REHVA:n COVID-ohje ilmanvaihdon käyttöön

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REHVA guidance for building services

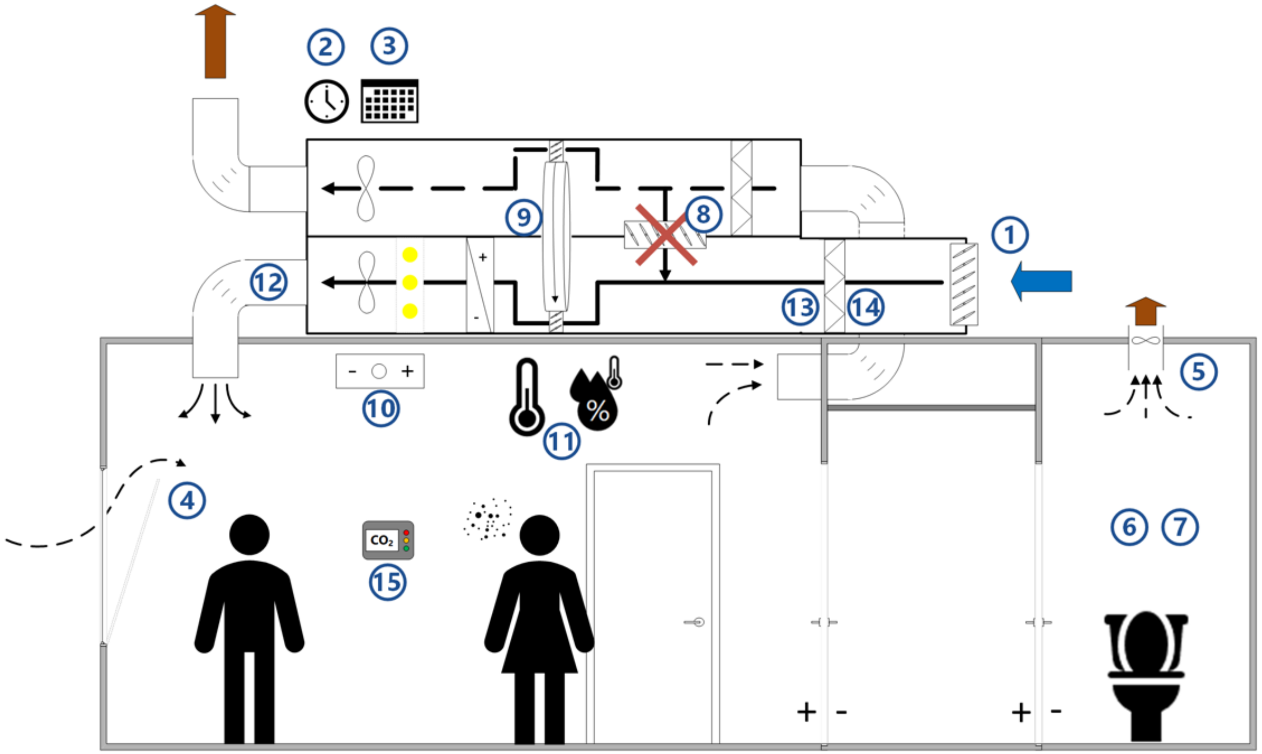
- https://www.rehva.eu/activities/covid-19-guidance
- An addition to the general guidance for employers and building owners that is presented in the WHO document ‘Getting workplaces ready for COVID-19’.
- First version March 17, 2020 that has been updated April 3 and August 3
- Targeted to HVAC professionals and facility managers but may be useful for occupational and public health specialists deciding how to use buildings
- The scope is limited to commercial and public buildings

- Practical guidance on temporary, easy-to-organize measures that can be implemented in existing buildings
- **Some discussion how to conduct a risk assessment and what would be more far-reaching actions** to further reduce the spread of viral diseases in future in buildings with improved ventilation systems

Soveltuminen Suomen oloihin:
https://finvac.org/rehva-covid-19-guidance-document-3-8-2020/

