REHVA

How to operate and use building services in order to prevent the spread of the coronavirus disease (COVID-19) virus (SARS-CoV-2) in workplaces

March 26, 2020 Jarek Kurnitski

Guidance for building services

- https://www.rehva.eu/activities/covid-19-guidance
- An addition to the general guidance for employers and building owners that is presented in the WHO document 'Getting workplaces ready for COVID-19'.

- Intended primarily for HVAC professionals and facility managers
- The scope is limited to commercial and public buildings (e.g. offices, schools, shopping areas, sport premises etc) where only occasional occupancy of infected persons is expected

- Recommendations are based on best available evidence and knowledge, but in many aspects' corona virus SARS-CoV-2 information is so limited or not existing that previous SARS-CoV-1 evidence needs to be utilized for best practice recommendations

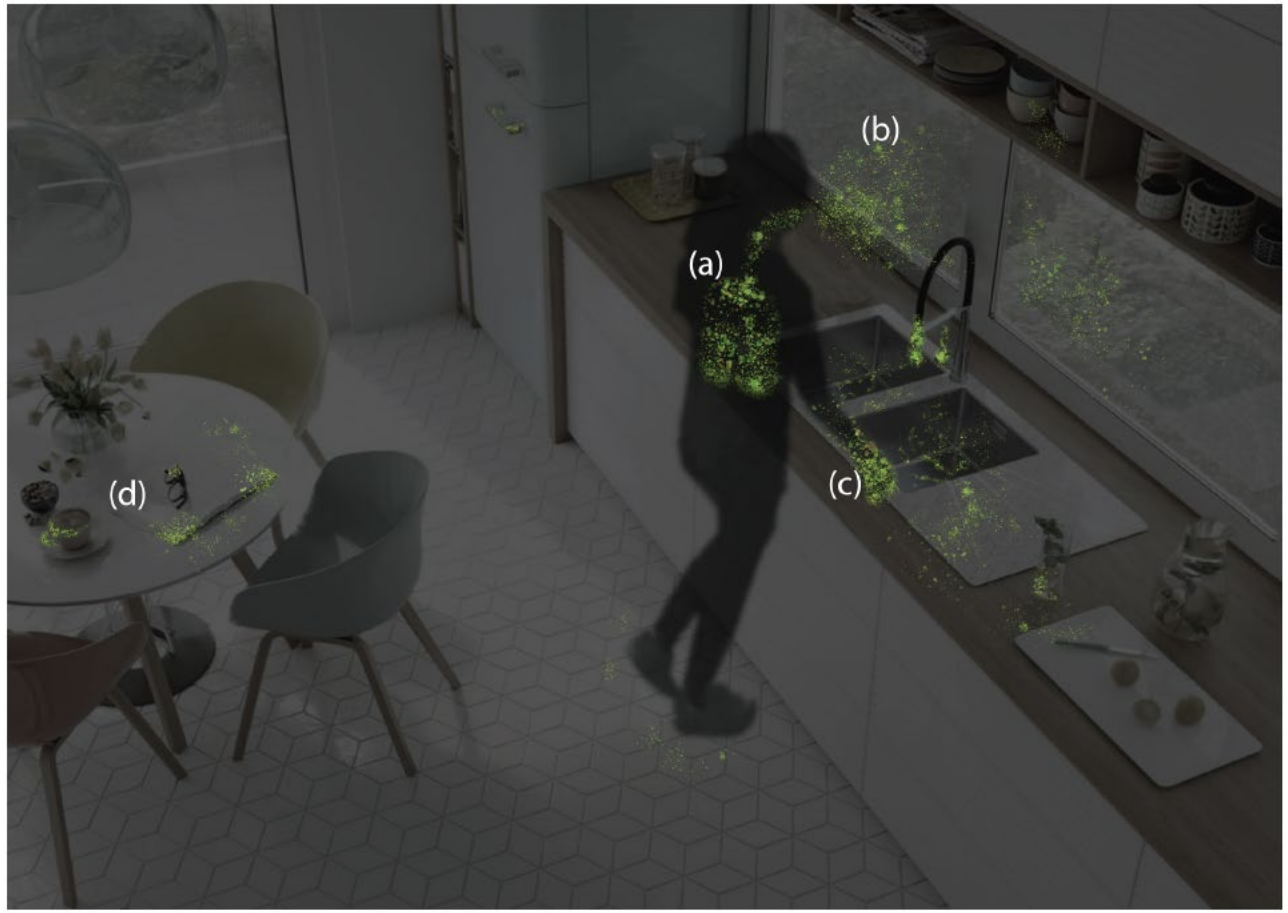
Transmission routes

(a) **viral particles** accumulate in the lungs and upper respiratory tract

(b) **droplets and aerosolized viral particles** are expelled from the body through daily activities such as coughing, sneezing, talking, and non-routine events such as vomiting, and can spread to nearby surroundings and individuals

