MESTEK, INC.

on-the-SPOT

SARS-CoV-2 COVID-19 Spread & Mitigation

BACKGROUND

SARS CoV-2 is one of the many coronaviruses that exist, but one of only seven that are known to infect humans. When infected with the SARS-CoV-2 virus, a person can develop the coronavirus disease COVID-19. Since the pandemic outbreak, there has been a concerted on-going global effort to develop relatively effective vaccines and therapeutic treatments for COVID-19. In general, some virus vaccines are highly effective for almost all people and inoculation provides decades long protection from disease (such as measles, polio, whooping cough, etc.), while other vaccines are not as effective for a significant proportion of the people and/or the immunity provided is shorter term.

Unfortunately, the protection from other viruses currently in circulation and genetically similar to the SARS CoV-2 virus are often in the second category. COVID-19 might become similar to the seasonal flu where periodic inoculation will be necessary to control its spread. Viruses also mutate over time and can become somewhat more or less benign. In any event, it's possible that this virus will be with us for a protracted period of time.

TRANSMISSION

COVID-19 is a respiratory disease where the virus lives in the lungs/airways. When an infected person breathes, they can emit liquid (saliva, mucous, etc.) droplets that contain the virus. Speaking, singing, coughing, sneezing and the like increase the number of virus-laden droplets emitted and the distance traveled. Simply talking can produce 50 droplets/second, while louder talking/singing produces more. A single sneeze can produce 40,000 droplets, and a sneeze or cough can propel the particles considerably longer distances.

The larger droplets remain in the air until, over time, through the force of gravity, most of the droplets tend to fall and land on surfaces (floors, office furniture, clothing, people, etc.). Some of the very small droplets become aerosol particles that remain floating in the air. Even slightly warm air wafting upward through the thermal plume created by each person can carry the aerosol particles up and away.

Once expelled, the virus remains viable/contagious for some period of time. There have been estimates made of how long the virus remains viable/contagious, from a few hours to days.

Regardless of the source of the transmission, the virus enters the body typically through the mouth, nose, and eyes. The probability of infection is proportional to the number of virus particles and the time duration of exposure. The more exposure over time, the more likelihood of contracting the disease.

There appear to be three main methods of the virus's transmission as follows:

- Surfaces– The virus-laden droplets that land on surfaces were initially thought to be a significant risk. Early on some people would wash packages shipped to their home and groceries bought at the local stores in an attempt to clean them of the virus. Eventually most airlines/hotels/restaurants, etc. that serve the public instituted rigorous cleaning regimens. Other steps in restaurants included the use of disposable utensils/napkins/tablecloths/menus, no shared condiments on the table, etc. These practices continue to this day and can't hurt, but their benefits are becoming more in doubt as the risk of transmission from surfaces is minimal.

- Airborne particles (larger droplets) - If an uninfected person is close to an infected person, they can be exposed to the virus-laden droplets. There seems to be no debate about the spread of the virus through this exposure. When employed, social distancing and masks appear to provide some degree of protection in these cases.

- Airborne particles (small droplets/aerosols) – As the larger droplets/particles are expelled and remain in the air, their size can become much smaller. This is due to the particle's desiccation of its moisture to the relatively drier ambient air. The droplets/particles can start out with a size of 100+ microns and through this removal of the moisture can shrink to 0.5 microns or less which are then considered aerosols. The degree to which desiccation occurs is affected by the specific humidity of the ambient air. The drier it is, the more the particles lose their moisture.

  A 10-minute conversation with an infected asymptomatic person talking at a normal volume would yield an invisible cloud of about 6,000 aerosol particles. When indoors the particles are trapped in an enclosed space while outdoors, the particles can be turbulently diffused away. The consensus is that the odds vastly favor transmission indoors. It's believed that mass gatherings in high density closed environments (schools, churches, mass transit, etc.) are exceptionally contagious and can lead to superspreading events.

There had been much debate about whether the virus in an aerosol form is contagious. The World Health Organization (WHO) had been slow to reach a conclusion on this issue. It's been known that strands of the virus's DNA have been found in the aerosols, but it's degree of virulence (if any) was unclear. The consensus now appears clear that aerosols are a major means of transmission.

