SYNOPSIS

KEY POINT SUMMARY

OBJECTIVES

To study the effect of particle control technology on fine and ultrafine particle loads within operating rooms and on the survival of *Bacillus subtilis*, a biologic warfare surrogate.

Particle control reduces fine and ultrafine particles greater than HEPA filtration in live operating rooms and kills biologic warfare surrogate

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Key Concepts/Context

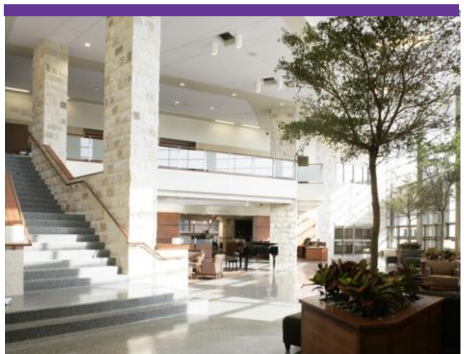
Modern buildings tend to feature more insulation and tighter building envelopes, which can increase concentrations of indoor pathogens, particles, and pollutants. This can lead to higher rates of hospital-acquired infections (HAIs), making the control of indoor air quality critically important. This study compares the efficacy of a high-efficiency particulate air (HEPA) filtration system with new particle control technology. Results indicate that the new particle control technology is significantly more effective at reducing air contamination and HAIs.

Methods

Two clinical settings and one laboratory setting were involved in this study.

The first clinical setting was a medium-sized 40-bed hospital. A baseline measurement of airborne particles was gathered from one OR over five consecutive weekdays during a variety of routine surgical procedures. The baseline filtration system featured a prefilter, minimum efficiency reporting value (MERV) 14, HEPA filtration, and 16 air exchanges per hour. There was a subsequent five weekday intervention period, during which a portable particle control device was added (Active Particle Control Technology, SecureAire LLC, Dunedin, FL). This device was placed inside the 4,200 ft^3 operating room with a particle monitor that remained in the same place for both the baseline and intervention phases. All ventilation system settings remained the same during both phases.

The second clinical setting was a 300-bed tertiary care teaching hospital. ORs that were immediately adjacent and supplied by the same air-handling system were involved in the study. The control OR was supplied via a prefilter, MERV 14, HEPA filtration, and 16 air changes per hour, while the adjacent room was served by a



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prefilter and a particle control device (MERV 15 system) with 16 air changes per hour.

The researchers used an identical laser-based particle monitor at both clinical sites, which measured particles that are >0.4 μ as well as those that are >2.5 μ. Mean particle counts were calculated throughout the baseline and treatment phases.

The laboratory setting was used to study the survival of *B subtilis* with the particle control system. The filter surfaces of the particle control system were loaded with *B subtilis* cells at a density of roughly 10^7 cells/cm^2 and statistical analysis was applied to compare mean particle counts before and after the use of the particle control system.

Findings

In the first clinical setting, the mean baseline particle counts during the first week (i.e., the control study using only the HEPA filter) were 167,408/ft^3 (peak of 629,100/ft^3). During the treatment phase, which featured the HEPA filter plus the particle control system, the mean particle counts were diminished to 9,313/ft^3 (peak count of 22,600/ft^3), indicating that use of the particle control system resulted in a 94.4% reduction in fine and ultrafine particles ($P < .0001$).

In the second clinical setting, the mean baseline particle counts during the control phase which used only the HEPA filter in the OR were 93,351/ft^3, while the OR featuring the HEPA filter plus the particle control system had mean particle counts of 3,820/ft^3, indicating that use of the particle control system resulted in a 96% reduction in fine and ultrafine particles.

During the pathogen killing portion of the study within the laboratory setting, at least 95% of viable *B subtilis* cells were killed. This was judged by the recovery of the cells on standard culturing media after they were exposed to the electrical field of the particle control unit for three hours.

Overall, across this study's two different real-world settings the application of the particle control technology resulted in a reduction of airborne fine and ultrafine particles by approximately 95%. In addition, during the laboratory part of the study use of the particle control electrical field resulted in the killing of 95% of *B subtilis* vegetative cells within three hours.

Limitations

The authors note that the differences in operating room volumes may have altered particle loads between the baseline and treatment phases throughout the studies. The length, quantity, and type of surgical procedures performed in the ORs during the studies were similar between the control and intervention phases; however, they were not identical, which may have resulted in some differences in particle loads.

Design Implications

The results of this study suggest that the use of particle control technology leads to significantly improved indoor air quality and safety, which could greatly benefit various healthcare settings such as ORs, intensive care units, and more. In some cases, this technology may be an effective way to reduce HAIs while foregoing other major architectural renovations.