(c) Viral particles, excreted from the mouth and nose, are often found on the hands and

(d) can be spread to commonly touched items



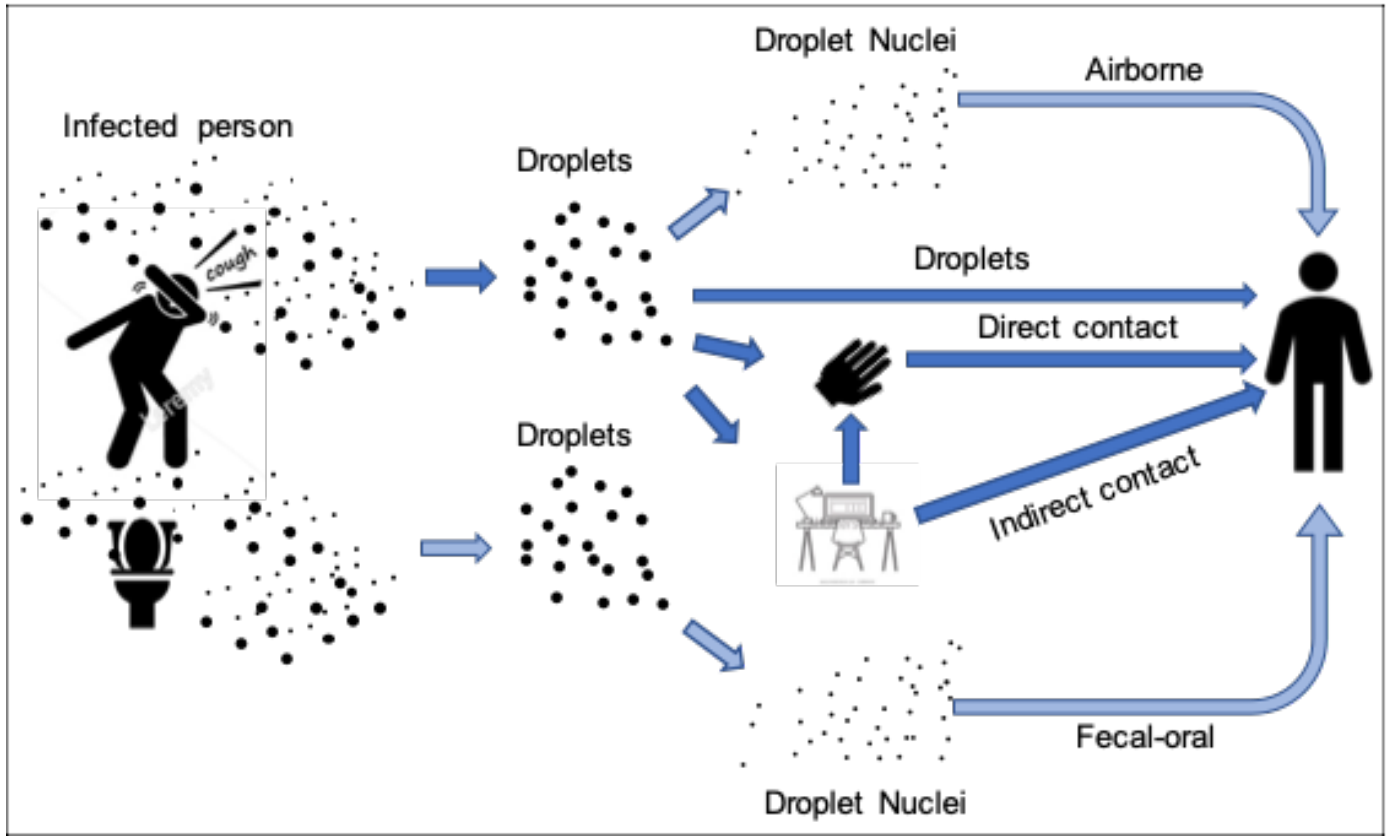
Leslie Dietz et al, 2020 Novel Coronavirus (COVID-19) Outbreak: A Review of the Current Literature and Built Environment (BE) Considerations to Reduce Transmission

