FACEMASKS' PROTECTION EFFICIENCY IN ATTENUATED E. COLI BACTERIA FILTRATION

Xiuhua April Si (1), Daniel Szeto (1), Jonathan Samonte (1) , Dylan Carmona (1) , Derek Mejia (1), Jinxiang Xi (2)

1. *Aerospace, Industrial, & Mechanical Engineering, California Baptist University, Riverside, CA, U.S.A.*
2. *Department of Biomedical Engineering, University of Massachusetts at Lowell, Lowell, MA, U.S.A*

Abstract

SAS-Covid-2 is a type of virus about 0.1 micrometer in diameter. The very small size makes it float in the air, and it can be easily breathed in with inspiratory air. In order to curb viral transmission, face covering has been recommended or mandated in indoor or outdoor settings during the past two and half years. Researchers studied the protection effectiveness of different facemasks through filtration testing, fluid flow visualizations, or computations simulations. Very few studies have evaluated the protection effectiveness through direct bacterial or viral reduction rate, which is one of the most straightforward indices for the protection that procedure can offer. The objective of this study was to evaluate the protection efficiency of varying facemasks via bacteria reduction. We designed a closed circulation filtration system where a certain amount of attenuated E. Coli was released into it and the facemask acted as the filter under different flow speeds. A petri dish was used to catch the filtered air to count the number of bacteria that passed through. Uunder the same flow rate and same amount of E. Coli release, the number of bacteria passing through different face coverings were compared between one-layer cloth, two-layer cloth, surgical, KF94, KN95, and N95, under the assumption of no leakage. The results showed that one or two layer cloth masks are not effective in filtrating out E.Coli bacteria. It indicates that they will not offer good protection in bacteria/virus intensive environment. The rest offers good protection from E.Coli under the situation of no leakage.

Figures

A close-circulation system was designed and built to check the filtration efficiency of different types of face covering from E. Coli (Fig. 1). An inhalation flow rate of 15 L/min was used to simulate the normal inhalation. During the test, the facemask was fixed between the buffer zone and flow conduit 2. Laminar flow regime was expected due to the low flow rate. the E-Coli containing solutions were sprayed into the system. The airflow transported the droplets toward the facemask, among which some would be filtered out by the facemask, while still others would escape the mask filtration and reached the petri dish. The petri dish was left 24 hours inside an incubator at a constant temperature of 25°C for 24 hours. Compare the number of E. Coli after 24 hours incubation are shown in Fig. 2 for one-layer bandana, two-layer cloth mask, surgical mask, and KN94 La Hautuer mask.

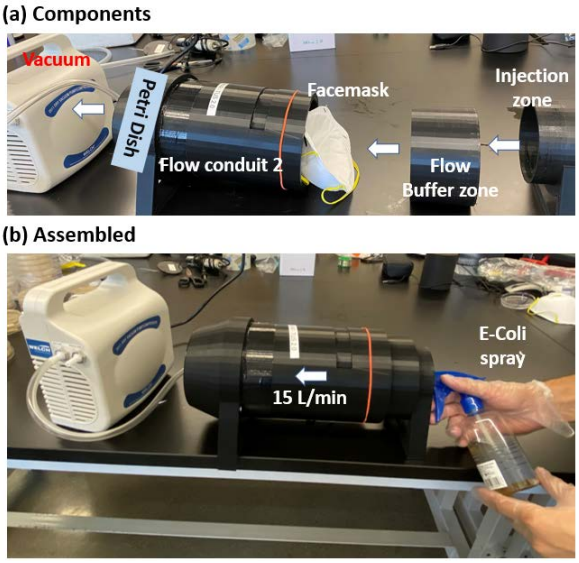

Figure 1: Experimental setup: (a) components, and (b) assembly.

Bandana's filtration efficiency is very low, it alone cannot provide enough protection to people from E. Coli. General surgical masks can provide pretty good protection in low bacteria concentration area. Average KN95, KF94 and m95i filtered very efficiently.

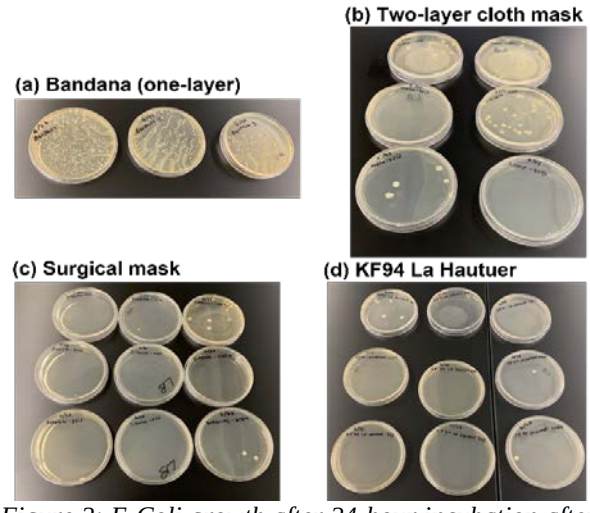

Figure 2: E-Coli growth after 24-hour incubation after the filtration of different masks.

References

1. X April Si, M Talaat, J Xi, "Effects of mask-wearing on the inhalability and deposition of airborne SARS-CoV-2 aerosols in human upper airway", Physics of Fluids 32(12), 123321, 2020.