

Literature Review on Ventilation/Filtration to lower airborne viral load in bathrooms, restaurants, and mass transit

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Science Investigative Unit

Recommendations

1. Encourage natural ventilation when feasible such as opening windows.
2. Lids should be required on toilets and should be put down before toilets are flushed.
3. Portable air filters are a relatively low cost and effective means for retrofitting spaces that lack filtration systems and natural ventilation.
4. Restaurants should avoid seating people close to air vents where air is being pushed out to avoid creating a flow of viruses from an infected person to people sitting downwind.
5. UV systems have interesting potential, but more research is needed and details of installation can have big impact on their effectiveness
6. If possible, HVAC systems should be bringing air from the outside as much as reasonable (not just recirculating air), turning air over at least 6-12 times an hour. A qualified technician may be needed, however, to ensure changes to systems do not create more problems.

Caveats

Some of the recommendations (e.g., CDC recommendations of 6-12 air turnovers per hour) were developed prior to the virus so may be out of date. There was also a paucity of empirical data that explicitly links the virus to recommendations. Consequently there is not much certainty around any of these recommendations.

Papers Reviewed

1. COVID-19 Outbreak Associated with Air Conditioning in Restaurant, Guangzhou, China, 2020

https://wwwnc.cdc.gov/eid/article/26/7/20-0764_article#comment

1. Documented pattern of transmission from index case to other individuals in restaurant based upon where they were seated and patterns of airflow.
2. They concluded transmission happened by droplets (which are larger than aerosols) and possibly aerosols.
3. They sampled the air conditioning unit and found no evidence of the virus.
4. Direction of airflow determined has virus was transmitted.

2. 2019 Novel Coronavirus (COVID-19) Pandemic: Built Environment Considerations To Reduce Transmission, American Society for Microbiology, Dietz et al,

<https://msystems.asm.org/content/5/2/e00245-20>

1. More airflow from the outside is good.
2. Increased airflow rates can resuspend fomites, which can increase transmission.

3. Maintaining relative humidity between 40 and 60% (previous recommendation was 20-60%) may reduce transmission since virus does not do as well in more humid environments, though this may not be practical.
4. Natural daylight is also potentially helpful.
5. UVC potentially beneficial, but more research on human impacts needed.
6. Interesting the paper was modified after initial publication to explicitly note that while viruses are smaller than most filtration systems, the viruses typically travel on larger particles and hence ventilation and filtration is important.

3. Airborne Spread of SARS-CoV-2 and a Potential Role for Air Disinfection, June 1, 2020

https://jamanetwork.com/journals/jama/fullarticle/2766821?guestAccessKey=edbb37fb-940f-4c2b-b7b1-0e4f36abc88e&utm_source=silverchair&utm_medium=email&utm_campaign=article_alert-jama&utm_term=mostread&utm_content=olf-widget_06032020

1. CDC recommends 6-12 room air changes per hour (guidelines updated 2019). I reviewed the original CDC document that was cited and could not find this recommendation, though there are numerous references to this many air changes per hour in health care facilities, so it seems reasonable.
2. CDC and WHO do not recommend Germicidal UV systems.

4. CDC recommendations on operating buildings

<https://www.cdc.gov/coronavirus/2019-ncov/community/office-buildings.html>

1. Open windows
2. Increase amount of outdoor air
3. Increase air filtration systems to as high as standards as possible (MERV 13 or 14)
4. Use portable high-efficiency particulate air (HEPA) fan/filtration systems when possible
5. Consider using UV

5. COVID-19 (Corona Virus) and Air Filtration Frequently Asked Questions (FAQs), National Air Filtration Association

<https://www.nafahq.org/covid-19-corona-virus-and-air-filtration-frequently-asked-questions-faqs/>

1. It is very hard to replicate the filtration system found in a hospital
2. Portable air filters can work if placed well and sized appropriately for volume of space
3. The details of a UV system are critical to whether it will work
4. Air filtration only small part of the problem because will not impact droplets, fomites, or direct contact

6. ASHRAE, Filtration / Disinfection

<https://www.ashrae.org/technical-resources/filtration-disinfection#mechanical>

1. Close lid before flushing toilet.
2. Vent bathrooms separately from building.
3. Keep toilet doors closed even when not in use.

7. ASHREA, Mass transit.

1. When using a vehicle restroom wait a few moments after someone exits with the door closed before entering to allow ventilation systems to clear the air.

8. Air purifiers: A supplementary measure to remove airborne SARS-CoV-2, Zhao et al., Build Environment, June 15, 2020

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7180358/>

1. Portable, affordable air filters are worth using.
2. Filters should be handled as biohazards.

9. National Academy of Sciences, Does UV light kill the coronavirus

<https://sites.nationalacademies.org/BasedOnScience/covid-19-does-ultraviolet-light-kill-the-coronavirus/index.htm>

1. UV C probably kills the new coronavirus, based upon data from other coronaviruses. However, more research is needed.
2. UVC should be should on surfaces and not individuals.

10. Coronavirus puts UV in the Disinfectant Spotlight, May 19, 2020

<https://www.webmd.com/lung/news/20200519/coronavirus-puts-uv-in-the-disinfectant-spotlight>

1. “despite the potential in commercial UV use, many germicide experts have little faith in home products. They aren't regulated, nor have they been studied sufficiently by scientists”,

11. <https://www.nytimes.com/2020/05/07/science/ultraviolet-light-coronavirus.html>, May 7, 2020

1. Good evidence that it could work
2. Technology on UV disinfectant not ready yet
3. Details of installation very important
4. Could cost up to \$100,000 to install unit on large building