possible, to increase the air exchange to 60 times per hour during outbreaks (Otis 2021).

Minimum ventilation rates are prescribed by local codes and recommended by ASHRAE standards (Standard 62.2 for homes and Standard 62.1 for spaces shared by people from different homes; 2019a, 2019b) as well as Strategy 7.1 of the *IAQ Guide* (ASHRAE 2018). Adjust the ventilation rate for the current number of occupants and use of each space, which is especially important if a room or area has been reconfigured or its use has changed since its ventilation system was originally designed (e.g., an office has been converted into an exercise room). This adjustment may need to be determined by an engineer and implemented by a technician, although some skilled contractors can also make this adjustment.

Central HVAC systems and those that serve common spaces in multifamily buildings should be commissioned[10] before a crisis. Some conditions that might reduce airflow from a central HVAC system are shown in Figure 15. A condition specific to rooftop units is shown in Figure 16. Once an outbreak occurs, contractors might not be available to take care of commissioning and deficiencies because they are likely to be busy or could develop the illness. Find out as soon as possible whether you can increase ventilation, which would be useful during any outbreak.

Shared Bathrooms in Multifamily Buildings, Group Homes, and Shelters

Toilets in most public bathrooms, including those in multifamily buildings, do not have lids, because toilets with lids can require more maintenance than toilets

10. Commissioning is a complete startup process for new heating or cooling equipment to make sure that it operates according to manufacturer specifications and the home's parameters.

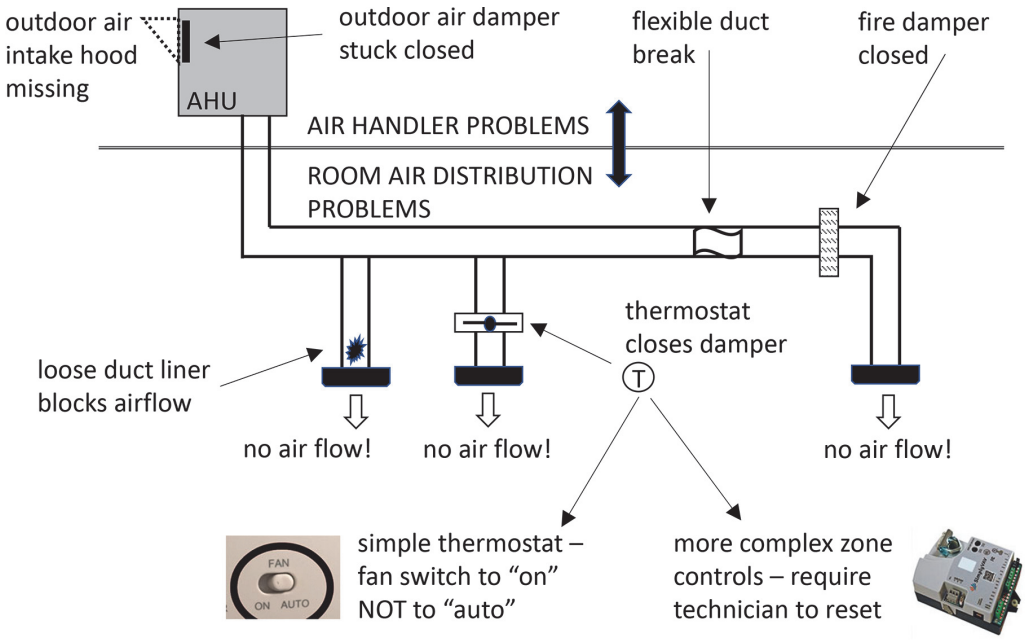

Figure 15 Potential air distribution problems with central air-handling systems.

Source: Schoen Engineering Inc. Reprinted with permission.

Figure 16 Rooftop HVAC units, including one with a missing ventilation hood.

Source: Schoen Engineering Inc. Reprinted with permission.

without lids. Plumbing codes usually require public bathrooms to have open-front toilet seats, which are shaped like the letter U and have an opening at the front, but do not prohibit toilets with lids (ICC 2017b).

In shelters for unhoused people and group homes, consider installing toilets with low flush energy (e.g., that have gravity-only tanks), and keep a supply of toilet lids to use during outbreaks. Of course, shared toilet rooms and bathrooms should have exhaust fans; see the Exhaust Fans section.

Install sinks for handwashing in the following locations:

- Near toilets
- In cafeterias, eating areas, and break rooms
- In meeting rooms where food or drink may be consumed

Consider installing sinks for handwashing in these additional locations:

- Next to high-traffic entrances and exits, including those to the outside
- Next to transaction counters
- Near shared desks, workstations, and telephones

Compartmentalization

When air flows between two apartments, it can transmit infectious particles from one apartment to the other. Air sealing—the sealing of gaps, cracks, and holes in surfaces or building enclosures from the flow of air—between units in multifamily buildings, known as *compartmentalization*, can reduce the risk of infectious disease transmission between apartments and other attached homes, such as semi-attached and row houses. Compartmentalization can also reduce the risk of poor IAQ and nuisance odor problems.