15 recommendations for existing buildings

1. Ventilation rates
2. Ventilation operation times
3. Continuous operation of ventilation
4. Window opening
5. Toilet ventilation
6. Windows in toilets
7. Flushing toilets
8. Recirculation
9. Heat recovery equipment
10. Fan coils and induction units
11. Heating, cooling and possible humidification setpoints
12. Duct cleaning
13. Outdoor air and extract air filters
14. Maintenance works
15. IAQ monitoring



Longer and continuous ventilation operation

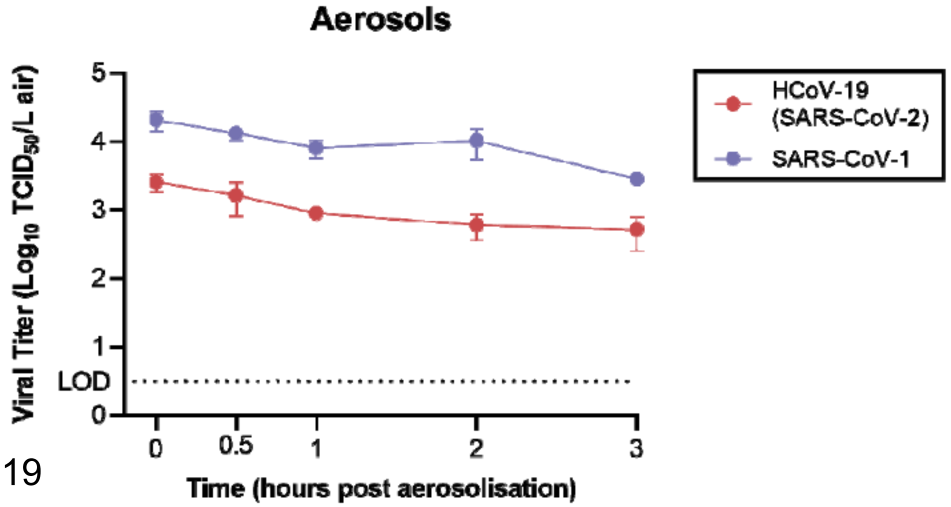
- Extended operation times are recommended: Change the clock times of system timers to start ventilation at nominal speed at least 2 hours before the building usage time and switch to lower speed 2 hours after the building usage time
- Do not switch off ventilation at nights and weekends, but operate at lowered speed (periodic operation to maintain 0.15 L/s per floor m^2)
- Extended ventilation will remove virus particles from air and also released virus particles from surfaces 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**
- Enlarge the spacing among employees (min physical distance 2-3 m between persons) in order to foster the ventilation cleaning effect
- Exhaust ventilation systems of toilets should be operated as the main ventilation system, and make sure that under-pressure is created, especially to avoid the faecal-oral transmission

What to do if there is no mechanical ventilation?

- In buildings without mechanical ventilation systems, it is recommended to actively use openable windows
- Windows should be opened for 15 min or so when entering the room (especially when the room was occupied by others beforehand)
- Also, in buildings with mechanical ventilation, window opening can be used to boost ventilation further
- Install CO_2 sensors at the occupied zone that warn against underventilation especially in spaces that are often used for one hour or more by groups of people, such as classrooms, meeting rooms, restaurants
- Set the yellow/orange light to 800 ppm and the red light (or alarm) up to 1000 ppm in order trigger prompt action to achieve sufficient ventilation even in situations with reduced occupancy

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 viability of SARS-CoV-2.
- SARS-CoV-2 has been found highly stable for 14 days at 4 ℃; 37 ℃ for one day and 56 ℃ for 30 minutes were needed to inactivate the virus (Chin et al, 2020)
- AC has no effect in this context (recirculation excluded)

