Title: Constant vs. cyclic flow when testing face masks and respirators as source control devices for simulated respiratory aerosols--Dataset

Dataset Number:

Introduction

SARS-CoV-2 spreads by infectious aerosols and droplets expelled from the respiratory tract. Masks and respirators can reduce the transmission of infectious respiratory diseases like SARS-CoV-2 by blocking these aerosols and droplets at the source. The ability of source control devices to block aerosols can be tested by expelling an aerosol through a headform wearing the device. These tests may be performed using constant airflows, which are simpler, or cyclic airflows, which are more realistic but require more complex methods. The purpose of these experiments was to compare the results found using constant vs. cyclic airflows.

A source control measurement system was used to measure the efficacy of two cloth face masks, two medical masks with and without an elastic mask brace, a neck gaiter, and an N95 respirator as source control devices for simulated respiratory aerosols. With this system, the aerosol flows from the inside of the mask toward the outside; that is, the aerosol flows in the same direction as it would flow during an exhalation by a person wearing the source control device. The experiments were conducted under four airflow conditions: cyclic breathing at 15 liters/minute (L/min), cyclic breathing at 85 L/min, constant outward airflow at 15 L/min, and constant outward airflow at 85 L/min. Each experiment began by placing the source control device on the headform and performing a fit test. The measurement system collection chamber was then sealed, and the cyclic or constant airflow and the aerosol generation were initiated. The aerosol concentration in the collection chamber was measured using an optical particle spectrometer (OPS). The source control collection efficiency was determined by comparing the steady-state concentration of aerosol particles in the collection chamber when the source control device was worn with the concentration when no source control device was used.

Data Collection Methods

1. Aerosol Particle Generation
    a. 1% w/v KCl aerosolized via single jet Collison atomizer
2. Airflows
    a. Cyclic breathing at 15 L/min
    b. Cyclic breathing at 85 L/min
    c. Constant outward airflow at 15 L/min
    d. Constant outward airflow at 85 L/min
3. Aerosol Particle Measurement
    a. An optical particle spectrometer (OPS; Model 3330, TSI) at the bottom of the collection chamber measured the aerosol concentration by continuously drawing an aerosol sample out of the collection chamber at 1 L/min.
    b. The OPS reported the aerosol particle number concentration (# particles/cm^3) at 1 Hz in 16 logarithmically spaced size bins from 0.3 to 10 µm.
    c. The control experiments with no source control device indicated that the aerosol concentration reached a steady-state in 8.2 minutes or less.
    d. The steady-state concentration was calculated based on the average concentration during the second 10 minutes of operation minus the background aerosol concentration.

e. The particle concentration data was checked to verify that the chamber aerosol concentration did not exceed 3000 particles/cm3, which is the upper concentration limit for the OPS.

4. Filtration efficiency and airflow resistance
    a. The filtration efficiency and airflow resistance were measured using automated filter testers (Models 8130 and 8130A, TSI).
5. Mask Fit Factors
    a. The fit factor was measured using a PortaCount® Pro+ respirator fit tester (Model 8038, TSI, Shoreview, MN) in Class 100 mode (also called N99 mode), in which the tester measures the concentration of aerosol particles from 0.02 to 1.0 µm at the mouth of the headform (inside the source control device) and in the ambient air (outside the device). The aerosol was generated using a 1% KCl solution in a medical nebulizer (Hospitak Up-Mist, Unomedical) at 34 kPa (5 lbs./in2) air pressure.

Citation

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