The stack effect happens when differences between indoor and outdoor air temperatures cause air to move between floors in a multistory building. The stack effect can transfer air, including air containing pathogens, from one unit to another that is vertically or diagonally above or below it. The taller the building, the stronger the effect. Airflow between units may be powered by the stack effect, operation of ventilation systems, wind pressure, or a combination of these factors. See *Multifamily Ventilation Retrofit Strategies* for more information on the stack effect (Ueno et al. 2012).

In addition to the stack effect, wind and air from exhaust fans, leaking ducts, and ventilation fans can cause air to move from areas of high pressure to areas of low pressure or between units. Wind can cause air to move from one side of a building to another side. Opening and closing windows can influence this airflow, sometimes in undesirable ways. When air flows between two apartments, pathogens in one apartment can be transmitted to the other.

Compartmentalization is the only practical way to reduce air transfer between apartments in a multifamily building. The ideal compartmentalization approach, shown in Figure 17, is used during initial construction or a major renovation. For existing buildings, compartmentalization is probably the single most important capital improvement to consider. Because compartmentalization is likely to be

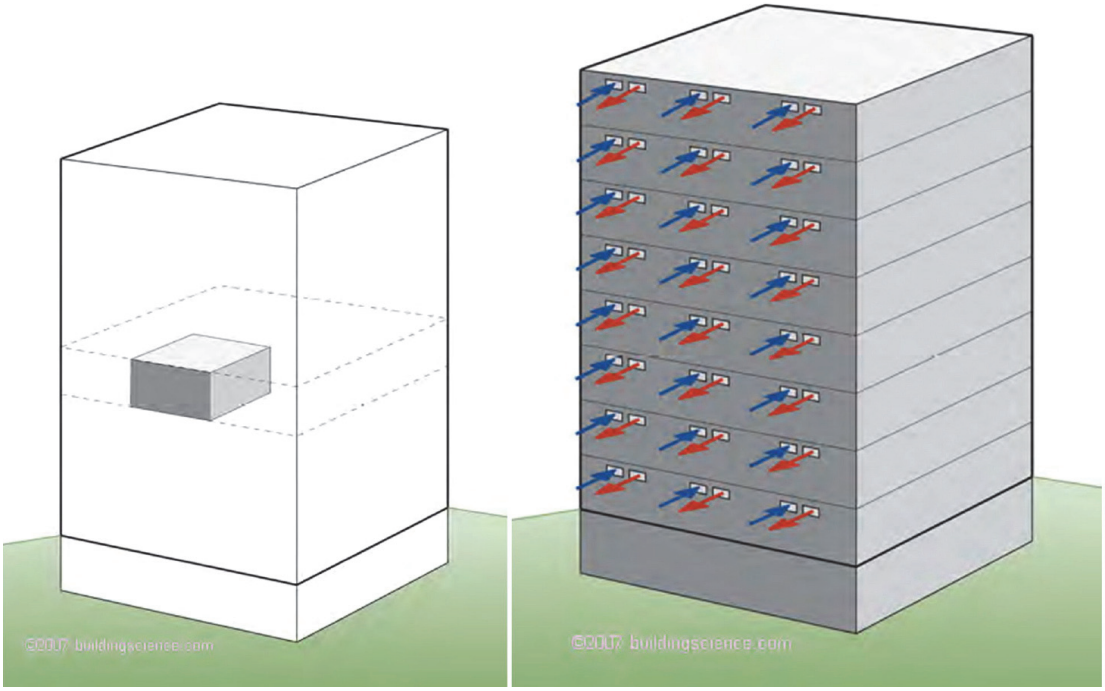

Figure 17 Ideal unit compartmentalization of a single apartment. This approach tightly seals an apartment, shown on the left, so that no air flows between that unit and other units. Each apartment has its own ventilation system, and air comes into each apartment only from outside (and not from other apartments). Air also travels from each apartment only to the outside (and not to other apartments), as shown on the right.

Source: Lstiburek 2005. Image copyright Building Science Corporation. Reprinted with permission.

costly and disrupt occupants, multifamily building owners and managers need to communicate the benefits of compartmentalization to residents.

Some examples of air sealing for compartmentalization are shown in Figures 18–20. For more details on compartmentalization techniques, see EERE's Building America Webinar, which focuses on wall, floor, and ceiling construction and covers potential barriers to compartmentalization in building codes (EERE 2016). Building Science Corporation's Information Sheet 405 provides equally important information on mitigating the penetration of walls, floors, and ceilings by pipes and wires (BSC 2014).

In general, compartmentalization can protect apartments in multifamily buildings from the transfer of air that might carry pathogens from other apartments in the building. However, this measure cannot prevent all airflow between different apartments in a building. In one dramatic outbreak of severe acute respiratory syndrome (SARS) in the Amoy Gardens high-rise apartment complex in Hong Kong,

particularly on the upwind side of one building, SARS spread from one building to another because of a dried-out floor drain (see the Bathrooms section for more details on how to use plumbing fixtures and floor drains to prevent this effect), a toilet exhaust fan, and the wind (Yu et al. 2004; Li et al. 2005b; Li et al. 2006).