It's this aerosol form of possible transmission that could be most problematic. In the case of measles and tuberculosis, it's known that the virus is highly contagious in the aerosol form and spreads quickly indoors. Viruses in general also appear to be more virulent as an aerosol. It is known that viruses remain viable/contagious longer when outside the host as specific humidity decreases.

MITIGATION

The most effective action that can be taken to mitigate the spread of the virus is to separate people, so they don't infect one another. Unfortunately, this quarantine approach is impractical on a longer-term basis and experience has shown that society has its limits to the disruptions that can be tolerated to our normal lives and routines. Working, schooling, dining out, shopping, etc. are optional for only so long without people losing patience. As such, the objective should be to allow people to return to the routines of their daily lives while still mitigating the virus's spread. That requires that we understand how the virus moves.

The steps to take to prevent transmission from surfaces seem to be reasonably well understood and appear effective (and of much less importance). The issue of airborne transmission is likely the area where mitigation steps would have the most beneficial effect. Unfortunately, there appears to be no single magic bullet and layers of approaches will be required to maximize the overall effectiveness of mitigation efforts.

There are numerous mitigation technologies currently available including -

- Ventilation – Due to our over-50-year focus on energy efficiency/costs, the amount of outdoor ventilation air provided by the central HVAC systems has often been minimized. Conditioning outdoor air requires much more energy/expense than previously conditioned return air (the energy required to heat/cool 0°F or 95°F outdoor air compared to 70°F return air).

  ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers) publishes guidance for minimum amounts of outdoor air per person. This guidance varies based on the occupant density and utilization of the space (i.e., offices, classrooms) and is subjective. Whether due to the original design (systems and equipment) in older buildings or in how more modern systems were operated, there have been a significant number of buildings where the lack of sufficient outdoor air has contributed to indoor environmental problems such as Sick Building Syndrome (SBS) and Building Related Illness (BRI).

  Regardless of the root causes of these problems, outdoor ventilation air strongly addresses these concerns. This has been confirmed in many studies. Some have said that "Ventilation is kryptonite to a virus". The inescapable question then is how much outdoor air ventilation is sufficient? In general, the best advice is "a lot" and "more is better".

- Filtration – The airborne particles can be trapped by air filters. The proportion of particles captured by size determines the filter's MERV (Minimum Efficiency Reporting Value) efficiency rating. MERV ratings range from MERV-1 to 20. MERV-13 and above rated filters trap a significant proportion of particles 0.3 microns or more (less than 75% for MERV-13 to better than 95% for MERV-16 and above). The highest rated MERV-17-20 (HEPA and ULPA) filters trap 99.97% or better of the 0.3 micron and larger particles.

  The higher the MERV rating the higher the air pressure drop (increased fan energy) and/or the lower the air velocity (increased equipment sizes). The use of ionization in theory may also improve filtration efficiencies.

- Deactivation/Disinfection - The virus can be deactivated (disruption of its replication abilities) using ultraviolet light. Ultraviolet light is at a frequency above the visible light spectrum. The lower end frequencies in this range (UV-A & B) have little effect, but the higher frequency (UC-C) has a beneficial disinfection effect, particularly with particles on surfaces. Some claim that even higher frequencies (Far UV) are effective for disinfection of aerosols in the air.

  UV-C is dangerous to humans as it can cause burns and blindness. As such, the light must be used only in a manner where humans have no direct exposure. While the UV-C in natural daylight is minimal as the ozone layer in the earth's atmosphere filters most of it out, whatever portion that passes through the atmosphere along with the UV-A & B light also appears to provide some deactivation of viruses.

- Humidity –Other than in hospitals, museums and other special applications, humidity control in the drier winter months is normally not provided in conventional HVAC system designs. The optimum humidity to reduce the spread of viruses is said to be 40-80% RH (most likely due to a reduction in the number of aerosol-sized particles). Adding humidification in commercial applications can also be helpful.