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Spread of microbes and their elimination from indoor air

Disease-causing microbes are very small in size. Typically, flu-causing viruses are sized from 80 to 120 nm, but bacteria or clusters can be much larger, up to several micrometers. Particles of the size of viruses travel in the air for long periods of time (hours) and distances. However, bacteria also remain in air currents, settling on the surfaces relatively quickly, mostly within tens of minutes.

The most significant transmission of microbes that are causing respiratory diseases occurs through the air via aerosols and droplets, and indirectly through surfaces. Breathing, talking, sneezing and coughing are the most significant sources of respiratory pathogens. Up to 40,000 droplets fly at a maximum speed of 100 m / s, and a cough can produce 3,000 droplet cores, as seen in Figure 1. Large droplets fall quickly on the floor or other surfaces, but medium-sized (5 µm… 100 µm) droplets can travel in the air for some distance and then transmit to people nearby. These droplets can also form smaller aerosols as the water evaporates. These droplet cores and small aerosols (<5 µm) linger in the air for long periods of time. They travel with air currents and are spread everywhere by turbulence vortices.

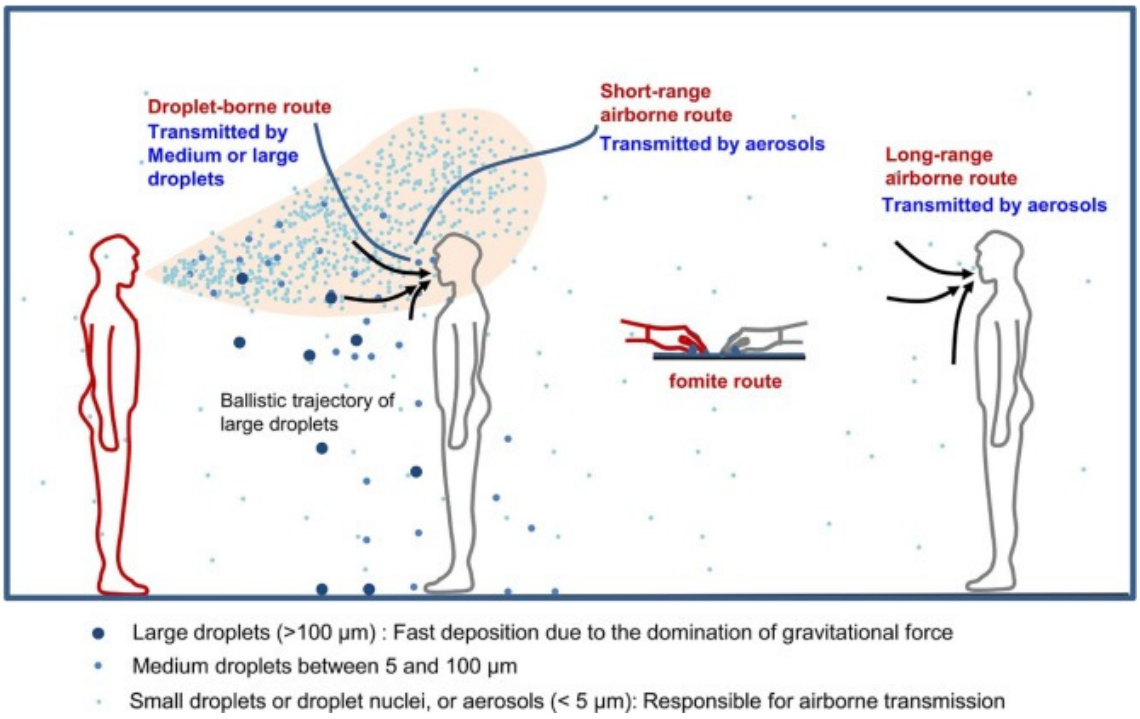

Figure 1. Dissemination of pathogens through droplets by air and from surfaces. [1]

Ventilation causes indoor air flows, and the air speed near the supply air and exhaust air valves can be high but less than 0.25 m/s in the living areas to avoid the feeling of draft. Flows in the door openings are caused by temperature differences between the rooms, and by opening and closing of the doors. Human activity also causes currents, respiration, and movement-induced flows. There is also an upward air flow caused by heat around the human body. Its speed can be up to 0.25 m / s in the upper body. The flow caused by body heat forms a protective layer around the person, but on the other hand lifts dirt from the vicinity of the floor into the breathing air. In addition, there may be devices in the room that cause airflows due to fans or heat.