For options to minimize airflow between apartments in a building during an outbreak, see the Protected Space for High-Risk Household Members section.

Figure 18 Air sealing for wood-frame construction.
Source: EERE 2016. Photographs from Energylogic.

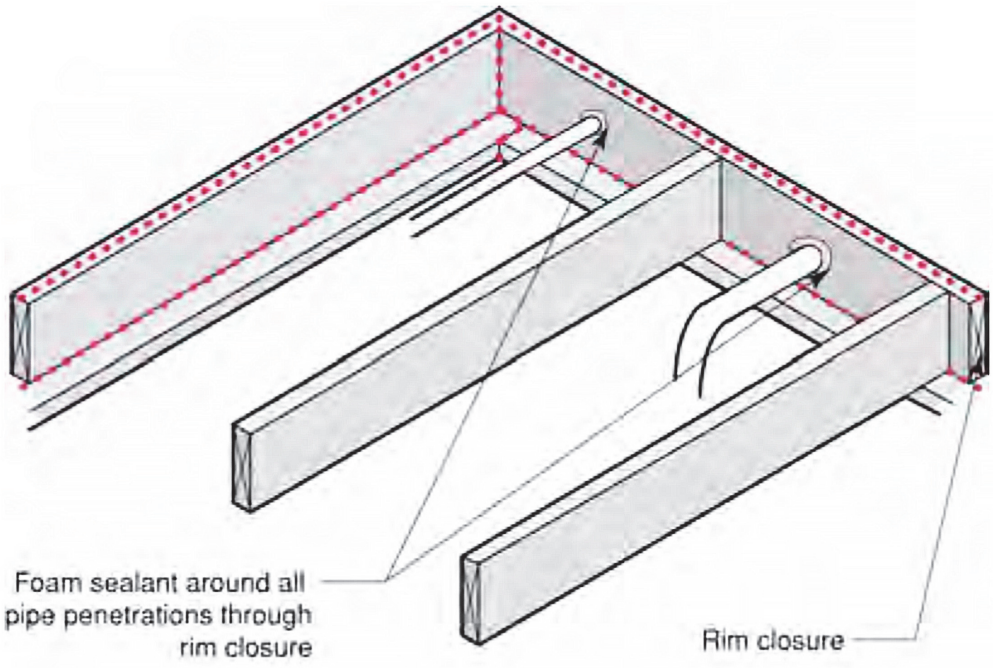

Figure 19 Air sealing where a pipe penetrates the outside wall.
Source: BSC 2014. Reprinted with permission.

