

Efficacy of portable HEPA air cleaners for reducing exposure to simulated exhaled aerosols in indoor meeting rooms

Materials and Methods

A schematic of the conference room is shown in Figure 1. The room HVAC system provided 0.1 m³/second of air flow (202 ft³/minute; 2 air changes/hour) with no recirculation of air. Two HEPA air cleaners (Honeywell 50250-S, Kaz Inc., Memphis, TN) were used in our experiments, each rated to provide 0.12 m³/second (250 ft³/minute) of air filtration for a combined total of 5.2 air changes/hour.

The respiratory aerosol source simulator (participant source) has been described in detail elsewhere (1). For these experiments, the source simulator was continuously breathing at 15 liters/minute while the aerosol generator was repeatedly cycled on for 20 seconds and off for 40 seconds to avoid exceeding the range of the aerosol instruments. Two participant breathing simulators (participant recipients) used the same mechanical design as the respiratory aerosol source simulator without the aerosol generation system. The recipients breathed continuously at 15 liters/minute. The speaker breathing simulator (speaker recipient) was a commercial simulator (Warwick Technologies Ltd., Warwick, UK) that breathed at 28 liters/minute. All simulators had elastomeric skin headforms mimicking human skin (source simulator, Hanson Robotics, Plano, TX; recipient simulators, Respirator Testing Head Form 1 – Static, Crawley Creatures Ltd, Buckingham, UK).

The face masks used in our experiments were 3-ply cloth face masks with ear loops (Defender, HanesBrands Inc., Winston Salem, NC). Experiments were conducted either with no masks on any of the simulators or with masks on all the simulators (universal masking).

To determine the exposure of each recipient simulator to aerosol particles, the concentrations of 0.3 to 3 μm aerosol particles were measured at the mouth of each recipient simulator using optical particle counters (OPC, Model 1.108; Grimm Technologies, Inc., Douglasville, GA) as described previously (1). When the simulators were wearing face masks, the particle counters collected aerosol samples from inside the masks (i.e., the particle counter measured the concentration of the aerosol being inhaled by the recipient simulator). For each OPC, the total aerosol mass concentration was averaged over 60 minutes to determine the mean aerosol mass concentration (mean aerosol exposure) at each recipient simulator. Each experiment was repeated four times.

1. Lindsley WG, Beezhold DH, Coyle J, Derk RC, Blachere FM, Boots T, et al. Efficacy of universal masking for source control and personal protection from simulated cough and exhaled aerosols in a room. *MedRxiv*. 2021;(preprint):doi: 10.1101/2021.04.21.21255880.

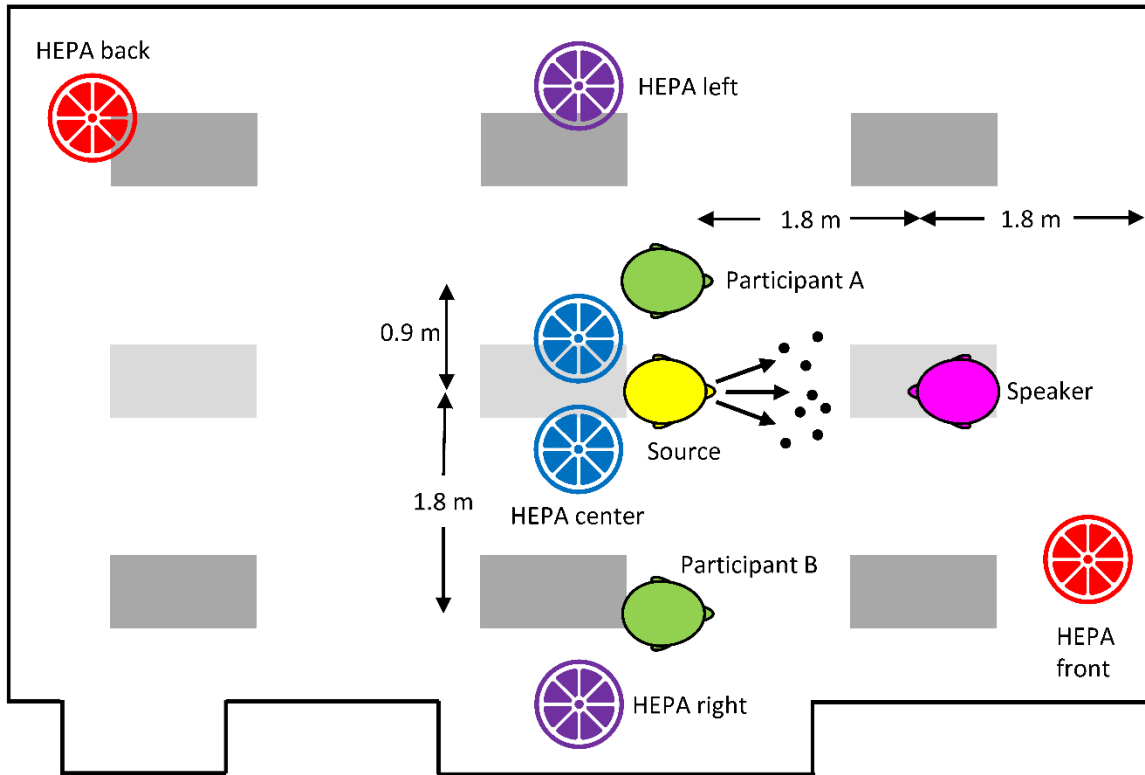


Figure 1: Schematic of conference room. The room is 6.3 m x 9.3 m x 3 m (21' x 31' x 10') high. The mouths of the participant source (yellow) and recipient simulators (green) were 1 m (40") above the floor, simulating people sitting in a meeting or classroom. The mouth of the speaker recipient (magenta) was 1.5 m (60") above the floor, simulating a speaker standing in the front of the room. The air cleaners were placed either side-by-side in the center of the room (blue), on the left and right sides (violet), or in the front and back of the room (red). The air cleaners were placed on the floor for all experiments except for one set of experiments in which the air cleaners were placed on tables on the left and right sides 0.8 m (32") above the floor (elevated). The room ventilation system air inlets (dark grey) and outlets (light grey) were located in the ceiling as part of the light fixtures.