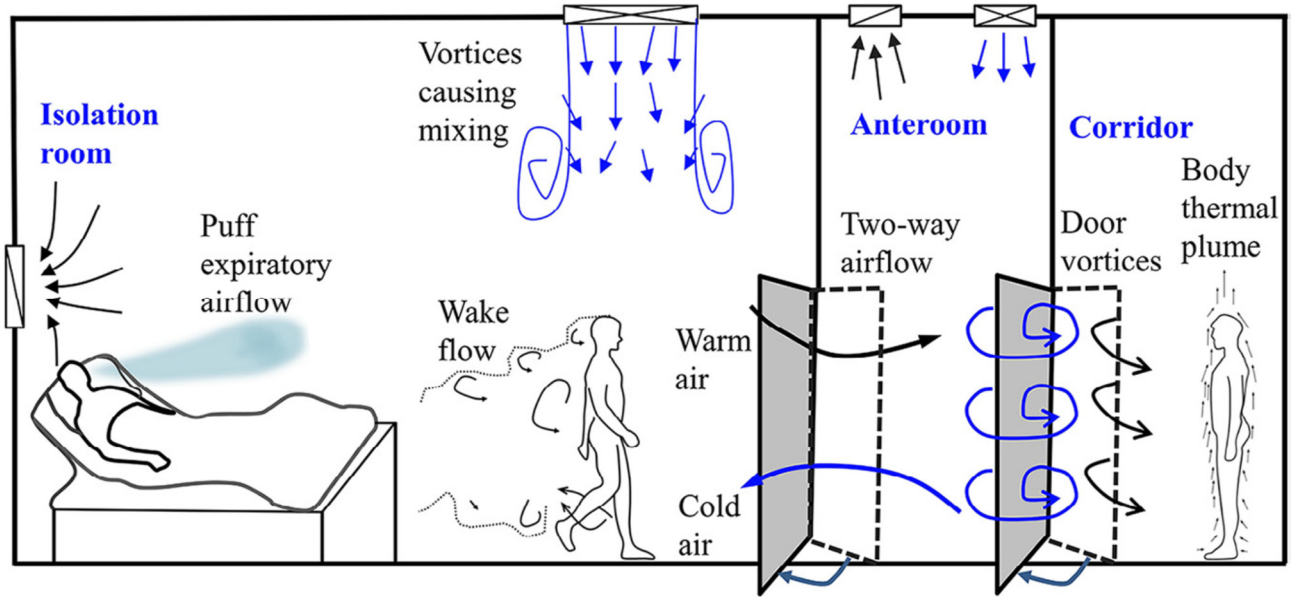

Figure 2. Factors causing indoor air flows [1]

There are many ways to prevent the spread of pathogens: prevention of pathogens at the point of origin, ventilation, air purification, surface cleaning and disinfection, protection of access openings, and protection of susceptible people. None of these protective measures provides complete protection, so it is advisable to use a combination of them.

The number of pathogens is reduced by a respirator used by the affected person, but it does not prevent infection. Ordinary respirators do not filter viruses but prevent larger droplets from propagating. They also reduce the spread of breath caused by the air jet. N95 class protectors also filter out small particles but their filtering ability is not perfect either.

Ventilation can be used to remove pathogens that remain in the air. Care must be taken to filter and disinfect the exhaust air so no further pathogens are spread with the exhaust air. Ventilation must also be regulated so that there is always a vacuum in the room, so air does not spread from the vents and gaps in the structures.

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Ventilation-induced eddies, on the other hand, spread pathogens in the air inside the room. This can be solved using laminar ventilation, but it is expensive to implement and is only used in clean rooms such as operating theaters.