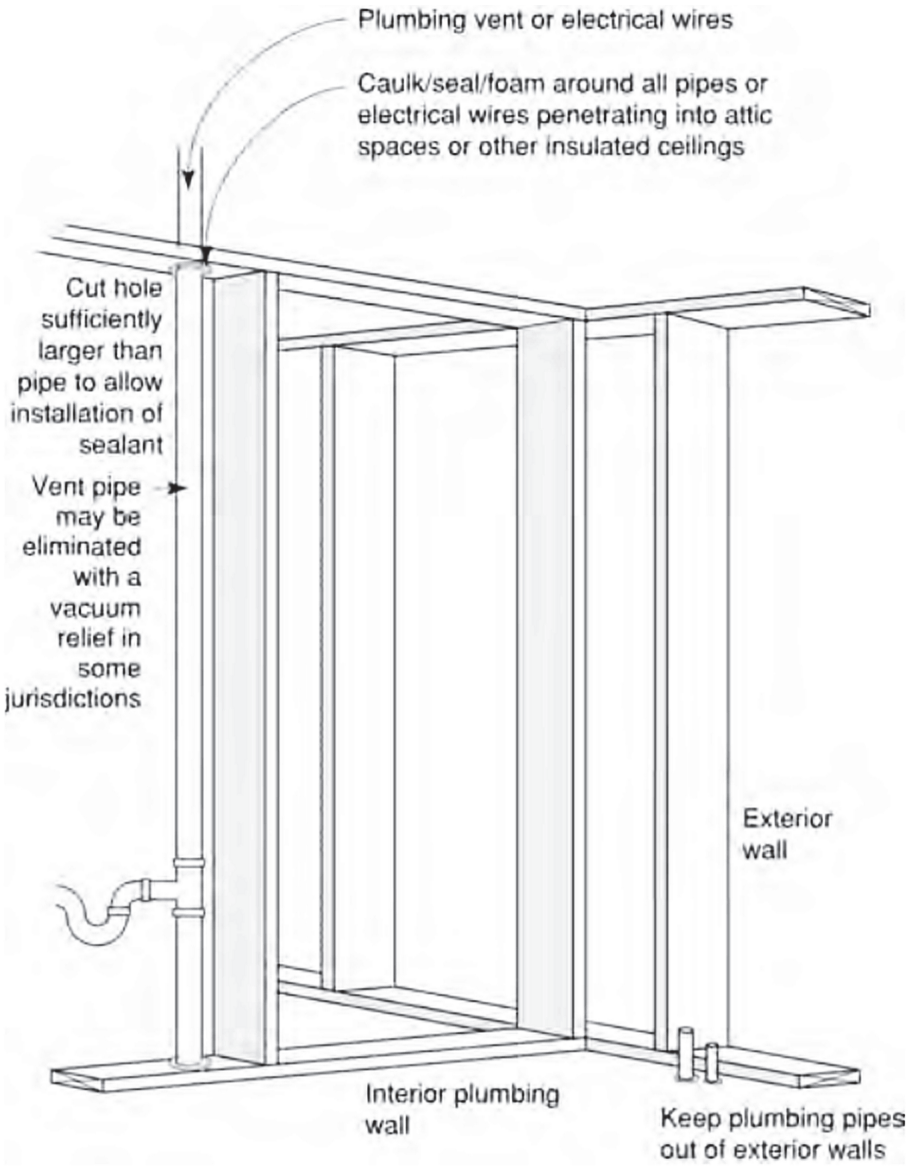

Figure 20 Air sealing at a vertical plumbing pipe.
Source: BSC 2014. Reprinted with permission.

Strategies to Minimize Risk in the Home During an Outbreak

When taking precautions during an outbreak, remember that the appropriate measures are different from those that are suitable for other types of threats, such as floods, wildfires, hurricanes, and active shooter situations.

Minimizing Risk to Household Members

During an outbreak, everyone needs to stay home if they are sick.

To minimize the risk of spreading the infectious pathogen, those who live with other people should cover their mouths with a tissue or fabric using the elbow technique (burying their nose and mouth in their elbow, preferably while wearing long sleeves) and not with their hands when they cough or sneeze. Everyone should also wash hands frequently, keep high-touch surfaces clean, and avoid crowded and poorly ventilated indoor spaces.

Do not share personal items with other members of your household during an outbreak. Follow health authority instructions for cleaning and sanitizing items that you bring into the home if the disease can be transmitted by contact with surfaces.

Preventing Transmission by Maintenance Personnel

When a maintenance worker, cleaner, or other person from outside the household comes into the home during an outbreak, residents who do not need to interact with the outsider should stay in a different room. If the disease can be transmitted by close contact with an infected person or through the air, residents should wear masks. Opening windows, running exhaust fans, or turning on portable air cleaners can reduce the risk that the visitor and household members will transmit the infection to one another.

Maintenance personnel should follow masking and sanitation practices recommended by local health authorities when they enter a home or, in a multifamily building, a common area during an outbreak. They should err on the side of safety and courtesy to the most vulnerable or cautious residents.

HVAC System Operation

During an outbreak, continue the normal operation of minisplit HVAC systems,[11] window air conditioners, and HVAC systems that have no filters or out-

11. Small, low-capacity heat pump or air conditioner, often in or close to the living space it serves. These indoor units are often ductless and serve a single room, but some can accommodate a small amount of ductwork and serve a few closely grouped rooms.

side air connections. However, move fans so that they do not blow air horizontally from one person to another.

Do the following whenever someone is home and air from outdoors does not make temperature or humidity inside the home uncomfortable:

- If your home has a central HVAC system with a MERV-rated filter, set the thermostat to Fan On and not Fan Auto (see Figure 21) if it has such a switch.
- Run bathroom exhaust fans continuously whenever more than one person is home. See the Outdoor Air and Humidity Effects sidebar.
- If your house has a whole-dwelling ventilation system, increase the system's airflow rate or its operating time, if possible.

All of the above steps will remove contaminants but will also use more energy and can affect humidity (see the Outdoor Air and Humidity Effects sidebar). Therefore, only take these steps during an outbreak when the home is occupied.

HVAC system operation is rarely the cause of disease transmission, and such systems are useful for health and comfort. See the Caring for a Household Member with the Infectious Disease section for guidance on isolating these household members, which includes changes in HVAC system operation. The HVAC system controls indoor temperature, humidity, and air movement to keep occupants comfortable, and running the system makes it easier for household members to stay home while preventing the indoor air from becoming too hot or too cold. All but the very poorest HVAC systems provide some air filtration, so they improve overall IAQ and might reduce the risk of disease transmission. For these reasons, HVAC systems should generally not be turned off during outbreaks.

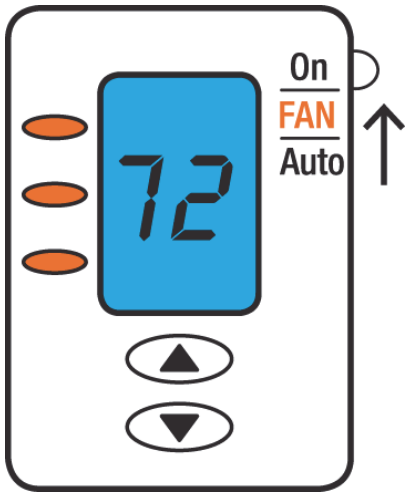

Figure 21 Fan ON thermostat setting for use during outbreaks.
Source: Lawrence Berkeley National Laboratory. Reprinted with permission.

Use of Portable Air Cleaners

The best location for portable air cleaners in your home during an outbreak depends on how many you have and whether a person in the home has been exposed to or infected by the pathogen.