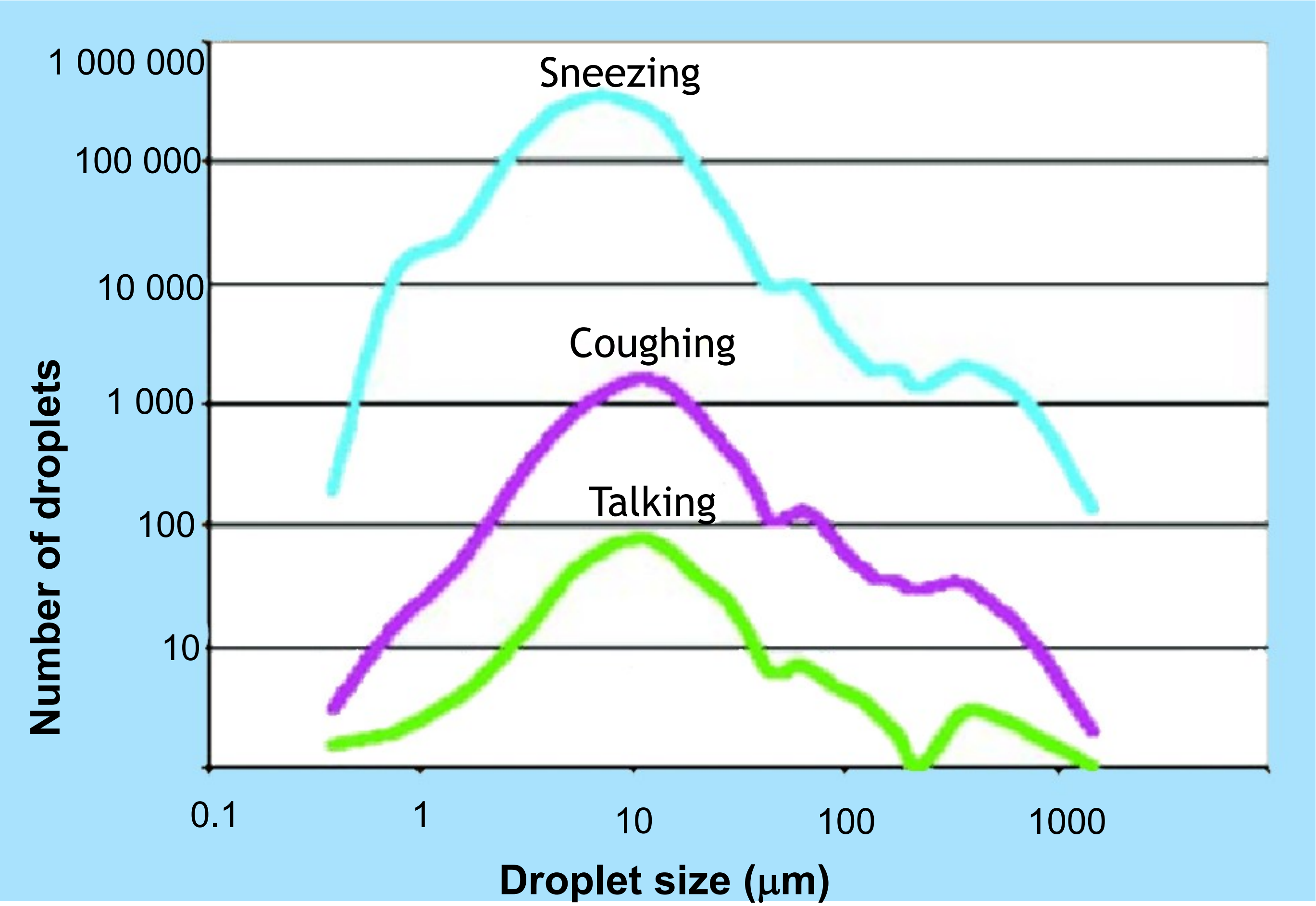


van Doremalen et al. 2020 Aerosol and surface stability of HCoV-19 (SARS-CoV-6 2) compared to SARS-CoV-1 (RH 65%)

