Low Cost Ultraviolet Light Decontamination Chamber

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Background: The SARS-COV2 pandemic created a global shortage of personal protective equipment (PPE) as demand surged beyond supply in late winter and early spring 2020. An acute need to reprocess PPE, particularly N95 respirators, existed across the nation and globe. We describe our efforts at creating a cost-effective ultraviolet (UV) light chamber to reprocess existing supplies of PPE, including N95 respirators.

Several methods of N95 decontamination have previously been described and evaluated.[1] Among these, vaporized hydrogen peroxide and ultraviolet germicidal irradiation (UVGI) became the predominant mechanisms whereby medical centers were decontaminating PPE because of their relative effectiveness whilst still maintaining fit and function of filtering facemask respirators.

Successful implementation of a PPE reprocessing program involves not only technical establishment of effective decontamination, but also a robust logistics operation to transport used/dirty PPE to and from the reprocessing center from the end users who may be in various units within a large medical center. They may also be in smaller affiliate hospitals or clinics within a healthcare system spread across a wide geographic area.

Methods/Results: Our approach was to create relatively inexpensive UVGI chambers that could be forward deployed to units within our medical center or at a number of our affiliate hospitals and clinics. We sourced our materials from readily available suppliers and endeavored for simple assembly of the chambers, with the intention of creating an open source design and approach.

Performance criteria of the chamber were based upon published and evolving data. UV-C (254nm wavelength) irradiation at $\geq 1 J/cm^2$ has been shown to result in $\geq$3 log reduction of viruses (H1N1, SARS-CoV1, and MERS-CoV) on the surface of N95 respirators without significant reduction in filtration performance of the respirator.[2-4]

We were able to accomplish this level of irradiation in a plastic storage container with 4 UV-C lightbulbs, aluminum foil reflectors, a removable rack (that would be preloaded with N95s for decontamination), basic wiring components, and a timer. We also implemented a safety switch that depowered the bulbs if the cabinet was opened during operation in order to protect users from accidental exposure. Total cost of materials for each cabinet was just under $500.

Conclusion: Energy levels were checked and validated using a handheld UV meter ($640). Multiple locations within the chamber, and within potentially “shadowed” areas of masks were mapped and assessed with the UV meter, ranging between 2000-3000μw. Assuming the lower end of power (2000μw), our chamber could deliver $\geq$ 1J/cm^2 to all surfaces in just over 8.3 minutes. We thus demonstrate feasibility of a low-cost decontamination chamber for PPE.

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1. Viscusi DJ, Bergman MS, Eimer BC, and Shaffer RE. *Ann Occup Hyg*. 53(8); 2009: 815-827.
2. Mills, D., Harnish, D. A., Lawrence, C., Sandoval-Powers, M., & Heimbuch, B. K. (2018). Ultraviolet germicidal irradiation of influenza-contaminated N95 filtering facepiece respirators. *American Journal of Infection Control*, *46*(7), e49–e55.
3. Heimbuch, B., & Harnish, D. (2019). *Research to Mitigate a Shortage of Respiratory Protection Devices During Public Health Emergencies (Report to the FDA No. HHSF223201400158C)*. https://www.ara.com/sites/default/files/MitigateShortageofRespiratoryProtectionDevices_2.pdf
4. https://www.n95decon.org