- If someone in the house is sick, the first air cleaner should be placed in the sick person's room because filtration is most effective when it is near the source of the infectious virus or bacteria. See the Caring for a Household Member with the Infectious Disease section.
- If no one in the house is sick, the first place to put an air cleaner is in the room where people spend the most time together.
- If you have more than one air cleaner, place the others in bedrooms where the largest number of people spend the most time or in the bedroom(s) of the most vulnerable person(s) in the house.

Portable air cleaners that are safe and effective can also improve overall IAQ, especially during wildfires or whenever outdoor air quality is poor.

Protected Space for High-Risk Household Members

Protect vulnerable, housebound people who are at high risk of serious health consequences or even death if they become infected (e.g., because of a compromised immune system) by creating a private space in the home. This space should keep them away from other people (and thus from potential sources of infection) in the home as much as possible.

The first step in creating a protection area is to select a space.

- A private bedroom with an attached bathroom or toilet room is a good choice for a protection area because the vulnerable person can use a sink, bath or shower, and toilet without leaving the space.
- A private bedroom without an attached bathroom is a good second choice.
- If the vulnerable person must share a room with someone who is not known to have the infection, choose a room with separate beds. A draped partition made from plastic film or clean sheets will provide some protection for the vulnerable person from exposure to others who might be infected.

The next step is to reduce airflow from the rest of the home to the protection area by doing the following:

- Keep the entry door to the protection zone closed, except when someone is entering or leaving that zone. If a significant amount of empty space is between the door and the floor, use a towel to seal that space when the door is closed. If someone in the home has the right skills, they can fit the bottom of the door with weather stripping (a strip of material typically used to keep out rain, snow, and hot or cold air) and a door sweep (a small piece of plastic or rubber attached to an aluminum carrier strip).

- If the room has doors that open into other rooms that are not needed, seal the cracks around the edges of these doors using painter's tape. This type of tape does a good job of preventing air from leaking and is not likely to damage the paint when it is removed.
- If the room is normally heated, cooled, or both from a central HVAC system but can be equipped with its own heating and cooling system, install such a system. If the space does not have its own heating and cooling system and the weather is mild enough to maintain reasonable comfort in the protection space without the central HVAC system, seal the supply air grilles (locations from which hot or cold air is pumped back into the home) and return air grilles (locations from which air is drawn into the air-handling system) as described in the Caring for a Household Member with an Infection Disease section.
- Lower the concentration of airborne particles to reduce the risk of transmitting the pathogen in the protection room by increasing air exchange with the outdoors. Alternatively, use a portable fan in a window to blow air into the room if the weather does not make the room uncomfortable when the fan is on. The fan should be just large enough so that when you stand outside the protection room and keep a door to the rest of the house open by about half an inch, you feel a slight breeze flowing through the crack from the protection room to rest of the house. Opening a window is a less effective method of increasing air exchange with the outside; do so if the weather, noise, and home security allow for open windows when the use of a fan is not possible.

See the Air Filtration section for more information on options for filtering air in the protection room, such as by using a portable air cleaner.

Less vulnerable family members should wipe down high-contact surfaces after using a shared bathroom or kitchen.

When in the protection area, do the following:

- Always close the door after entering or leaving.
- Wear a mask and gloves while in the room, and wash your hands or apply hand sanitizer before entering and after leaving the room.
- Monitor your symptoms and those of everyone in the household.

Maintain the temperature in the protection room within a comfortable range. If the room is too warm or too cold, you might need to use a space heater or window air conditioner.

Being isolated for several days is disorienting and stressful, and people in isolation areas benefit from having visitors. However, reduce the risk of disease transmission to the vulnerable person by limiting the number and frequency of visitors. Ideally, visits should take place outdoors. If visits must take place indoors, everyone should wear a mask during the visit and wash their hands before and after the visit.

The vulnerable person might need to leave the protection room to use the bathroom, eat, or simply to stretch their legs and break the monotony. Whenever they

leave the protection room, they should wear a mask while they are out of the room, close the door to the protection room after they leave it, and wash their hands when they return. Surfaces in the home that the vulnerable person touches should be cleaned frequently.

Caring for a Household Member with the Infectious Disease

When an infectious disease can be transmitted by close contact or is airborne, it is a good idea to isolate anyone who has the disease, has symptoms of the disease but has not (yet) been diagnosed with it, or has been exposed to someone else with the disease.

The first step in creating an isolation area is to select a space.

- A private bedroom with an attached bathroom or toilet room is a good choice for an isolation area because the patient can use a sink, bath or shower, and toilet without leaving isolation. In addition, the bathroom is likely to have an exhaust fan that can reduce the spread of contaminants from the infected person to the rest of the household.
- A private bedroom without an attached bathroom is a good second choice.
- If the infected person must share a room with someone who does not have the infection, choose a room with separate beds. A draped partition made from plastic film or clean sheets will provide some protection for the uninfected person.

