

Team 16 Final Abstract

Since the start of the global SARS-CoV-2 (COVID-19) pandemic, 477,789 healthcare professionals have contracted the virus with 1,565 of these individuals having died as a result, as of April 30, 2021. A major contributor to this rate of contraction is the still present shortage of N95 masks, resulting in nearly 50% of healthcare professionals reporting reuse for up to two months, during which they are operating in highly contagious situations. These N95 masks are not designed for reuse beyond 4 to 5 uses due to the specific manufacturing methods that ensure filtration efficiency. This reuse also requires sterilization methods like bleach that damage mask integrity, contributing to the high rates of infection. An improvement of the N95 mask that allows for greater reusability with maintained filtration and structural durability is necessary to reduce the health risk to healthcare professionals, minimize environmental waste, and lower manufacturing costs. In response to this, we have designed a fluid simulation model in SolidWorks that allows for the material selection of a particular mask design to be tested for filtration efficiency via varying particle sizes, concentrations, and flow velocities. A three-layered N95 mask model with an inner and outer layer composed of either nonwoven polypropylene, polyester or cotton and a melt-blown polypropylene middle layer was modeled using particle studies to simulate breathing, coughing, and sneezing situations. From this it was found all three materials passed the 95% filtration efficiency, but cotton was the most consistent and best fit the previous literature data, making it our material of choice. The outer layer of this mask was made hydrophobic in order to filter liquid aerosols and for improved comfortability and an enhanced fit, a silicon seal was added at the nose bridge, allowing for better sanitization, and structural durability. Physical prototypes of the N95 mask model were then fabricated and tested for filtration efficiency to determine durability after repeated moist heat sterilization in a microwave. This method was chosen based on literature studies that found moist heat was comparable to other approved sterilization methods such as autoclaving, and due to the easily available device for at-home cleaning. Our results show that there is no statistically significant difference in filtration efficiency pre- and post-sterilization, making this an effective method for our proposed mask design. The creation of the SolidWorks model will allow for an easy to use system by other researchers to test different mask designs and materials for simulated filtration efficiency. Our prototype testing shows that making a cotton mask that can be cleaned using moist heat sterilization is an effective alternative to current N95 models, which will allow for the safer reuse of our mask by utilizing a more effective and easier at home cleaning method. This proposed mask construct will hopefully minimize both future infection rates and the environmental impact during this pandemic and any future healthcare crises.