

# Researchers create mask filtration effectiveness hierarchy

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This spring, due to limited national supplies of N95 face masks, hospitals across the country asked the public and private companies to donate personal protective equipment (PPE), including many different

types of masks, to be sure healthcare workers were protected while caring for patients.

With so many options, infection prevention experts at the UNC Medical Center set out to gather evidence on the fitted filtration efficiency of dozens of different types of masks and mask modifications, including masks sterilized for reuse, expired masks, novel masks sourced from domestic and overseas sources, and homemade masks.

Their data, published today in *JAMA Internal Medicine*, show that reused, sterilized N95 masks and very out-of-date N95 masks retain their effectiveness at protecting healthcare workers from COVID-19 infection.

To assess mask fitted filtration effectiveness, Emily Sickbert-Bennett, Ph.D., director of Infection Prevention at UNC Medical Center and colleagues turned to someone she knew she could trust: her dad, William Bennett, Ph.D., professor of medicine, who leads the Mucociliary Clearance and Aerosol Research Laboratory at the UNC Center for Environmental Medicine, Asthma, and Lung Biology (CEMALB).

"I told him we had two types of masks—used, sterilized and expired N95 masks—and we needed to know whether they would offer safe and effective protection, in case we needed our healthcare co-workers to use them." Sickbert-Bennett said. "And he said it would be possible for his lab to test them and give us data upon which to base our decision-making."

Thanks to a cooperative agreement with the EPA Human Studies Facility on the UNC-Chapel Hill campus, in which Bennett's labs reside, Bennett, assistant professor Phillip Clapp, Ph.D., and research associate Kirby Zeman, Ph.D., teamed with EPA research scientist, James Samet, Ph.D., to measure the fraction of submicron particles that penetrate into

the breathing space of subjects wearing a mask while performing a series of tasks that simulate conditions such as speech and movement during a work shift. Such tests provided infection prevention leaders quantitative data they used to rank the best respiratory protection options for healthcare personnel during the COVID-19 outbreak.

The researchers found that certain N95 masks—as rated by the National Institute of Occupational Safety and Health (NIOSH) Administration—provide greater than 95 percent effectiveness at keeping the wearer from inhaling very small airborne particles that may carry SARS-CoV-2—the virus that can cause COVID-19. Furthermore, these masks retain such effectiveness many years beyond the masks' expiration dates. In addition, these NIOSH-rated masks can be subjected to sterilization with hydrogen peroxide or ethylene oxide without compromising their efficiency. Finally, their fitted filtration procedures showed that surgical masks with ties were approximately 70 percent effective at filtering their inhaled particles, while surgical masks with ear loops were about 40 percent effective. Clapp, co-first author, emphasized that, "One of the keys to protection is how snug a mask fits. An N95 mask that forms a tight seal offers the optimal infection prevention. However, evidence from previous studies suggests that even the surgical masks with

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