# Ultraviolet Disinfection for COVID-19 in Schools

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Ultraviolet (UV) disinfection technologies can have an important role in making classrooms, cafeterias, hallways and other indoor spaces safe by preventing transmission of the virus that causes COVID-19.

UV light is at the far end of the light spectrum, beyond the visible range. The UV spectrum is divided into three: UVA, UVB, and UVC. Sunscreen is designed to block UVA and UVB wavelengths. The UVC wavelengths in sunlight do not penetrate the earth's atmosphere.

UV light is a disinfectant for airborne viruses and bacteria. It inactivates viruses by damaging their genetic code (viral RNA) and preventing them from replicating.† Laboratory tests show that some viruses are damaged by UV exposure more quickly than others, but all can be inactivated at the appropriate doses. Viruses do not develop resistance to UV.

"UVC" refers to ultraviolet light which is in the germicidal range (200-280 nanometers). UVA and UVB wavelengths cause skin cancer and cataracts, but shorter wavelength UVC is absorbed by the dead outer skin and the top epithelial layer of cells, which are regularly shed. It does not reach the living layer of basal cells, and therefore does not cause any permanent damage.‡

This means that exposure to UVC light is far safer for humans than sunlight or tanning lamps (which also emit UVA and UVB), even at the same doses.

There are several types of UVC disinfection. "Whole-room" UVC devices use an intense burst of light to disinfect exposed surfaces in unoccupied spaces (such as hospital rooms in between patients). "Upper-room" UVC devices use a continuous dose of less intense light. A fan mixes the air, bringing airborne viruses which have been shed by people in the lower, occupied space to the upper room to be decontaminated. "Far-UVC" devices are still under development.

When a UVC light fixture is placed in the upper room, there is little or no exposure in the lower part where people are located—at most one-fortieth the amount of UV light you would absorb from being outside at noon in summer. That makes upper-room UVC extremely safe for occupants.[1]

Upper room UVC disinfection has been used in schools for almost 100 years. Rigorous studies in the Philadelphia school system in the 1930s and 40s showed a dramatic protective effect against school-based transmission of measles.[2]

UVC light is known to inactivate at least two other coronaviruses, SARS-CoV-1 and MERS-CoV, that are close relatives of the virus that causes COVID-19. Evidence suggests that similar results can be expected when treating COVID-19's virus, SARS-CoV-2.[3]

Preliminary results from a recent modeling study based on SARS-Cov-1 suggest that given adequate airflow, upper-room UVC fixtures can be expected to inactivate more than 90% of ambient SARS-CoV-2 with a low light intensity (10 μW/cm2).[4]

Upper-room UVC light fixtures are relatively inexpensive. A fixture and fan that can disinfect the average classroom space cost approximately $1000.

NOTES

† Biologists use the word 'inactivate' for viruses rather than 'kill' because they are not considered alive.

‡ Direct exposure to some UVC wavelengths can cause transient skin irritation and inflammation of the top corneal epithelial cells on the surface of the eye. But there is no lasting injury, even with long term exposure.

[1] Nardell E, Vincent R, Sliney DH. Upper-Room Ultraviolet Germicidal Irradiation (UVGI) for Air Disinfection: A Symposium in Print. *Photochemistry & Photobiology*, 2013 Jul-Aug; 89(4):764-9.

[2] Nardell E, Nathavitharana R. Letter: Air disinfection in measles transmission hotspots. *Lancet*, 2019 Sep 21; 394(10203):1009-1010.

[3] Nardell E, Nathavitharana R. Airborne Spread of SARS-CoV-2 and a Potential Role for Air Disinfection. *JAMA*, 2020 Jun 1. Online ahead of print. doi: 10.1001/jama.2020.7603.

[4] Beggs CB, Avital EJ. Upper-Room Ultraviolet Air Disinfection Might Help to Reduce COVID-19 Transmission in Buildings. Preprint. *medRxiv*, posted 2020 Jun 14. doi: 10.1101/2020.06.12.20129254.