No use of central 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)
- In air systems and air-and-water systems where central recirculation cannot be avoided because of limited cooling or heating capacity, the outdoor air fraction has to be increased as much as possible and additional measures are recommended for return air filtering:
  1. HEPA filters would be needed to completely remove particles and viruses from the return air (usually not easy to install in existing systems)
  2. Alternatively, duct installation of disinfection devices, such as ultraviolet germicidal irradiation (UVGI) also called germicidal ultraviolet (GUV), may be used
  3. A minimum improvement is the replacement of existing low-efficiency return air filters with ePM1 80% (former F8) filters

Filtration with ePM1 80% (former F8) filters



- An airborne virus is not naked but is contained inside expelled respiratory fluid droplets
- Most of expelled droplets > 1 μm
- F8 (ePM1) filters provide capture efficiency of 65-90% for PM1
- Therefore, good fine outdoor air filters provide reasonable filtration efficiency for a low concentration and occasional occurrence of viral sources

Farhad Memarzadeh, Particle generation by sneezing, coughing and during talking,” [https://www.researchgate.net/publication/234076687_Improved_Strategy_to_Control_Aerosol Transmitted_Infections_in_a_Hospital_Suite]

Outdoor air filtration

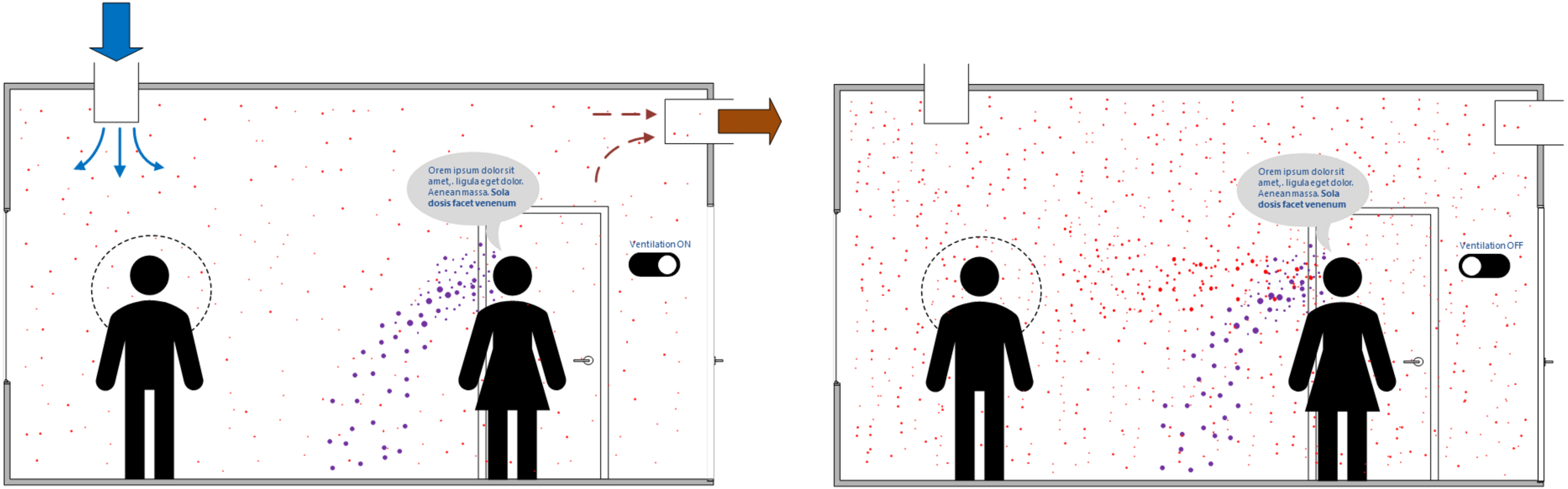
- Outdoor air is not a source of viruses, thus no need to replace filters (despite of regular maintenance)
- Outdoor air filters (filter class F7 or F8 or ISO ePM1) are not designed to capture viruses – the size of the smallest viral droplets in respiratory aerosols of about 0.2 mm (PM0.2) is smaller than the capture area of ePM1 / F8 filters (capture efficiency 65-90% for PM1)
- No need to clean ventilation ductworks as well (despite of scheduled maintenance)