Airborne pathogens can be effectively reduced with an air purifier that filters and disinfects the room air. Such an air purifier can also be easily added retrospectively to a room not intended for special use, as in Figure 3. When the air entering the air cleaner is taken from the patient's environment and the cleaned air is then led to the working area, the likelihood of an infection is significantly reduced. The number of pathogens entering the corridor when opening the door also decreases. It is especially important in a room with no hallways, such as the room pictured below. The air volume of such a room is ca. 80 m3. With Aavi Leaf air purifier, the room air can be cleaned twice an hour, which maintains the pathogen concentration in the air very low. When the patient leaves the room, the air is quickly and completely purified.

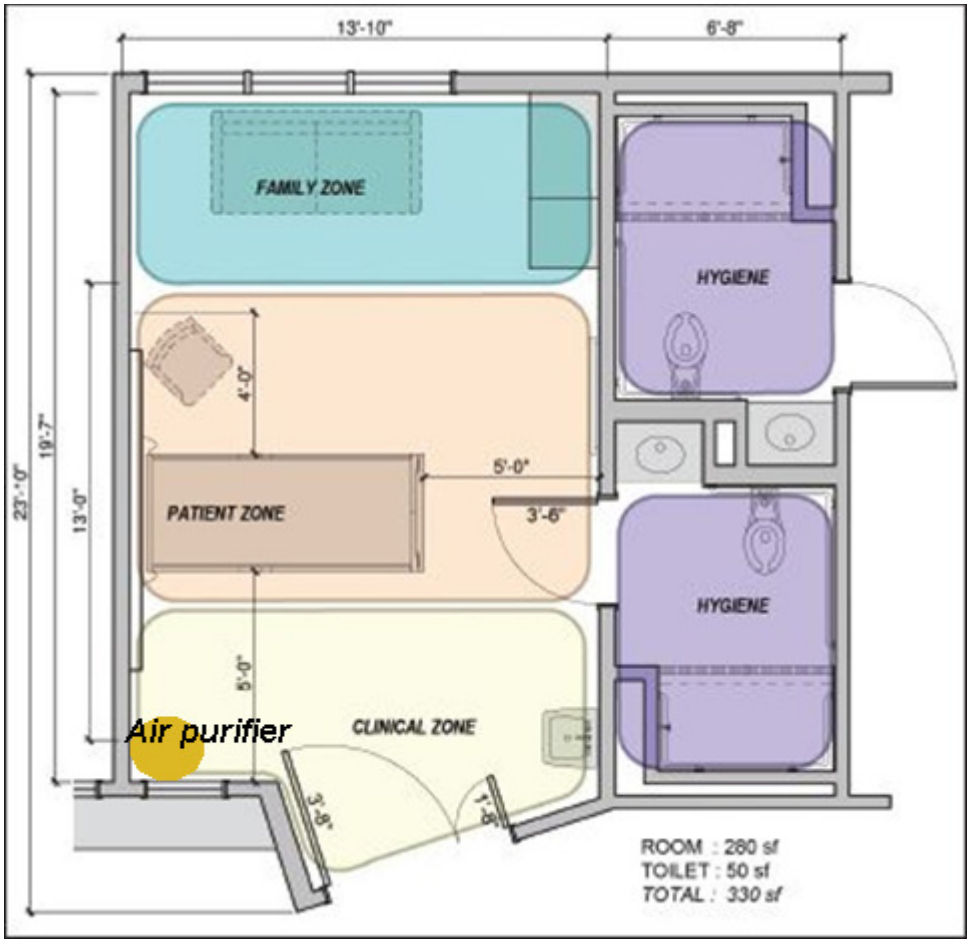

Figure 3. Hospital room with an air purifier added.

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[1] JianjianWei PhD, Yuguo Li PhD, Airborne spread of infectious agents in the indoor environment, Department of Mechanical Engineering, The University of Hong Kong, Hong Kong, American Journal of Infection Control 44 (2016) S102-S108

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