The next step is to make sure that air from the isolation area does not reach the rest of the home by doing the following:

- Keep the entry door to the isolation area closed, except when someone is entering or leaving that area. If a significant amount of empty space is between the door and the floor, use a towel to seal that space when the door is closed. If someone in the home has the right skills, they can fit the door with weather stripping and a door sweep.
- If the room has doors that open into other rooms that are not needed, seal the cracks around the edges of the doors using painter's tape. This type of tape does a good job of preventing air from leaking and is not likely to damage the paint when it is removed.
- If the room is heated, cooled, or both from a central HVAC system, seal any return air grilles in the room. You can apply painter's tape or contact paper directly to the grilles or louvers (the angled slats) to seal them, or you can tape paper or plastic film over them. In some cases, you can remove floor grilles and registers, wrap them in plastic bags, and place them back into the duct openings. Finally, magnetic grille covers (such as the one shown in Figure 22) are commonly available.
- If the home has gas appliances, make sure that it also has a good carbon monoxide detector that is less than 10 years old and works properly. This is especially important if you add exhaust fans or close off supply or return air grilles.

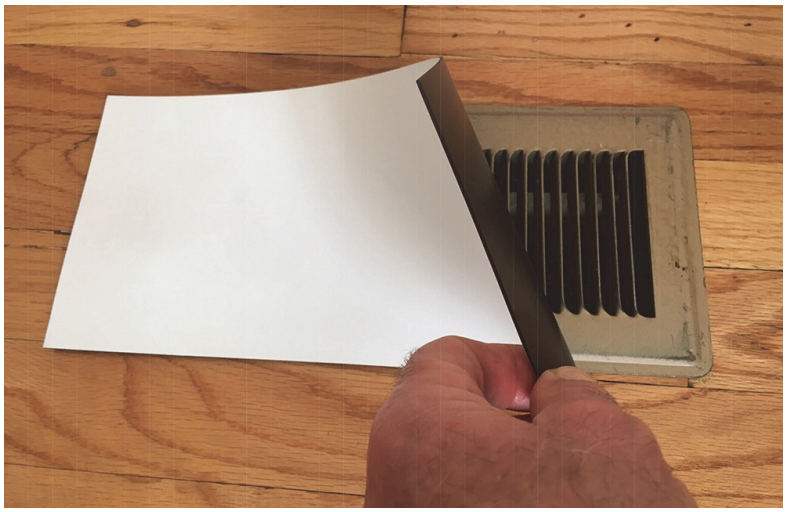

Figure 22 Magnetic air grille cover.
Source: Schoen Engineering Inc.

- Run the exhaust fan in the bathroom if the isolation area has one (see above). If it does not, use an exhaust fan in the isolation room (see below). Keep the fan running until the person no longer needs to be isolated; see the Outdoor Air and Humidity Effects sidebar. Keep people away from exhaust fan outlets that are close to operable windows, doors, other intakes, or areas where people walk by or congregate (such as patios); keep nearby operable windows closed; or do not run the exhaust fan.
- If the room can be equipped with its own heating and cooling system or the weather is mild enough to maintain reasonable comfort without heating or cooling, then seal the supply air grilles in addition to sealing the return air grilles as described above.
- Lower the concentration of airborne particles in the isolation room by increasing air exchange with the outdoors or filtering the air to reduce the risk of transmitting the disease to others in the home.

To increase air exchange with the outdoors and to keep air in the isolation area from reaching the rest of the home, you can use a portable fan in a window to blow air out of the room, as long as the fan does not make the room uncomfortable. The fan should be just large enough so that when you stand inside the isolation room and open a door to the rest of the house by about half an inch, you feel a slight breeze flowing through the crack from the rest of the house to the isolation room. Opening a window is a less effective method for increasing air exchange with the outside; do so if the weather, noise, and security allow for open windows when the use of a fan is not possible.

See the Air Filtration section for more information on options for filtering air from the patient's room. For example, portable air cleaners not only filter air but also offer a useful alternative to exhaust fans for increasing the delivery rate of clean air.

If the sick person feels well enough, they should wipe down high-contact surfaces after using a shared bathroom or kitchen. Otherwise, the healthy occupants should clean these surfaces often.

Caregivers must be able to safely and easily enter and leave the isolation area numerous times throughout the day. To keep themselves safe and protect other household members while caring for the patient, caregivers should do the following:

- Always close the door when entering or leaving the isolation area.
- Wear a mask and disposable gloves while in the room, and wash their hands or apply hand sanitizer before entering and after leaving the room.
- Place used gloves, tissues, and other disposable items used for personal care into a trash bin lined with a disposable bag that can be sealed and removed.
- Remove laundry from the isolation room in plastic bags while wearing disposable gloves. Caregivers should not shake laundry items before putting them into a plastic bag or washing machine.
- Monitor their own symptoms.

Maintain the temperature in the isolation room within a range that is comfortable for the patient. If the room is too warm or too cold, the room might need a space heater or window air conditioner.

As noted in the Protected Space for High-Risk Household Members section, being isolated for several days is disorienting and stressful for patients, and they benefit from having visitors. However, reduce the risk of disease transmission by limiting the number and frequency of visitors. Ideally, visits should take place outdoors. If visits must take place indoors (because the patient is too sick to go outside or the weather is poor), visitors should wear masks during the visit, and they should clean their hands before and after the visit.