- Maintenance personnel needs to apply common protective measures when replacing filters including respirators, because filters may have active microbiological material on them

Room air cleaners

- Room air cleaners remove particles from the air, which provides a similar effect compared to the outdoor air ventilation
- To be effective, air cleaners need to have HEPA filter efficiency or air cleaners with electrostatic filtration principles (not the same as room ionizers!) often work well too
- To select the right size air cleaner, the airflow capacity of the unit (at an acceptable noise level) has to be at least 2 ACH and will have positive effect until 5 ACH (calculate the airflow rate through the air cleaner in m^3/h by multiplying the room volume by 2 or 5)
- In large spaces, air cleaners need to be placed close to people in a space and should not be placed in the corner and out of sight
- Special UVGI disinfection equipment may be installed in return air ducts in systems with recirculation, or installed in room, to inactivate viruses and bacteria (health care facilities)
- Air cleaners are an easy to apply short term mitigation measure, but in the longer run, ventilation system improvements to achieve adequate outdoor air ventilation rates are needed

Long range airborne transmission & ventilation



- The means to deal with close contact and long range airborne transmission routes are physical distance to avoid the close contact, and **ventilation to avoid (>1.5 m) airborne transmission**
- In addition to outdoor air ventilation, virus laden particles can be removed with filtration or deactivated with UVG

Airborne transmission risk assessment

- COVID-19 disease has been associated with **close proximity** (for which ventilation isn't the solution) and with spaces that are simply **inadequately ventilated**
- In superspreading events the outdoor air ventilation has been as low as 1–2 L/s per person (Guangzhou restaurant, Skagit Valley)
- Would 10 L/s per person recommended in existing standards be enough? No evidence available
- Some evidence of no cross infections from hospitals (about 40 L/s per patient, 6-12 ACH)

- Typical sizing according to ISO 17772-1:2017 and EN 16798-1:2019 results in default Indoor Climate Category II to 1.5 – 2 L/s per floor m^2 (10–15 L/s per person) outdoor airflow rates in offices and to about 4 L/s per floor m^2 (8–10 L/s per person) in meeting rooms and classrooms
- 4 L/s per floor m^2 in meeting rooms and classrooms corresponds to 5 ACH

