Evaluating Filtration Performance of Face Masks Following Repeated Cycles of Decontamination Treatments

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Abstract

The emergence of the Covid-19 pandemic compromised the health of millions. Knowledge that SARS-CoV-2, the responsible virus, was primarily spread through droplets called for further aerosol research and caused many to turn to protective face masks as a means of filtering out potentially virulent air droplets. In an effort to act sustainably and preserve inventory in the case of a shortage, many investigated possible methods of decontaminating masks for reuse including detergents, water, light, and heat. The aim of this study is to evaluate the filtration performance of widely used face masks (cloth, surgical, and KN95) that have undergone 10, 30, and 100 cycles of selected decontamination methods: incubated at 58° (dry heat), placed in an incubator at 58° with constant water vapor from a humidifier (wet heat), placed in a rice cooker at 58° (rice cooker), and strung on a clothesline outside to receive solar irradiation (sunlight). Filtration performance was evaluated by placing a PM2.5 particle counter inside a sealed chamber. The chamber was fitted with tubing connected to a port inserted in each tested mask. Masks were then worn by a human inhaling continuous water vapor from an atomizer. The following results illustrate that masks that have been decontaminated in an effort to remove virions, may be compromised in terms of filtration effectiveness depending on mask type, treatment method, and number of decontamination cycles used.

Methods

Mask Treatment

- Masks were treated using dry heat, wet heat, rice cooker, and sunlight methods
  - Three mask types were treated: cloth masks, surgical masks, and KN95 masks
  - Masks underwent continuous treatment until 10, 30, or 100 cycles had elapsed
  - After treatment, samples were stored in airtight containers in a room temperature area out of direct sunlight

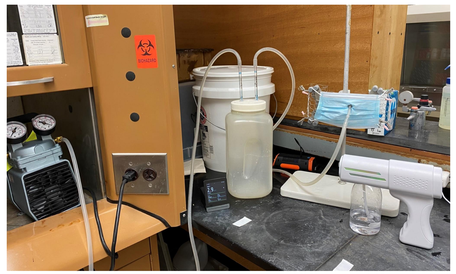
Methods	Type	# of Cycles
Dry Heat	A: Cloth Mask	10
Wet Heat	B: Surgical Mask	30
Rice Cooker	C: KN95 Mask	100
Sunlight		

Figure 1-4. Dry heat, wet heat, rice cooker and sunlight treatments

Methods

Filtration Performance

- Filtration performance was measured by a particulate matter (PM2.5) particle counter inside a sealed chamber
  - A hypertonic solution of sodium chloride in deionized water was placed in an atomizer to create the challenge vapor
  - Masks were worn by a human for experimental trials and placed on a wire frame for control trials
  - The aerosol stream passed through a port inserted in each mask, through a sealed chamber containing the particle counter, and out of a vacuum placed inside a fume hood using silicone tubing
  - PM2.5 was continually measured over the course of two minutes and recorded at every five-second time point



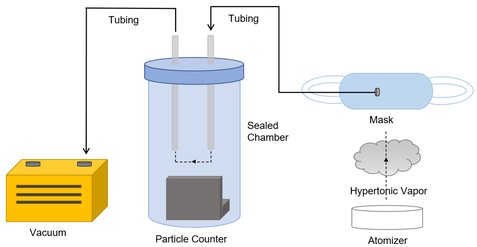


Figure 5,6. Photo and diagram of filtration assay setup

Results

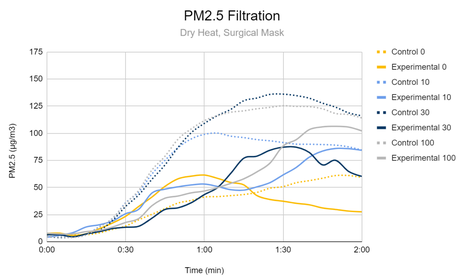


Figure 7. PM2.5 filtration for dry heat-treated surgical masks

Results

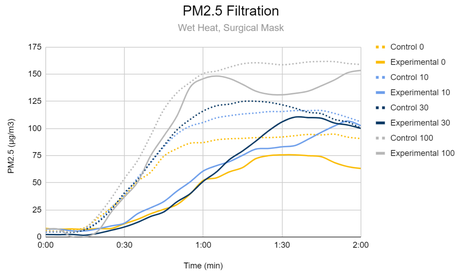


Figure 8. PM2.5 filtration for wet heat-treated surgical masks

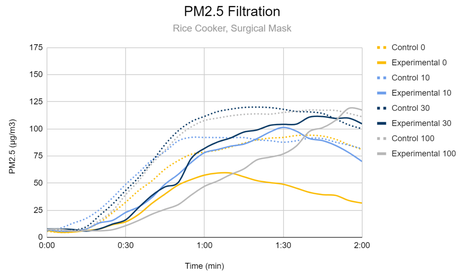


Figure 9. PM2.5 filtration for rice cooker-treated surgical masks

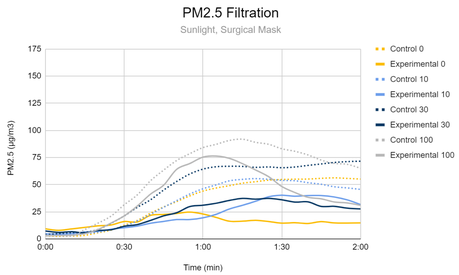


Figure 10. PM2.5 filtration for sunlight-treated surgical masks

Conclusions

- Observed mask filtration performance decreased with more decontamination treatments
- More drastic differences were observed in dry heat and wet heat methods compared to sunlight and rice cooker

Acknowledgments

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