Transmission routes

1. Close contact, large droplets > 10 μm (<1 m distance), but rule of thumbs up to 2-3 m
2. Airborne transmission, small particles, droplet nuclei < 5 μm stay airborne for hours
3. Via surface (fomite) contact
4. Faecal-oral route

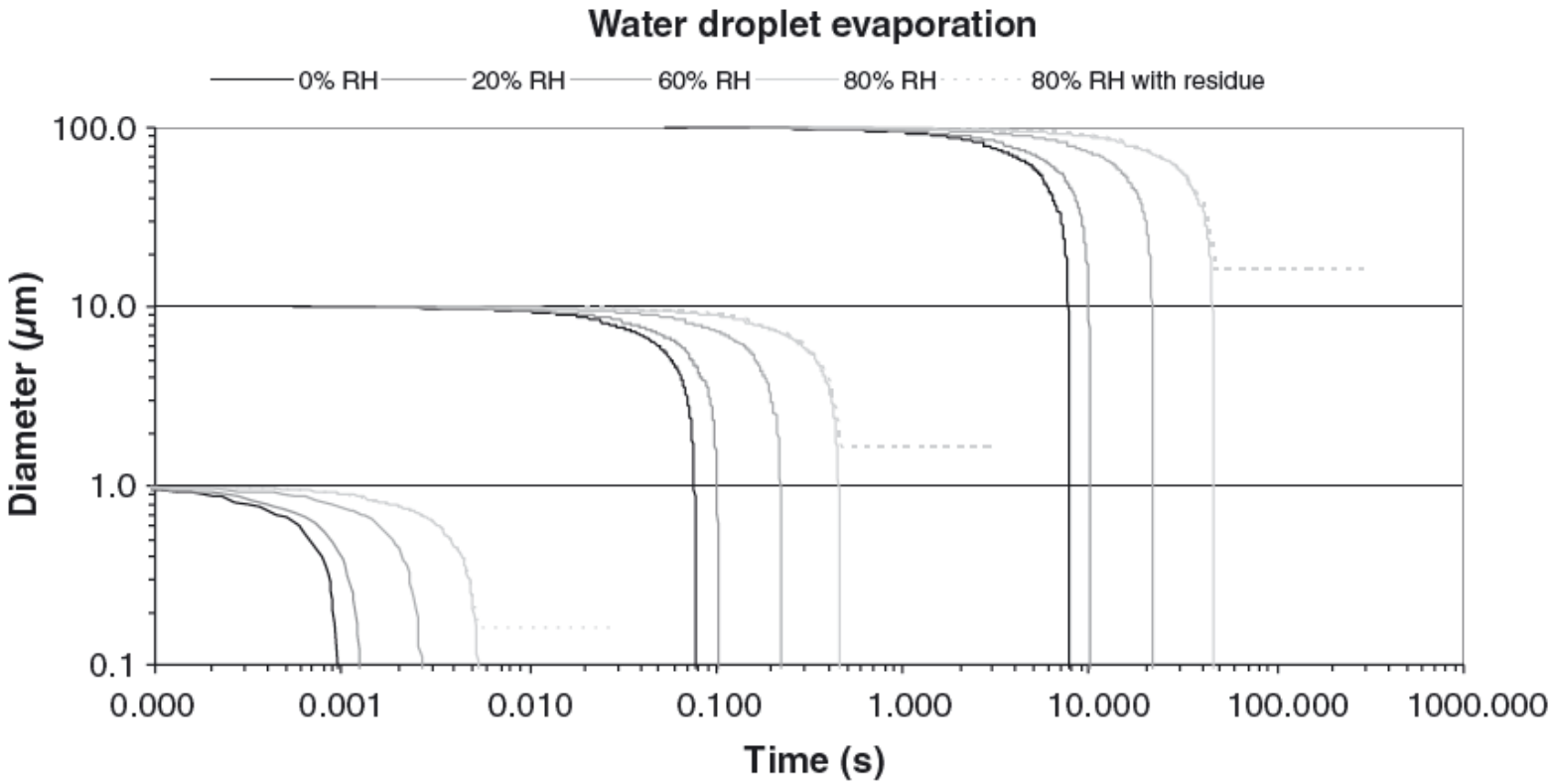
Dark blue: evidence exist

Light blue: evidence for SARS-CoV-1



Droplet evaporation to droplet nuclei or residue

- Small droplets evaporate in milliseconds
- 10 μm droplets evaporate in 0.2 s
- Only very large droplets can reach surfaces before evaporation