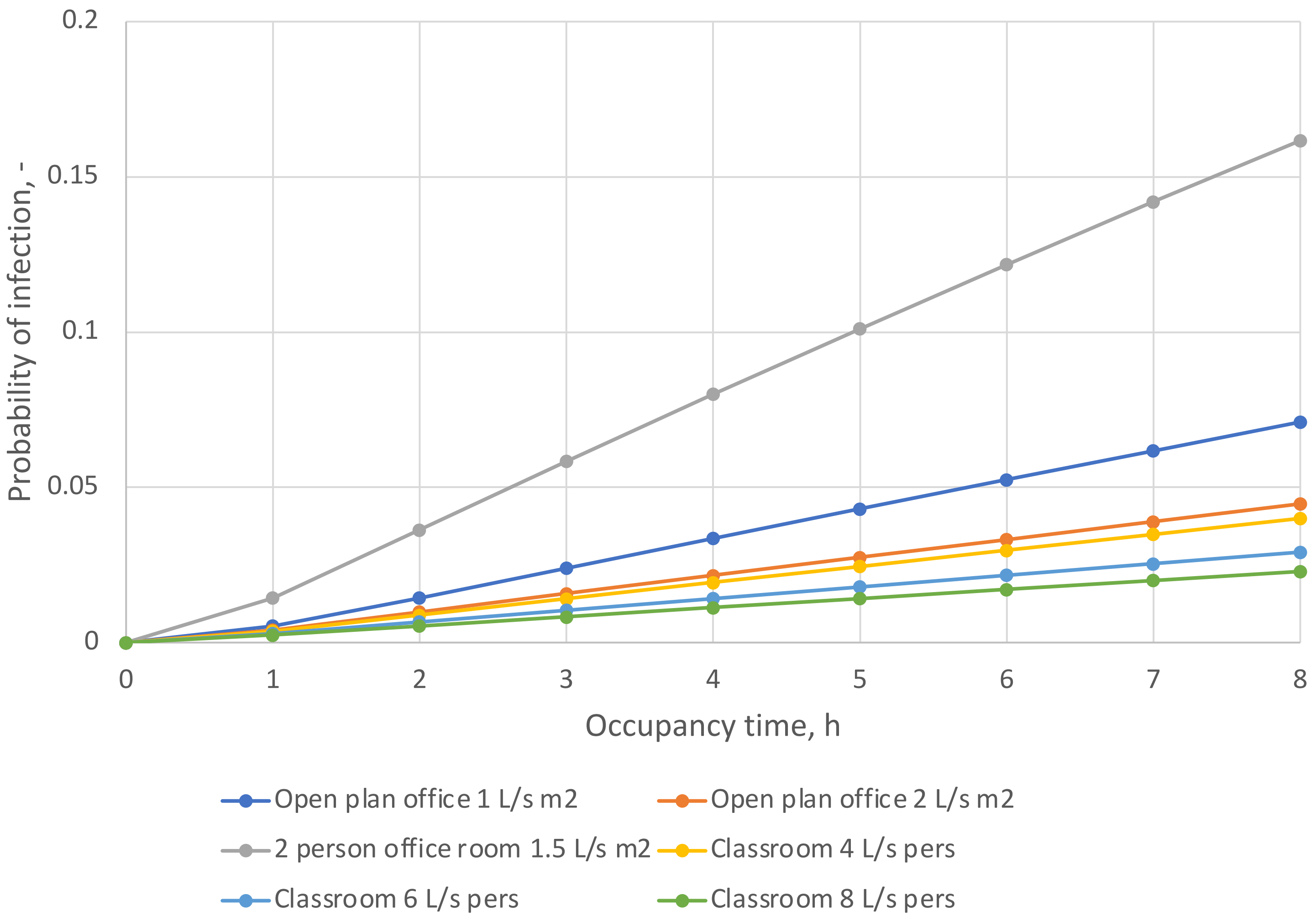
Standard airborne disease transmission Wells-Riley model application

- Common cold/rhinovirus (Yuexia Sun et al. 2011) 1-10 quanta/h
- Influenza (Mesquita, Noakes and Milton 2020) 0.1-0.2 q/h in average, but 630 q/h max daily rate
- SARS-CoV-2 (Buonanno G, Morawska L, Stabile L, 2020):

Activity	Quanta emission rate, quanta/h
Resting, oral breathing	3.1
Heavy activity, oral breathing	21
Light activity, speaking	42
Light activity, singing (or loudly speaking)	270

