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Consider the Options; Can Decontamination and Reuse be the Answer to N95 Respirator Shortage in COVID-19 Pandemic?

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Health care workers (HCWs) are heavily involved in the fight against COVID-19 in all over the world. They have the vital role of treating patients and searching for the proper treatment for the disease, while supporting and protecting their families. It is imperative that the systems should try hard to keep them safe and healthy. World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) have recently published guidelines for keeping HCWs safe and protected [1, 2]. The Personal Protective Equipment (PPE) is the cornerstone of recommendations and contains face mask (air purifying respirator), goggles or face shield, gown, and gloves [1]. There is no doubt that a proper mask (e.g. N95) is the most important element of the protective gear when it comes to transmission of COVID-19.

Rapid progress of COVID-19 has resulted in shortage of respiratory protective masks. Consequently, many countries have begun to increase PPE production at full capacity and/or import them from other countries. The shortage of PPE equipment, particularly the protective respiratory masks continues to put the lives of many HCWs at risk. Some have suggested using and reusing the respiratory masks during clinical shifts. While this could be the only solution until the supplies are replenished, the safety of this practice is unclear. Several studies have evaluated the safety of methods used to decontaminate and reuse such masks. To our knowledge, all of these studies have been conducted in laboratory settings and not in actual clinical settings. Most of these studies are also fraught with methodological limitations. Of note, some of these studies contaminated the respiratory masks with non COVID-19 microorganisms like H1N1, H5N1, bacillus subtilis, staphylococcus aureus or escherichia coli and therefore, their conclusions might not apply to COVID-19 [3]. To be effective, a decontamination method needs to eliminate the viral load while maintaining the mask's structural and functional integrity such as filtering function and airflow resistance [4]. There are eight decontamination methods noted in the literature including bleach, ethylene oxide (EtO), microwave/oven irradiation, ultraviolet germicidal irradiation (UVGI), hydrogen peroxide (vaporized or liquid forms), autoclaves, steaming, and 70% alcohol [3, 4]. Heimbuch et al. and Lore et al. reported encouraging data regarding the ability of microwave generated steam, warm moist heat, and UVGI to decontaminate H1N1 and H5N1, respectively [5, 6]. Furthermore, Lin et al. investigated the ability of ethanol, bleach, UVGI, autoclaves and a traditional electric rice cooker to decontaminate bacillus subtilis spores on respirators. These studies revealed that bleach, autoclaves and rice cookers had better biocidal efficacy than ethanol and UVGI [7]. In a non-peer-reviewed article, Price et al. reported results in support of hot air in oven, UVGI and hot water vapor from boiling water. The authors claimed that these methods not only are very efficient in disinfecting Escherichia coli but also they preserve the filtering function of the respirator [4]. Ethanol and chlorine-based disinfectants have also been used to decontaminate respiratory masks whereas the filtering function of respirators were remarkably reduced [4]. Heimbuch et al. reported contradictory results regarding decontaminatory effect of chlorine-based disinfectant on respirators that were contaminated by staphylococcus aureus [8]. In another study, Lin et al. showed that bleach significantly decreased filtering function of N95 respirators due to destruction of the gauze mask [9]. There is not adequate evidence to support decontamination efficiency of EtO and hydrogen peroxide. Viscusi et al. tested the effect of five decontamination methods including EtO and Hydrogen peroxide on respirators' filtration performance and airflow resistance but not the viral load [10].

Overall, it appears that some of the disinfecting methods could be effective in decontaminating respiratory masks. However, it is unclear how these methods impact the respirator's filtration performance. It is also not clear how many cycles a

respirator can be decontaminated with minimal effect on its filtering performance. In summary, whether decontamination of respiratory masks is safe and effective, still remains to be determined. Studies proposing methods of decontamination must:

- Ensure maximal decontamination (reducing the viral load)
- Preserve the integrity of the mask
- Preserve filtering function
- Preserve proper seal

We hope that high quality trials specifically designed to address decontamination of respirator masks with COVID-19 in real clinical settings shed light on these issues very soon.

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