Morawska 2006

Airborne transmission

- Opportunistic airborne transmission of SARS-CoV-2 (van Doremalen et al. 2020) is currently recognized only in hospitals and speculated for poorly ventilated spaces
- Airborne transmission evidence for SARS in 2002/2003 for SARS-CoV-1 in Amoy Gardens, hospitals, hotels and residential homes
- On the Diamond Princess Cruise Ship the reproductive number increased from common R_0 estimate of 1.5-3 up to 5-14 (Mizumotoa K, Chowell G 2020 and Zhao S et al 2020), corresponding to the contagiousness of measles (R_0 of 12-18).
- Transmission mechanism is not known, but it is widely speculated that without airborne transmission such a high R_0 is not possible, even in the occupant density of a cruise ship

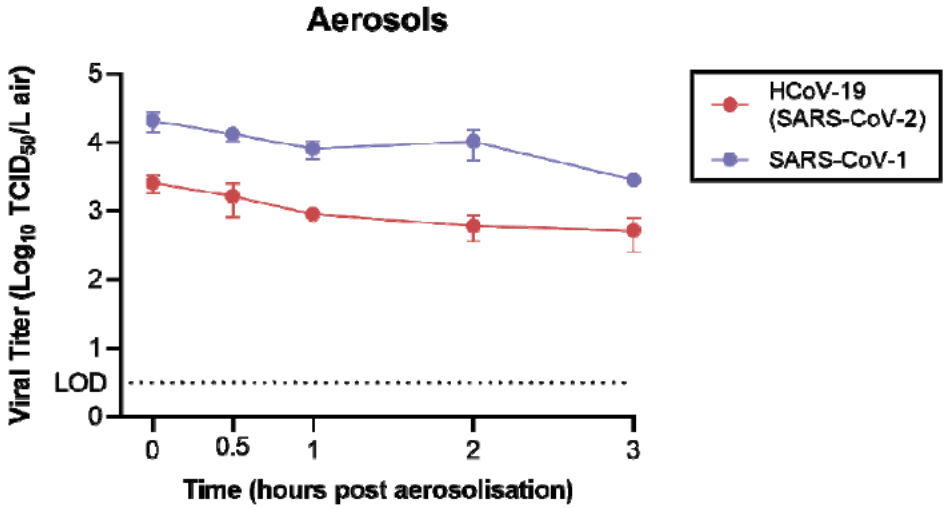
→ Good justification to take a set of preventive mitigation measures and to apply ALARA principle (As Low As Reasonably Achievable) that help to also control the airborne route in buildings (apart from standard hygiene measures as recommended by WHO)

Longer and continuous ventilation operation

- Extended operation times are recommended: Change the clock times of system timers to start ventilation a couple of hours earlier and switch off later than usual
- Do not switch off ventilation at nights and weekends, but operate at lowered speed
- Considering a springtime with small heating and cooling needs, energy penalties are limited, while virus particles from air and also released virus particles from surfaces will removed out the building
- The general advice is to supply as much outside air as reasonably possible. The key aspect is the amount of fresh air supplied per person. If, due to smart working utilization, the number of employees is reduced, do not concentrate the remaining employees in smaller areas but maintain or enlarge the spacing among them in order to foster the ventilation cleaning effect.
- Exhaust ventilation systems of toilets should always be kept on 24/7, and make sure that under-pressure is created, especially to avoid the faecal-oral transmission

