Hypotheses & Ideas

Brief Ultraviolet Irradiation Before Doffing May Prevent Transmission of Infection due to COVID-19

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Introduction

COVID-19 was declared a pandemic by WHO on 11 March 2020. It has affected nearly 80 lakh people worldwide but exact data regarding its infectivity among healthcare workers (HCW) is still missing. Data from the Chinese center of disease control and prevention showed that out of 44672 laboratory-confirmed cases, 1716 were healthcare workers (1). Data from Italy showed that by April 7, 2020, there were 12680 documented cases of COVID-19 among healthcare workers, and approximately 100 physicians and 26 nurses have died from Covid-19 (2).

COVID-19 is caused by a novel coronavirus belonging to genera Beta coronavirus, with single-stranded (positive-sense) RNA associated with a nucleoprotein within a capsid comprised of matrix protein (3).

COVID-19 virus is primarily transmitted among people through respiratory droplets and close contact (4, 5). To mitigate HCW infection spread, the WHO has recommended infection prevention and control (IPC) strategies. While the use of personal protective equipment (PPE) remains a mainstay of IPC strategies, it needs to be supported by effective administrative and engineering controls, in the absence of which PPE has limited benefits (6).

The use of PPE is associated with meticulous donning and doffing protocols. Errors in doffing, however, may result in the transmission of infective particles to uncovered areas along with possible aerosolization (7). Effective training and the presence of a doffing buddy, successful adherence to the Centers for Disease Control and Prevention's (CDC's) guidelines for PPE doffing at each instance remains a challenge (8, 9). Studies reveal that contamination of the skin and clothing of HCW's occurs frequently during this process (10).

Such contamination may place the healthcare personnel at risk of getting an infection, as demonstrated by a recent study in which Ebola virus infection was acquired despite the use of PPE (9). To reduce this risk, the Centers for Disease Control and Prevention have recommended serial glove disinfection at multiple steps during PPE doffing (11). Disinfection of other protective equipment with a disinfectant wipe or spray is recommended if visible contamination is present. However, pathogen contamination often occurs without visible soiling, and the application of effective quantities of liquid disinfectants to equipment such as gowns and face shields may not be feasible (12).

Hypothesis/Idea

Acknowledging the above difficulties, we suggest a

disinfection booth as a part of the engineering tool to disinfect PPE before doffing. The booth will provide Ultraviolet germicidal irradiation (UVGI) light of adequate intensity.

UVGI is electromagnetic radiation causing changes in nucleic acids affecting microbial regeneration. The spectrum varies from 100nm to 400 nm (13). The wavelength of our interest includes UVC (200–280 nm) and UVB (280–320 nm). Microbes are vulnerable to the light of wavelengths at or near 253.7 nm because the maximum absorption wavelength of a DNA molecule is 260 nm (14). The efficacy of far-UVC light inactivation has been proven on airborne viruses carried by aerosols. For surface decontamination of 90% viral reduction, the UV dose required was 1.32 to 3.20 mJ/cm2 for ssRNA, and for 99% viral reduction the dose was 2 times higher than those for 90% viral reduction (15). A very low dose of 2 mJ/cm2 of 222-nm light inactivates more than 95% of airborne H1N1 virus (16), while virus-reduction factors of 3.4 or more for SARS-CoV have been achieved with the UVC-based disinfection of platelet concentrates (17). The maximum permissible 8-hour dose of UV radiation from a monochromatic source of wavelength 254 nm is 6.0 mJ/cm2. (18) This is higher than previously used doses of UV radiation.

This approach was considered during the earlier Ebola epidemic. Jinadatha et al (19) found that this method can be used to reduce viral load in a controlled experimental environment on PPE material. Glass carriers, face shield, and gown material demonstrated a >4.00 log reduction relative to respective time zero controls in their study. The transmitted UV light passing through face shields and gowns were less than the exposure limits. Usage of reflectors facilitated the redirection of light toward the person thereby effectively reducing the exposure required for PPE disinfection by half. However, no such data on the COVID-19 virus is available.

Tomas et al (20) used a disinfection suite delivering UV-C radiation via 4 low-pressure UV-C lamps designed to disinfect the outer surface of PPE before removal. Their method reduced recovery of bacteriophage MS2 and MRSA by 3 logs or more on PPE materials within 1 minute at 6 inches from a UV-C lamp and within 3 minutes at 2 feet from the lamps.

They also studied the safety aspect of this novel technique in terms of HCW exposure to UV-C rays. UV-C photo chromatic detection strips were placed on the inner surface of gloves, gowns, and face shields for 5 minutes. Photochromatic detection strips found no evidence of UV-C penetration of PPE materials during 5 minutes of exposure. So it was suggested by them that such an approach may be used for the disinfection of contaminated protective equipment before removal.

Therefore, we suggest an engineering tool similar to Tomas et al (20) to disinfect the PPE before doffing to reduce the risk of accidental exposure to HCW during the doffing process. A disinfection booth with ultraviolet light of adequate intensity can be utilized for the same purpose with certain modifications. So:

1- any visibly solid or liquid contaminants should be removed physically from the PPE as the UV irradiation required for disinfection is higher for viruses in suspension. (29, 30)

2- and as its efficacy can be affected by multiple factors, it should always be used as an add-on to standard precautions protocol.

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