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UV air cleaners and upper-room air ultraviolet germicidal irradiation for controlling airborne bacteria and fungal spores

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Abstract

In-room air cleaners (ACs) and upper-room air ultraviolet germicidal irradiation (UVGI) are engineering control technologies that can help reduce the concentrations of airborne bacteria and fungal spores in the indoor environment. This study investigated six different types of ACs and quantified their ability to remove and/or inactivate airborne bacteria and fungal spores. Four of the air cleaners incorporated UV lamp(s) into their flow path. In addition, the efficacy of combining ACs with upper-room air UVGI was investigated. With the ventilation system providing zero or six air changes per hour, the air cleaners were tested separately or with the upper-room air UVGI system in operation in an 87-m³ test room. Active bacteria cells and fungal spores were aerosolized into the room such that their numbers and physiologic state were comparable both with and without air cleaning and upper-room air UVGI. In addition, the disinfection performance of a UV-C lamp internal to one of the ACs was evaluated by estimating the percentage of airborne bacteria cells and fungal spores captured on the air filter medium surface that were inactivated with UV exposure. Average airborne microbial clean air delivery rates (CADRm) varied between 26-981 m³ hr⁻¹ depending on the AC, and between 1480-2370 m³ hr⁻¹, when using air cleaners in combination with upper-room air UVGI. Culturing, direct microscopy, and optical particle counting revealed similar CADRm. The ACs performed similarly when challenged with three different microorganisms. Testing two of the ACs showed that no additional air cleaning was provided with the operation of an internal UV-C lamp; the internal UV-C lamps, however, inactivated 75% of fungal spores and 97% of bacteria cells captured in the air filter medium within 60 min.

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