The patient might need to leave the isolation room to use the bathroom, eat, or simply to stretch their legs and break the monotony. Whenever they leave the isolation room, the patient should wash their hands, wear a mask, and close the door to the isolation room. A caregiver should clean and sanitize any surfaces that the patient has touched after the patient returns to the isolation room.

Stay-at-Home Orders

Restrictions on public activity during outbreaks might be recommended by public health authorities; ordered by governments; or implemented by businesses, schools, and other organizations. Restrictions may include stay-at-home orders or recommendations (as shown in Figure 23), closures of nonessential businesses, and limits on the sizes and locations of gatherings. During an outbreak, everyone should stay home as much as possible and leave only for essential or healthy outdoor activities that can be done without mingling with crowds. These precautions benefit everyone in the household.

Visits can spread infectious diseases. Follow the advice of health authorities regarding receiving visits from friends and family from outside the home.

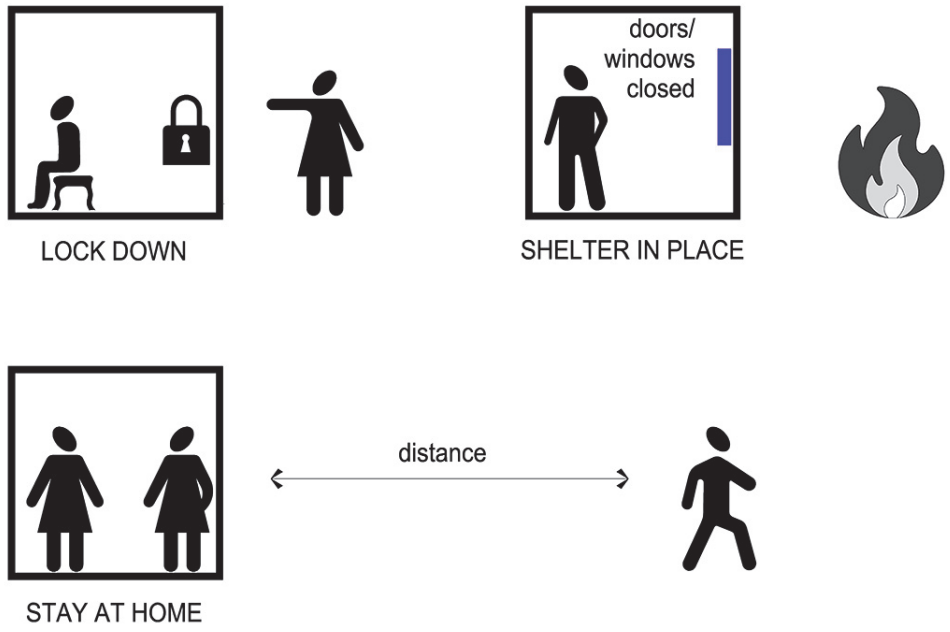

Figure 23 Different responses for different emergencies.
Source: Schoen Engineering Inc. Reprinted with permission.

Crowding

The best way to prevent crowding in the home depends on the type of pathogen and available resources. If no options are available for making the home less crowded, use the techniques described in the Protected Space for High-Risk Household Members and Caring for a Household Member with an Infectious Disease sections.

When the bathrooms in the home are shared, keeping them clean is particularly important. Good bathroom hygiene practices to follow during an outbreak include turning on exhaust fans while using the bathroom and closing toilet lids before flushing.

Windows

Keeping windows open whenever the weather permits, including in multifamily buildings, can reduce the spread of airborne pathogens by diluting the indoor air. Windows should have insect screens, which are especially important when the disease is transmitted by insects.

Opening more than one window at a time allows cross-ventilation[12] and is especially effective if the windows are on opposite walls. Opening two windows in walls that are perpendicular to each other is almost as effective. Even opening the top and bottom of a single window can achieve some additional ventilation.

12. Relies on wind to force cool exterior air into the building through an inlet while an outlet forces warm interior air outside.

If a household member is isolated, opening windows in the isolation room can help keep the temperature comfortable when the weather is mild. However, keeping the person too hot or too cold for the sake of increased ventilation can make them even more uncomfortable and could have adverse health effects, so this is not advised.

Windows in Multifamily Buildings and Attached Houses

Keeping windows open in multifamily buildings and attached houses increases the effects of wind-driven pressure differences between homes. As a result, air can move between attached apartments or houses in unpredictable ways, especially in multistory buildings (such as apartment buildings). In most cases, this effect is offset by the dilution of the indoor air.

Special Considerations for Owners, Builders, and Managers of Multifamily Buildings

Show Leadership

Builders, owners, and managers of multifamily buildings should exercise their collective responsibility to communicate and reinforce the ways in which personal choices affect the spread of infectious disease and its impact not only on themselves but also on building residents. Choices related to hygiene and social distancing[13] directly affect the chances of spreading infection.

Reduce Direct Interpersonal Contact

Close all but the most essential public restrooms unless public health authorities determine that the pathogen cannot be transmitted through human waste.

Postpone maintenance and inspections inside apartments during outbreaks. The only exceptions are maintenance and inspection activities that affect proper operation of ventilation and filtration systems or are otherwise critical to occupant health and safety.