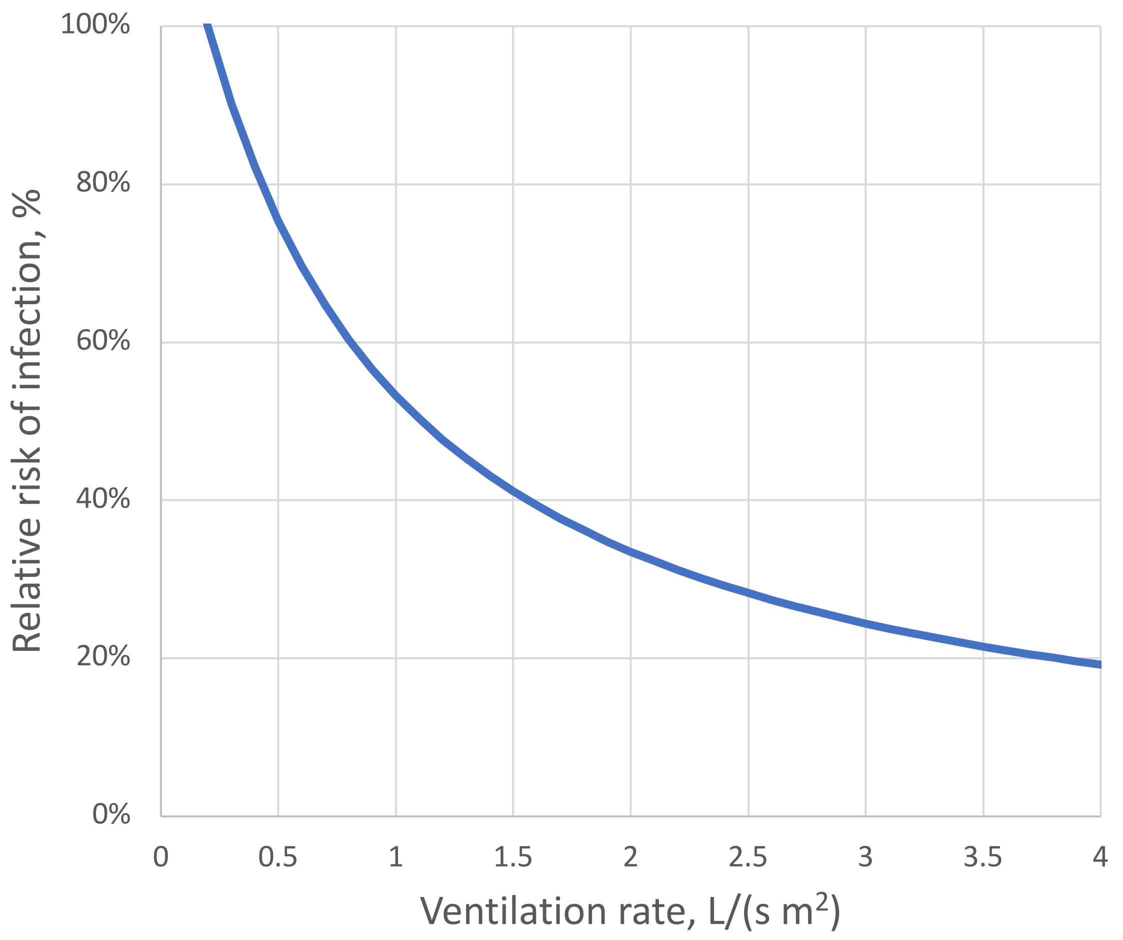
Calculation examples

- Assumption of 1 infected person in all rooms
- 5 quanta/h for office work and classroom occupancy
- 1.5 L/s per m² ventilation rate in 2 person office room of 16 m²
- 50 m² open plan office
- 56 m² classroom



Converting the results to relative risk

- Open plan office with 2 L/s per person (0.2 L/s per m^2) with occupant density of 10 m^2 per person considered as 100% relative risk level
- This ventilation rate that is a half of an absolute minimum of 4 L/s per person can be used to describe superspreading events
- 2 L/s per m^2 will reduce the relative risk to 34%
- Doubling to 4 L/s per m^2 will provide relatively smaller further reduction to 19%



Conclusions

- While there are many possibilities to improve ventilation solutions in future, it is important to recognize that current technology and knowledge already allows the use of many rooms in buildings during a COVID-19 type of outbreak as long as ventilation rates correspond to or ideally exceed existing standards
- Regarding the airflow rates, more ventilation is always better, but to dilute the aerosol concentration the **total airflow rate in L/s per infected person matters**
- Large spaces ventilated according to current standards are reasonably safe, but smaller rooms occupied by fewer people pose a higher risk even if well ventilated
- Limiting the number of occupants in small rooms, reducing occupancy time and applying physical distancing will in most cases keep the probability of cross-infection to a reasonable level
- For future buildings and improvements, Category I ventilation rates can be recommended as these provide significant risk reduction compared to common Category II airflow rates