Humidification and air-conditioning have no practical effect

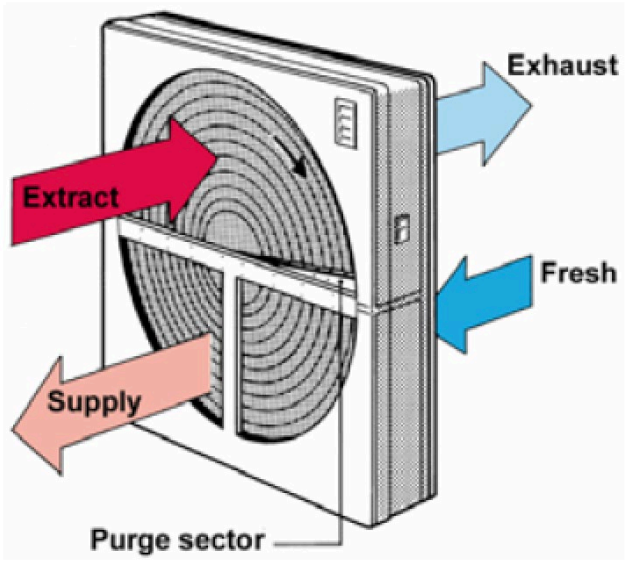
- SARS-CoV-2 stability (viability) has been tested at typical indoor temperature of 21-23 ℃ and RH of 65% with very high virus stability at this RH. Together with previous evidence on MERS-CoV it is well documented that humidification up to 65% may have very limited or no effect on stability of SARS-CoV-2 virus.
- Therefore, the evidence does not support that moderate humidity (RH 40-60%) will be beneficial in reducing viability of SARS-CoV-2, thus the humidification is NOT a method to reduce the transmission and spread of SARS-CoV-2.
- Viability at 4 ℃ has been tested for surrogate viruses and was longer compared to 21-23 ℃ (Casanova et al. 2010), thus AC has no effect in this context (recirculation excluded)



van Doremalen et al. 2020 Aerosol and surface stability of HCoV-19 (SARS-CoV-6 2) compared to SARS-CoV-1 (RH 65%)

Safe use of heat recovery sections

- Under certain conditions virus particles in extract air can re-enter the building. Heat recovery devices may carry over virus attached to particles from the exhaust air side to the supply air side via leaks.
- In the case of regenerative heat exchangers (rotors) the minimal carry over leakage and correct pressure difference between exhaust and supply side are important
- The carry over leakage, carrying over also particles, may increase from the good-practice limit of 5% to 15% if fans create higher pressure on the exhaust air side



- Evidence suggest that rotors with adequate purge sector practically do not transfer particles, but the transfer is limited to gaseous pollutants (e.g. smells, tobacco smoke)
- Because the leakage does not depend on the rotation speed, it is not needed to switch rotors off. If needed, the pressure differences can be corrected by dampers or by other arrangements.

No use of recirculation

- Virus particles in return ducts can also re-enter a building when centralized air handling units are equipped with recirculation sectors (may be in use at least in older all-air heating and cooling systems)
- Recirculation dampers should be closed (via the Building Management System or manually)
- Recirculation air filters are not a reason to keep recirculation dampers open as these filters do not filter out particles with viruses effectively since they have standard efficiencies and not HEPA efficiencies
- When possible, decentralized systems such as fan coil units that use local recirculation, also should be turned off to avoid resuspension of virus particles at room level (esp. when rooms are used normally by more than one occupant)
- Fan coil units have coarse filters which might collect particles. If not possible to turn off, these units may be included into cleaning campaigns and are one reason to prolong ventilation operation time

Filtration and air cleaners

- Outdoor air filters (filter class F7 or F8 or ISO ePM1) do not operate in the capture range of viruses – the size of a coronavirus particle of 80-160 nm (PM0.1) is smaller than the capture area of F8 filters (capture efficiency 65-90% for PM1)
- Outdoor air is not a source of viruses, thus no need to replace filters
- No need to clean ventilation ductworks as well
- In the case of air cleaners, to be effective, HEPA filter efficiency is needed
- Air cleaners with electrostatic filtration principles (not the same as room ionizers!) often work quite well too
- Because of limited airflow through air cleaners, the floor area they can effectively serve is normally quite small, typically less than 10 m^2 – to be located close to breathing zone
- Maintenance personnel needs to apply common protective measures when replacing filters including FFP3 respirator, because filters may have active microbiological material on them

Conclusions

- General recommendation is to stay away from crowded and poorly ventilated spaces
- Adequate outdoor air ventilation rate per person must be provided – will eliminate the the airborne route in non-hospital environment
- Ventilation operation times may need to be extended depending on occupancy, it is not recommended to switch ventilation off, but to reduce speed
- Toilet ventilation is recommended to be kept 24/7 in operation
- Recirculation must be switched to 100% outdoor air and leakage in heat recovery sections are to be avoided
- Recirculation of fan-coils to be considered as potential risk factor
- Humidification is NOT a method to reduce the transmission and spread of SARS-CoV-2
- Outdoor/return air filters and duct cleaning are generally not an issue, but regular filter replacement needs a common protective measures