Shared Bathrooms

Some bathrooms that are shared, especially if these are the only bathrooms available to certain residents, must stay open during an outbreak. Signs may be needed instructing users to close the toilet lid before flushing.

Homes with High Occupancy Turnover Rates

When residents move out of an apartment, building owners and managers should develop strategies to reduce infection risk to the new occupants. Strategies to prevent the spread of pathogens after the previous occupants leave and before the new ones move in should include the following:

- Airing out or ventilating the unit
- Thoroughly cleaning kitchens and bathrooms
- Disinfecting all high-touch surfaces
- Ensuring that the ventilation and filtration systems operate as intended
- Making sure that plumbing traps have water seals

13. Increasing the space between individuals and decreasing the frequency of contact to reduce the risk of spreading a disease.

Common Spaces

To minimize the spread of infection in common spaces in multifamily buildings during an outbreak, clean and disinfect high-contact surfaces frequently—including elevator controls, railings, door handles, buttons, and mailboxes. To prevent the spread of airborne disease, encourage all residents to maintain social distancing and wear masks in common spaces. Other strategies might include closing nonessential common spaces (e.g., pools or exercise rooms) and using signs to remind occupants to maintain appropriate distances from one another.

Building owners and managers might also take the following additional steps during an outbreak:

- Increase rates of ventilation and improve filtration (see the Ventilation and Air Filtration sections).
- Decrease occupancy when the ventilation rate of indoor air to the outdoors or the level of air filtration cannot be enhanced.
- Change schedules for using common spaces that remain open to prevent close contact among people from different households. For example, stagger activity times, reduce the sizes of groups allowed, and reduce mixing among groups.
- Maintain access to and adequate supplies in laundry facilities, but restrict the number of people who can be in these spaces at the same time.
- Shut down shared food preparation and warming areas, including pantries and coffee stations, and other nonessential indoor shared spaces, such as game rooms, computer rooms, exercise rooms, and lounges. If shutting down these spaces is not possible, supervise them closely.
- Close water fountains or post warning signs recommending the use of bottle filling stations and sinks instead. An even better approach is to encourage residents to use water from their own apartments.

Elevators

During an outbreak, sick people might be able to infect others while waiting for or riding in an elevator. Little information is available on whether elevators are a major source of infectious pathogen spread. Elevators are required by local code to have ventilation openings, and they might also have ventilation fans, although local codes do not require such fans (Otis 2021).

Guidance for operating elevators in multifamily buildings during an outbreak is as follows (CDC 2021):

- Use floor markings, stanchions for lobbies, and signs to encourage social distancing between people waiting for or riding in an elevator.
- Encourage people to wear masks and avoid speaking, which can transmit the pathogen into the air.
- Consider limiting the number of people allowed to ride at the same time to maintain social distancing.
- Post signs reminding occupants to avoid touching surfaces as much as possible and encourage them to use an object or a knuckle to push elevator buttons.

- Encourage residents to ride the elevator alone whenever possible.
- Encourage passengers to wash their hands and avoid touching their faces after holding on to handrails or touching buttons in an elevator.
- Consider increasing air ventilation and filtration in the building's elevators.

Steps for enhancing the ventilation in elevators are listed below:

- After ensuring that the elevator's fan is operational, adjust its airflow rate to at least the code requirement and, if possible, set it to exchange the air 60 times per hour (Otis 2021).
- Set the timer to run the ventilation fan continuously, especially during high-use periods. Some elevator controllers turn the fan off a minute after the elevator stops moving. This time should be lengthened during an outbreak. During low-use periods, you can program the fan to run for 10 minutes (for comparison, an 18-minute run time might be sufficient for a hospital elevator's ventilation fan) (Van Rijn et al. 2020).
- Consider leaving the elevator door open when the elevator is not used for long periods (Van Rijn et al. 2020). However, doing so could accelerate the spread of fire and will increase infiltration of outdoor air into building lobbies, which will increase energy use and humidity levels.

The U.S. Centers for Disease Control and Prevention suggest that occupants use stairs instead of elevators, when possible, during outbreaks. However, use of stairs is less essential in residential buildings, where many people are less likely to use the elevators at the same time. Furthermore, stairwells that are not regularly occupied often have no code-required ventilation.

Recommendations for elevator behavior during the COVID-19 pandemic that are applicable to future outbreaks include the following (Allen 2020; HSPH 2020):

- Wear a mask.
- Enter the elevator in a checkerboard pattern.
- Face forward.
- Ask someone standing near the elevator buttons to push the right buttons for all of the passengers.
- Use your knuckle instead of a finger to push a floor button.
- Avoid unnecessary talking to anyone else in the elevator.
- Stand as far away from other passengers as possible.
- Try not to sneeze or cough. If you cannot avoid sneezing or coughing, turn toward the wall and cough or sneeze into an elbow while wearing a mask.
- When the door opens at each floor, move to the side if you are standing in the middle or, if you are standing at the front, leave the elevator to allow others to exit.

Of course, if you have the option (and time), the best strategy is to ride the elevator alone.

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